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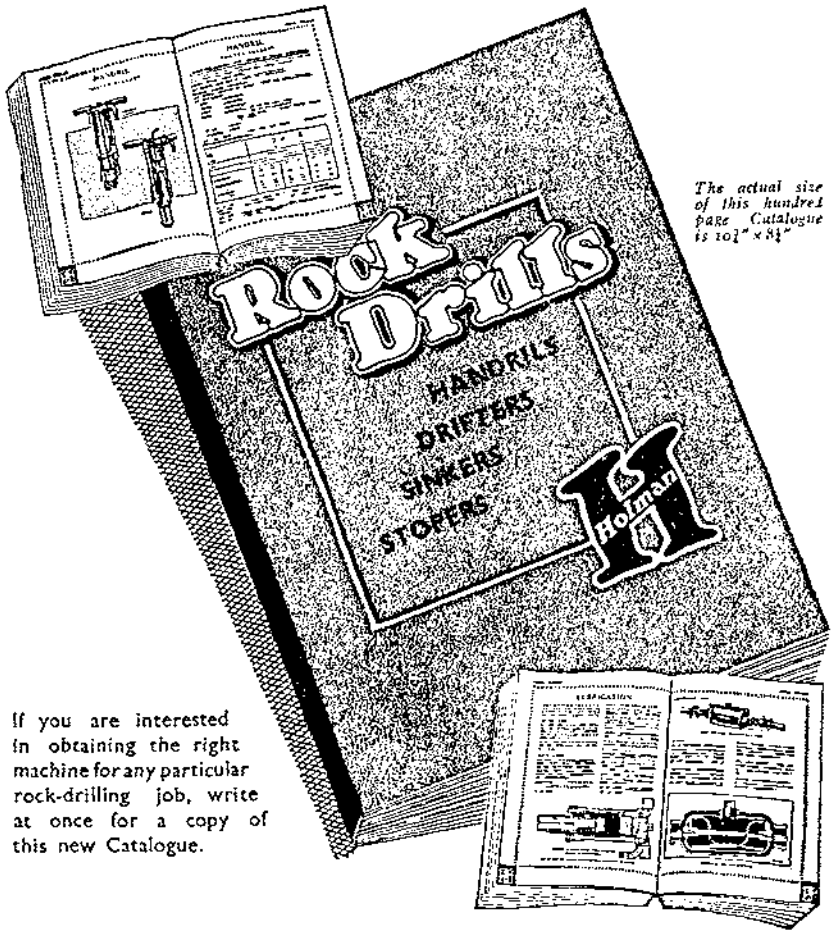

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All Reviews on Books on military subjects are included in the provisions of K.R. 535(c) (*1935*).

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THE INSTITUTION OF ROYAL ENGINEERS.

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THE CHIEF ROYAL ENGINEER.

On 23rd April, 1940, it was announced by the War Office that H.M. The King had approved of the appointment of Lieut.-General Sir Ronald Charles, K.C.B., C.M.G., D.S.O., Colonel Commandant Royal Engineers, as Chief Royal Engineer, in succession to General Sir Bindon Blood, G.C.B., G.C.V.O., who had resigned the appointment.

The Late General Sir Bindon Blood, G.C.B., G.C.V.O.

At the great age of 97 and within a month of the acceptance by H.M. The King of his resignation of the appointment of Chief Royal Engineer, Sir Bindon Blood passed away on May 16th.

It is with the deepest sorrow that the Corps of Royal Engineers learns of the death of their aged Chief, who for his distinguished career is honoured and venerated not only by the Corps, but also by the Country that he served so long and so brilliantly.

He was appointed a Colonel-Commandant R.E. in July, 1914, and in 1917 became Representative Colonel Commandant. In that capacity, for the next sixteen years, he maintained an exceedingly active interest in the welfare of the Corps and was constantly present at numerous Corps functions and occasions, travelling all over the country for the purpose.

In October, 1936, he was appointed by H.M. King George V to the re-created post of "Chief Royal Engineer." He had, three years previously, ceased to be Representative Colonel Commandant but continued to maintain an active interest in all that affected the welfare of the Corps, and to the end he retained the appointment of Colonel of King George V's Own Bengal Sappers and Miners.

The Corps renders homage to the memory of a national personality and a great gentleman, who was regarded by all with pride for his achievements and with affection for his genial and lovable nature.

In a letter to the Chief Royal Engineer, Lady Blood writes:— "Tell the Corps that his first thoughts always were of what he could do for his beloved Royal Engineers—he called them always 'his children'."

MUHANDISIN.

THE STORY OF THE ENGINEER TROOPS, SUDAN DEFENCE CORPS.

By CAPTAIN (LOCAL MAJOR) A. J. KNOTT, R.E.

THE story of the Engineer Troops, Sudan Defence Force, up to the end of 1932, has been told in a previous article in *The R.E. Journal.* The last seven years have seen changes in personnel and organization, the recording of which will complete the picture up to the outbreak of this present war.

For two years from the beginning of 1933 there were no great alterations. Officers came and went, the command changed hands, but training continued as usual. The whole Sudan was then passing through a bad time financially, and money for any extensive works or engineer operations was hard to obtain. In spite of this, a series of small undertakings was carried out with success. The improvement of river navigation, commenced in 1928, was carried a stage further, some rocks near Atbara being successfully demolished. The benefit on this occasion was felt mainly by the "date fleet," which sails annually for Egypt. Casualties to this fleet in the past had been heavy, from the many snags and rocks which abound in certain stretches of the Nile, and which even the expert watermanship of the riverain tribes could not always avoid, when their unwieldy craft were carried along on flood river. Boats are still lost each year, but the reduction in the toll of wrecks which has been effected by the removal of even the small number of rocks which it has so far been possible to tackle has been considerable, and much appreciated by the owners and sailors of the boats.

Following on the completion of the building programme at Torit, the Headquarters of the Equatorial Corps, the question of water supply there arose. The existing system was primitive in the extreme, consisting merely of lorries to carry the water from a stream some twelve miles away and distribute it to the consumers in Torit. This was not only unsatisfactory, but extravagant to maintain, and when once it was decided that Torit should remain a permanent military station, with no likelihood of a reduction in numbers, something better was required. The medical report on the river water, too, was far from satisfactory, though not completely damning.

Examination of such geological data as was available indicated that water should be obtainable in Torit itself. Experiments had

been made earlier, and the remains of two wells, each still open to a depth of some 20-30 feet, were examined by the Government Geologist. He reported favourably on the prospects of obtaining water, at least before the 100 foot mark was reached.

After considerable argument as to the merits and demerits of the old wells, possible sites for new wells, the probability of finding water at all, the best season of the year at which to make the attempt, and the relative importance of this work as compared with the cutting of the long grass, it was decided that two new experimental wells should be dug by the Engineer Troops. They were to be assisted by such Equatorial labour as could be spared from the grass-cutting, and work was to commence in December, 1933. The wells were to be 8 feet in diameter, though if the experiments were successful, any further wells would be 16 feet. Bricks for steining until the solid rock was reached were to be burnt locally.

Work on the two experimental wells continued into June, 1934, when the arrival of the rains made further work impossible, as surface water could no longer be kept out of the wells, even by pumping. In order to gain greater depth in the limited time available, one well was abandoned at 38 feet, and work concentrated on the other. When work ceased for that season this well stood at 85 feet—still 15 feet short of the geologist's limit. Although this level was some seven feet below that of the river, from which the water was originally drawn, no positive indication of water had been noticed. Those who had been sceptical of the whole project, including some amateur diviners, British and Native, reared their heads once more, and declared that water would never be found on the sites chosen. But the geologist was not to be intimidated by mere superstitions or expressions of lay opinion, and insisted that a little further excavation would reveal the water.

Another detachment left Omdurman to continue the good work in October, 1934. On their arrival they met with a serious setback, for the well on which it was proposed to work contained some 25,000 gallons of water! Much of this was accumulated rain water, but there was also a spring, about eight feet down, which was delivering into the well some 90 gallons an hour. Various attempts were made to clear the well for work, by pumping out the water and stopping up openings in the walls, but it was a month before work could begin in earnest. Even then, other springs started at intervals and in April some 40 buckets of water had to be emptied daily from the well before the party could get to work. By the end of June, when the rains again stopped work, the depth was 124 feet, well beyond the geologist's limit, but no permanent water had been encountered.

This was the end of the attempt to produce water from wells in Torit. It had provided valuable and sometimes arduous training

for small detachments of Sappers, in a branch of Engineer work which they seldom get, particularly in Africa. For the greater part of the time, blasting through hard rock was the order of the day, and the daily rate of progress was often as little as a few inches. This in itself was disheartening, and served to increase the disappointment which they all felt, that no useful results were achieved by the months of hard work.

At the same time that these experiments were being discussed and carried out, alternative plans were being made. A roof catchment scheme was tried, but resulted in so much sickness in proportion to the quantity of potable water produced that it was neither popular nor effective. A proposal for a piped supply, with purification plant, using the original stream as source, was also prepared. This scheme, modified and elaborated according to later ideas and individual opinions, and increased owing to rises in prices, has now grown from an original estimate of £2,000 to more than double that sum. But for this war, there seemed a good chance of money being available for the project in 1940, although the experts, both acknowledged and self-styled, were still arguing as to the best type of machinery to instal. But sterner considerations have intervened and driven mere amenities into the background. Once more the Torit Piped Water Supply Scheme has been cut out of the Budget, and the inhabitants rely, as they have done for ten years, on the good offices of a Thorneycroft lorry.

During those same two years various other small jobs were carried out, providing such training as could be combined with useful work at the minimum of expense. The Forestry Section were of the greatest assistance over this period in finding jobs. Tree-felling and general forestry work, laying of Decauville track, erecting shelters for saw-mill machinery, all came the way of Engineer detachments, in connection with the installation of mills along the Blue Nile to cut sleepers from the heavy, fibrous sunt wood (*Acacia Arabica*). The fact that this use of local wood for railway sleepers was a new departure, and that the Sudan was ahead of all tropical African countries in persuading its Railway Administration to adopt these sleepers instead of importing steel, added interest to the work. When the scheme was a little further advanced, a house was required at one of these mills for a British official. The house was only to last for three years, by which time that part of the forest would be worked out and the official would move on. Locally burnt bricks were to be used, and the design included steel window-frames and other fittings which could be dismantled and used again. The final cost, using soldier labour from the Engineer Troops, was approximately one-quarter that of the original estimate submitted for normal construction. The house was not a thing of great beauty, but it served its purpose and lasted as long as it was wanted.

Meanwhile, the march of time had begun to have effect on the S.D.F. Mechanization was creeping in and beginning to oust the picturesque camels and mounted units which had hitherto characterized the units of this attractive "scallywag" army. The preliminary stages, though complicated, were not long drawn out. In the winter of 1934–35, an experimental motor company was formed in El Obeid, found satisfactory in principle, and adopted as a model for further similar units. It was not clear at first how the general mechanization of the Force was going to affect the Engineer Troops. Visions of self-contained M.T. for its Sapper Company appeared, and the possibility of getting some power tools was considered. Money, it was realized, would not be plentiful, but mechanization was in the air, and many hours were spent thinking out how best to apply it to improving the efficiency of the Sudan's only Engineer unit. Alas, these hours might have been saved, for the immediate effect on the Sappers, when it came, was a sad blow.

So far from there being any money available for mechanizing the Engineers as such, a vast sum had somehow to be economized to provide funds for the formation of the three Motor Companies which were decided upon as the first instalment of the modernized S.D.F. The search for possible economies led straight to Omdurman, to the Engineer Troops. Taking into consideration the country, the type of operation which might occur, and the character of the native troops, could the present strength of the Sapper Company be fully justified? In the mind of any R.E. officer there was, of course, no doubt that any reduction in trained Sapper strength would be a retrograde step, if not a catastrophe. But putting a sound case on paper to a Headquarters, which just had to have money for its own schemes and was far from sympathetic, was a very different matter!

The Sapper Commandant could and did point to the fact that in almost every patrol and operation in the Sudan the Sappers had played their part, but at that time, in the midst of changing conditions and problems, rather vague historical facts of that nature carried but little weight in determining future policy. A map was prepared, showing all the places in the Sudan where Sappers had been employed, in recent years, on operations or military works, but, though no other unit could point to such wide-spread activities, it failed to impress. At one stage in the argument, Headquarters were rash enough to say that the Engineers did not appear to "earn their pay." It was easy to point out that, in fact, the Engineer Troops was one of the only two units in the country which produced any return on its pay at all! By undertaking engineering work, both in shops and in the field, which would have cost the Government considerably more if undertaken by other agencies, the Sappers saved an appreciable sum each year, to say nothing of the work

carried out on repayment for individuals. Nice though the retort was, it achieved little in regard to the major issue.

In a country such as this, where the rivers are too wide and fast to bridge when in flood and can mostly be forded in the dry season; where trenches and defensive works are practically unknown; where water supply consists for the most part in dipping and carrying from the river or from wells; where native troops in the field require no temporary accommodation; and where the soldier is by nature a very handy man in a rough and ready way, it is not easy to make out a convincing case for the retention of a moderately large Engineer unit, when money is urgently wanted for other purposes. It had to be admitted that, of all the usual branches of field engineering, leaving out constructional work, which was properly the province of the Public Works Department, the only thing which the Sappers could do which was beyond the capabilities of other units was demolitions.

At the same time it was pointed out again and again that the unexpected was the job for which the Sapper was really useful. Memories of past experience convinced many of the "opposition" of the truth of this and, as luck would have it, an example arose at the very time. A unit had been sent out in connection with possible trouble on the Abyssinian border, and the first thing they asked for was a Sapper platoon to accompany them. It was not very clear what they were wanted for, but the Commander on the spot, a man of some experience in the country, knew they would be useful and would materially contribute to the comfort and efficiency of his unit. This timely appeal was made full use of in the battle against the destruction of the Sapper Company.

The fight was a long one, waged partly on paper, partly verbally, and partly indirectly, by trying to enlist the sympathies of influential members of the Government and to convince them that such a reduction in the technical strength of the Force as was proposed must react on the country as a whole, as it would mean the removal of a valuable means of getting jobs done cheaply and quickly, without employing the cumbrous machinery of departmental routine.

The original proposal was never formulated in writing, but amounted to the abolition of three-quarters of the Sapper Company, leaving one weak platoon as the only effective Engineer unit in the Force. The necessity of raising three Motor Companies having been agreed to by the authorities, there was no longer any question of abandoning the scheme, and a compromise was inevitable. The result was a unit which must be almost, if not quite, unique in the history of the Corps. The basis of the new Motor Companies, arrived at as a result of the experiment at El Obeid, was an organization of one Machine-Gun Platoon with eight cars, and three Rifle

Platoons, each of three trucks, each carrying a section of nine men. There were already in the S.D.F. three Motor Machine-Gun Batteries, and these were to provide the Gunners and Machine-Gun cars for the new Companies. The Company to be formed in Omdurman, it was finally decided, was to obtain the men for its Rifle Platoons from the Sapper Company, and these men were to retain something of their Engineer status. The new Company was to remain part of the Engineer Troops and was to include, in addition to the fighting portion organized in the same way as the other two new Companies, a purely Sapper Platoon for technical work. The unit was to be commanded, in the first instance, by an infantry officer, with a Sapper as his second-in-command. The native officers were engineer-trained, from the Sapper Company, and the establishment also included a British N.C.O. fitter from the R.A.S.C. Seldom can more different arms have been represented in one small unit.

The likelihood of more trouble on the Abyssinian frontier interfered with the peaceful and orderly formation of this new unit, but it was finally fully equipped and organized by October, 1935. Its role was to function militarily in the same way as the other two companies, which were formed about the same time in other areas. The personnel of the Rifle Platoons, being trained Sappers, were to be used on technical work as opportunity offered. In order to maintain the standard of technical training, it was intended to turn over these men in rotation with those remaining in the Sapper Platoon.

As soon as it was ready to move, this Company was sent out on reconnaissances of the area most likely to be affected by the Abyssinian trouble. Returning to Omdurman after three weeks' absence, they were only left in peace for a fortnight before they were off again for another month. Although the company was composed of men fully trained in ordinary military duties, and included the men of the old M.M.G. Battery, who were accustomed to riding in vehicles, there was much to be learnt. March discipline, security at night, intercommunication, maintenance of vehicles, all had to be taught afresh in the new unit, which moved so much faster than the native usually does on his feet or his donkey. Tactics, of course, were entirely different, signalling took on a new importance, and self-reliance and the ability and intelligence to act on their own became an essential to all N.C.O's and car commanders.

It is a tribute to the energy and enthusiasm, no less than to the ability, of the infantry officer who was that company's first commander that he shook his unit down into its new and strange organization so quickly, and produced the high standard of training which was evident by the end of that first winter. Like many of his kind, he at first regarded Sappers of all ranks with something of suspicion, almost of distrust, and as an intruder into the sacred

precincts of an Engineer unit, whose whole nature was being changed by reason of his presence, his position was not an easy one. But he was so keen and able, considering always the efficiency of his unit, no matter how many arms it contained, that the many initial difficulties were overcome and potential causes of friction removed without once having more than a minor difference of opinion with the narrow-minded Sappers over him. If he derived some small satisfaction out of being the first (if not the only) infantry officer to command an Engineer unit under a Sapper Commandant, the Engineer Troops got great benefit from his enthusiasm, overwhelming though it sometimes was. They learnt a lot, too, from his broader outlook and from having, as one of themselves, an officer whose early military horizon had not been bounded by the Shop, Chatham, and a Field Company in peace. It is satisfactory to be able to record that, having commanded this new Motor Machine-Gun Pioneer Company for a year and set its footsteps in the right way, he was selected and promoted to command a newly expanded central training depot in Omdurman and that he subsequently passed into the Staff College.

After a year's trial of this new organization, the Sapper Platoon was again divorced from the Motor Company. It was not normally wanted to go out on patrol with the fighting portion of the company, its training threw an extra burden on an already over-worked Commander, and it had been, in effect, " nobody's baby." Slightly enlarged in numbers, it was re-formed into a Sapper Company of two platoons, commanded by a native officer, directly under the control of the Commandant.

At about the same time that the Sapper Company was being reduced to provide money for mechanization, the Engineer Troops benefited in a different way from the same process of development. Since their inception, the Engineer Troops had included a boys' company, at one time glorified by the title of School of Military Engineering, whose function it was to train tradesmen for the Sapper Company and for M.T. units. The motorization of units which was now beginning was going to create an increased demand for trained drivers and artificers, and the problem of how to meet this increased demand led to a review of the whole question of trade training in the Force, in the light of probable future developments. In addition to the Sapper and M.T. tradesmen already trained in Omdurman, all units of the Force had on their establishments carpenters, farriers, tailors, saddlers, pioneers and other miscellaneous specialists. The increased use of wireless, which must result from the greater mobility of mechanized units, would also produce a demand for military wireless operators who, in the light of past experience, would have to be trained as boys.

There was some inertia among commanders of outside units,

who had hitherto recruited and trained their own tradesmen, but after discussion they all realized that a scheme of training for boys would raise the standard of technical efficiency throughout the Force, as well as making for uniformity of qualifications. Until recent years, when units of the S.D.F. remained for the most part in their own parts of the country, when transfers of officers or men from one unit to another were rare and communications difficult, it did not matter if different units had different standards, different qualifications and different methods. Now, with the advent of mechanization, much more movement between companies and districts, and the increased intermingling of men from all over the country, which must come from that movement, standardization is essential, for what one company has got another similar one naturally wants. This result of changing conditions has had many results in the general organization and equipment of the Force, but these are beyond the scope of the present article.

So, out of the search for economical efficiency was born the S.D.F. Boys' Technical School, to train boys for all trades in all parts of the country except the south. Practical considerations prevented the inclusion of the Equatorial Corps in the scheme. It was thought that a similar school might eventually be started in the south, but this idea has got no further. For the Omdurman school it was agreed that outside Corps should select their own boys and send them in for training. A guarantee was given that they should receive their own boys back when their training was complete, and this promise did much to allay the fears of the Corps and unit Commanders, that the scheme might result in their being landed with boys of strange tribes and habits who, however technically efficient, would never really fit in happily into their units.

The school was to be enlarged on a five-year plan. From its original strength of 140 it was to grow to over 300 in 1940, by which time it would be turning out tradesmen to fill all vacancies throughout the Force. The actual training of the boys is partly carried out in Omdurman, where normal engineer trades are catered for, where the boys live and carry out their military, physical and educational training and are developed from, in many cases, pot-bellied little weaklings into fit and healthy soldiers. The Stores and Ordnance Department of the Sudan Government deal with tailors, saddlers, and armourers, while the M.T. workshops carry out the higher training of fitters, electricians and turners. As was to be expected, the scheme has been modified in detail from the original idea. Farriers, originally included within the scope of the school, have been left for the mounted units and Veterinary authorities to train. Wireless operators are now trained in a separate Signal school, as it was found that they did not fit into the Omdurman organization. They had to be older, better educated and of a different type from

the ordinary boy recruit, and higher pay had to be offered to induce suitable boys to enlist. For these reasons, and because of the lack of space, it was found more satisfactory to train them entirely separately from the Boys' Technical School.

These modifications, and the fact that it has been found possible to speed up the training in certain trades, have reduced the eventual strength of the school to about 240. The instructional staff has only been increased by a few native N.C.O's. The military staff, who are both technical and administrative, consists of one British officer, one native officer, one British N.C.O. These are assisted by one native schoolmaster and five civilian artisan instructors. At the time of writing, the School has just lost its British N.C.O., who has been recalled to receive a commission in the Corps.

Although the School deals with all branches of the Force, it remains essentially part of the Engineer Troops, organized, trained and administered by them. The high standard of physical training which was insisted upon by the founders of the old Boys' Company is well maintained. Their annual Boxing Competition is now one of the most popular little entertainments of the Khartoum winter, while a display of P.T. by the boys is a standing dish in any menu of " fantasia " which has to be prepared for distinguished visitors, Tattoos and the like.

The winter of 1934-35 saw the commencement of one of the more interesting of the jobs which have come the way of the Engineer Troops in recent years. For economic and political reasons, as well as military, it was desired to improve communications between the southern Fung Province and the Upper Nile. A road existed to the Upper Nile Province boundary, but from the River Yabus southward to this boundary there was no route practicable for transport.

In view of the military considerations involved, and of the fact that the Engineer Troops are better equipped and organized for carrying out such rough work in a rather desolate area than the Public Works Department, their assistance was invoked by the civil authorities, and it was agreed that they should take on the job. The approximate trace of the road had been marked out by the P.W.D. expert, and it was as well that his reputation as a path-finder stood as high as it did. In spite of a further brief reconnaissance by a Sapper Officer, when the detachment arrived they found it hard to believe that the road could run over such impossible hillsides and precipitous valleys. Only complete confidence in the road Engineer's report and the care with which he had blazed the trail enabled the soldiers to find or believe in the way.

Before starting on the new bit of road, the detachment had spent some days improving the existing road, widening narrow places between rocks, removing trees and easing gradients at local " passes "

which had been constant sources of trouble to the always overloaded native lorries carrying people, merchandise, and animals.

From roadhead onwards, the work consisted first in clearing trees and bush and removing the bigger rocks by digging or blasting. The latter, with no power tools and only a field forge for re-sharpening and case-hardening the jumping bars, was slow work. But it was not so slow as the laborious picking which had to be done in many places, where the "rock" was a mixture of flaky slate and semi-petrified earth which would not respond satisfactorily to explosives.

The native labour provided to help the soldiers came from the Koma and Berta tribes. They were willing enough, and did their best, but poor physique, the result of generations of slavery and under-nourishment in the past, made them quite unable to tackle heavy or continuous work.

As soon as the initial clearing was completed for a few hundred yards ahead, the real work began. Throughout the greater part of the length of the new road, it had to be cut into the hillside. In that remote district ordinary road maintenance was going to be impossible, and therefore it was decided not to risk very much in the way of "cut and fill." Cutting the whole width of the road out of the side of the hill, as was done except in a very few places, meant more digging and blasting, but the work progressed slowly and steadily. Since, in the Sudan, except in the towns, a road is anywhere that a motor vehicle has gone in the past or can reasonably be expected to go, no soling or surfacing was included in the scheme, which was limited to clearing the way and making a track which, it was hoped, would stand up to the weather. This district is cut off in the rainy season, in any case, by areas of impassable cotton soil and bog to the North and South, and the new road was only for use in the dry weather. But steps had to be taken to prevent it being washed away by the torrential rains and the spate of water which would rush down the hundreds of little gullies from the hills above. This entailed putting in a large number of culverts. At that time of year it was impossible to be sure just where the spates would occur. The entire hillside was indented with potential water-courses, some of which would fill one year, some another. To provide a culvert for every possible stream was ruled out by considerations of time and money. All that could be done was to guess which valleys were most important or dangerous, put culverts in there and hope that the total water-way provided would be sufficient to carry the flood. In the event, the guessing turned out to have been remarkably successful.

The type of culvert used was very simple. Expense and the difficulty of transporting stores precluded the use of any ready-made culvert device or any elaborate design. Local stone was

available in plenty, and when the labour gang had been taught what shapes, sizes and types of stones were suitable, it did not take long to collect. Two straight rubble walls were built, the foundations and corner stones in cement mortar, the remainder in mud mortar faced with cement. The gap between the two walls was bridged with bigger flat stones, set in cement, and the roadway made good over the top of these. It was a simple, rough construction which could be made easily and quickly, which suited the local conditions and has stood up to the work required.

The supply of water, both for drinking and for the work, had to be carefully watched. Wells are few and far between in those parts and become harder to find and less productive as the dry season wears on. At one time, all the water required had to be carried three miles by donkey or, when such a luxury was available, by lorry. Paradoxically, the weather had to be watched from the other point of view as well. The coming of the rains would not only make work impossible, but would also mean that the roads further north would be closing, the River Yabus would be impassable, and the party might be cut off. The whole of the job could not be completed that first winter, but the worst of it was done, and the detachment just managed to get back across the river before the floods became too strong.

In the following winter, the authorities asked that the work might be continued and finished, but at that time, early 1936, military commitments elsewhere made it impossible to spare the troops for the purpose. In the winter of 1936-37, however, the situation in other parts had eased somewhat, and military considerations in the region of the road itself had become more important. It was decided to send the new Motor Machine-Gun Pioneer Company to finish off the job. The roadwork was to be combined with the military occupation of Kurmuk, which had been effected previously, and with machine-gun training for the non-technical portion of the company. The Sappers reached roadhead on December 2nd, and started work two days later. The road which the previous detachment had made was carefully inspected and found to be in excellent condition. Only minor repairs were required, and the culverts, without exception, had withstood the onslaught of the rains very well indeed. In the first week the party cleared 1½ miles of new road, but this was a comparatively easy stretch and their rapid rate of progress was not maintained. They encountered no serious setbacks, however, and the whole road, as originally planned, was completed and declared open to mechanical transport on January 2nd, 1937.

Thus, quite soon after its formation, No. 1 (M.M.G.) Pioneer Company had justified its peculiar composition and dual roles. It was ideal for this purpose, and it is sad to have to record that,

since then, hardly any similar jobs, making use of both its military and technical abilities, have come its way.

There is little more to record of the doings of the Engineer Troops. In 1933 they played a small part in an episode which has now faded into insignificance, but which loomed large at the time. In consequence of information received about the activities of a certain foreign power near some oases in the western desert, a patrol was sent to occupy some wells. An Engineer detachment accompanied the patrol for water and other duties, and it is recorded that when, having battled with heavy sand, intense heat and cold, rocks and other bad going, and many other discomforts, they arrived at a well and the pump worked, there was great jubilation! The only field water supply equipment at that time was some antiquated lift-and-force pumps, which were only kept going by continuous attention in workshops, so the achievement was not as ordinary as it might appear.

A little later, the Sappers were employed building sangars, block-houses and accommodation for the patrol at the oases. Local stone was used for this purpose, and the houses were given double roofs against the weather. The actual volume of work done was not great, but it was an arduous trip for all of them. Living conditions, even after the buildings were completed, were far from comfortable, and a certain M.T. Officer mentioned in one of his reports: "I am informed that whisky improves the taste of the water." This seems to be as near as anyone could get to being complimentary about the neighbourhood or the conditions.

A second trip to these parts was made in 1939, and again an R.E. Officer and a few men accompanied the party. This time nothing more than reconnaissance was carried out, and the party returned with valuable information about the route, the state of affairs at the oases themselves, and the conditions and the behaviour of different types of motor vehicles.

This account of the doings of the unit is no place for mention of names and individuals, but it would not be complete without a reference to one. About 1930, or it may have been earlier, Ahmed Bashir Tombal joined the Boys' Company. In birth and upbringing he was no different from hundreds of other boys who have done the same thing, and have, in the ordinary course of events, learnt their trade, served their time as men, and eventually returned to civil life. In character and intellect however, Tombal was outstanding from the first. By a lucky accident, a new scheme for obtaining native officers for the S.D.F. was introduced soon after he became officially a man, and this gave him his chance. With such assistance as could be arranged for him, he mastered enough English, arithmetic and general knowledge to pass the qualifying examination, in which he was competing against youths who had

studied for as much as four years, in some cases, in Government schools. Passing through the necessary interviews, he was eventually selected for training as a cadet. In his cadet courses he finished third of the class, and was commissioned in January, 1940. Whether he will achieve his ambition of returning to the Engineer Troops as an officer remains to be seen, but by being the first to rise from boy recruit to commissioned rank he has set an example which should be an inspiration to all the boys who leave their homes to learn the mysteries of military engineering.

For the past year or more the demands of training of a more military nature have left little time or opportunity for carrying out Engineer work. The Pioneer Company, while still composed partly of engineer personnel, has had few chances to devote itself to the technical side of its dual role, though it has, on manœuvres and combined training, provided demolition parties and the like which would have been beyond the powers of the ordinary M.M.G. Company. In spite of this, there are doubts whether its organization is really sound. Born of economy and expediency, it has justified its existence, but when easier times permit the departure from Engineer auspices of the M.M.G. Company proper, the formation of a Sapper unit of adequate size, mechanized now, of course, may well be the next step in the development of the Engineer Troops. But this must wait, and for the time being the Pioneer Company, the Sapper Company (small though it is), and the Boys' Technical School can be relied on to wear the grenade with dignity, and to uphold the honour and tradition of the Corps, which has already meant so much in the development of the Sudan.

THE PROBLEM OF ACCOMMODATING THE ARMY ON THE OUTBREAK OF WAR.

A Lecture given to the Architectural Association by MAJOR-GENERAL G. B. O. TAYLOR, C.B.E.

MR. CHAIRMAN, LADIES AND GENTLEMEN,

To give you a proper picture of the problem facing us on the outbreak of war of providing accommodation for all the troops who would be called to the Colours, I must start with a brief review of the situation prevailing in the previous four months.

About April, 1939, the Militia system was inaugurated. The annual contingent who would be liable to be called to the Colours was about 300,000 men, of whom, making allowance for unfit and exemptions, it was estimated that some 200,000 a year or so would be actually called up. The period of training was 6 months and the call up was spread over the 6 months at 2-monthly intervals, commencing in July, 1939. This had to be done, otherwise the necessary training staffs could not have been found, and the training was divided into some 2 months at a Training Depot, and the remainder with a Training Unit or Regular Battalion.

There were no surplus barracks and little empty accommodation available, and we therefore had to provide extra accommodation at all existing Depots, at all existing Battalions or Unit Barracks, and build a number of training camps as well.

In brief, accommodation was provided for 150 men at each existing Depot, for 300 men at every Infantry Battalion Barracks (*i.e.* 38,000 men in all), and we also built 51 Training Unit Camps at 36 centres, providing accommodation in these for some 55,000 men. The balance was fitted into existing accommodation. By the time these preliminary details were settled, *i.e.* numbers to be built for and localities where Military Camps were to be built, it was well into May.

The Secretary of State for War had laid down that the standard of comfort and scale of provision for the Militia was to be equal to that of the Regular Soldier and he further guaranteed in Parliament that every man would be properly housed before the winter.

This gave us about 5 months in which to provide complete accommodation for some 100,000 men.

I propose, later on in this talk, to discuss the forms of contract adopted for all our work in its various stages, with our reasons for

doing so. It must suffice at this point to say that, as we had no completed designs for this particular type of hutted camp, no lay-outs, obviously no bills of quantities, and that scales and schedules of accommodation were still in active preparation, it was obvious that any form of competitive tendering on a lump sum or schedule of quantities basis was quite hopeless. It would have taken us not less than two and probably three months to prepare sets of contract documents on which tendering could have been invited, *i.e.* well into the middle of the summer. We therefore allocated the work to selected contractors on a prime cost plus fixed profit basis, the only element of competition being in the amount of fixed profit. As you all know, from the end of June to the middle of August we had, I suppose, the worst summer weather within living memory, 6 weeks of almost continuous wet. It had a disastrous effect on our work, camp sites became seas of mud, there was very serious loss of time and costs went up by leaps and bounds.

A further handicap, and a very serious one, was the state of the labour market.

Considerations of speed and economy led us to adopt timber as our principal material for construction (I will, later on, run very briefly through the actual type of building adopted) and this meant a heavy demand on carpenters. To reduce the numbers required on the site, we adopted a sectional form of hut, which was fabricated in various shops and assembled on the site.

Even then, at our peak we were employing some 18,000 carpenters. At the beginning of our programme there were some 11-12,000 carpenters unemployed. At the end between 5-6,000. These were, broadly speaking, so dispersed over the country as to be ungetatable or even unemployable. The balance shifted to our camps from other work—not because, as so frequently stated, a higher wage rate was paid, but because long hours of overtime were worked and men were thus able to earn more money in the work.

Actually, we only paid the rates authorized by the Building Industry, with allowances as sanctioned by the National Working Rules, *i.e.* in accordance with our interpretation of them. I will not deny that there were abuses. There were many, but as soon as they came to light, they were stopped.

One complaint was that we were working excessive hours, so that, in fact, men were not doing any more work owing to fatigue than they would have done in a lesser number of hours, and were of course getting more pay.

This was gone into in great detail and finally a Government decision was obtained that total weekly hours worked should not exceed 60.

It is of interest to record that many of our contractors were asked their views on this overtime aspect. A few were emphatic

that over a short period, say of 3 or 4 weeks, men could work up to 80 hours a week without loss of output. Others were equally emphatic that any hours in excess of 60 were wasteful. All were decided that Sunday work, involving payment of double time, was wholly objectionable, as men tended to work on Sunday to get double pay and then took Monday off and sometimes Tuesday as well.

I might remark here that in some other countries, even in Europe, a 70-or 80-hour working week is, I believe, not uncommon.

I will deal in detail with the various safeguards introduced in these contracts by the Department when I discuss contracts later in this talk to you.

The outbreak of war faced us with the following problem: Air Defences were manned at full strength. The Territorial Army, which as you can recollect was doubled in Establishment during the summer, was called up, and the Regular Army was mobilized, involving the calling up of all reservists from civil life.

Fortunately we were spared the wholesale volunteering which took place at the beginning of the last war, and which swamped every military centre with thousands of men without arms or uniform, and which led to many thousands spending most of the 1914-15 winter under canvas under very arduous conditions.

We still had a stiff problem to face.

The first obvious step was to apply war scales throughout. In brief, this meant housing men at 45 ft. super instead of 60 ft. super. This was made applicable to all military barracks in permanent construction, as well as to the militia camps.

Actually, owing to the planning of peace-time buildings, it was not possible to give a rigid application to this, as window spacing, positions of fireplaces, etc., did not always permit of it. The very fact of increasing the numbers in barracks and existing camps, however, compelled us to provide more accommodation in other directions, such as increases to dining rooms, institutes, ablutions, latrines, and so forth.

It was not considered hygienically wise to give less than 45 f.s. per man, owing to the dangers of spread of infection of air-borne diseases, such as cerebro-spinal meningitis.

The net result, however, was that in one fell swoop we increased the accommodation available for the Army by some 30%. You will forgive me if in the course of this talk I avoid giving you exact figures of strength or locations of units, as for obvious reasons these cannot be made public.

It was obvious that Territorial Units, apart from those employed on the Air Defence of the country, could remain in billets and hired or requisitioned premises for a considerable time, although it was equally obvious that, at some predetermined moment before

their departure overseas, it would be necessary to assemble these units into larger formations to permit of their collective training.

This, however, did give us a breathing space which was invaluable, as in many other directions no such interval was permissible.

Thus, on A.D.G.B. and Coast Defence, defences had to be manned at once. Internee and Prisoner of War Camps had similarly to be built at once. Vulnerable points had to be protected and so forth.

I will now touch for a moment on the problem of the Air Defence of the country, dealing with it purely from the " Works " aspect.

In essence, it involved the provision of accommodation for well over 100,000 men, scattered all over the country in battery positions, searchlight posts and so on. There are, for instance, several thousand of the latter scattered in single units all over the place: apart from the men's accommodation, gun emplacements and their accompanying buildings had to be constructed, vehicle, ammunition and supply depots of various kinds built and so forth.

A substantial start had been made on this work in 1938, but there was plenty left to be done.

The main difficulty was the excessive dispersion of the job and the innumerable small packets into which it was subdivided. Again most of this organization was mobile and this demanded a form of portable hut which could be easily erected, taken down, transported and re-erected.

We have not found any really suitable alternative to timber for this class of work, and this had a considerable bearing on the general timber situation which I will talk to you about in a few minutes.

Actually the Nissen hut is, of course, quite suitable, but for reasons I will explain in a minute or two, we were unable to count on making any extensive use of them. We have also got another small hut, the " Mansard," a variant of the " Weblee," which uses very little timber.

Apart from the provision of accommodation for A.D.G.B. the remainder of our building programme consisted of:

1. The provision of a large number of Training Centres.
2. The provision of a number of Training Areas in which larger formations could assemble for collective training prior to going overseas.
3. The provision of practice camps for training in particular weapons.
4. The provision of additional hospital accommodation.

The Training Centres were based primarily on the Training Centres which had just been completed for the Militia. They were thus built at all the depot towns in the country, where possible adjacent to the existing barracks and Militia hutments which had

been added to them, and in other cases on the nearest land which could be obtained, in many cases this might be three or more miles away.

The additional accommodation to be provided was, of course, on war scales, *i.e.* with every frill cut out and involved building for varying numbers in each case, but averaged some 1,300-1,400 men each.

In all, some 50-60 of these training centres were put in hand. Work is in progress on all of them, but is in varying stages according to the ease or otherwise with which we were able to get the necessary land. The training areas consisted of (1) a number of brigade training areas spread over the country. The sites were chosen primarily for facilities for combined training, and each comprised 4 or 5 unit camps reasonably close together. (2) A few divisional training areas for higher formation training prior to going overseas.

These divisional areas merely consist each of 3 or 4 brigade areas sufficiently close to each other for combined training.

I will not give you the numbers or exact locations of these areas, but in all they comprise hutted accommodation for 90,000 men approximately, which total may now be reduced owing to shortage of material.

These training area camps are now being put out to tender as rapidly as possible, *i.e.* as soon as sites and lay-outs can be selected and prepared, and our task is to get them completed before next winter.

Now, before I leave this general picture of our activities and descend into details, I must just touch on two more points. The first is that over and above this programme of hutting we naturally have a good deal of other work.

I reminded you earlier that the Territorial Army had been doubled, and that for the time being it was living in billets, requisitioned buildings and so on.

I can give you no picture of our ultimate military effort, but I can say that at the present moment there are several hundreds of thousands of men in billets, and that it is the objective to transfer these men to hutted camps and requisitioned buildings as rapidly as we can. Not much engineer effort is required as far as billets are concerned, but requisitioned buildings nearly always require work on them to fit them for occupation. In most cases additional latrines, cooking and washing facilities and so on are required.

If you consider the enormous dispersion of this class of work and the annoying volume of petty detail involved in each case, you will appreciate that no small effort is required to cope with it.

The second point is that, apart from carrying on with most of our pre-war work in permanent construction, we have also had to provide additional workshop and storage accommodation for Army

activities of all kinds, as well as additional Coast Defences and so forth.

Broadly, we estimated to spend some fifty millions in 1939 financial year. I cannot estimate the 1940 figure with any accuracy yet, although I hope that it will be less. This I think is sufficient for the broad picture. Now for the details.

I will consider lay-out and construction first, forms of contract last.

I imagine that most people are familiar with the mathematical regularity of a typical military camp. It follows well-established principles. Thus the parade ground is the centre of activity. Conveniently on one or two sides of it are the living huts in orderly rows with their conveniences in or adjacent to them. Dining rooms, cookhouses, institute, are convenient of access from the living huts and are served by a road. Gymnasia, drill sheds and garages border the other faces of the parade ground. Officers' and serjeants' messes are given such privacy and prospect as the site offers. Guardhouse, and regimental offices are near the main entrance to the camp, and so forth.

Economy is naturally studied in the detailed lay-out to reduce camp roads to the minimum, facilitate drainage and water supply and so forth.

Under war conditions the picture is different.

The reduction of the air target presented is the chief consideration. For economy, the parade ground must occupy the most level portion of the site. Buildings which must be road-served fringe it. Living and other huts are in small irregular groups of 6 or 7 in irregular pattern, groups are not less than 50 yards apart and so forth. In fact, the lay-out is so arranged that no bomb aimed at any collection of huts can automatically hit another collection because it is in the line of descent of the bomb. In practice it looks as if the huts had been scattered haphazard over the area from a pepper pot.

The lay-out of hutted hospitals must, of course, even in war follow a regular pattern. That of stores, depots, workshops and so forth must again be governed by convenience of operation, etc., and must similarly be regular.

DESIGN.

Now for design.

The first point I want to make is the enormous extent of repetition work in military building. On thought you will, I think, admit at once that it is essential.

Similar units are the same strength wherever they are. Standardized accommodation for them is, therefore in fact, very desirable if not essential.

Thus in peace and in war detailed scales of accommodation are established, *i.e.* the unit space per man in barrack room, dining room, institute, etc., is laid down, as are the proportion of baths, washing basins, latrines, and so forth. In fact, every single item of accommodation is provided for, and a scale established for it.

War scales are naturally far less than peace ones, in every respect, and I have already called your attention to the chief one, *i.e.* the reduction of floor space from 60 f.s. per man to 45 f.s. Design is, therefore, limited to the production of standard designs for every building used in the Army. These are, of course, under constant examination and revision under peace conditions, and in certain types of building, such as married quarters, officers' and serjeants' messes, etc., there is considerable diversity of design.

Hutting, on the other hand, hardly lends itself to any diversity of design or architectural treatment, particularly where standardized sections or units are adopted.

The primary considerations here are simplicity, economy of material, particularly when mass production is concerned, rapidity of erection and general cheapness.

Traditional materials for hutted camps are, of course, timber and corrugated iron. During the Militia hut programme, it became evident to the department that it was making very heavy inroads on the stocks of timber in the country, and representations were made with a view to official Government action being taken to replenish them.

You will forgive me if I am not more precise in this matter. Unfortunately nothing was done, chiefly I imagine because no one could really force themselves to believe that war was imminent.

The net result was that we started the war with the stocks of timber in the country far lower than they had ever been at that time of the year. It must be borne in mind that the principal source of supply, viz. the Baltic, was likely to prove difficult to maintain, anyhow at full swing, that Arkangel became icebound in the early winter as also the Eastern Coast of Canada, and that British Columbia, the other chief source, required 3 months or more for the round trip.

When Russia made her agreement with Germany the position naturally became worse.

Now you must bear in mind that, in addition to hutting for troops at home, the War Department was faced with the problem of providing a large amount of hutting as well as store and workshop shedding for the expeditionary force. Another factor was that the situation which had arisen over timber was almost certain to be repeated over steel. I am, of course, now talking of our appreciation of the position last September.

We were faced therefore with two main problems. How were we to provide the hutting required in England and how were we to do it for France?

In passing, I might remark that it was made very clear that France could not supply the timber required for this from her native forests.

We decided that huts for France should be in steel and corrugated iron with such timber as necessary, and that huts in England should be in various substitutes for timber. In fact, for France we decided on the Nissen hut, an improved pattern to that used extensively in the last war, and we are providing accommodation (living or hospital) over there for some 250,000 men or more, before next winter.

This, of course, bears no relationship to the number of troops in France, as a large number of men are in billets, may at any one time be in trenches and so forth.

The Nissen hut has many virtues; it is very cheap (it costs about £9 per man accommodated), is portable, can be erected by unskilled labour and is fairly durable.

We have one form of timber mobile hut which costs much the same, and which we have used extensively on A.D.G.B. but, as I have told you, we have had to cut out timber almost entirely for any future programmes.

We now come to our home programme.

Prior to the institution of the Timber Control and the imposition of quotas of timber for Government Departments with its attendant licensing system, we had arranged for the manufacture of a large number—some 3,500 in all—of sectional huts as living huts in what I call our first wave of war hutting, *i.e.* the Training Centre Camps.

It was our intention to build the living accommodation in timber, and all the remaining buildings in other forms of construction.

The timber hut was the same as that for the Militia camps, but we cut out connecting corridors to ablution rooms, etc., central heating, wardrobes and other frills, and reduced the amount of timber in windows, wooden fittings, etc.

We also called in to our councils expert timber hut manufacturers to revise our specifications, and to make certain that these could be complied with with the minimum waste on conversion of timber. It must be realized that, with the drying up of supplies from the Baltic, timber ready converted to size would no longer be available and conversion would have to take place in this country.

In this way we reduced the cost of our hut sections from £243 for a 60 x 19 hut to £180.

It is a remarkable fact that out of the 350 firms who had been manufacturing hut sections in our Militia programme only 18 were capable of doing so at the new figure of £180, and with the specified

loss on conversion of 6% as opposed to the previous average of about 15%.

In fact, only these 18 firms had the equipment of saws, and the factory lay-out to permit of their doing so. The net result was the saving of over £200,000 to the State, and this in spite of the very considerable increase in the cost of timber which had taken place. Our first consideration as a timber substitute was naturally brick, our second, concrete.

It is, of course, unfortunate that these primary substitutes practically drove us to a form of permanent construction and thus put up building costs, but we couldn't help that. To be certain that we were on right lines we consulted the trades unions and were instrumental in having an expert committee set up to review the situation and advise on alternatives to timber. We also consulted the Building Research Station, and had the benefit of the advice of a distinguished member of your Association, Mr. Alfred Bossom.

As regards concrete, we called in a consultant to produce us a suitable design of block which would permit of mass production.

We examined the use of other forms of walling, such as terra-cotta, gypsum blocks, paving slabs, slate cemented on wall board, and so forth, and in our contracts we permit the substitution of any of these, or in fact of any alternative material or form of construction the contractor may like to suggest, subject to its being no more expensive than our standard method in brick or concrete, and to our being satisfied about its structural stability.

It is worth noting that, as the result of these investigations and alternative plans, we have reduced our timber requirements on the following scale :

In our Militia camps we used between 800 and 900 standards a thousand men. In our first flight of war camps, *i.e.* the Training Centre Camps, where we build living huts only in timber, we require 180 standards a thousand men. In the camps where we only use timber for roofs, doors and windows we will require 70-80 standards a thousand men, and in our final camps, where we shall cut out timber entirely except for doors, windows, shelving and soldiers' lockers, we shall use 20-30 standards a thousand men only. We could reduce this a little by cutting out timber doors and windows, but we distrust doors lined with any form of pulp board, as we do not think that it will stand up to military wear, and we are afraid that steel windows may be unobtainable in the quantities we want. We, of course, allow them as alternatives.

I don't want to waste your time with details of camp construction. They are elementary and not worth dwelling on, but I do just want to make a point or two on design.

It is, of course, elementary that you want as few variations as

possible in your unit of building. Thus we only have three different spans, 19 ft., 24 ft., 28 ft., and bays are standardized at 12 ft.

Different types of windows, doors, etc., are reduced to a minimum.

Again, although we specify a certain type and quality for sanitary ware and so forth, we allow of any substitute which costs no more and is of reasonably equal quality.

Now before I deal with contracts I want to say a word or two about timber substitutes. So far I have touched on alternative forms of construction to timber; now I want to mention alternatives to timber itself, *i.e.* substitute materials lending themselves to a timber technique.

We have not yet found this material, at least not an ideally suitable one. We have tried out or are testing such materials as cement and sawdust, cement and wood wool, cement and wood chippings. I.C.I. are experimenting with an extruded material in which I believe gypsum and resin play a big part.

Frankly, the difficulty is to get tensile strength without reinforcement, or to get a reinforcement which will stand up to the chemical action, as in some at least of these substitutes, the wood chippings or what-not, must have a prior chemical treatment.

Cement and sawdust looks the most promising. It will saw, and hold a screw or nail and can undoubtedly be used as a substitute for wood framing or studding. What we want really is a timber substitute which will act as a joist or purlin—we may have it, but we are not quite certain yet.

Cement and wood wool looks promising as a substitute boarding, but again we haven't anywhere near reached finality yet in this respect.

These substitutes or most of them use timber in some form, but it is only the waste product. And although I have rather implied that timber is almost non-existent, there is, of course, a sufficient supply, particularly when you take home production into account, to provide all the sawdust or wood chippings we would be likely to require.

Wood wool will probably be difficult to obtain, at least in any large quantity.

CONTRACTS.

I will now consider briefly the contract side of our programme.

The Militia camps were, for the reasons I have already stated, placed on a cost plus fee basis. Time was short, sites unknown, details and plans of buildings not yet prepared. What happened was that some of the leading firms of contractors were asked to undertake the work. They all expressed willingness to do so. In order to introduce some element of competition, they were invited to tender for the fee.

The full scope of the work was undecided, and an approximate estimate was worked out by the War Office for each camp, and an upper and lower limit was also fixed for the purposes of earning a fee.

Thus a job estimated to cost £250,000 was given an upper limit of £300,000 and a lower one of £200,000; and contractors were asked to state what percentage they would require if the job cost £300,000, £250,000 and £200,000.

If it cost more, the fee remained on the £300,000 mark, subject, of course, to the total scope of the job remaining unaltered. In many cases contractors tendered a fixed lump sum to cover the whole range of the job.

Actually there was a continual increase in the scope, and during the work some forty or more items were added, including such items as fire fighting tanks (50,000 gallon reservoirs), cinema halls, various buildings in connection with A.R.P. measures, garages, and so forth.

It is of interest to note that those contractors who quoted the highest fees carried out their work more cheaply than those who skinned their fees to be certain of getting the job.

We gave contracts at as low a fee as $2\frac{3}{4}\%$ and as high as 6%, the average being $4\frac{3}{4}$–5%. I would like to deduce from this that with the higher percentage fee, the contractor was able to pay higher salaries to his resident staff and thus obtained more efficient supervision, but the data are not sufficiently well established for such a deduction.

As the contracts were prime cost ones, the War Department was obviously intimately concerned in every item of expenditure, and leading firms of surveyors were therefore appointed to watch and supervise each contract. They did this by means of resident surveyors and staff on every camp.

Finally, W.D. auditors carried out detailed audits into all the contractors' accounts.

There is no time to enter into the various details of the contracts which followed the general practice in prime cost jobs, but I do want to emphasize the controls which the department tried to set up.

First. The selection of only large and well-established firms of contractors of reputation, such that it was hoped that they could not afford to have their names associated with bad or extravagant work.

Second. The watch and control exercised by leading firms of surveyors.

Third. The final audit by trained and experienced Government auditors.

Let me say at once that this method of procedure met with only

qualified success. Some contractors did well, one or two definitely badly. The main factors were the bad weather in July and first half of August, and the shortage of skilled labour, particularly carpenters.

The W.D. realized very early that this form of contract had many undesirable features, the principal one being, of course, the lack of any financial inducement to the contractor to carry out the work economically.

The next series of contracts placed by the department, *i.e.* for forty Searchlight Battery Camps, each estimated at about £45,000, was therefore placed on a target cost form. This form of contract fixes an estimate or target cost for the job. The contractor gets a fixed fee, *i.e.* 4% or so on the target cost and a bonus of 25% of any saving made on the target cost. Again the job was tendered for and allowed for an up and down variation. Furthermore, contractors were limited to a total profit—fee plus bonus of 10% of the net prime cost of contract. The target cost was to be established by agreement between the W.D. surveyors and those of the contractor. In actual practice it was found that there was so much delay in fixing these mutually agreed costs that the contractors' prime costs tended to become the target cost and the contractor lost any opportunity of earning a bonus. No doubt this was particularly the case in these special contracts, as they were only small ones costing not more than £50,000 or so, and four months was the time allowed for completion.

In larger contracts lasting over a longer period no doubt it would have been more of a success. However, we abandoned this form of contract, and in our next series of some fifty-two contracts estimated at between £100,000 and £250,000 each, we introduced a modified form of target contract which operated as follows:

Two target costs or rates were established—what I will call the basic one, on which the fee was calculated, and the actual or local target rate, on which the bonus could be earned.

The basic rate was fixed on the wage rate of the district, and consisted therefore of the W.D. estimate of the cost of the job, labour being paid whatever the local rate was.

This estimate was checked by a leading firm of London surveyors, and all contractors agreed to accept it.

It was recognized, however, that in many places labour would have to be brought to the site at higher rates of wages than the local rate and perhaps with subsistence and other allowances.

Any payments of these kinds would effectively prevent the contractors from earning any bonus. We therefore establish an actual wage rate on the job by dividing the total wages and allowances paid by the total number of hours worked. This result is applied as a correction to the basic target figures. On the broad

assumption that labour to materials is 50/50, a ½d. increase in the wage rate meant an increase of 1% in the target cost.

This system, though it sounds complicated, is not actually difficult to apply, and does in fact give the contractor a genuine chance to earn a bonus. These contracts are still in operation, but we do know of at least two cases where the contractor hopes to earn a good bonus. Incidentally, in these contracts, we increased the bonus to 33⅓%.

Needless to say, contractors' pay rolls, attendance cards, etc., are rigidly watched by surveyors and W.D. auditors.

In this form of target contract the fee was fixed by the department at 4% on the first £250,000, with a reduction of ¼% on each additional £250,000 up to £1,000,000.

The largest contract we have placed on this basis is one for £800,000.

Our final form of contract and the one which we hope to adopt for most, if not all, our future work is virtually a lump sum one. The only feature about it is that the tendering is on a schedule of quantities for the whole of a camp, instead of on a detailed bill for each individual building in the camp.

The reason for this is that we do not wish to delay the start of the work by the time required to prepare these detailed bills, a laborious process in view of the number of alternative materials and methods of construction permissible. The schedules cover all the necessary operations of work, with the various alternatives, and the quantities, although naturally approximate, are got sufficiently close to ensure that we get close pricing and tendering by contractors genuinely desirous of getting the job.

It will be, of course, a simple matter during the progress of the work to prepare the necessary detailed quantities for each building and to transfer the rates quoted by the contractor to these bills, and this will obviate any necessity for measurement on the site by local surveyors other than what is customary for external sources.

This finishes my review of our building programme on the outbreak of war.

Architecture, as such, plays little part in it. Our difficulties have been and are not those of design as such, but to adjust our plans to the availability of materials and labour. I hope, however, that it has proved of sufficient interest to you to-night to justify my having come here to talk to you about it.

I need hardly add that I very much appreciate the honour which has been done me by my invitation from your President and Council to come and talk to you, and I would conclude by saying that I shall be very pleased to do my best to answer any questions which you may like to put to me about this programme as a whole or any details of it.

NOTES ON ALTERNATIVE MATERIALS AND METHODS OF CONSTRUCTION FOR WAR HUTTING.

By MAJOR C. M. SINGER, R.E.

THE following is a brief account of the investigations into possible substitutes for timber and steel in war hutting, made by Directorate of Fortifications and Works during the winter 1939-40.

I. GENERAL POSITION OF MATERIALS.

Of all possible materials for the construction of huts, timber is normally the most suitable from the points of view of both cost and speed of erection. Consequently, the large amount of hutting put up for the Militia in the summer of 1939 was almost entirely built of timber, full advantage being taken of the possibilities of cheapening and speeding-up work by pre-fabricating sections of huts at central workshops.

The large amount of timber thus consumed during the summer had not been replaced by the autumn, and the outbreak of war found stocks in the United Kingdom far lower than normal for the time of year. Further, the principal sources of supply of the soft woods used for this class of work, *i.e.*, the Baltic and North Russia, were unlikely to be able to provide any appreciable quantities. It was, therefore, early apparent that the war hutting programme would have to be carried out with the absolute minimum of timber.

A common substitute for timber in the walling of huts is corrugated iron. But here again it was clear early in the war that the use of steel for this purpose could not be justified if other materials were available.

Investigations were therefore put in hand to evolve a form of " hutting " which would involve the use of as little timber or steel as possible, but which would be comparable with the usual timber and corrugated iron hut in other respects, *e.g.*, cost, speed of erection, portability, etc. The hutting required could be divided into two classes :

(*a*) Portable hutting for mobile searchlight positions, and for use in the field generally.
(*b*) Static hutting, for the housing of troops at home in general.

II. Portable Hutting.

A portable hut has to be light, and capable if possible of being erected and dismantled by unskilled or semi-skilled labour, and it should, therefore, be composed of light pre-fabricated sections. A really satisfactory portable hut involves the use of timber; other types, such as the well-known Nissen hut, may be regarded as "semi-portable," but require corrugated iron and steel ribs. The employment in such hutting of alternative materials, such as asbestos sheeting in lieu of corrugated iron, concrete floors in lieu of timber, etc., inevitably detracts from the portability of the hut. It was consequently decided that such timber and steel as was available for hutting should in the main be devoted to the portable hutting, and the use of these materials in static hutting reduced to a minimum.

III. Static Hutting.

The evolution of a standard design.

In view of the number of possible alternative materials and methods of construction, the first essential was to arrive at some standard, or standards, against which other alternatives could be judged as regards both cost and technical suitability. It is convenient to consider the main portions of a hut in turn, bearing in mind always that a camp consists not only of simple living huts, but also of a great variety of ancillary buildings such as messes, dining rooms, institute, bath houses, offices, stores, etc., possessing different structural requirements.

1. *Floors.*

The principal alternative to a wooden floor is concrete. For certain buildings, such as bath houses, stores, etc., a solid concrete floor, with no special covering, is good enough. In living huts, and, broadly speaking, wherever a raised timber floor would normally be provided, some covering to the concrete is advisable, and for this it was decided to adopt linoleum. Now, to ensure a reasonable life to linoleum on concrete, it is essential that no damp should be allowed to reach it. It is advisable, therefore, that the concrete floor be raised on sleeper walls, but this will involve the use of a certain amount of steel as reinforcement, and of timber or steel for form work, unless use is made of pre-cast blocks or paving slabs on frequent sleeper walls. Such a floor is likely to be costly unless stocks of blocks or slabs are readily available in the locality, and while, therefore, this form of construction was not ruled out, a solid cast-in-situ floor had often to be adopted, even where it was intended to lay linoleum on it later. In such cases a waterproof bituminous layer was specified between two 3-inch thicknesses of concrete.

2. *Walls.*

The obvious alternatives to timber and corrugated iron are brick and concrete.

Brick.—The first thing to be considered in the use of brick walls is what type of brickwork would best suit the purpose, having regard to cost, insulation and weatherproof qualities, and stability. A plain 4½-inch wall is ruled out for nearly all buildings, owing to its poor insulating and weatherproof properties. A 4½-inch wall, rendered externally and plastered internally, would be more satisfactory in these respects, but an 8-inch cavity wall formed of two skins of brick on edge, is still more satisfactory and probably cheaper. It was, therefore, decided to adopt such an 8-inch cavity wall as a standard, and this decision was endorsed by an expert civilian committee which had been set up to examine the whole problem and by practical bricklayers themselves, as represented by the National Union of Building Trade Operatives.

In practice, it has been found that this type of work presents little difficulty, once bricklayers have become accustomed to it. Moreover, it has been found possible to obtain in most districts, at reasonable cost, bricks sandblasted or rusticated on the exposed face; this gives a pleasing appearance to the hut walls, and generally obviates the necessity for camouflage painting thereon.

Competitive tendering has proved, moreover, that the 8-inch brick walling described above cannot be beaten on price except, possibly, in localities remote from brickfields or where difficulties are experienced in obtaining the bricklayers required.

Concrete.—The lack of timber for form work precludes the use of cast-in-situ work to any extent. Investigations were therefore made into the use of pre-cast concrete blocks. This proved a difficult problem, owing to the necessity of adopting a few standard sizes of block out of which a great variety of huts could be built with different window and door spacings. Several designs of this nature are in existence and a standard design was also produced, but these have as a rule proved to be too complicated, compared with the brick walling described above, to be adopted generally.

Framing.—Both the above types of walling need to be supported at intervals by columns, which also carry the roof trusses. It was at first hoped that sufficient steel would be available to permit of steel stanchions being used. When, however, it became apparent that this would not be the case, brick piers or reinforced-concrete columns were considered. To resist the overturning moment, brick piers tend to be very bulky: in some buildings, such as store sheds and offices, such piers may not matter, but in other buildings, such as living huts, they are objectionable on the inner face of an external wall, and if projecting on the outer face involve an increase in span

of the roof truss, if the same clear dimensions inside the hut are to be retained.

Reinforced-concrete columns, however, can be of reasonable dimensions, and various types of both pre-cast and cast-in-situ columns were considered. Pre-cast columns involve some difficulty in the fixing of roof members and are cumbersome to handle, while timber or steel formwork for cast-in-situ work was out of the question. A design was consequently evolved in which a 3-inch skin of brick on edge, into which the walling is bonded, is utilized as formwork round a cast-in-situ reinforced-concrete column. Practical opinion was divided on the feasibility of this design and experience shows that the wholly brick column is sometimes preferred. On the whole, however, the design appears to be satisfactory.

3. *Roofs.*

Framework.—Far the most difficult problem arising from the present shortage of materials is that of roof design. Timber and steel are the two materials normally employed to give the tensile strength required in truss members, purlins and rafters, and the problem therefore becomes one of :

(*a*) Finding a substitute material possessing tensile strength, or
(*b*) Evolving a design from which members in tension, or beams whose lower flange is in tension, are eliminated.

(*a*) *Substitute Tensile Materials.*

While nothing has so far been found possessing tensile strength comparable with wood or steel, some materials in common use possess a certain degree of tensile strength, and can therefore be used as beams or slabs over small spans or to carry light loads. For example, 4-inch diameter asbestos cement piping, spaced about 3 feet apart, may be used as purlins over a span of about 10 feet or so. A complete truss built up of asbestos cement piping, which may prove satisfactory, has also been evolved for a span of 19 feet. The liability of asbestos members to fail suddenly under loads far below the normal failure point, however, makes it important to allow a large factor of safety in a truss, though this unreliability might be more readily tolerated in a less important member, such as a rafter or purlin.

Various suggestions have also been put forward involving the use of fibrous materials, or light wooden rods, as " reinforcement " for concrete members. None of these have as yet, however, been successfully developed, chiefly owing to the difficulty of finding a " reinforcement " which will not be attacked chemically by a component of the concrete, and at the same time possesses elastic properties comparable to steel.

(*b*) *Elimination of Tensile Members in Design.*

Theoretically, the only form of roof from which *all* tensile members

are eliminated is the parabolic arch, springing from the ground. Several designs based on this principle have been examined, the most successful being one built up of pre-cast sections of a cement-sawdust composition, which are readily assembled into 19-feet span living huts. The Nissen hut is an example of a design which approaches this ideal, though its semi-circular section throws some bending stress on to the ribs and the covering of corrugated iron or asbestos sheeting involves the use of purlins.

Except in individual huts of relatively small span, however, it is inconvenient to carry the curved roof right to the ground. For the larger huts needed for dining rooms, institutes, messes, etc., the arch must be restricted to the roof itself, springing from eaves level. This, however, would require either tie bars (which are precluded by the lack of suitable tensile material), or massive and somewhat impracticable buttressing on the outer walls. Moreover, the rapid erection of arched roofs in any quantity may be difficult on account of the centering involved.

A perfect solution does not, therefore, seem feasible along either of the above lines, and a small amount of steel or timber must consequently be accepted as inevitable in roof construction. Up to the time of writing (April, 1940) the most satisfactory compromise, and one in which the quantities of these materials are reduced to a figure compatible with the supplies estimated to be available, has been on the following lines :

(i) For single huts of small span.—Pre-cast concrete roof trusses and purlins using about 8·25 cwt. of steel, and no timber, per 60 ft. by 19 ft. hut.

(ii) For larger huts, and multiple span huts.—Trusses and purlins built up of strip steel, using the equivalent of about 24 cwt. of steel, and no timber, per 60 ft. by 19 ft. hut.

These designs were, therefore, adopted as standard.

Should supplies of steel be restricted still further, it will be necessary to revise these designs (especially (ii) above) : the most promising line seems to be in the direction of adopting light pre-cast concrete members throughout, possibly pre-stressed or with a high tensile steel, while for single huts more extensive use could be made of novel forms of arch construction.

Roof Coverings.—These do not present any special problems. The common corrugated asbestos sheet roofing is admirable for lightness and its capacity to span up to 4 feet or so between purlins without the use of rafters. Where, however, a flat roof design has to be adopted—as may be the case if pre-stressed concrete members are used—asbestos sheeting is unsuitable, owing to the danger of men climbing on to it. In such cases, and indeed for any roofs of

about 20° pitch or less, a better covering is given by pre-cast hollow concrete blocks: several types of such blocks exist capable of spanning up to 4 feet or so.

Asbestos sheet roofing requires in most huts a lining to give adequate thermal insulation. The normal linings are fibre board and asbestos cement sheeting. Plaster board may be used as an alternative, except in situations where much damp or steam is expected.

IV. Other Alternative Materials and Methods of Construction.

In addition to the investigations described above, a large number of suggestions for the use of proprietary materials and methods of construction were received and examined.

Ignoring those which are hopelessly extravagant in steel or timber (such as some requiring pressed steel sheets) the most promising alternatives may be summarized as follows:

1. *Complete Designs.*

The majority of these are in *concrete* and fall into one of two classes:

(*a*) Pre-cast units for floors and walling, with normal roofing as described above. Such hutting can be dismantled and the units recovered for use elsewhere after the war. Against this somewhat problematic advantage must be set the difficulty of handling units, which are often heavy, and of making a few types of unit serve for many different forms of hut.

(*b*) Cast-in-situ designs, generally consisting of reinforced-concrete piers supporting some form of arched roof, with block or cast-in-situ concrete walling. Though several of these schemes make use of ingenious methods of travelling cradles supporting patent shuttering, the lack of timber and steel for any quantity of shuttering precludes their use on a large scale.

One or two proposals, using *cast iron* instead of steel in the framing of the building, were investigated. In general, however, it was found that approximately fifteen times as much cast iron as steel by weight was required: this, owing to the shortage of raw materials, rules out such designs.

Several suggestions for the use of *tubular scaffolding* framing members were also examined. These, while not reducing the quantity of steel required, make use of existing stocks of tubing, and may therefore be useful to a limited extent. Considerable demands

have, however, been made of such scaffolding as a substitute for steel ribs and purlins in Nissen store sheds, and for other purposes, so that the quantity of scaffolding available for hutting purposes is not great. Moreover, the difficulties which arise in assembling the tubes into trusses and purlins, and in the fixing of roofing and lining, have so far prevented the use of this form of framing to any extent.

2. *Walling Materials.*

There are numerous possible alternatives to the standard 8-inch cavity wall, which may be summarized as follows:—

Outer Skin.

Concrete blocks.
Breeze blocks, cement rendered.
Hollow clay or terra-cotta blocks, fair faced, painted with bitumen emulsion.

Inner Skin.

Breeze blocks with skimming coat of rendering and/or plaster.
Hollow clay blocks, fair faced or plastered.
Composition blocks such as cement, sawdust or wood wool plastered.
Any proprietary plaster faced blocks.

Other types of wall.

11-inch brick cavity walling.
Pre-cast hollow concrete blocks, rendered outside, plastered inside.
Pavement slabs outside, with dished porous concrete slab and plastered inside.
4-inch or more hollow clay or terra-cotta blocks, cement rendered outside, plastered inside.
Inner and outer skins of rendering on Hessian, expanded-metal lathing, corrugated tarred felt.

Any type of walling must, of course, be considered in relation to the hut in which it is proposed to use it and the local conditions of the site. A rendered hollow clay block, for instance, may give a perfectly satisfactory wall for an office or store hut in a sheltered situation, but may be far from satisfactorily weatherproof for a living hut on an exposed site.

No solid walling blocks in a single skin wall were considered sufficiently weatherproof for general use, even where rendered externally. Reliance cannot be placed on such rendering, as expan-

sion and contraction may take place in the blocks, causing hair cracks in the rendering through which moisture may percolate.

3. *Roofing Materials.*

There are few satisfactory alternatives to the normal corrugated asbestos or concrete block roof coverings described above. Tiles and slates are practically ruled out on account of the amount of timber or steel in battens needed for their support, though ingenious suggestions have been made (but not yet tried out in practice) for cementing slates to pulp board.

Thatch-board will form a satisfactory roof covering if painted outside with bituminous paint and plastered inside. The reeds out of which thatch-board is commonly made, however, are of Dutch origin and therefore difficult to obtain at the present time; it is possible though, that thatch-board formed of home-grown reeds may be obtainable in some parts of the country.

V. Conclusion.

The foregoing must not be regarded as an exhaustive discussion of all possible alternatives. Conditions as to the supply of timber, steel, etc., change rapidly and investigations are continually being made into the use of novel materials and fresh methods of construction.

Further, on any particular job opportunities will frequently arise for the use of materials which may be readily obtained locally, but which are not available in sufficient quantities for general adoption. Many of the problems arising from the shortage of normal materials may be solved in this way and in such work the R.E. officer's aptitude for improvisation should find ample scope.

CONTROL OF ENGINEER WORK IN WAR.

(A lecture delivered at the S.M.E., Chatham, by MAJOR-GENERAL SIR PHILIP G. GRANT, K.C.B., C.M.G.)

(Reprinted from *The R.E. Journal* of December, 1920.)

Synopsis. Co-operation Essential—Pre-War Engineer Control—Early War Engineer Control—Later Developments, Engineer Control—Engineer Control at end of War—Military Policy Dominates Engineering—Reaction of Engineering on Policy—Scope of Engineer Control—Methods of Engineer Control—Duties of Engineer Staff Officers—Delegation to Engineer Staff Officers—Classification of Work—Comparison of Methods of Engineer Control—Final Remarks.

Co-operation.—F.M. Lord Haig, reviewing the Work of the Arms and Branches of the British Forces during the War, said in his Final Despatch :—

"An intelligent appreciation of the other man's job is the first essential for successful co-operation."

Taking this maxim to heart we engineers must study the work of other arms and branches as well as our own. And we must not let ourselves become so engrossed in our own point of view that we fail to realize that of others. So we shall go far to secure successful co-operation between the R.E. and other arms. But besides this we must have successful co-operation of engineers with engineers, if we are to develop our full power. However efficient we may be, individually or as units, we shall not produce the best co-operative results if the engineers of armies, corps and divisions work in separate compartments, each entirely free of any higher engineer control. I shall try, therefore, to explain how the technical control exercised by an E.-in-C., Chief Engineers and C.R.E's enables all these groups to act in combination as parts of a single engineer organization, though each group remains under the command of its own particular formation.

Pre-war Control.—In pre-war days the "Division" loomed in the eyes of the British Army as a very large formation. The R.E. certainly did not think of war in terms of armies and corps, any more than the bulk of the Army did. So we devoted much thought to the functions of a divisional C.R.E. but little to those of a corps or army C.E. and still less to those of an E.-in-C. In fact, there seemed to be little necessity for higher engineer control in those days.

Early War Control.—It is not surprising therefore that in the early days of the War, the functions of the E.-in-C. and C.E's in regard to

the engineers of lower formations were not understood either by the army in general or the R.E. in particular. A prevalent impression was that they advised the G.O.C. of their formation upon engineering matters when their opinion was requested and that they regulated the issue of certain engineer stores. Their position was regarded as one of considerable dignity and much leisure. The engineers of formations considered themselves to be self-contained groups with little or no responsibility in engineering to anyone beyond the G.O.C. of their own formation. Too much interest in their doings by the C.E. of a superior formation was to be deprecated. If a crisis arose, such as a shortage of sandbags, he might be useful, as it was up to him to produce them. Any other assistance he might be able to give was gratefully received, but not much was to be expected. *Vide* War Establishments 1914.

Later Developments.—Later on, as the British Army grew in size, and especially when offensives on a large scale began, armies and corps became the only more or less permanent institutions in a given area. Through them flowed a constant stream of divisions attacking or recuperating after heavy losses. So it became increasingly necessary for the larger formations to take control of many matters formerly left to divisions in order to secure continuity of policy. This applied equally to engineering. As a result, the functions of C.E's expanded. They were expected to get much more grip on the engineering work of their areas, and to turn the engineering picture into one connected whole, instead of there being a series of poorly developed snapshots of jobs ever starting but never finished. Lack of continuity was producing disappointing results in out-turn of work compared with heavy expenditure in time, labour and material. C.E's, in the eyes of their Generals at all events, soon ceased to be regarded as mere advisers and storekeepers. They were expected to exercise some measure of control over the engineering of lower formations and, besides, to undertake themselves work of all kinds extending far forward into the battle zone as well as far in rear of it.

For example, in 1916, during the battle of the Somme, a Corps Chief Engineer might find himself held directly responsible for :—

(1) Constructing and completing by a given date three pairs of up and down communication avenues, each about 1,200 yards long, trenchboarded throughout, provided with splinter-proof runner posts at 200-yard intervals and debouching on to the front infantry support trench.
(2) Watching and reporting on the conversion by Divisions of an old German trench into a " Second Line."
(3) Constructing a new " Third Line," wired throughout and provided with tunnelled dug-outs for m.g's, etc.
(4) Recovery, repair and upkeep of the roads through the battle

zone, upon which the whole heavy artillery ammunition supply depended.

(5) Sinking and equipping with power-driven pumping machinery, tunnelled wells in the shelled zone, in readiness for the pipe-lines which were pushed on following up each successive advance.

(6) Construction and maintenance of reservoirs, horse watering points, and water-cart filling points, with miles of pipe-lines buried 3 ft. below the surface.

(7) Buildings, roads and water supply for several Casualty Clearing stations.

(8) Construction of approach roads and " Cours " for ammunition and other rail heads.

(9) Buildings, water supply, etc., for aerodromes and miscellaneous army and corps units and departments, and corps workshops.

At this period of the war the staff of a Corps C.E. normally consisted of 1 staff officer and 3 field engineers, and he probably had permanently under his orders

3 A.T. Co's R.E.
2 or 3 Tunnelling Co's R.E.
1 Co. of a Labour Bn. R.E.
½ M.T. Pontoon Park
1 Infantry Labour Bn.

supplemented by a varying number of Field Squadrons and Co's R.E. and working parties drawn from miscellaneous units, such as the Special Brigade R.E., the Corps Cavalry, Corps Cyclists, Squadrons of Cavalry, etc., etc., and as much horsed and lorry transport as he could persuade the D.A. and Q.M.G. of his Corps to place at his disposal.

Control End of War.—Under the pressure of such circumstances all C.E's of armies and corps evolved their own systems of engineer control, but its extent in any particular case was a variable quantity up to the end of the War, dependent upon the personal and many other factors. No standardized system of control was imposed, so that there was presumably diversity in the 5 army systems, 18 corps systems and 50 to 60 divisional systems. Many disadvantages are inherent in such lack of standardization. I will cite one example: officers, units R.E., and whole formations moved constantly from one command to another. On each occasion a new set of engineering " ropes " had to be learnt, *e.g.*, " What is the procedure for replacing pontoons in this army," " How does this corps run roads," " How are the pioneers dealt with in this division," etc., etc., etc. Some may regard standardization as stifling initiative and pernicious in

other ways, but remember that variations in procedure cause loss of time and increase the strain on individuals. Time is a factor of the utmost importance in war, and increased strain on hard-worked individuals produces increased casualties in *personnel*. Doubtless there were excellent reasons preventing clear definition during the war of the engineer control to be exercised from G.H.Q. and H.Q's of armies and corps and divisions. Also the introduction of standardized methods of effecting such control. Presumably the omission will be rectified in due course by the issue of an official manual regulating both these matters. If in sufficient detail, such a manual will be a useful guide for commanders and staffs in handling their engineers, and to the E.-in-C., C.E's and C.R.E's in the exercise of their functions.

Policy Dictates Engineering.—It is the military policy, programme or plan in force for the time being which dictates the engineering policy to be pursued. The converse can only hold good in very exceptional circumstances. Nevertheless, engineering considerations are nearly always so important that they cannot be safely ignored when some military operation or course of action is being designed.

Influence of Engineering.—If this view is accepted, the following principles should also be accepted :—

(*i*) The engineers should receive information in sufficient time to be able to express a considered opinion upon the engineering aspect of a projected military scheme.

(*ii*) That opinion should be duly taken into account before the scheme is approved for action.

(*iii*) The engineers should draft the engineer instructions involved.

Unless these principles are conceded and acted upon, control of engineering in war is rendered difficult, and success in the engineering part of a scheme cannot be guaranteed. At the same time, we must not be disappointed when our views do not always carry all the weight which we think they should. The outlook of a G.O.C. formation is higher and broader than ours. He has to balance our pros and cons against others unknown or imperfectly known to us, and will often come to a decision adverse to our views. It is for us in such a case to accept his decision loyally, and do our utmost to carry out the engineering part of his scheme to a satisfactory conclusion.

Scope of Engineer Control.—Clear definition of the matters which can be appropriately assigned for control in the engineer channel is necessary. They are :—

(*i*) Strict adherence in a lower formation to the engineering policy prescribed by the command of a higher formation.

(*ii*) Strict adherence to the order of urgency prescribed by that command.

(*iii*) Non-diversion of labour, materials, or transport to engineer work outside the prescribed policy—*except* in case of urgent tactical necessity.
(*iv*) Strict adherence to standard specifications and plans.
(*v*) Issues of engineer tools, plant and materials.

It should be clear from the foregoing that engineering control deals only with technical matters, supplementing the chain of military command so as to ensure that all engineering in progress is in conformity with the expressed will of the commander. Units R.E. cannot of course be moved under engineer orders—movement orders must be issued by the staff. But allotments of engineers, labour, and transport should be made on engineer recommendation. This amounts to a 6th " Principle."

Methods of Control.—Effective engineer control within the limits above defined can be achieved by a combination of the following :—

(*i*) Engineer circulars.
(*ii*) Standard specifications and designs.
(*iii*) Engineer instructions.
(*iv*) Inspections.
(*v*) Reports.
(*vi*) Conferences.
(*vii*) Correspondence.

Circulars are much like standing orders. Each deals with some specific matter which is not confidential or secret, *e.g.* : " C.E's staff—distribution of duties," " Periodical Returns and Reports," " Issue of Engineer Stores," " Heavy Bridge Projects," " Water Supply Projects," " Replacement of Pontoon Equipment," " Issues from Army Workshops," etc., etc. They are a guide to procedure. They must be revised to date constantly. New circulars regulating procedure will be found requisite from time to time. Circulars are issued to H.Q's engineers of formations, with spare copies. It is essential to file them in an engineer circular file, kept always to hand for immediate reference.

Standard specifications deal with matters such as designs for :— " Horse Watering Points," " Water Cart Filling Points," " Lay-out of Sedimentation and Filtration Beds," " Mobile Water Points," " Tunnelled Dugouts Battalion and Brigade H.Q's," " Tunnelled M.G. Dugouts," " Plank Roads," " Accessories for Hutments," " Engineer Railheads," " Accessories for C.C.S's," etc., etc. Enforcement of strict adherence to standard specifications and designs is just as important in war as in peace. The fewer the patterns in use, the quicker will work be done and the cheaper as regards expenditure of time, labour and material.

Engineer instructions are secret. They deal with the engineer work

of a specific projected operation or possible contingency. They are issued in numbered copies to H.Q's of formations at the same time as issued to H.Q. engineers of those formations. They quote the G.S. orders or instructions on which they are based. If it is desired to issue an engineer instruction not definitely based on such orders or instructions, concurrence of the G.S. with the proposed engineer circular must be previously obtained.

Inspections should be personal visits of the C.E. himself as far as possible, but he cannot cover all the ground in a large area sufficiently often, so much inspection work has to be done by members of his staff who make verbal or written reports as necessary. Adequate motor transport must be allotted to engineer H.Q's of all formations if these important duties are to be performed efficiently.

Reports should be cut down to the minimum. It is better to see things for oneself than to read about them. Certain progress reports, however, cannot be dispensed with. Sometimes, as during an advance, reports showing the restoration of roads and bridges must come in daily in order that the H.Q. engineer situation map may be kept up to date. Other progress reports will probably deal with matters like " Defences," " Bridge and Road Crater Mines," " Water Supply," " Pillboxes," " Tunnelled Dugouts," etc., etc. Standard symbols to be used in maps should be prescribed to facilitate compilation at H.Q., also standard forms and headings in written reports.

Conferences of C.E's, C.R.E's, etc., are best limited to explanations regarding the engineering to be carried out during a projected operation, or of some possible contingency. Unless this is their *raison d'être*, large conferences are apt to degenerate into rambling discussions arriving at no decision. Specific points requiring elucidation can generally be settled better at a small meeting of the few concerned in that particular matter. A record of decisions made at a conference must be issued promptly to those concerned, unless the issue of an engineer instruction follows the conference. C.R.E's can order the attendance of their unit commanders but C.E's must obviously arrange attendance by request.

Correspondence includes the telephone, telegrams, letters. Telephone calls from a lower formation should be made in the first instance on the particular officer of the superior engineering staff concerned in the matter in reference. If not satisfied, the C.R.E. or C.E. should call up the C.E. by name. This procedure acts as an S.O.S. signal or safety valve for use in emergencies. Letters are apt to fade into oblivion very rapidly in war. Matters required for future quick reference are best embodied in circulars.

Liaison must not be overlooked. Touch should be kept, not only with R.E., but also with commanders, staffs, and others, by informal visits to their H.Q's. Important matters come to light on such

occasions which may be otherwise overlooked. It is also much easier to conduct business satisfactorily between individuals personally acquainted with each other.

Duties of Engineer Staff.—Effective engineer control is facilitated by careful distribution of duties among the members of one's staff, and as already stated it is important that this distribution should be made known to the engineer staffs of lower formations by the issue of a circular. A C.E. or C.R.E. requires time to ponder, to foresee and to plan ahead. He must also be out and about constantly or he will be out of touch with men and matters. To secure this leisure he should leave details to his staff, dealing, himself, only with the larger questions and matters of policy. He must give full power to his staff to deal with ordinary business on their own responsibility. The senior engineer staff officer should act as deputy C.R.E. or C.E. Deputies should know everything there is to know about current questions, and see, as far as possible, everybody and everything that their chiefs do. They should know their seniors' views and intentions and have full power to act for them in their absence except in questions involving a new policy, which should be reserved for their C.E. or C.R.E.'s decision unless too urgent to await their return. The other members of an engineering staff should be regarded as the administrative heads of their respective branches. If there is a bridging officer, for example, he discusses projects with the C.E. or C.R.E. concerned, makes recommendations to his own C.E., and when the project has been approved he deals with all subsequent details without further reference to his C.E. He is not an executive officer, and should never have engineer units placed under his orders, though he should constantly visit work in progress, and act generally "for the C.E." verbally and in writing. The water supply officer's duties are similar, viz.: Examination of W.S. Projects; Recommendations; Regulation of Details; Inspection of Work in progress, but no executive charge. A C.E. or C.R.E. can easily keep touch with the work proceeding in the different branches of his office by glancing daily at the office copies of letters and messages dispatched and by short interviews with the members of his staff. A C.R.E. of army or corps troops is an executive officer. He commands and controls the work of his own units and should have his own area, workshops and stores depot, in stationary warfare. He should be in executive charge of the army workshops and parks, taking orders as regards policy of manufacture from the C.E. personally and orders as regards issues from the S.O. for stores as representing the C.E. Situations sometimes arise in which it is necessary for a C.E. to take under his own direct control engineer units nominally at the disposal of his C.R.E. army or corps troops. The C.R.E. may not be able to supervise work because it lies so far forward and he has much work in progress in his back area. In such a case, the C.R.E. and the

units concerned must be informed that the latter are temporarily placed under the C.E's direct control. During the war, engineering staffs and C.R.E's of army and corps troops could seldom develop their full power of work owing to lack of personal motor transport facilities.

Delegation.—The only way in which a C.E. or C.R.E. can avoid the paralyzing effect of masses of detail is by delegating definite responsibilities and powers to his staff and to his C.R.E. corps or army troops. No officer R.E. can be efficient unless he knows how to trust his subordinates and work them to their full capacity. At the same time he must be careful to keep the main threads in his own hands, otherwise "delegation" degenerates into a condition of affairs commonly called "The tail of the dog wagging its head."

Classification of Work.—The old slipshod statement that work "will be carried out under engineer supervision" is quite out of date and should never be used when co-operation of engineers with other troops is meant. Works in the field are either

(*a*) Engineer jobs, or
(*b*) Contract jobs.

By the latter I do not refer to civil contracts such as are entered into on the L. of C. The difference between the two is that in an engineer job the R.E. are entirely responsible, whereas in a contract job the commander of a brigade, a battalion, a company, or some other unit is entirely responsible. Portions of a big job will often have to be executed by both these systems simultaneously. Erection of a heavy bridge may be cited as a typical example of an engineer job. Here the engineers do all the technical work, having under their direct control any auxiliary labour required for carrying material and gear to site and so forth. Tunnelling is another example.

A typical contract job would be the construction of trenches and entanglements in a rear defence zone. The R.E. may perhaps roughly indicate by a furrow in the ground the approximate location of the trenches and approaches. They may perhaps peg out the location of tactical wire swept by M.G. fire; dig a sample length of model trench and indicate the style of revetting. But some unit commander should be entirely responsible for exact siting of trenches and for pushing on work in accordance with a plan and specification provided for his guidance. Officers R.E. would visit the work from time to time to assist in any way possible. A few Sappers might also be placed at the commander's disposal to work under his orders. Meanwhile the units R.E. detailed to work on the scheme push on with command and observation posts, tunnelled m.g. emplacements, concrete pill-boxes, and so forth. Any supplementary labour working with them would be entirely under engineer orders. Before a C.E. or C.R.E. decides how a certain job should be classified, he must

appreciate correctly the amount of engineering involved. The classification allotted must be clear to those concerned. Haziness on the subject leads to divided responsibility, friction and frittering away of one's engineers. For example, an unskilled labour unit, plus seven or eight Sappers, cannot make a job of repairing a badly shell-pitted, water-logged road. If work is exposed to shell-fire, it is desirable to make it an engineer job even though it seems hardly necessary from the engineering point of view. In such circumstances the R.E. have a naturally steadying influence upon the labour units that may be working with them. They have *esprit de corps* behind them.

Comparison of Methods of Control.—The value of well organized engineer control and co-ordination may perhaps be shown somewhat more clearly by comparing an earlier and a later stage of development of army engineer control. An offensive is projected in each case. In the *earlier* example we find something of this kind. A.H.Q. operation orders and instructions hardly refer to engineering. The C.E. is quite ready as regards certain work, which will be under his direct control—but he is opposing an agitation by a certain branch to place some of his engineer units under their orders forthwith days before "zero." Such proposals are apt to crop up repeatedly, to the disgust of any C.E. or C.R.E. who appreciates the A B C of engineer control. The C.E. is not in agreement with the arrangements of some C.E's of corps, especially a case in which labour provided for engineer work has been handed over for ammunition supply work. Co-operation as between divisional, corps, and army engineers relieving each other on partially completed work seems to be somewhat hazy. Some C.E's of corps know very little about the engineering programmes of their divisions. *Liaison* work, right and left, seems weak, especially in the divisions. One division will use its engineers for the construction of strong points under brigade arrangements. Another will devote them to improvement of roads and communications. The next proposes to employ them on strong points and improvement of communications under divisional control. There are different policies all along the line. The corps engineers are to be chiefly employed on road restoration but not in close touch with the army road engineers, so that the latter express fears as to whether the work of the corps engineers will accord with their practice when they come to take over from them as the advance proceeds. Briefly put, we may say that the separate compartment system is in full swing and co-operation of engineers with engineers leaves much to be desired. In the *later* example, the engineering picture is clearer. A.H.Q. staff instructions prescribe that restoration of communications is to be first in order of engineering urgency and a map has been issued defining certain roads as army priority roads, viz., roads which must be made fit for heavy traffic promptly

as the advance proceeds, in order to secure lorry routes for supply and ammunition services, etc. From this map it has been possible to decide the bridges which have to be restored. Heavy bridge projects have been prepared by corps and approved by C.E. Army, who has had the materials and erecting gear sent up from the base direct to C.E's of corps and supplemented their transport by certain special army bridging lorries and M.T. and horsed pontoon wagons. An army Engineer Instruction has been issued which reads somewhat as follows :—" With reference to G.S. Secret Instruction — of —"

Divisional engineers are responsible for clearing army priority roads of obstructions and rendering them fit for horse-drawn traffic. Temporary bridges must keep clear of alignment of permanent bridges to be erected by corps engineers.

Corps engineers are responsible for further clearance of A.P. roads, including road-side drains, water courses, and for filling craters. They will make these roads fit for lorries and heavy artillery, using any material available locally, such as timber and masonry from buildings, and road slabs when this method is unavoidable. They will also undertake erection of all heavy bridges on these roads.

Army engineers are responsible for complete restoration of A.P. roads, using road metal and rollers.

Forward boundary of army road engineers will move forward from day to day, so as to be 10,000 yards from the front line shown on the daily army situation map.

It must be noted that though specific road and bridge tasks have been assigned in the foregoing instruction, which must be performed, the corps and divisional engineers will certainly have other road and bridge tasks necessary for tactical reasons. In practice, tasks are not definitely allotted until the whole engineering situation has been thrashed out and distribution made to the best advantage of the labour, transport and material available. Corps and divisional commanders will, therefore, have had an opportunity for considering whether their engineers are likely to be overloaded by the tasks proposed to be allotted to them for army reasons, and, if necessary, representing their case for modification of plan or increased engineer assistance. Before passing on, we should note the necessity for keeping in each formation a reserve of engineers and material to meet unforeseen contingencies; some labour and transport should also be kept in hand if possible.

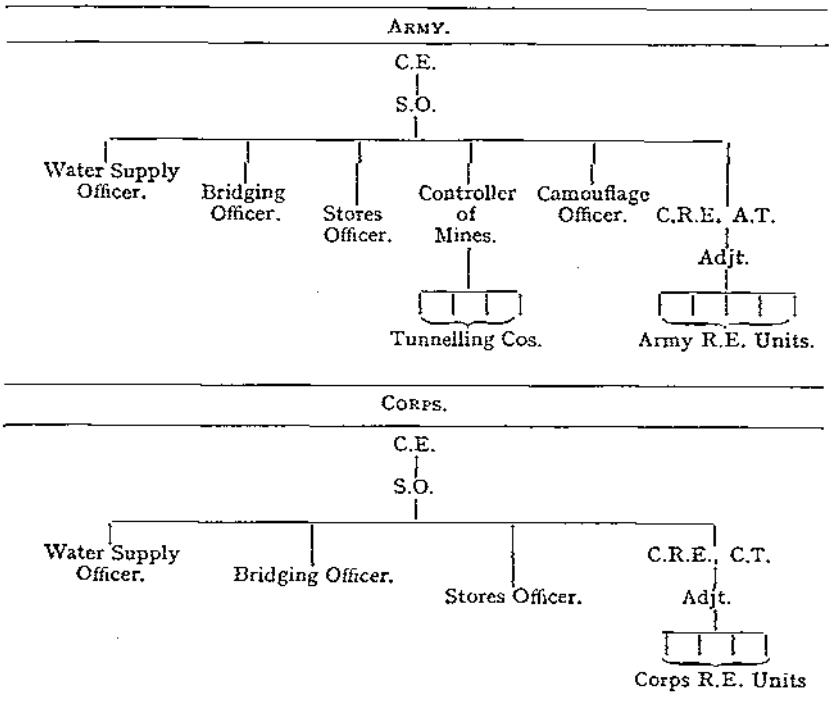
Final Remarks.—Summing up to the subject of the lecture, I think that efficient Control over Engineer Work in War by Engineers-in-Chief, Chief Engineers and C.R.E's, in their respective spheres depends upon the following :—

(*i*) Possession of that intelligent appreciation of the other man's job which Lord Haig considers to be essential.

(*ii*) Adequate previous experience of engineering under varied conditions.
(*iii*) Clear official definition of their responsibilities.
(*iv*) Standardized methods.
(*v*) Due delegation of duties.
(*vi*) Adequate transport for engineering staffs.
(*vii*) Cordial relations between the many individuals of high and low rank in all branches of the service, who can do so much to ease one another's burdens if mutual goodwill subsists.

ENGINEER STAFFS.

1918.



PUBLIC ADDRESS EQUIPMENT.

By MAJOR W. H. WARING, R.E.

(*Concluded.*)

VIII.

It is an unfortunate fact that reproduced sound is seldom, if ever, the exact replica of the original that it should be, and it may be as well to mention what fidelity of reproduction is needed and where it may go wrong.

The audible scale of sound frequencies extends from about 30 cycles per second to about 20,000 cycles per second, the limits not being very definite. It is seldom essential and often not desirable to reproduce the whole of this range. The ear's sensitivity is highest in the neighbourhood of 1,000 to 3,000 c.p.s., tailing off above and below. Middle C on the musical scale is 264 c.p.s. and doubling or halving the frequency means going up or down an octave.

Speech covers a considerable part of the audible range, but the frequencies which make for intelligibility, defining the consonants and distinguishing the vowel sounds from each other, lie in the upper middle part, from about 1,000 c.p.s. upwards. The lower frequencies contribute body but not intelligence, and in whispering one does perfectly well without them. The ordinary telephone, which covers some 300 to 3,000 c.p.s. only, loses nothing but natural effect by its lower limit, though its upper calls for the " three-fife " technique of the operator, and other expedients for taking the doubt out of consonants. P.A. reproduction should go up to 6,000 or preferably 10,000 c.p.s. for perfect clarity.

Musical reproduction should go down as low as possible in order to include the whole bass, without which it is thin and unsatisfactory. Technical difficulties set a limit, but good reproduction down to 150 or even 100 c.p.s. is fairly easily obtained and will satisfy any but the most critical. At the other end of the scale, the highest audible frequencies include the overtones, which give the various sounds their individual character, and they should be reproduced at full strength for the best results. Wireless reproduction often has to be limited to 4,000 to 5,000 c.p.s. in order to avoid interference from the transmitter on the next wavelength, and attenuation may start much lower. The result is a general " woolliness " of tone, and such instruments as flutes and violins sounding much alike. The notorious

offensiveness of the canned soprano voice, which shorn of its delicate overtones becomes a mere formless shriek, is an example of this effect. Ideally, full value reproduction up to at least 10,000 c.p.s. should be available, with means provided for cutting down the upper register when necessary.

The sound on its way from microphone or gramophone pick-up to the outer air once more may get distorted in a number of ways. Amplitude, or harmonic, distortion occurs when the shape of a sound wave is changed as it passes through the amplifier owing to non-linear behaviour on the part of the valves. The result is that the original sound has added to its harmonics, or spurious noises, whose frequencies are multiples of those in the original. The quantity of spurious sound can be measured and expressed as a percentage of the whole. The term " undistorted " is generally taken to mean not more than 5 per cent of harmonic distortion, an amount which is fairly inoffensive. When this form of distortion is very bad it can sound just as though something is rattling in the loudspeaker, particularly accompanying loud low notes. When less serious it produces " blasting," a hoarse effect on loud sounds and a shrill harshness in the upper register. A set which sounds less objectionable when the tone control is turned to " soft " or " mellow," thus cutting out some of the false harmonics as well as the true high notes, is a self-confessed amplitude distorter. Serious distortion of this type is unpardonable nowadays unless there is some fault in the amplifier, or unless the equipment is being asked to deal with a larger volume of sound than it should.

Frequency distortion occurs when the various audible frequencies are not reproduced at their correct relative strengths. Some effects of this have been mentioned above. A certain amount of it is inevitable in practice, and some is often produced deliberately for various reasons. When it is unintentional the loudspeaker is the chief offender. It may make the reproduction sound boomy, shrill, tinny, woolly, according to the form it takes. In some bad cases one can hear an undue emphasis on some notes and a suppression of others. This form of distortion cannot be expressed as a simple percentage, and the performance of apparatus is best indicated by a curve of relative response plotted against frequency. With certain reservations, the flatter this is the better.

Phase distortion is fortunately less important, as it is a controversial matter over which experts wrangle. It occurs when the various components of a sound wave are shifted in phase relative to each other. It is probable that, in conjunction with certain forms of frequency distortion, it is responsible for bad reproduction of transient sound and lack of " attack " in music. Incidentally, it can also afflict a television signal, having a bad effect on the picture.

Finally, there is what has been called scale distortion, a form of

frequency distortion, which is not due to the apparatus at all, but to the peculiarities of the human ear, and here it is that the tone controls come in. As already mentioned, the sensitivity of the ear is greatest about the middle of the audible range, tailing off to zero at the extreme ends both high and low. The eye behaves in rather a similar way, being most sensitive to yellow light and less so to blue and red. When a coloured scene is viewed in a dim light, only the yellows stand out from the general greyness, but in a strong light the reds and blues may appear as bright or brighter. The relative brightness of the colours varies with the intensity of illumination. Just so with the ear, the relative loudness of various pitches varies with the general level of loudness. If a complex sound is reproduced with perfect accuracy and free from frequency distortion, but heard louder than life size, the lowest notes, and to a lesser extent the very highest notes, will sound too loud compared with the middle register. If it is heard softer, the high and low notes may disappear altogether. Only if the reproduction is heard at about its natural level will it sound right, and failing this the bass in particular should be cut down or boosted up by means of the tone control as the case may be. It should be realized that, although the volume of noise emitted by a P.A. loudspeaker is always greater than that emerging from the mouth of the announcer, the loudness at the ear of the hearer may be greater or less than it would be if he were listening to the original in the ordinary way, and either case may apply. The distance between hearer and loudspeaker comes into it, and where the audience is much scattered it is not possible to get the scale distortion correctly compensated for all the members of it.

In practice, the tone controls do more than merely correcting scale distortion. Speech is generally reproduced louder than life size, and consequently bass cut should be applied, to get rid of the leathery boom so often heard. In addition to this, the low notes in speech use up most of the power and convey none of the intelligence, and a given amplifier may be able to produce more useful noise if they are cut down further than required for a natural effect. The high notes, on the other hand, contribute distinctness, and boosting them may make the reproduced speech actually more intelligible than the original, even if it sounds a bit odd. The top control should be turned up until d's, t's, b's p's, etc., are incisive and well distinguished from each other, but not so much so as to make the sibilants hiss excessively. If this treatment produces queer " shishing " sounds which defeat its object, it indicates inter-modulation, which is another manifestation of amplitude distortion. Sibilants, sounding like th's are a sure indication of insufficient top.

Reproduced music, on the other hand, is often heard at less than life size, and bass boost will be necessary to correct the scale effect. Still more of it is required when the music comes from a record,

because, owing to the limitations of recording, the bass is not present at full strength on the disc. At the same time, if one is using a horned loudspeaker with a high cut-off frequency, bass boost is somewhat futile, since it only means using up most of the power of the amplifier making noises which will not be heard. As often as not the top will need to be cut, even at the cost of musical quality, in order to get rid of the scratch of the needle, particularly if the record is worn. Non-scratching types of needle do this without the aid of the tone control.

It will be seen from this why two separate tone controls, for bass and top, each capable of either cutting or boosting, are desirable. A single "tilting" control, giving top cut and bass boost when turned "down" and vice versa when turned "up", is fairly useful but not so good. Many single controls, particularly on domestic wireless sets, are capable of top-cut only, their chief use being to cut out radio interference at the cost of top notes. When a volume control is described as "compensated" it has a bass tone control linked with it, on the not always justified assumption that the compensation needed for scale distortion depends on the volume setting.

IX.

With luck a good P.A. equipment will give long service without trouble, provided it is reasonably treated. But it is liable to develop defects in use, and the cause of many of them can be guessed at from their audible results.

Valves do not last for ever. Like electric lamps, they have an expectation of useful life of about 1,000 hours. They do not fail suddenly, as a rule, but their performance deteriorates gradually, giving rise to low power and audible harmonic distortion. Sudden failure is not unknown, however, and they may get broken, so that a spare set of valves should be kept in case of emergency. A valve should always be replaced by one of the correct type, and there are sure to be a number of different types in a set.

Harmonic distortion and loss of power, together or separately, may be due to broken connections or short circuits or broken down resistance units in the amplifier, and occasionally to a low supply voltage. Foreign matter in the mechanism of the loudspeaker, fouling the movement, can produce similar noises, and so can a diaphragm damaged or a moving coil displaced by a blow, or joints either not airtight or not mechanically tight between the sections of the horn. Or a damaged microphone or gramophone pick-up may be responsible.

Hum due to the mains supply is always liable to creep into the reproduced sound. When it arises in a set formerly free from it, the commonest causes are failed smoothing condensers or broken

connections causing some part of the amplifier which should be " earthed " to cease to be so.

Crackling and fizzing noises, unless due to a carbon microphone being mishandled, indicate that electrical interference is being picked up. It may come in with the mains supply, but a good set should be proof against this. It may be radiated from neighbouring electrical machinery or wiring, and this will be encouraged if the microphone or gramophone cables are unscreened, or if the screening is not continuously bonded through to the amplifier. Earthing the amplifier is often a palliative.

Various odd noises occur if for any reason the later stages of the amplifier improperly affect the earlier stages. The commonest of these is known as " motor-boating," instantly recognized when heard, and the commonest cause is a broken-down decoupling condenser. A replacement valve of the wrong type sometimes produces it.

Condensers have no business to fail as often as they do, but many manufacturers are stingy in the factor of safety they allow, and they are frequently the weakest part of the whole equipment.

Complete silence is the most difficult sympton to resolve, but it is often due to nothing more abstruse than failure to make some connection in input, output or supply lines. It may also be caused by one's falling into some booby trap, such as using a carbon microphone without a supply of polarizing current, or a fibre needle in a needle-armature gramophone pick-up. Any fuzes should be looked at before going further.

The precautions in handling necessary to avoid trouble are not elaborate, provided the set is well designed for its purpose. All knocks should be avoided as far as possible, and the various components protected from dust and damp. Out of doors, the loudspeaker must generally be in the open, but it is a wise precaution to mount the rest of the equipment under cover if possible. The amplifier has a good deal of heat to dissipate, and its ventilation arrangements should be respected and not covered up in an overzealous attempt to protect it. When working, it will keep itself dried out fairly well, but it should be protected when switched off.

Hornless loudspeakers are mostly not intended to be exposed to the weather, but horned ones are generally designed for it. The latter type often have " pot " units detachable from the horn, which should be taken off and capped to keep out dust when not in use. If a pot unit has a gauze in its mouth, this should be kept slightly oily to repel moisture. At all costs, loudspeaker movements should be kept away from magnetic dust, which gets in never to come out.

Carbon microphones will stand most vicissitudes, since they are mechanically robust and can be to all intents and purposes hermetically sealed. The moving coil pressure type has delicate moving parts and fine clearances, making it more easily damaged,

and there is generally a way in for moisture. The velocity type, having to be open both front and back, is more vulnerable still, and its inner parts are even more delicate.

The flare ends of horns are liable to get dented with rough handling. They should be bent back to shape, or performance may suffer.

X.

One of the major obstacles in the way of getting good results is the difficulty of getting the announcer to use the microphone properly. Since the man in charge of the set is likely to be a sapper or lance-corporal, and the announcer may be a lieutenant-colonel or upwards, or worse still a warrant officer, the difficulty is a real one.

The chief fault is speaking too close to the microphone, as though it were a telephone mouthpiece. Most microphones are fully loaded by quite a quiet tone of voice at a distance of a foot, and it is generally better to stand back three feet or more and speak up in proportion. This sounds much more natural than a mutter vastly magnified, there is less noticeable scale distortion, and accidental noises such as breathing and lip licking form a small proportion of the whole. Making too much noise into the microphone merely overloads it and produces amplitude distortion.

There are times when a part of the audience may be able to hear the announcer direct as well as via the loudspeaker, and the effect is the same as that of a bad echo. This must be avoided by using a low tone of voice at a range of a few inches, when it will often be found that better results come from talking across or over, rather than into, the microphone. Carbon microphones in particular object to being breathed into.

Another popular vice is clutching the microphone stand. This looks well on the pictures but sounds bad over the loudspeaker, as well as being quite unnecessary. The microphone should be left severely alone and not touched at all.

Papers should be held away from the microphone, and not rustled in its face or, worse still, allowed to brush against it. This can be avoided by standing slightly sideways.

If the microphone is hung a few inches above head level it is less open to abuse than if it is on a stand, as well as being less in the way.

Announcers vary in virtue, both as to habits and as to quality of voice. Experience shows that people with well-developed parade-ground voices are not good. Force of habit is too strong for them, and in any case there is little help that a moderate powered amplifier can give them.

Many novice announcers are attacked by "microphone fright" at the critical moment, and some, hearing for the first time their

own voices coming back to them possibly a syllable later, stop to listen to themselves and lose the place.

From all points of view it is a good thing to have a trial run of any set-up before a public performance is given.

The same elementary rules of speaking should be observed as when mechanical aids are not used. Speech should be slow and distinct, with clear intervals between phrases, and particular attention should be paid to keeping the voice up on final syllables. An even loudness of voice, but stopping short of monotony, and a constant distance from the microphone, contribute to good results.

It should be remembered that such remarks as "This way," "on my right," etc., emerging from a loudspeaker, or worse still from several, seldom succeed in their object.

XI.

The following are some details of the set in use at the S.M.E. and some remarks arising out of a short experience with it.

The amplifier is of the A.C. type, with a rated output of 15 watts undistorted. All valves are triodes, and the output stage is push-pull, class AB. It is housed in a pressed steel ventilated case, and is reasonably stout and weatherproof.

There are two input channels, one for microphone and one for gramophone. The former, intended for a carbon microphone, is provided with polarizing current from a small rectifier circuit built into the amplifier. The microphone input uses all the amplifying stages, but the gramophone input cuts out the first, and is connected to the grid circuit of the second. The two inputs are controlled by a cross-fading volume control, which allows one to use either but not both. There is no provision for mixing inputs.

Two independent tone controls are fitted, one for top and the other for bass, and there are two switches, one main and one H.T. only. The purpose of these has already been explained.

All smoothing is done by chokes in the amplifier and there is no provision for energizing loudspeaker field coils. The output transformer is included in the amplifier, and there is no ready means of altering its ratio.

The set has two loudspeakers, a 6-foot projector and a vertical horn diffuser. The two horns are the same and the latter can be used as a second projector if mounted horizontally with the deflector removed. Either of them can take the full output of the amplifier, and the speech coils are the standard 15 ohms. Thanks to the triode output valves, it is possible to use either loudspeaker alone or the two in series on the same transformer ratio without any bad effects from mis-matching.

The microphone is a miniature transverse current type with a light telescopic stand.

The gramophone unit is separate, with a clockwork motor and piezo-electric pick-up, housed in a suitcase container.

For use away from the mains there is a 150-watt rotary converter, mounted on rubber in a metal box. It takes over 20 amps from a 12-volt battery, falling to about 14 amps when the H.T. switch is off. A pair of 6-volt 150-amp-hour accumulator units are used with it. They are given a full charge after being used, and then stored on trickle charge until wanted again.

The outfit includes cables for input, output, and supply lines. It has been found convenient to keep the input and output cables on small drums, with their inner ends brought out at the centre, so that they can be run out as far as needed like hose-reels, any unwanted length remaining coiled on the drum. If they are carried about in hanks they get in a dreadful tangle, and the braided metal sheath on the input cable is easily damaged by kinking. Watertight plug and socket fittings are used on the cable ends. The fittings on the amplifier are non-interchangeable, so that wrong connections are impossible.

One 50-foot length of microphone lead and two 100-foot lengths of loudspeaker cable meet all usual requirements. Only short lengths are needed for the other connections. When a longer line to the loudspeaker is needed, any wire will do as long as its resistance is small compared with the 15 ohms of the speech coil.

The set is not as handy for carrying about as some that are available. The 6-foot horn speakers, of course, are distinctly unwieldy. The projector is the more portable of the two, and is the one chiefly used on travelling jobs. A 3-foot wide-angle diffuser or a short-horn type would be a useful addition for these occasions.

The drawbacks of the carbon microphone have already been indicated. This one is rather a noisy specimen of its type.

The shortcomings of the piezo-electric pick-up have also been mentioned. It has been known to be excellent with a recently renewed crystal, but it spends a good deal of its time performing poorly.

A clockwork turntable was chosen to save battery current and do away with supply wires. Apart from the slight inconvenience of winding, its main drawback is that its speed drops very slightly as it runs down, and this is noticeable when marching or P.T. music is being played. The cure for this is continual winding as the record proceeds. Often records have to be run at other than the standard speed, but the speed control has enough range to cover this.

One argument in favour of clockwork is that speed is independent of any variation on the voltage and frequency of the supply. The

rotary converter or load actually produces about 190 volts 42 cycles instead of the normal 230 volts 50 cycles.

The set as a whole is good on speech, which is its primary object, especially when the microphone is well used and the controls set to the best advantage. On music, apart from the shortcomings of the pick-up, reproduction suffers from the deficiency of bass imposed by the type of loudspeaker, though it has given a very reasonable performance with borrowed hornless speakers. With its own diffuser, playing march music on the barrack square, the sound of the big drum is so much subdued that rhythm is lost and step-keeping made difficult. This difficulty has been met by attaching a human big-drummer to the loudspeaker, and the combined effect, once the drummer has had a little practice, was most life-like. A record of machine-gun fire, used to enliven a night exercise, came through well enough to elicit remarks from authority on waste of ammunition, but sounds of bombardment on the same record were less realistic owing to the lack of bass notes.

Occasions arise sometimes for mounting the whole equipment on a vehicle for use on the wheel, and this has been done in two ways on military vehicles. On a 30-cwt. lorry, the projector horn was lashed to the hood members with its mouth just above the driver's left ear (this is a little hard on the driver), and the microphone was used at the extreme rear of the body. On an 8-cwt. truck, the projector was used on its tripod standing on the platform of the truck suitably lashed down and pointing backwards, with the microphone beside the driver. In both cases the volume control could only be turned part way up without causing a howl, but necessary purpose was served. A closed vehicle is best, with the loudspeaker on the roof and the microphone inside.

The set picks up electrical interference only when it is used near D.C. machinery and lines, and when this happens, earthing the amplifier case makes a great improvement. A water pipe is generally the best improvised earth, but a screwdriver pushed into the ground has been found quite effective.

XII.

On rare occasions one may want to put a wireless programme through the P.A. equipment. Sometimes a radio unit is included among the auxiliaries sold with the set, but an ordinary wireless receiver can be pressed into service. No violence to the receiver is involved in diverting the output of its detector, through a blocking condenser, into the gramophone input of the P.A. amplifier, and the receiver itself can be silenced or not as required. Very good results indeed have been obtained in this way from a portable receiver,

which has the advantage that it can be used anywhere without the need for an aerial. An even simpler way, though it is not likely to be so good, is to allow the receiver to play acoustically into the microphone.

A P.A. equipment is as capable of handling the sound part of a talking film as it is of any other of its duties, and many commercial sets are designed with this end, among others, in view. A talking film projector includes a sound head which produces an electrical signal similar to that of a microphone or pick-up. With this as input, the P.A. set is used in the ordinary way with the loudspeakers disposed behind, below or on either side of the screen. It may be that an amplifier not designed for the purpose will have insufficient gain for the rather feeble signal from the sound head, in which case it will be necessary to add a pre-amplifier.

One unorthodox use to which the set has been put is that of an improvised noise-meter. It was required to try the effect of various silencing devices on some portable engines, and a means of comparison less controversial than the human ear was needed. The amplifier and microphone were used in the normal way, but the loudspeaker was replaced by a low reading moving-iron voltmeter whose resistance, 20 ohms, happened to be just about right for the output of the amplifier. On the assumption that the whole thing had a linear response to frequency, which is unlikely, one could say that the power received by the microphone was proportional to that emitted by the amplifier, and therefore to the square of the voltage indicated. The sound level could then be expressed as $20 \log_{10} V$ decibels above an arbitrary zero. The answer is given, of course, not in phons, which are units of loudness to the human ear, and may be described roughly as decibels distorted to suit the ear's peculiar characteristic, but in rather dubious decibels distorted in an unknown manner. A proper noise-meter contains circuits giving a frequency characteristic approximating to that of the human ear, and produces an answer in fairly creditable phons. It was thought all the same that the figures obtained would be good enough to serve as a basis for comparison.

The tests went well for a bit, but after a while the inevitable happened. A modification to an engine which made it undoubtedly louder to the ear gave a lower reading on the voltmeter. What had happened, of course, was that the pitch of the predominant noise had been altered to one to which the ear is more sensitive although the sound intensity may have been actually lower. The noise had been increased in phons, but decreased in decibels. The whole experiment was thus brought into discredit.

A similar arrangement was later a great success as a " try your shout " machine at a children's party.

XIII.

There remains the question of cost. It is difficult to give hard and fast figures, since there is almost as wide a choice of quality and refinement as there is in the case of motor-cars. But a set of the calibre envisaged above, including an amplifier developing from 10 to 30 watts, a microphone, a gramophone unit and a selection of loudspeakers covering ordinary requirements might be expected to cost anything from £50 to £100. A further £20 would include a rotary converter if wanted. £10 per year should cover maintenance if the set is kindly treated, and operating costs are so small as to be almost negligible.

MODERN WELDING SERVICE.

By C. W. BRETT, M.INST.W. (*Managing Director of Barimar Ltd., Scientific Welding Engineers*).

CHANGES in methods of engineering are seldom rapid and anything in the nature of an innovation is examined from every aspect and tested step by step. Thus, if there is general acceptance of a new procedure, it may be taken that the advantages are undeniable.

Welding is a complete illustration of the foregoing, for from the cautious investigation of years ago there has been such whole-hearted request for still wider application, that only those in close touch with the modern practice of scientific fusive engineering can have any complete idea of the scope of such work.

During a period of war the importance of welding is naturally emphasized, particularly as it applies to general maintenance and the efficient reclaiming of parts which might otherwise be scrapped. Wastefulness is a fault that is all too common ; it is bad enough in peace-time, but now it is inexcusable, the more so because welding is never temporary and calls for no concession in the matter of efficiency.

Although it is intended in this article to sketch broadly the lines of present development, particularly in the sphere of repair work, at the outset something must be written regarding similar methods employed for the fabrication of new plant.

It needs little effort of the imagination to realize how rapidly sheet steel may be welded to take the place of a wide variety of castings required for all manner of machinery. Even the first step of shaping the sheet metal is accomplished by the oxy-acetylene cutting flame. This system of fabrication shows to special advantage in cases where only a limited number of units are required, for in this way patterns are avoided. Even for repetition work, in which great strength with reduced weight is required, welding meets the need.

A pertinent example of the foregoing arises in the case of certain Diesel engines, the crankcases and cylinder jackets of which are built up in the manner described, the actual cylinders being in the form of wet liners. On large engines of this type, even the rocker arms operating the overhead valves are often of box section built up from welded sheet steel.

For all work of this kind it is essential that the design be prepared

primarily with a view to fusive needs and is not merely an adaptation of principles dictated by foundry methods, for the two systems of construction have practically nothing in common and it is necessary for the draughtsman to remember the fundamental differences, if the advantages of welding are to be exploited to the fullest possible extent.

Railway work affords many further illustrations of welding progress and although cast steel is being used to an increasing extent for locomotive parts, welding, too, is being employed more and more, particularly in regard to rolling-stock.

There are few readers of *The Royal Engineers Journal* who are not interested in bridge-building to a greater or less degree. During recent years many welded bridges have been constructed and these are notable for their clean design. Over the River Raduza, at Pilsen in Czechoslovakia, there is an all-welded bridge, having a span of 166 ft. The arches were fabricated in five separate pieces, which were finally welded together on the site. With this branch of engineering, as with many others, it is repair work which is of special interest.

It is generally considered that the repair of bridges by fusive means has been more or less confined to the Continent, but actually this class of work is much more widespread. Even so long ago as 1925, some outstanding work was undertaken in connection with the reconditioning and strengthening of the Echuca bridge over the Murray river, Australia. Upwards of 42,000 ft. of welding was completed without any interruption of traffic, although this bridge carries a single railway track and a roadway. Erected in 1878, this bridge was designed originally for a concentrated load of 62 tons, this representing the weight of the locomotives then employed, but in order to deal with the increasing traffic it became necessary to carry engines weighing 118 tons. In addition to this, a footway for pedestrians was cantilevered from one side of the bridge.

In course of time the heavy loading began to tell upon the structure and when a careful inspection was made it was found that several of the cylindrical cast-iron supporting piers were cracked. This trouble was cured either by welding the cracks or encircling the piers with butt-welded steel straps. Rivet stresses in the stringer end connections were relieved by welding the girder flange angles and web splices were welded to the webs wherever this seemed advisable. The lateral bracing was stiffened by a series of steel flats welded in position.

It is not always appreciated that welding can be used with advantage for reinforced-concrete work. It is useful for the fabrication of grids and the construction of shoes for reinforced-concrete piles.

Only a few general possibilities have been touched upon, but it will be obvious that fusive work of the nature described allows of a

material saving in weight, particularly in the case of plate girders. Such units, of uniform depth, require the usual layers of plate, top and bottom, but, of course, all riveting is eliminated and the flanges are welded. Web plates are treated in the same way to give a T-section without the use of angles, thus still further reducing weight.

It is of interest to observe that the flange plates of a welded girder vary in width to provide angles for the fillet welds and they also vary in length to conform to the theoretical strength requirements of the designer. In a riveted plate girder, obviously the flange plates are uniform, bringing about an unnecessary increase in weight.

Plate girders of the hog-back and fish-belly type, once displaced by the uniform-depth girder, have now returned to favour for certain classes of bridge work. This change has been brought about by welding methods in construction with the consequent elimination of angles, admittedly difficult to place in the line of a curve.

A further advantage of welding over any other form of construction is the practicability of making a welded joint at any desired angle without the necessity for planing the edge of the attached plate.

It is of special importance that the type of electrode should be determined with a full knowledge of requirements, for it is most important in connection with bridge work that the welds should have adequate ductility as well as the necessary margin of strength.

It is impossible to give precise information as to the type of electrodes which should be used, for although the correct size and grade are vital to success, the factors which govern the choice are obviously variable. On account of this it is important to emphasize that the more or less haphazard determining of electrodes is to be condemned, as it is one of the most common causes of indifferent welding.

Unless the operator is highly experienced, such questions as the foregoing should be settled by the drawing office and marked clearly on the prints. Electrode-makers are invariably willing to give the benefit of their experience in all cases of doubt; sometimes this is essential on account of the composition of the metal.

Striking progress has been made in regard to the thickness of the metal which can be handled after fracture has occurred; not long ago there was pertinent evidence of this fact. What is reputed to be the largest granite-crusher in this country suffered a serious breakdown. The machine concerned is operated at Penmaenmawr, North Wales, where, located 1,500 ft. up the mountain side, is a powerful plant which reduces blocks of stone, often weighing more than 5 tons, to road-making material in the course of a few minutes.

The largest of the battery of crushers was rendered useless when a side-member of the unit cracked in several places. Some idea of the

size of this machine may be gathered from the fact that the damaged component is formed of a single casting weighing 25 tons.

The fractures extended in several directions, one being over 12 ft. in length and through metal varying from 3 in. to 4 in. in thickness. A welding repair of this magnitude naturally calls for considerable skill on the part of the operators, who, in this instance, were directed by a metallurgical chemist whose calculations were of an intricate nature, for not only was perfect union but accurate alignment fundamental to success.

One reason why this method of repair was chosen was because it permitted reinforcement and there was no assurance that a replacement, which, like the machine, would be of foreign origin, would possess the strength needed to cope with the burden imposed by normal service. In order to conserve time, the operators worked in relays with highly satisfactory results, for the work which has since been undertaken by this crusher has proved conclusively that it possesses a considerably greater reserve of strength than was previously the case.

Equally notable was the manner in which another somewhat similar engineering problem was solved. A firm of electric cable manufacturers, whilst engaged upon important contracts, suffered the misfortune of a breakdown of a 1,000-ton hydraulic press, used for extruding the lead covering of cables of very large size.

The head of this press, which comprises a single casting weighing 15 tons, broke in two pieces right across the centre and through metal which, at some points, is fully 4 in. in thickness. Apart from the need for avoiding delay, which would have been unavoidable had it been necessary to wait for a replacement part, in this instance, too, it was desirable to increase the strength of the broken component, so that there would be no likelihood of a similar failure in the future. Owing to the size of the part, portable welding equipment was used and the result was guaranteed at the outset which, nowadays, is a normal procedure.

When the work was finished the press was submitted to exacting tests, after which it was maintained in constant operation for a week, partly in order to catch up with arrears of output. From the first, however, it was evident that the welding repair had provided increased security against further trouble.

It was an unfortunate coincidence for the cable-makers that, a few weeks later, a second press failed in almost the same manner as the first ; this time there was no hesitation in deciding upon the best means for overcoming the difficulty, not only from the point of view of strength, but also economy, for the previous welding repair had been instrumental in saving several hundreds of pounds, quite apart from the penalties which would have been incurred had the contracts been more seriously delayed.

It may be added that presses, usually of smaller type, are frequently in need of fusive attention, for breakage of the main casting is not uncommon, although it is often the result of error on the part of an operator.

Apart from the magnitude of some of the work carried out recently, scientific welding engineers are anticipating that important developments will result from years of research work conducted with a view to the fusive union of metals having a different coefficient of expansion. Already important success has been registered by the evolving of a relatively simple process for uniting steel to cast or malleable iron. Although the chief object of this method has been to increase the scope of repair work, the advantages offered are so important that it seems probable that the system is likely to influence machinery design in certain directions, a specific instance being the welding of steel bearing housings into the cast-iron crankcases of Diesel engines, the result being to increase strength and rigidity without a corresponding rise in weight.

The repair of boilers and containers provides another important sphere for welding activity. Not long ago, comparative tests were made in connection with two boilers of identical type, both being in need of similar repairs. In one instance, the time-honoured method of riveted patches was used, whilst in the second case, reconditioning was carried out exclusively by fusive means. Quite apart from the fact that in the case of the welding work no trace remained when the job was complete, this sightliness was accompanied by greater strength, but an even more important advantage followed upon the use of butt joints, which were, of course, impossible in the case of the riveted work, which caused ledges that afforded a lodging place for scale with the inevitable sequence of unequal expansion and contraction. In one or two places the boilers showed signs of grooving. In the case of the riveted repairs there was no option but to patch or renew entirely the defective plates. In contrast to this, the welding operator was able to deposit new metal upon the weakened places and thereby restore the original strength, a method which is rapid, inexpensive and dependable.

Boiler plate calls for very different treatment to steel components which, subsequent to welding, must be ground to a high finish and within strict tolerances. Crankshafts are an example of this particular class of work and it is now normal practice to build up worn crank pins and journals by fusively depositing specially hard grades of steel upon the bearing surfaces. In passing, it may be observed that frequently these parts are finished oversize, so that after a further long period of service re-grinding is all that is necessary to restore the original dimensions of the shaft, thus it is not called upon to operate under-size as in the case of an ordinary re-grind.

At one time, steel presented certain difficulties in instances of this

kind owing to surface blemishes in the form of pit marks, which were caused by the affinity of the oxygen in the atmosphere for the molten metal. This obstacle has now been overcome entirely by what is known as the hydrogen-field process. In short, the weld is enveloped in hydrogen, so that contact with the atmosphere is impossible. Not only is pitting obviated in this way, but the quality of the weld metal is otherwise improved, so much so in fact that this process can be employed, with absolute assurance of success, to reunite crankshafts which are actually broken, usually through a web.

In order to substantiate their confidence in the hydrogen-field process, one well-known firm of scientific welding engineers maintained a careful record of some six hundred shafts reunited in this way and varying in size from a few inches in length to marine engine cranks measuring 16 ft. overall. In only one instance was a second failure recorded, but when this was investigated it was found that the second breakage was at a point remote from the weld and obviously due to a flaw in the forging which had not shown itself at the time of the first failure.

The past winter was so severe that it caused an almost record number of frost fractures to the cylinder jackets and heads of all kinds of internal combustion engines. Some of these breakages were most complicated. For example, it was not uncommon for upwards of thirty pieces of metal to be broken away from the parent casting, whilst in other instances there was no external evidence of failure and it was only when the engine was turned that it was discovered that the crankcase contained water and broken metal.

In these days when many cylinder block castings are ultra thin, great experience is needed on the part of the operator to bring about a perfect repair in which reliability and alignment are above reproach. The fact that not one of the many hundreds of frost fractures, which have come to the notice of the writer within the past few months, had been turned down as being impossible of repair under guarantee, is a fact which speaks for itself.

It is not generally realized that furnace treatment is no longer regarded as an essential preliminary to the welding of cast or malleable iron. In the past, this time-wasting and therefore expensive preparation was necessary in order to avoid stresses being set up in the metal, due to rapid local expansion brought about by the intense heat necessary to achieve a weld. In these days the means provided for controlling heat-flow are so successful that muffle furnaces can be disregarded. This results in more rapid completion of the job and a further reduction of the already low cost.

The welding of alloys as distinct from ferrous metals would alone provide sufficient material for several articles, but this interesting aspect of fusive engineering can only be touched upon briefly. Not

only is the aluminium group of alloys amenable to welding, but even those having a high magnesium content, such as Elektron, can be handled successfully. In these days particularly, magnesium alloys are specially important owing to their extremely light weight and surprising strength. Elektron, for instance, is only two-thirds the weight of aluminium and contains 90 per cent of magnesium.

The welding process most usually followed needs normal oxy-acetelyne equipment, but for certain classes of work, such as the fusing of bars and sections in contrast to sheet metal, there is no objection to the electric resistance process, but it is desirable to know the specification of the alloy which is to be welded, so that the wire or rods may be suited exactly to the work in hand. The flux, too, is important, as this varies in relation to the composition of the metal.

Care needs to be taken in regard to temperatures, for magnesium alloys are usually inflammable in the form of swarf or filings. After treatment, it is necessary to remove all trace of flux as this is corrosive, the usual procedure being to wash and scrub the part concerned in a 10 to 15 per cent solution of nitric acid, to which potassium bi-chromate has been added.

The importance of welding in military operations can hardly be over-emphasized. For rapid and dependable repair work it is unequalled and, in these days of mechanization, scientific fusive engineering is an essential part of any maintenance organization.

Obviously only the fringe of the subject has been touched upon within the limits of this brief article, but sufficient has been written to indicate something of the scope of welding activities and their special importance during a time such as the present, when unremitted output and efficiency are common national objectives.

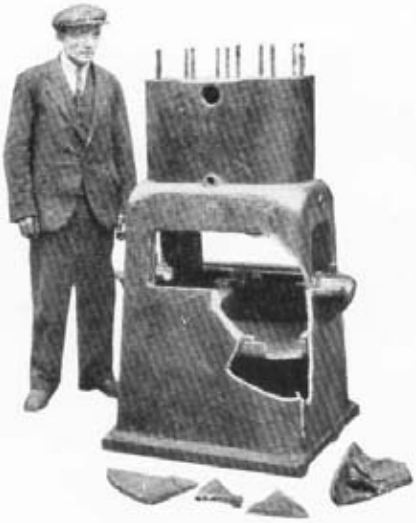


FIG. 1.—Large air compressor cylinder block, with a big piece broken out of crank chamber. One bore was also broken.

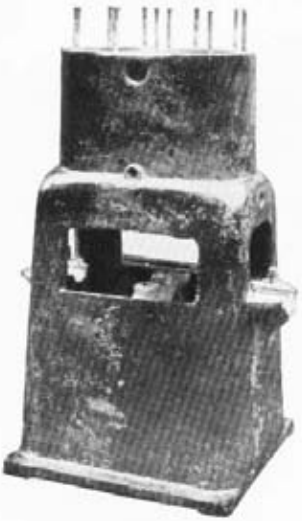


FIG. 2.—All the damage was repaired by welding and the bore cleaned up to original size, to save the expense of a new piston. This repair shows a big saving on the cost of a new cylinder block. (Repaired in the Barimar Welding Works.)

Modern welding service 1 & 2

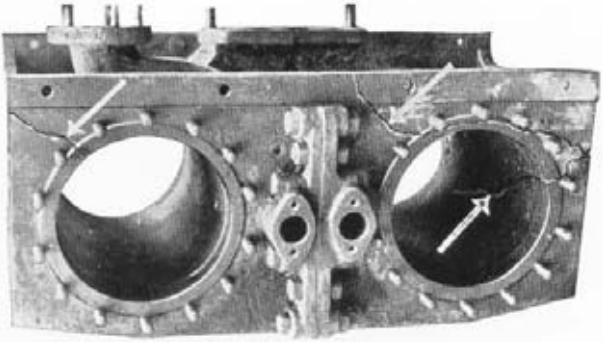
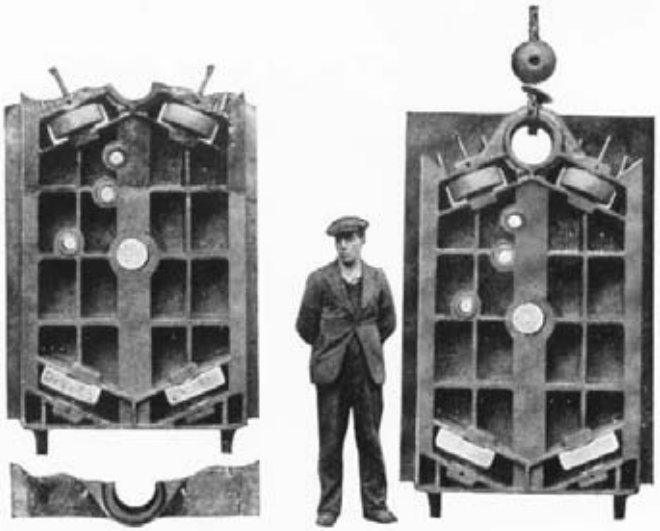


FIG. 4.—Railway locomotive cylinders cracked in both bores. The cracks were successfully repaired by welding and proved perfectly satisfactory in service. Many other repairs of various kinds have been carried out to locomotive cylinders, including building up worn slide-valve faces.



FIGS. 4 and 5.—This is an excavator bedplate before and after repair. It weighed nearly 2 tons, and one end was broken right off. Repairs to excavator and crane bedplates are frequently made by welding. (This bedplate was repaired in the Barimar Welding Works.)

Modern welding service 3 & 4

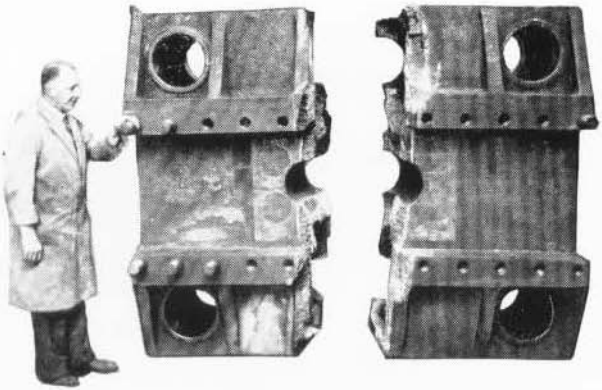


FIG. 6.—One of the hydraulic press heads mentioned in the article. This is the head that was broken in two. It weighs 15 tons.

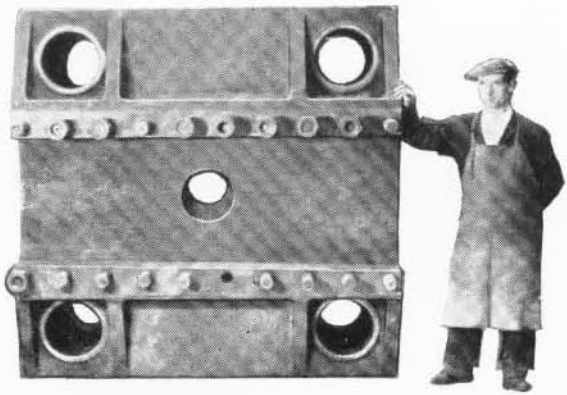


FIG. 7.—This shows the press head after successful repair by welding. The work was carried out at the works in which it is used. Accurate alignment as well as great strength were needed in the repair.

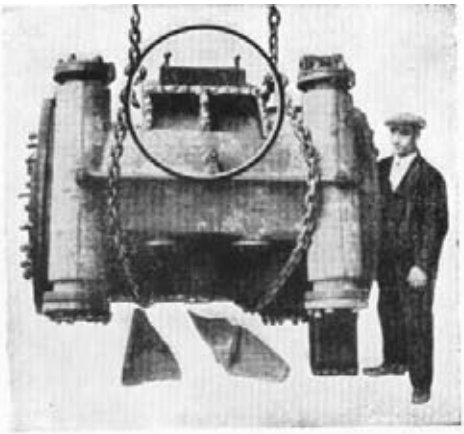


FIG. 8.—Low-pressure steam-engine cylinder, 8 ft. × 7 ft. × 7 ft. The broken pieces shown in the illustration were burst out by steam from the H.P. cylinder. The broken portion of the jacket can also be seen.

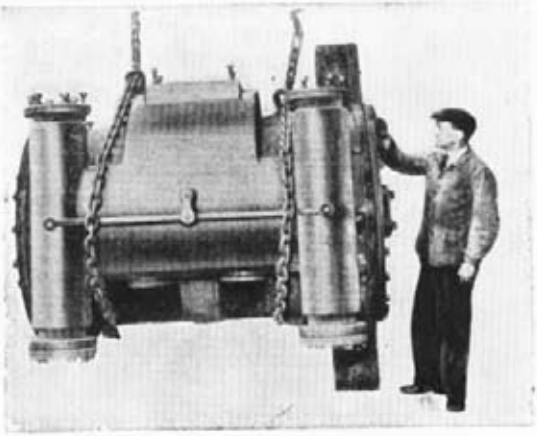


FIG. 9.—The repair was rendered more difficult because of the pressure of the web inside the jacket. In spite of this a successful repair was made by welding at comparatively small expense. (Repaired in the Barimar Welding Works.)

SOME USES OF WELDING AND CUTTING IN THE FIELD.

By MAJOR C. WARREN, R.E.

WELDING was only in its infancy in the war 1914–18, but has made rapid progress since then and can now be depended on to give reliable results, with considerable saving of time and labour where it is properly applied. The object of this article is to show some of its possible uses and ways of avoiding some of the difficulties that may be met.

The two types of equipment best suited to use in the field are, firstly, a high-pressure oxy-acetylene set, and secondly, a portable metallic arc electric welding plant.

OXY-ACETYLENE SET.

The oxy-acetylene set can be used for either welding or cutting, and the equipment is very compact. The necessary cutting and welding blow-pipes, regulators, connections, etc., can be packed in a box weighing about 100 lb., while the gases are contained in cylinders weighing roughly 1 cwt. apiece, and contain 100 cu. ft. of oxygen or 150 cu. ft. of acetylene. All that is necessary in addition for welding are the necessary filler rods and fluxes depending on the type of job in hand. The whole equipment can therefore easily be manhandled to the site of work should this be necessary.

OXY-ACETYLENE WELDING.

Oxy-acetylene welding is ideal for small repair jobs, both in ferrous and non-ferrous metals, and also for sheet metal work.

The welding of mild steel does not, as a rule, present much difficulty, either for repairs or in the fabrication of new articles, except in thick sections when the heat from the blow-pipe is rapidly carried away by the mass of the metal. In this case metallic arc welding should be used in preference.

Cast-iron, owing to its common use and inherent brittleness, is likely to form the bulk of the repairs required. Unless a fracture is so situated within the casting that it is free to contract on cooling after welding, it is liable to crack again near the weld because of its poor tensile strength and ductility. This is illustrated in Fig. 1. If the broken leg B of the framework is welded, the heat of the welding flame will cause the leg to expand and the edges of the crack to be forced hard together. On cooling down after welding the leg B will try to contract again, but will be held rigidly by legs A and C, and

is almost certain to crack again. The trouble due to contraction can usually be got over by pre-heating. If this is done, the legs A and C will expand on heating and will contract at the same rate as B when cooling after the weld is complete. A pre-heating oven can be made very easily from fire bricks as shown in Fig. 2. A sheet of asbestos or steel can be used as a cover, which is taken off for the actual welding. The fuel used should be charcoal, as this does not give too fierce a heat. The heat can be controlled by opening or blocking the gaps left in the lower rows of bricks.

Cast-iron may be successfully welded with cast-iron filler rods or with bronze rods. In the latter case, the edges of the crack need not be melted and the welding temperature is therefore much lower than in the former case; also bronze is more ductile and softer than a cast-iron weld. By using bronze it may be possible to avoid pre-heating, and in any case a much lower temperature is required. It may even be sufficient merely to heat the casting with the blow-pipe before starting the weld. A cast-iron filler rod gives rather a hard weld, which is not good for machining, and should subsequent machining be required it is advisable to use a rod that contains silicon as well as iron, or else a bronze rod.

Brasses, aluminium and its alloys, and magnesium alloys can also be successfully welded with the oxy-acetylene blow-pipe, using suitable filler rods and fluxes. Special fluxes are needed for all metals except mild steel. It is advisable to obtain a flux specially made for the purpose rather than try to make one up.

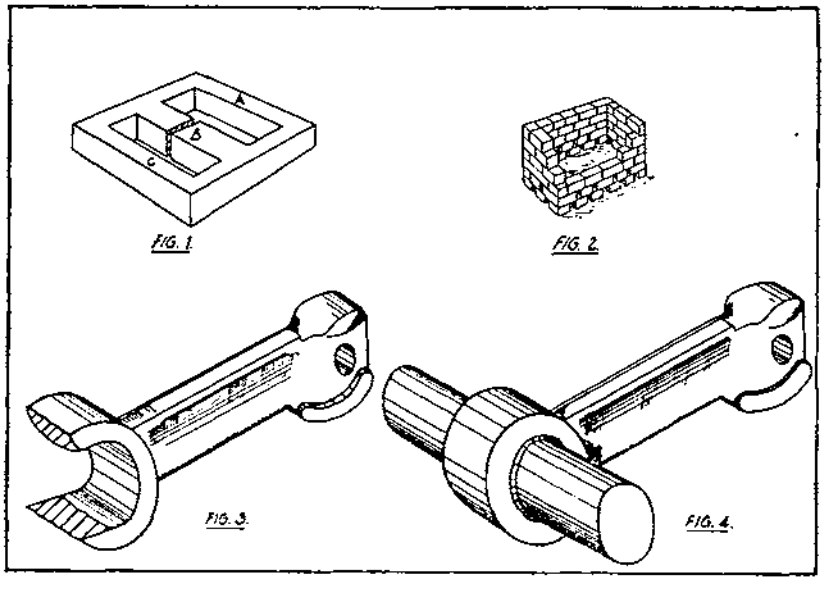
It is not easy to get good results with copper, owing to the liability of oxygen being included in the weld, which is detrimental to the strength. Die castings made from an alloy with a zinc base are also difficult to weld. This is due to the tendency of the metal to collapse as it reaches its melting point. Many carburettors are made of this alloy, and repairs should not be attempted unless the operator has experience of this type of work.

The oxy-acetylene process can also be used for building up broken or worn parts or for depositing a hard-wearing or cutting surface on to a part. Examples of this type of work are building up a broken tooth on a gear wheel, and depositing a hard surface on the teeth of a mechanical excavator. The blow-pipe can also be used for brazing and in some cases for the local heating of parts in order to assist blacksmith's work.

It is not possible in the space of this article to give many examples of the use of the oxy-acetylene set, but a typical repair job is shown in Fig. 3. This is a valve rocker from a small petrol engine. The pin on which the rocker worked had worn and torn its way right through the end of the rocker, which is a drop forging. No spare parts being available, it was decided to repair the broken one. The repair was executed by completely filling up the end of the rocker

with weld metal, and then filing it to shape and drilling out for the pin, which was then refitted as shown in Fig. 4. The whole job took about three hours and has now been in use successfully for several months.

Another typical job recently carried out was the repair of the cylinder head of a water-cooled engine which had been cracked by frost. There were two cracks about 6 in. long on either side of the water jacket. In this case the cracks were drilled at the ends to prevent spreading. The cracks were then roughly " veed " out, the head pre-heated and it was then welded with bronze.



Apart from straightforward welding jobs, other possible uses of the plant are illustrated by another type of repair which is unfortunately too commonly needed at present, owing to the attraction a telegraph pole seems to have for a learner driver. This is a bent dumb iron on a lorry chassis. Where the distortion is not too bad the oxy-acetylene flame has been used to heat the dumb iron so that it can be straightened hot *in situ*. Where, however, there has been considerable distortion of the dumb iron this is not possible. A case of this sort was dealt with by cutting off the damaged part of the dumb iron with the oxy-acetylene cutting blow-pipe, and removing the part to a blacksmith's shop, where it was straightened. The part was then welded back in position, great care being taken over its alignment. This type of repair only takes a few hours and has proved to be entirely satisfactory. The particular vehicle was a badly-needed winch lorry.

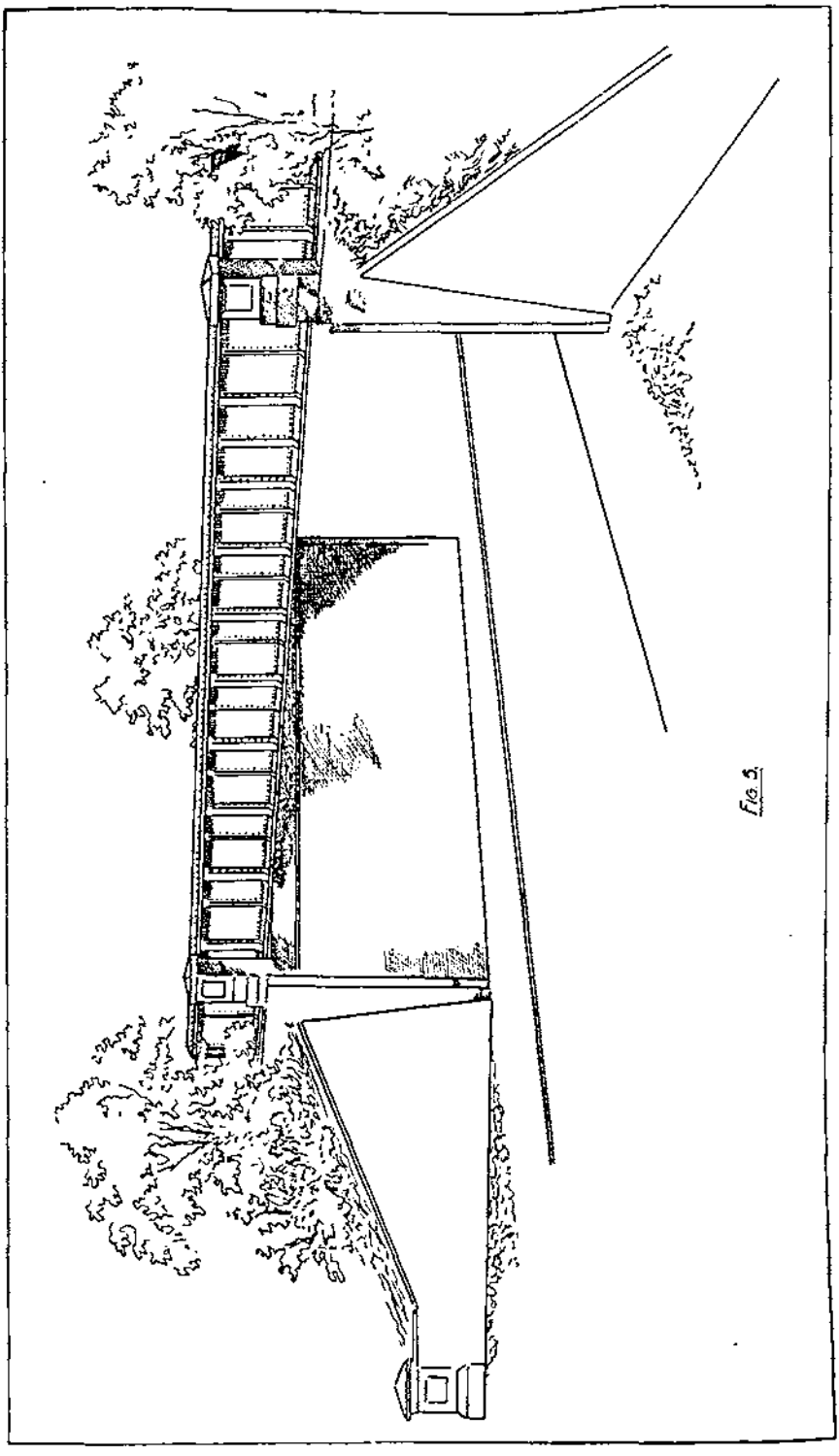


FIG 5.

Oxy-acetylene Cutting.

The oxy-acetylene cutting blow-pipe is very well suited to the rapid cutting of mild steel up to any thickness that is likely to be met. It can be used for such jobs as :—

Cutting off steel parts to length, *e.g.*, R.S.J's.
Cutting parts to shape out of plate.
Cutting the necessary bevels on plates preparatory to welding.
Clearing obstacles such as demolished bridges.
Recovery of steel from damaged or demolished structures.
Cutting out damaged portions of structures preparatory to repair.
Damaging plant or machinery in a raid or before a retirement.

A saving of time and labour will be found to result from the use of oxy-acetylene plant in these cases.

Besides cutting mild steel, the plant can also be used for cutting high carbon and high tensile steel and for cast-iron, although the results are much slower.

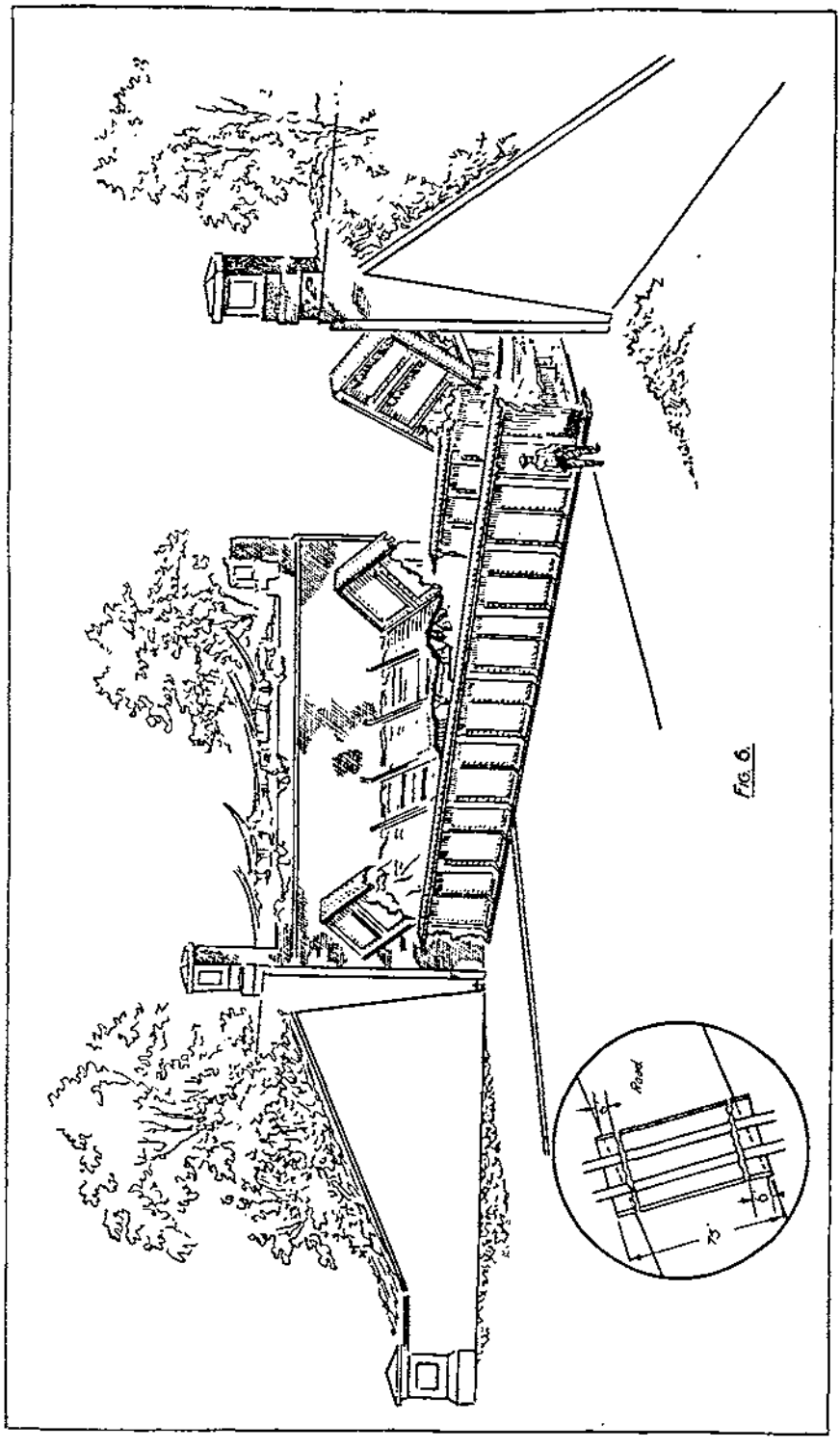
As an example of the use of the plant, it is supposed that the bridge shown in Fig. 5 has been demolished across the road of an advancing force as shown in Fig. 6. There is no other possible route, and the slope of the railway embankment is too steep for vehicles to climb. The bridge must therefore be removed or at least a gap cut in it for vehicles to pass. The bridge is a modern rivetted plate-girder, consisting principally of two girders 9 ft. deep, of which the web is $\frac{5}{8}$-in. thick and the flanges are 2 ft. 4 in. wide by $1\frac{7}{8}$ in. thick over the middle of the span.

To cut a gap 19 ft. wide through the bridge, using one cutting blow-pipe to cut the steel into suitable sized sections and a derrick lorry to remove these, is estimated to require the following time and materials :—

No. of men	6
Time	5 hours
Cylinders of oxygen	6
Cylinders of acetylene	1

The only alternative method of clearing a passage in a short time is by using explosives. Owing to the large quantity required, it will be necessary to cut the steel into pieces of about 4 tons each. These will then have to be dragged out of the way on skidding with tackle or the use of a winch lorry. The following are the principal estimated requirements :—

No. of men	20
Time	10 hours
Guncotton	712 lb.


Roof
FIG. 6.

The use of oxy-acetylene thus gives a considerable saving in energy.

Metallic Arc Welding.

Construction using metallic arc welding is based on two main types of joints :—

Butt welds—for joining plates or sections in one plane.
Fillet welds—for joining lapped plates or sections.

Typical butt welds are shown in Fig. 7. For plates under 3/16th in. no preparation of the edges to be joined is required, but for plates 3/16th in. or over, the edges must be prepared to give a single or double V, a single or double U, a single or double J, or a single or double bevel joint. If it is not possible to prepare the edges beforehand in a shop, the V or bevel type of preparation can be done on site by oxy-acetylene cutting, a portable grinder or a pneumatic chisel. This preparation is essential to enable a sound weld to be made throughout the thickness of the plate.

Typical fillet welds are shown in Fig. 8. As a rule, no special preparation of plates is required for this type of weld.

The following table gives the maximum working stress in welded joints in mild steel that is often used for design purposes.

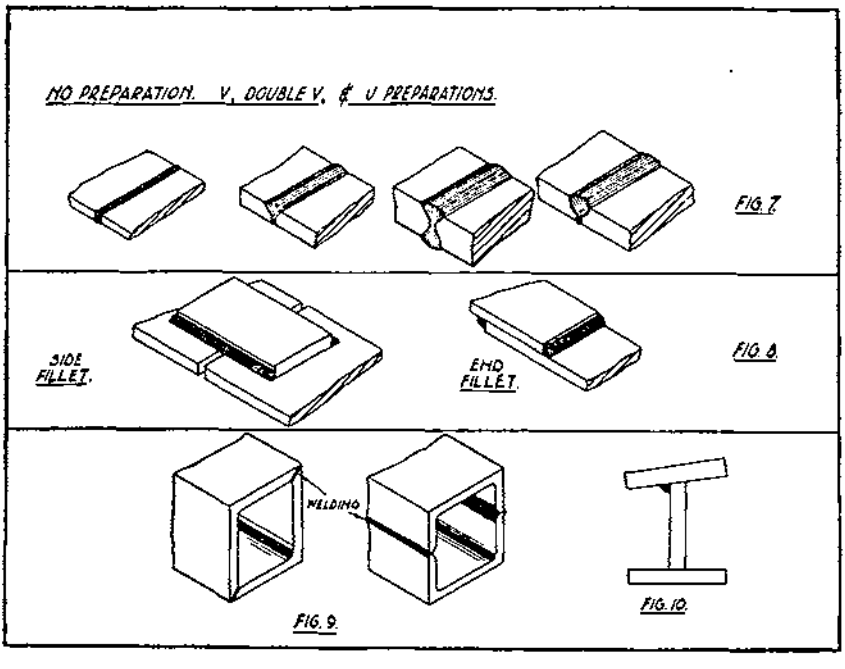
Type of stress in joints.	Max. working stress. Tons per sq. in.
Tension and compression in butt welds	8
Shearing in butt welds in webs of plate girders and joists	6
Shearing in butt welds other than above ..	5
Stress in end fillet welds	6
Stress in side fillet welds, diagonal fillet welds and tee fillet welds	5

For the making of these welds the first necessity is a source of power. For use in the field, a set comprising a petrol engine and a suitable drooping characteristic generator will probably be found the most convenient type. About 80 volts on open circuit and 30 volts for welding, with current adjustable up to 200 amperes are needed for normal requirements. Although sets can be obtained for two or more operators, a single operator set is probably best and will weigh about 15 cwts. It can be carried in a lorry or mounted on a trailer.

The next requirement is a supply of suitable electrodes. Although welding can be done with bare wire electrodes, trouble may be experienced due to oxidization and more reliable results are obtained

with flux-covered or shielded-arc electrodes. Suitable electrodes can be obtained for each kind of job, *e.g.*, mild steel, high tensile steel, hard surfacing, cast-iron, bronze, etc. Electrodes are also obtainable in various diameters depending on the size of run that is required. Gauges 12, 10, 8 and 6 will be found to cover most of the jobs that are likely to be met.

Besides these a number of small stores such as electric cable, electrode holders, welder's screen, chipping hammer, etc., are needed.



These can usually be obtained from the makers of the welding set. In addition, if welding is to be done at night, tarpaulins or some other form of screen will be needed to hide the arc from enemy observation, as a considerable quantity of light is given out by it.

Metallic arc welding is very well suited to the welding of mild steel, and for thicknesses of over about $\frac{1}{4}$-in. will be found to be more expeditious than the oxy-acetylene process. Although welding can be done in any position, down-hand, vertical or overhead, it is best wherever possible to use down-hand welding.

It is, of course, possible to arc weld almost any type of iron or steel, but care is needed with high carbon or anything approaching an air-hardening steel. This is because the mass of cold metal adjacent to the weld may have a quenching and therefore a hardening effect which is liable to cause fracture. Pre-heating or some special technique may be required with these steels.

For such work as repairs to steel bridges, strengthening of existing bridges and fabrication of steel structures, etc., welding will be found to give a saving in time and labour over rivetted work. The process can also be used for repairs, building up worn surfaces and depositing a hard skin on a wearing surface. It is not possible in the space of this article to go into the question of design or the details of repairs, but a few illustrations will show the kind of work that can be done.

As an example of new work, suppose a stanchion is wanted. It is very easy to weld two angles or two channels together as shown in Fig. 9. These give stanchions of symmetrical shape that are easy to produce and whose strength is easy to calculate. Compare this with the production of the normal types of rivetted stanchions.

As an example of strengthening an existing structure, consider the main girders of the bridge shown in Fig. 5. The flanges could be strengthened by welding on additional plates at top and bottom ; this would, however, necessitate drilling or burning holes in the new plates for the existing rivet heads. Although normal practice in peace, this would usually be too slow in war, and an alternative method is to weld metal bars, rectangular in section, between rows of rivets or on the edges of the flanges. For the web, additional plates could be welded on to the existing web between stiffeners. All this work could be done without interrupting the normal flow of traffic across the bridge.

As an example of repair work, consider that the same bridge has been damaged by a bomb or shell fire. If no serious distortion had occurred in the main girders, it would be possible to cut off the rough edges of a hole in web or flanges with oxy-acetylene plant and then weld new plate, cut to shape, into the holes. If distortion had taken place, it might be possible to jack the girders back into position, but for this scaffolding would be needed and the repair would take a considerable time. In this case it might be quicker to demolish the bridge and replace it with a stock span if such were available. Damage to the deck plating is easily repaired by welding on new plate. The cross girders can be repaired in the same way as the main girders, or if too badly damaged it would be possible to make a new girder by welding together the necessary sized plates.

The most likely difficulty to be met with in metallic arc welding is distortion due to contraction on cooling of the weld metal or in a lesser degree of the parent metal. An instance of this is the section of an I-beam in Fig. 10. Here the fillet weld has been made all along one side between flange and web, with the result that on cooling it has pulled the flange plate out of truth. There are several ways of dealing with this distortion ; one is to clamp the parts rigidly before welding. Another method is to weld short lengths at a time, first on one side of the web, then on the other. In some

cases it may be necessary to weld a short length, skip a bit, then weld another short length and so on, filling in the skipped bits by similar short runs later. By this method the parent metal never becomes very hot, and so distortion is avoided.

ELECTRIC ARC CUTTING.

It is possible to cut with the electric arc. Special electrodes are sold for this purpose, but a carbon electrode, or an ordinary electrode dipped in water, will be found quite satisfactory. This type of cutting is useful on thin mild steel and cast-iron and can also be used for copper, brass and aluminium.

INSPECTION OF WELDING.

Failure in welded work can occur owing to such causes as incomplete fusion of the weld and parent metal slag and oxide inclusions in the weld or oxidization. The best way of avoiding these is to use good electrodes and to employ only competent operators, since it is difficult to test welding in the field. Work should be inspected in progress to see amongst other things that the runs of weld metal are of the specified size, that the slag which forms on the top of each run is completely removed before a superimposed run is made, and that there is no burning away of the parent metal at the edges of the weld. If these precautions are taken, it will be found that perfectly reliable results are achieved.

SOME NOTES ON STARTING TO TEACH IN AN O.C.T.U.

By CAPTAIN D. W. PRICE, R.E.

TRAINING IN PEACE AND WAR.

IN peace-time the Army is mainly engaged in the business of training. The regular officer's chief employment is the work of training his men. The intervals from this he spends attending courses, where he himself is trained; and, from time to time, he may even be occupied in training himself in order to pass his promotion examinations or, if he feels so inclined and circumstances allow, to qualify for the Staff College. Broadly speaking, the regular officer spends his time either teaching or being taught. He is familiar with instruction from both angles. In spite of all this, instructional jobs of an unfamiliar kind are likely to be thrust at short notice on the officer in war, and in most cases he has to work out his own salvation.

What follows is not the story of how a certain Officer Cadet Training Unit began, nor an account of the fun that we all had as we helped to build it. These notes describe only the way in which the teaching of one subject in the programme of instruction was evolved. That is all they aim to do. They may, it is hoped, be of interest to those who will have similar jobs to do in the near future.

THE PROBLEM OF WHAT TO TEACH.

The subject was Tactics.

The first thing to be done was to read the syllabus laid down by the War Office for O.C.T.U's of the Royal Engineers. The next operation can only be described as guessing the number of hours to be spent on each part of the subject.

This did not take long, as, at that time, any good guess would do. The next stage was to decide how much of each part of the subject to teach, in the light of the fact that the most junior R.E. officer's command, a section of a Field Company, may often be all by itself in support of a Unit of the size of a battalion. Now, tactics cannot be taught properly except by doing exercises on the ground, so that it was very soon discovered that what really had to be decided was how much should be taught in any one outdoor scheme, *i.e.*, what few lessons was it essential to teach. The aim of the lectures would

then be to cover the ground necessary to solve the problems set out of doors. The outdoor scheme rather than the lecture was to be the medium of instruction.

THE PREPARATION OF T.E.W.T's.

Tactical exercises do not, unfortunately, grow overnight, and the struggle to keep production ahead of requirements was a severe one at the beginning. At first, a policy of wholesale plagiarism seemed to offer the best chance of quick and, we hoped, nearly effortless results. So officers were sent in all directions to gather where they could. In a few days piles of schemes in white and pink and blue paper had been collected from various sources. They varied from simple exercises for a platoon of infantry to the type of puzzle set for the Higher Commander's Course at the S.M.E.

It is very odd how difficult it is to adapt other people's schemes, and at that time we found it very disappointing! Most of those that we had found, at any rate, just would not do. They either taught too little for our purposes or appeared to be trying to teach everything at once, and all hopes of plagiarism on a large scale were early dissipated. Not that we did not get some really helpful ideas; and, for these, the schemes were certainly worth the trouble of collecting—and reading, too.

Another problem to solve was that of the ground. There were three principles to be observed, and, like all truly military principles, they were apt to be conflicting. Firstly, the ground had to be in the recognized training areas. This was to avoid having to write letters to landowners, which could so easily be forgotten and would be a recurring burden each time an exercise was repeated. Secondly, the ground chosen had to be as near as possible to barracks, at first, to save petrol and, later, when our Fairy Godmother had presented the unit with bicycles, to save time. Thirdly, the ground was, if possible, to be suitable for the particular lessons to be taught. Perhaps some would say this is in the wrong order, but it was the order that seemed to suit us best. Considerations of time and space also forced us to disregard a principle that has been much honoured by custom and tradition, and that is, the one by which the day's manœuvres should come to a halt shortly after mid-day at a licensed house, for the rest and refreshment of the weary tacticians. But in the rush to produce something at the beginning of the war, we had to set a limit to the number of conditions to be fulfilled, and where we were happily able to observe this principle it was entirely fortuitous.

Once more reconnaissance parties were sent out. This time they were to choose convenient areas for work. Actually, they did much more and produced outline schemes to fit the ground. To the piles of white, pink and blue typescript were now added fresh piles of

manuscript, all to be " vetted " and subsequently, if suitable, gone through on the ground. So passed the first few weeks of the war. The days were largely spent in reconnaissance and the nights in writing.

Trial and Revision of T.E.W.T's.

The narrative, questions and answers having been written, the scheme would be ready to " try on the dog." In almost every case the " dog " happened to be the senior class of cadets, as they naturally did everything first. Amendments on a larger or smaller scale were certain to be required, and it was found best to keep all schemes in a provisional stage until they had been given successively to about three classes of cadets. In fact, as a result of their reactions (and, in one case, lack of reaction), a series of three exercises was completely changed, and another of the exercises was developed into a " think-aloud " demonstration of the way in which it was hoped a commander might conduct his reconnaissance and make his plan. When a scheme seemed to have settled down to its final form, it would be compiled and " sent to press." A complete scheme would then consist of a statement of the lessons to be taught, a time-table, the instructors' notes, the narratives and problems. To this would sometimes be added a list of the special equipment to be carried or issued for the exercise. The narratives and problems would be duplicated in black or blue and all the rest in red. This prevented a cadet being issued with the answer by mistake !

Squads and Instructors.

As important as having a scheme which teaches the right lessons, is the collection of a team of squad instructors. One instructor to about fifteen cadets produces squads that are just small enough for all to have their say and large enough for argument. Any officer who had had a share in the compilation of the exercise was clearly a valuable man to secure for the team: more often, however, the squad instructor had himself to attend the exercise on a previous occasion in order to learn his part. In a unit where there were many other duties besides attending tactical exercises, this was not so simple to arrange as it would seem, and it was a matter that had to be planned beforehand, otherwise a sudden dearth of squad instructors would result.

Wet Weather.

October, 1939, was, if one may now be allowed to mention it, abnormally wet, and very early the necessity for providing an indoor alternative to an outdoor exercise was impressed on us. The sand table has for long been one of the standard answers for wet weather.

Possibly it was because the writer is like the students in *Training Regulations* "who are unable to grasp the idea of ground portrayed on a sand model," but in any event a sand table was not used. In *The R.E. Journal* of September, 1939, there appeared an article by the Commandant of the S.M.E. on "The Training of the R.E. Officer" (since issued in pamphlet form), and this provided ideas for two of the indoor exercises, one on administrative problems and the other on the use of mobile bridging equipment. They contained problems that would be solved off the map in actual life or for which neither map nor ground were required. Another wet weather exercise was planned on the assumption that wet days sometimes clear up. This exercise was an outdoor exercise held within a short marching distance of barracks. The number of problems set could be varied with the time available, and there was one problem that could be completed indoors if it began to rain again. Though rain was a sore trial at times in the early months, we were, literally, able to weather the storms as and when they came.

LECTURES.

Lectures, of course, there were. It seems that they really cannot be avoided. *Training Regulations* is on very sure ground when it warns one to be "careful to ensure that the number given is not excessive," and a recent *Army Training Memorandum* said much the same thing. However, for as long as military manuals are written, as they must be, with a view to covering every possible eventuality, lectures will be required to explain them and as a guide in reading them. In fact, much note-taking can be saved by references to the relevant passages of the text-book during a lecture. Besides that, lectures have to be directed at preparing the way for the exercise to follow and at warning those under instruction against the mistakes which some of them will, nevertheless, quite certainly make.

With the time for training as short as it is, there is rarely an opportunity for repetition, so that the first time a cadet does any particular piece of work he should be so well prepared for it that he does it as nearly as correctly as possible. His work is bound to become for him a sort of standard example: whether his answer is right or wrong will make little difference to him. It was found, therefore, that it was very important that a cadet should, if possible, get the right answer first time—because it was probably for him the only time. It was hoped to achieve this result partly by being very careful to observe the correct sequence in the time-table of lectures and partly by dealing more with the particular than with the general, always laying more emphasis on how a thing was done than on what was done. In this connection, too, on outdoor exercises, it was found most necessary to be on guard against vague answers or attempts at "hedging" over practical details.

There is much that could be written about lecturing; there is, however, an article by Major A. C. Shortt, R.E.,* entitled "Some Notes on the Art of Lecturing," in *The R.E. Journal* of September, 1931, and any who have to lecture would do well to read it, if they can get hold of it. Few of us take naturally to lecturing and most of us find the "lesson" type the easier to give, even if the more troublesome to prepare. This type is more successful if one knows a class well. The problem is to find a way of interrupting, from time to time, the steady flow of information that all those who lecture are compelled to pour forth. A story, if one is of the sort that can tell an apt one, an interval during which one draws on the blackboard, the asking of questions by the lecturer or a short break for questions by the class, are ways worth trying.

Correcting.

Besides lecturing and running schemes, the work of correcting is a major commitment. As important as the correct sequence in the arrangement of the programme, is the punctual return of corrected work. This is the only really uninteresting part of teaching, a labour which is continuous and sometimes disheartening. But it is a worthwhile task. Even though a piece of work may have been discussed in more or less detail before a class, it is a strange fact that nothing really satisfies the individual under instruction so much as seeing his own work returned, however rudely covered it may be with red ink. If some can only learn by their mistakes, this is a method of instruction worth exploiting to the full.

The Case for Teaching Tactics.

Nothing has so far been said about the way in which liaison was maintained with other instructors in order to avoid water-tight compartments. Instruction in tactics and fieldworks can always be made to march hand-in-hand; for instance, a defence exercise can easily be developed into an organization of work scheme. An assault crossing scheme leads without difficulty to the consideration of the use of mobile bridging equipment. The tactical side of the withdrawal can be made to link up with the engineer problems connected with demolitions. Nor is it very difficult to relate a field sketch to a tactical situation; the need for accurate map-reading is rarely absent from any outdoor exercise, and it should always be insisted on. Snap questions on anti-gas measures can also be introduced: in fact, a recent *Army Training Memorandum* directed that this should be done.

The basis of the case for teaching tactics to R.E. cadets is that all

* Reprinted on page 232

R.E. officers, including specialists, need to have a general knowledge of the organization and role of other arms and to understand their problems and requirements in order to provide their technical assistance most effectively.

This case is enormously strengthened if every endeavour is made to keep the division between tactics and engineer subjects so indefinite that they become, if possible, one subject only.

SOME NOTES ON THE ART OF LECTURING.

By Captain (now Major) A. C. Shortt, R.E.

(*Reprinted from "The R.E. Journal" of September, 1931.*)

LECTURES may be divided into two classes.

Perhaps the clearest way of differentiating between them is to consider the attitude of mind of the lecturer *vis-à-vis* his audience.

In the first class, which may be referred to as "Large Scale Lectures," the lecturer is in a position analogous to that of an actor. His audience is an impersonal entity.

* * * * *

In the second class, which may be called "Intimate Lectures," his audience is, to the lecturer, a collection of individuals, limited in number; known to him personally; observed and studied by him—as individuals. Here his object is not merely to display his knowledge for the benefit of those who care to listen and are mentally capable of following his argument: it must be to express what he wishes to teach in such a form and with such simplicity that each individual member of his audience may understand and learn what he has to tell them.

In other words he must study the individual characteristics of his audience.

From the point of view of the lecturer, the two types of lecture have much in common. Most of the rules to be observed apply equally to both. There are, however, many points in which the methods of the lecturer must differ materially in accordance with the type of lecture he is giving.

The following is the text of a lecture given to Young Officers: it is, therefore, confined exclusively to the discussion of the second type—the "Intimate Lecture."

* * * * *

I propose to divide my lecture into two parts:—

I. *The Preparation of a Lecture.*

(i) *Know your subject.* This seems almost too simple and obvious an idea to justify inclusion at all. Actually it is the first and most important rule of lecturing, non-observance of which is the commonest cause of failure.

The point is that there are degrees of "knowing your subject." A common method of preparing a lecture is somewhat as follows:—You satisfy yourself in your own mind that experience of the subject has taught you all you need to know about it. You turn your proposed lecture over in your mind, decide vaguely on the line you are going to take and, for the rest, rely on your natural ability to express yourself to give you inspiration and carry you through. This is not "knowing your subject" from the point of view of a lecture. There are few people who are competent to give a good lecture on such casual preparation.

"Knowing your subject" means (i) deciding upon the exact scope of your lecture, (ii) examining yourself on it and testing your power of explaining clearly each successive point—in other words your ability to write it down—and finally, (iii) having passed yourself out, revising your knowledge of kindred matters, outside the actual

scope of your lecture but possible sources of enquiry by your audience. Always be question-proof on more of the subject than you actually include in your lecture.

(ii) *Never lecture without notes.* By which I do not mean "Never lecture without *referring* to your notes." To do so, on the contrary, should be the ideal at which to aim; but do not scorn invariably to write out beforehand full and comprehensive notes to form the basis of your lecture, or, better still, write out the whole thing verbatim. This is no confession of incompetence. There is a story of a well-known political orator who, on one occasion, by delivering a masterly "impromptu" speech at the appropriate moment, was enabled to win an important victory for his cause. Every word of that speech, it afterwards transpired, had been written out by him, not once but three times! Men with the gift of impromptu speaking—by which I mean speaking without written preparation—are extremely rare, and in ninety-nine cases out of a hundred the perfect speaker has only attained perfection by hard work. In this, oratory differs in no wise from the other arts: the easier it looks, the more labour its perfection has probably entailed.

Therefore, write full and thorough notes—if possible, write out your lecture in full. The latter process has the additional virtue of ensuring that you know your subject.

(iii) *Arrange your lecture in a logical order.* There is little to be said about this except on one important point. Remember the limitations of your audience and do not assume that they know more than they actually do. If you are beginning a subject *ab initio* you will find yourself, unless you take pains to avoid it, omitting or slurring over points which, because you yourself are so familiar with them that they are almost second nature to you, you either forget or consider unworthy of mention. Everything seems simple when you know all about it. Your audience do not know all about it, and these small points may not seem as simple to them.

(iv) *Use of the blackboard.* Decide beforehand what sketches you are going to draw on the board; include them in your notes and, if any of them are elaborate, draw them on the board before starting your lecture. Long pauses for drawing on the board break the thread of your argument, and the attention of the audience is apt to wander. Devote a certain amount of trouble to these sketches and, above all, draw them correctly. A bad or inaccurate sketch may give an entirely wrong impression or obscure an otherwise well-developed argument. Good sketches, on the other hand, may save hours of talk.

(v) *Convince yourself.* Read through your lecture or your notes and convince yourself that it is "the goods." If you cannot do this you will never convince, impress or even interest your audience. Get up with the idea in your mind that you are going to tell them something worth listening to, and they will listen and be infected with your own enthusiasm. If, on the other hand, there is doubt in your mind as to the importance or value of the lecture you are trying to give, you will merely be wasting your own time and that of your audience.

Therefore, (i) avoid padding, and (ii) make quite certain that you yourself clearly understand every point or fact with which you propose to deal. It is surprisingly easy to miss the point when reading up subject matter for your lecture. A sentence which may appear obvious when read over casually often presents unforeseen difficulties when you attempt to elucidate it.

II. *The Delivery of a Lecture.*

(i) *Don't be in a hurry.* Speak slowly; complete each sentence; deal with each point in turn and finish with it before going on to the next. So far as you are able, speak good, grammatical English. Split infinitives, and the like, may not matter materially, but a proportion of your audience will be irritated by them and their attention distracted from the subject.

The thing to remember is this: in lecturing, as in acting, both speech and movement appear very much slower to the performer than they do to the audience. The average man speaking in his normal voice and at his normal speed would, even if he

were perfectly audible, be perfectly intelligible only to the more nimble brains in his audience. The ruck would be left far behind. It may seem to you that you are progressing at a funereal pace: it will seem otherwise to your audience.

(ii) *Speak as if you yourself were interested.* A great many lecturers—not only beginners but those with considerable experience of lecturing—either through self-consciousness, nervousness, or lack of interest when dealing with an elementary subject, speak in a bored, dead, manner which may be guaranteed to send any audience to sleep with unfailing regularity. Above all, avoid speaking in a scornful and superior way as if to imply that the subject is so ridiculously simple that it is hardly worth talking about. This method merely gives your audience a feeling of inferiority; they ask no questions, and they learn nothing. Remember that it is all new to them; they are, presumably, interested, and they will expect you to be the same.

Therefore, no matter how elementary your subject, or how many times you have given the lecture before, do your best to work up some sort of enthusiasm about it.

(iii) *Look at your audience.* Look at them individually and make them feel you are talking to *them* and not to the four walls, your notes, or the blackboard. Watch them: you will sense it directly their attention begins to wander, and this is the moment to wake them up again with a joke, a startling statement of some kind or an argument.

* * * * *

(iv) *Keep as still as possible.* Mannerisms and movement of any kind, in addition to being irritating, distract attention from the main issue. If you must refer to your notes, keep calm about it: don't get flustered and lose your head. Similarly, when asked a question, don't be afraid to stop and think a moment before answering if the answer does not come readily. If you do not know the answer there are several courses open to you: (i) admit your ignorance and promise to find out; (ii) invite suggestions from your audience and initiate a discussion; (iii) say that you are proposing to deal with the point in full in a later lecture, and seize the first opportunity of looking it up, etc., according to your individual preference. Provided that you keep your head and don't get flustered you will get away with it.

(v) *A few miscellaneous Do's and Don'ts.*

About jokes. Jokes are excellent tonics, provided that they come naturally to you. If they don't, avoid them: they are by no means indispensable.

Avoid monotony: either of tone of voice, or of facial expression. Put some light and shade into your lecture.

Be natural in your manner and behaviour. Treat your audience as intelligent human beings, expect them to be interested, and avoid affectation of voice or manner, particularly sarcasm.

Avoid "Er" like the plague.

Don't apologize for your ignorance of your subject. Your audience will probably take you at your own valuation and resent being compelled to listen to you.

You need to be a good lecturer to hold the attention of an audience for more than three-quarters of an hour at a stretch.

Speak "up" both literally and metaphorically. Hold your head up and don't drop your voice at the end of a sentence.

Don't mumble. If a thing is worth saying, it is worth saying sufficiently loud for everyone to hear. If it isn't, don't say it. Mumbling merely aggravates your audience.

If you start off *expecting* to get ragged or laughed at, you assuredly will be.

III. *Conclusion.*

The essence of good lecturing is self-confidence. Self-confidence springs from two things: (i) Personality; (ii) Knowledge. A really first-class lecturer must have both. Anyone with normal faculties can acquire proficiency in lecturing, provided that he is able to make up for a lack of one by an abundance of the other.

THE SIEGE OF MODLIN, SEPTEMBER, 1939.

(From German sources.)

THE old Polish fortress of Modlin lies at the junction of the Narew with the Vistula, which there changes its course from south to west, so that the Narew and the lower reach of the Vistula form an east-west river line. On the northern side of this line lies the town of Modlin. It has an old Vauban half-circle *enceinte* resting on the rivers. About 2½ miles outside the *enceinte* were three old forts, Fort No. 1 near the Vistula west of the town, No. 2 north of it, and No. 3 to the north-west, with a marsh between it and the Narew.

About three miles farther out was a line of newer forts, in good condition and with shell-proof casemates. For reasons at present unknown, the outer ring was not occupied by the Poles, and the forts served as shelters for the staffs, reserves, etc., of the besieging force. The defence line adopted was that of the old forts; these were connected by trenches, with an occasional concrete machine-gun post, and a continuous wire entanglement with tank obstacles in front of it. The Polish artillery, says a German account, was not strong and obviously had little ammunition at its disposal.

In the second week of September the German troops pushing south from East Prussia, in order to get east of Warsaw and turn the Polish north-south defence line along the middle (Warsaw) course of the Vistula, detached a *Landwehr* division to invest Modlin from the north, sending two machine-gun companies by air to reinforce it. The division occupied the outer line of forts and established outposts beyond it, thus depriving the Poles of many acres of potato fields between the two lines of forts.

In Modlin was not only the garrison but also a large number of men just mobilized and fugitives from the frontier fighting, amounting in all, according to German accounts, to 35,000 men; but no active steps were taken to keep the enemy at a distance.

On the 19th September, that is, after the entry of the Russians into Eastern Poland and the collapse of the Polish field troops, a German armoured division, some light and heavy artillery and a Danzig so-called "Police" regiment, now uncamouflaged and called the "Danzig Infantry Regiment," arrived on the northern front and relieved the *Landwehr* division, the latter shifting to the eastern front between the Narew and the Vistula. Immediately after the relief, a German Storm company drove in Polish advanced troops on

the extreme west of the line near the Vistula, and in the following days the Germans crossed the river, which was very low, on this flank and completed the investment line. Large quantities of ammunition were brought up and, on the 24th, bombardment both from the ground and the air was begun.

"The actual military buildings, as later discovered, offered great resistance to both shell and bomb, but the destruction of dwelling-houses was very great. The streets in Modlin itself were gradually made useless for traffic by shell craters and debris of houses."

An infantry division now arrived and took over the eastern sector of the Armoured Division.

By the 27th the Poles were hardly firing at all. It appeared that Fort No. 1 and a village (Zakrozym) south of it on the Vistula were very weakly held, and at 6.30 a.m. on the 28th, after a quarter of an hour's bombardment, part of the Armoured Division proceeded to assault. At once the Polish defence awoke, the attack made little progress; but with the use of flame-throwers the Germans managed to reach the western edge of the village.

Meantime, at 6.45 a.m., the Polish Commandant of Modlin had given orders to cease hostilities and hoist the white flag, apparently on account of lack of food and ammunition. He no doubt remembered that, in olden days, a fortress was disgraced if it surrendered before it had stood an assault against its walls.

The number of prisoners taken by the Germans has not been announced, but over four thousand wounded were found by them in the town.

SUBSTITUTES FOR STEEL IN REINFORCED CONCRETE CONSTRUCTION.

The following article has been taken from a paper entitled : *Norme, materiali e strutture per la limitazione dell'impiego del ferro nelle costruzioni*, by Dr. D. de Simone, published in the *Annali dei Lavori Pubblici*, for December, 1939.

Translated by LT.-COLONEL A. S. HOLME, O.B.E. (late R.E.).

DURING the past five years great efforts have been made in Italy to render the country self-supporting and to restrict the use of imported materials to a minimum. No iron ore is mined in Italy, so iron and steel have been included amongst the materials whose use is banned as far as possible.

Experiments have been made with wood, bamboo and asbestos-cement as substitutes for steel in reinforced concrete.

Wood has been found to be useless. The cross section necessary would have to be very heavy, and wood does not bind with concrete.

Better results have been obtained with bamboo canes. In the first attempts to use them in conjunction with concrete, the idea has been to utilize the concrete as a protection from the ravages of insects and atmospheric effects. Such systems have been adopted in countries where bamboos are plentiful, such as India and Japan.

Bamboo grows very fast without special attention. In tropical countries it will grow three feet in one day. Even in Kew Gardens, near London, a growth of nearly three feet in 24 hours is said to have been recorded.

Many species of bamboo are found in nature : all have great tensile strength. From experiments carried out in various countries, and especially in Germany, it has been found that bamboo strips, in tension, have a modulus of elasticity of about 180,000 kg. per sq. cm. (2,550,000 lb. per sq. in.), approximately the same as that of concrete, with a resistance to tension of 2,000 kg. per sq. cm. (28,250 lb. per sq. in.).

The remarkable resistance to tension suggests the possibility of combining the two materials in loaded beams ; the concrete taking the compressive stresses and the bamboos the tensile stresses. Since the modulus of elasticity of bamboo is about a tenth of that of steel, lengths of bamboo can take the place of steel rods, provided they have a cross-sectional area ten times that of the steel.

It is only of recent years that the problem of combining bamboo and concrete, with a view to getting the best value out of both, has been rationally treated by technicians, with satisfactory results. The main difficulty to be overcome is that bamboo absorbs water readily, and swells considerably when damp.

The first experiments showed that, as soon as bamboo was immersed in fresh concrete, it absorbed water out of the latter very rapidly, swelling to such an extent as to crack the surrounding aggregate during the period of setting. Later on, as the setting progressed, the bamboo gave off some of its moisture, diminishing in volume, and losing its adherence and leaving a perceptible play between bamboo and concrete.

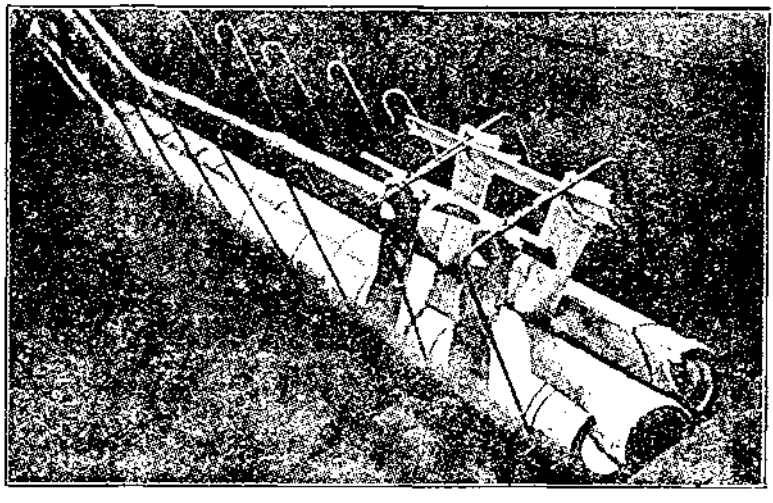


Fig. 1.—Reinforcement of a Concrete Beam.

Professor Graf, of Stuttgart University, has made interesting and thorough studies of the subject. Having realized the above drawbacks, he succeeded, in a first experiment, in avoiding cracks in the concrete by using a very thick covering layer and an exceptionally rich mixture.

However, when building up concrete beams, with bamboo in the part subjected to tension, he found that, under the above conditions, the bamboo took up no additional stress, even when provided with hooks at the ends.

It was therefore found necessary to protect the bamboo by soaking and painting it with suitable mixtures that would have to satisfy the following conditions. They must give no chemical reaction with the cement; they must be insoluble in water and must adhere firmly both to the bamboo and the concrete.

Mixtures of petroleum, linseed oil and other compounds proved ineffective, but satisfactory results were obtained by the use of white lead diluted with 10% of varnish. Some canes, when painted with such a mixture and then immersed in water, only absorbed 1·5% after 24 hours, and 5% after 72 hours. If they had not been treated, they would have absorbed anything up to 40%.

As a result of the varnishing the adherence was found, by experiment, to be 3·5 kg. per sq. cm. (49·4 lb. per sq. in.) The adherence was increased considerably by the knotty projections and the internal diaphragms when half canes or strips were used.

Once the adherence problem was solved, experiments were made with concrete beams reinforced with waterproofed cane strips.

Further experiments were made with concrete columns reinforced with one and four canes respectively, and also with unreinforced columns.

These experiments showed that the bamboo cane reinforcements increased the resistance of the concrete columns, and that the steel binders had no appreciable effect on the resistance, but they prevented the formation of cracks before the tests were applied, and so contributed to the preservation of the canes.

It was observed that there was perfect adherence between the waterproofed bamboos and the conglomerate. By not removing stumps of branches from the canes, slipping was prevented entirely.

The loads necessary for producing the first signs of failure were not affected by hair cracks formed during the setting of the cement in the protective covering, nor did these hair cracks affect the loads necessary to produce complete destruction of the beams. The conditions of stability are appreciably improved by the use of steel binders.

Experiments have also shown that by winding iron wire round

Fig. 2.—Reinforcement of Concrete Columns.

bamboo canes their resistance can be increased. The use of entire canes leads to a lightening of the whole structure. When inserted in the compression zone of a beam, bamboo canes work in conjunction with the concrete and increase its resistance.

With the conquest of Abyssinia, the problem of concrete reinforced with bamboo has acquired importance for Italy, since, if satisfactory results are obtained, it will be possible to utilize numerous bamboo plantations which are mainly to be found in the Galla and Sidamo countries.

With this object in view, the engineer Albertoni and the architect Paoloni have completed a series of experiments in the East Africa Government laboratory. The results are all the more remarkable when it is remembered how rudimentary the means at the disposal of the experimenters were.

Professor Graf's researches make an important contribution to the problem of the combined working of concrete and bamboo. But, in order to get down to practical politics and to achieve results on an industrial scale, Messrs. Albertoni and Paoloni consider that further investigations should be made on the following lines :

(1) Prepare a plan of the distribution of bamboo in the Italian empire, with dimensions, physical and chemical characteristics, cycles of reproduction, etc., and consider the best varieties for propagation, which can easily be done by subdivision of the root-stock.

(2) Establish the most suitable time for cutting. This affects the bio-chemical properties of the material, and, consequently, the mechanical resistance and the life of the fibres.

(3) Make experiments to determine the most efficacious and economical systems of seasoning—natural or artificial —so as to preserve the bamboo from damp, fungi, insects, etc., and to improve its mechanical resistance and its impermeability.

(4) Establish, on the basis of Graf's experiments, the best and simplest arrangements to obtain a thorough bond between concrete and bamboo, and the most satisfactory form of practical constructional design.

(5) Investigate the problem of varnishing adopted by Graf. To varnish wood before it is fully seasoned prevents the evaporation of the moisture it contains and has the effect of predisposing it to rot rather than of preserving it.

(6) Investigate the effect of contraction and of temperature changes, and fix the limits of permissible cracks and the elastic limits of the structural system.

(7) Investigate the bio-chemical effect produced by the immersion of the bamboo in concrete and its effect on the mechanical resistance of the system.

(8) Define the methods of calculation of structures that can be built on these principles, establishing the permissible stress to which bamboo can be subjected, and the relation between the moduli of elasticity of the two materials.

(9) Arrange a design, based on the foregoing, that will get the best value out of the bamboo, taking all practical considerations into account.

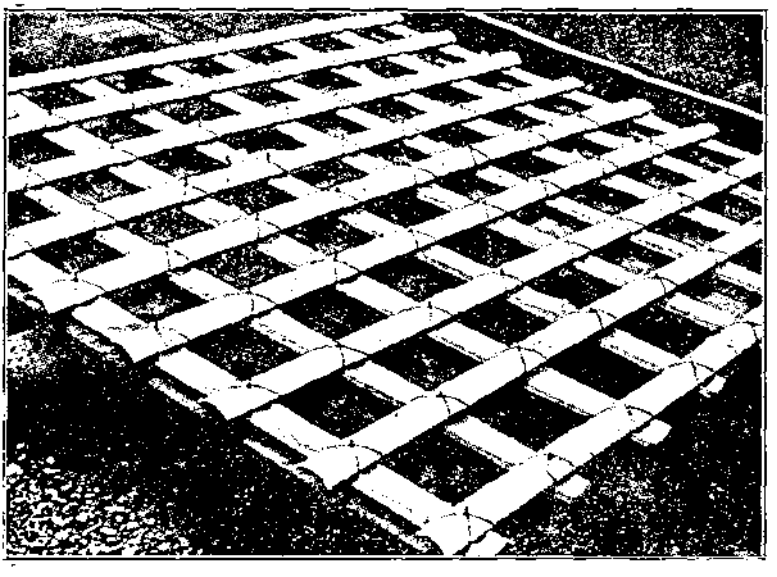


Fig. 3.—Trellis-work, reinforcement for a Concrete Floor.

In order to throw light on the above questions, Messrs. Albertoni and Paoloni, making use of the modest means at their disposal, undertook a series of researches, in the absence of a suitable laboratory. These researches were naturally of a practical kind.

They inspected a number of Abyssinian forests and noted the straightest and most homogeneous varieties of bamboo.

The commonest variety was *Arundinaria alpina*: external diameter: average, 7 to 8 cm.; maximum, 10 to 12 cm.; thickness, 0·5 to 1·5 cm.; average density of growth, 7,000 to 15,000 canes per hectare; height of canes, 12 to 20 metres; approximate extent of bamboo forests, 100,000 hectares; average altitude above sea level, 2,000 metres.

Other suitable forests were found in the zone of the great lakes; here the maximum diameters exceeded 30 cm. and the height 30 metres.

As already mentioned, the main difficulty is the seasoning of the canes. In this connection experiments are being made with: natural seasoning by exposure to the air; osmotic seasoning; hydraulic seasoning by a hot process; seasoning by vaporization; chemical seasoning.

With regard to the waterproofing processes experimented with, Messrs. Albertoni and Paoloni give the following opinions:

> Deep waterproofing is effected by injecting under pressure any of the following substances: fats, resin, coal tar, ether of phenol, naphthol, etc.
>
> Superficial waterproofing is effected by the application of varnish, or by immersing or painting the bamboos with any of the substances mentioned in the last paragraph. Varnish with a lead base can be replaced, with satisfactory results, by varnish with a base of zinc oxide, with 5% of white lead added.

Bakelization.—A very convenient process is the direct application of a cold bath, consisting of a suitable form of phenol and formaldehyde, with the addition of a catalyser that produces polymerization with heat only. The operation can be carried out with very varied proportions of bakelite: from 1 to 30%. Bakelization does not act merely as an incrustation or as a reinforcement of the membranes, increasing their mechanical resistance, but penetrates deeply into the membranes themselves, protecting the dead wood from decomposition. Bakelization can also be applied to the surface only, if desired.

Colloidal Process.—Colloids (*i.e.* gum, casein, mucilage, glue, gelatine, etc.), can be injected when the fibres are damp. By this means a way of penetration is opened up, allowing the drying process to take place. The procedure improves the tenacity of the material, especially when gelatine is used. The resistance to tension, compression and flexure is increased.

Mineral Treatment.—Baths of basic acetates are used. These are decomposed in the interior of the fibres, liberating hydrate and volatile acid. The combination of soluble metallic hydrates with the woody substance gives the latter an increased tenacity, due to contraction of the cellulose, in the presence of hard and insoluble matter diffused evenly throughout the cellulose mass.

Vulcanization.—Substances are used capable of being vulcanized (such as rubber, guttapercha, and certain oils) and a suitable solvent, which, besides speeding up penetration, also permits the addition of sulphur. Starting with dry samples, a liquid containing fats or gum, or a mixture of the two, is introduced, together with a suitable admixture of sulphur, and under such conditions that the materials do not combine before the whole introduction is completed.

Other processes are being experimented with, such as mercerization

with alkali, gelatinization and antiseptic impregnations (*e.g.* copper sulphate, corrosive sublimate, creosoted oils, etc.).

In the Imperial Laboratory systematic trials are being made, amongst others, of the contraction, of the cracks, of the absorption of the shear forces, of the permanent and elastic deformations of the bamboo-concrete system, of the breaking loads, and of the cracking of the elements undergoing tests.

So far, results appear satisfactory enough, but it is still early to draw definite conclusions. The following inferences may, however, be drawn with regard to the employment of bamboo as reinforcement for concrete :—

There is no chemical reaction between bamboo and cement mortar. Bamboo that is not waterproofed, if placed in fresh conglomerate, absorbs water, and in swelling produces cracks in the concrete during the period of setting. As it dries it loses adherence.

By waterproofing the bamboo, using steel stirrups, and providing a reasonably thick protective coat of cement mortar, the trouble referred to does not materialize, and a firm adherence takes place even under a load, provided the ends are properly anchored back. Adherence is greatly increased by the interior diaphragms of the canes, when half canes or strips are used, as well as by the outer knots.

Owing to the low value of the modulus of elasticity, the presence of bamboo reinforcement in the elements subject to flexure, only slightly increases the initial load of failure, but it increases the final breaking load very considerably. Fracture always occurs in the compression zone of the concrete, never through fracture of the bamboo.

Bamboo can be used either in entire canes or in strips. Sometimes fine cracks appear in the covering layer of mortar, but they are not harmful and do not affect the safety of the beam.

Concrete reinforced with bamboo resists compressional stresses ; this makes the system suitable for columns. The presence of bamboo in columns preserves them against possible bending stresses.

In order correctly to distribute the stresses in a beam subjected to flexure, the cross-sectional area of the bamboo must be ten times that required for steel reinforcement. The concrete must be of good quality, with a resistance not less than 300 kg. per sq. cm. after 28 days (4,200 lb. per sq. in.).

Before waterproofing bamboo, it must be dried in the air. The best species of canes are those of small diameter, but with thick walls.

In the present state of our knowledge it is not possible to lay down the exact limits for the employment of concrete with bamboo reinforcement. But the prospects of its use are encouraging, especially for small structures that are not subject to excessive strain.

It is in the colonies that we are likely to find the greatest use

for it. Small floors not heavily loaded, roof coverings, walls, etc., can be built safely and at low cost.

We have seen that the presence of bamboo does not appreciably increase the resistance of the elements to cracking. It would be as well to keep the safe loads well below those at which the first cracks appear, in spite of the fact that they have been found not to be harmful. By the use of a good conglomerate a satisfactory resistance to tension is obtained. The presence of bamboo raises the breaking strain of the elements in tension by an appreciable amount, and provides a considerable margin of safety when loads are adopted below those which produce the initial cracks.

An interesting field of employment has been road surfacing. An experimental stretch of road has been laid down in Nanking, in which the sub-grade has been reinforced with bamboo. It is reported to have stood up well after a year's use.

The system might well be employed in the Italian colonies, and in Italy itself. Cane might be grown in suitable parts of Italy if it should happen not to be convenient to import it.

As already remarked, the last word has not yet been said. Experiments will have to be made on a large scale, especially on buildings, to enable a judgment to be formed as to how the system stands the test of time.

Another material that can take the place of steel is asbestos-cement.

This material has made remarkable progress in recent times, and it is being used for many purposes.

Asbestos-cement is ordinarily manufactured in sheets that are impervious to the action of frost and heat, they are waterproof and fireproof and are not liable to decay; they have insulating properties (both thermal and electrical), they are light, weighing 7 kg. per sq. metre (12·8 lb. per sq. yd.), with a normal thickness of 5·5 mm. (0·22 in.).

They are therefore extremely useful as a roof covering, they can be fixed so as to resist the action of the wind. They can also be used for ceilings and wall panelling.

Fresh sheets of asbestos-cement can conveniently be moulded into different shapes. Receptacles for water, flue pipes, chimney pots, septic tanks, eaves gutters, down pipes and sewage pipes can be made in this way.

Other uses for this material are rabbit hutches, dog kennels, fowl houses, sectional huts and colonial bungalows. The frame-work of such structures can be of wood or of asbestos-cement.

The most important application of this material is undoubtedly that of gas or water pipes under pressure. They possess the following properties: resistance to atmospheric agency and to chemical agents in the soil, lightness in comparison with metal pipes, absolute

waterproofness, capacity of withstanding considerable hydraulic pressure (a pressure of 65 atmospheres has been attained in joints of recent construction), appreciable resistance to fracture by tension, crushing, flexure, or blows. All these properties make asbestos-cement pipes safe, and, in many cases, they can with advantage replace cast-iron or steel pipes.

It will not be out of place to mention experiments that are being made to substitute asbestos-cement railway sleepers for wooden ones. These experiments have so far given good results, but no definite opinion can be given until the tests have continued over a longer period.

A form of construction has recently been studied in which compound floors have been built of slabs of asbestos-cement with joists and wall plates of reinforced concrete.

This type of floor has the advantage of dispensing with the use of staging and shuttering necessary for some types.

A special application of asbestos-cement is its employment as the tensile element in reinforced concrete in the place of steel. This idea was worked out by Professor Periani.

If a mixture of Portland cement and asbestos, in suitable proportions, is subjected to very high pressure, the result is a material that has an average tensile breaking strain of 260 kg. per sq. cm. (3,672 lb. per sq. in.), and a modulus of elasticity in tension of 400,000 kg. per sq. cm. (5,650,000 lb. per sq. in.). From its very nature the material does not alter when in contact with cement mortar; it lasts well, and has a coefficient of thermal expansion nearly the same as that of concrete.

It remained to be proved whether fillets or rods of the material in question have the necessary adherence with the surrounding ncrete to ensure their combined mechanical collaboration.

Beams were constructed of a section of 12 cm. by 15 cm. (4·8 in. by 6 in.), 1·50 metres long (4 ft. 11 in.), containing, near the bottom face, four rods of asbestos-cement, 2 cm. by 1 cm. (0·8 in. by 0·4 in.) in section, arranged longitudinally in two layers, separated by a 2 cm. (0·8 in.) layer of cement mortar. In addition, strips of asbestos-cement, 1 cm. by 1 cm. (0·4 in. by 0·4 in.) in section, were disposed vertically, alongside the principal longitudinal reinforcement, near the side faces of the beams. These strips functioned as stirrups to take up the tangential stresses.

The reinforcement of these joists was calculated by the usual formulæ, adopting as safe limit for the tensile stresses in asbestos-cement the value of 100 kg. per sq. cm. (1,412 lb. per sq. in.), and as ratio of the modulus of elasticity:

$$n=\frac{E_a}{E_c}=\frac{400,000}{200,000}=2$$

After a suitable period of seasoning, the beams were submitted

to tests of static and pulsating loads in the laboratory of the Turin Polytechnic, and the results were compared with the tests on similar beams composed of (1) plain concrete, (2) concrete reinforced with steel rods.

The results showed that the asbestos-cement reinforcement appreciably increases the resistance to flexure, and that this increased resistance is roughly equal to that produced by reinforcement with steel rods having a cross-sectional area of one-tenth of that of the asbestos-cement bars. The resistance under the action of pulsating loads is about half of that under the action of static loads.

The following results were obtained with beams having a concentrated load at the centre, over a clear span of one metre, the section of the beams being 12 cm. by 16 cm. :

(A). *Static tests :*

Unreinforced beams : breaking load : 631 kg. (1,388 lb.).

Beams reinforced with bars of asbestos-cement (cross section of reinforcement : 8 sq. cm.) (1.28 sq. in.), breaking load : 1,444 to 1,482 kg. (3,179 to 3,260 lb.).

Beams reinforced with round steel bars (cross section of reinforcement 1·5 sq. cm. (0·24 sq. in.), *i.e.* $\frac{1}{8}$th of the total section of asbestos-cement bars), breaking load : 2,955 kg. (6,501 lb.)

(B). *Endurance tests :*

Beams with an asbestos-cement reinforcement (the cross section of the latter being 8 sq. cm.) (1·28 sq. in.), subjected to a pulsating load between 400 and 700 Cgr. (0·88 and 1·54 lb.), have stood up to 1,500,000 pulsations without fracture.

In the experiments with a static load, the beams reinforced with asbestos-cement gave way suddenly in the centre without warning, without previous distortion or appreciable cracking, as happens in the case of steel-reinforced beams.

This circumstance is evidently due to the fact that asbestos-cement has a tensile breaking load very nearly the same as its elastic limit.

The above results relate to beams of a rectangular section. It was therefore necessary to extend the tests to T beams, which are more extensively employed in reinforced concrete construction. With this object in view, two floors were constructed with joists and panels of concrete reinforced with asbestos-cement, as in fig. 4 (*a*) and (*b*).

The two floors were built with a span of 4·50 metres and a width of 1·14 metres, so as to include three complete T beams. They were calculated for a temporary load of 400 kg. per sq. metre (1,056 lb. per sq. yd.) in addition to their own weight of about 300 kg. per sq. metre (792 lb. per sq. yd.) considering the beams as semi-fixed (the moments at the supports being taken as $\frac{pl^2}{12}$: those

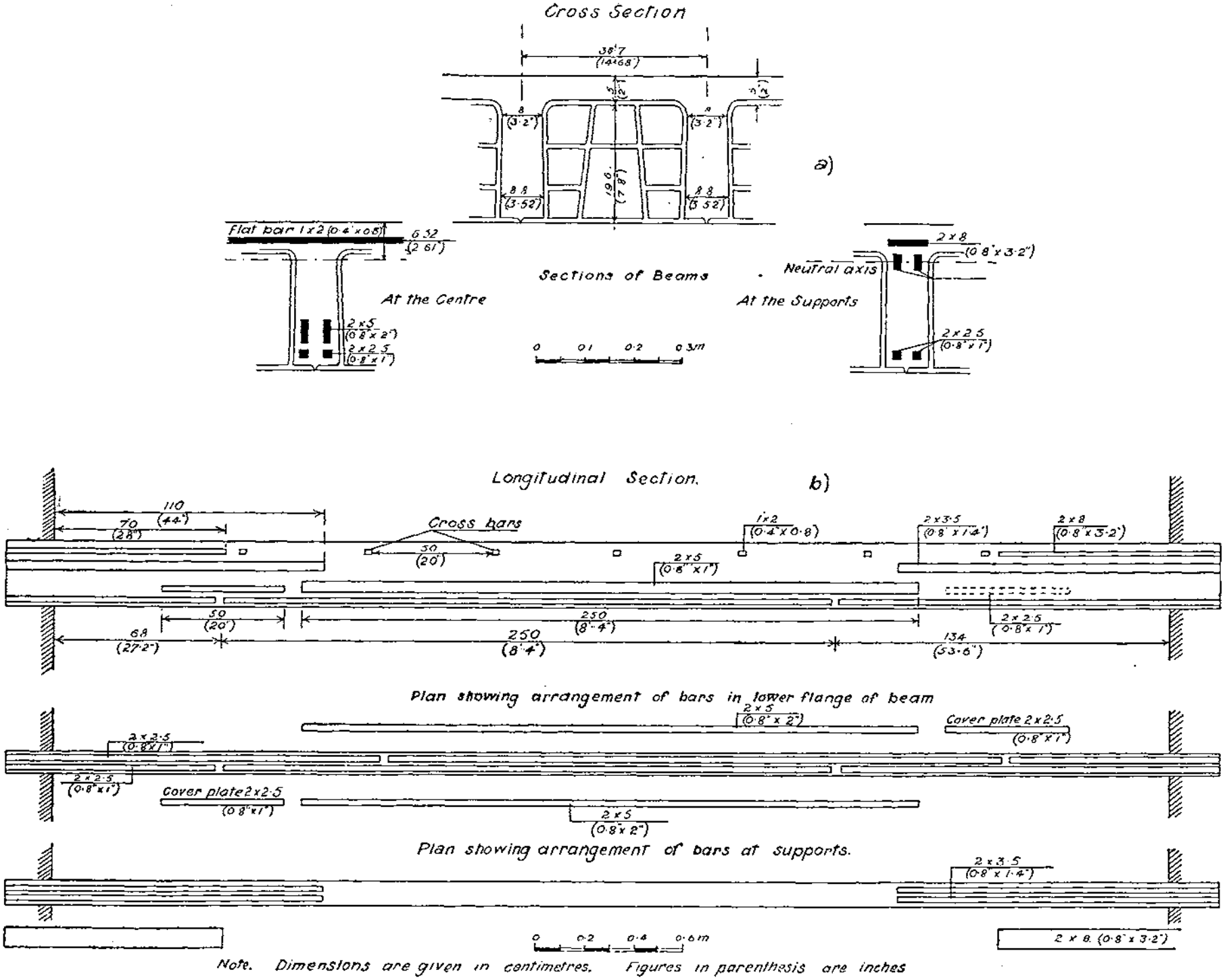


Fig. 4.—Floors of Cement Concrete Beams and Slabs, reinforced with Bars of Asbestos-Cement.

at the centre as $\frac{pl^2)}{10}$. Assuming the safe tensional stress of asbestos-cement to be 100 kg. per sq. cm. (1,412 lb. per sq. in.), the cross section of the reinforcement works out to 30 sq. cm. (4·56 sq. in.) for each beam, and has been arranged as in fig. 4.

The slab has been reinforced with strips of asbestos-cement having a cross section of 20 mm. by 10 mm. (0·8 in. by 0·4 in.), laid flat, at 50 cm. intervals.

The floors were tested with a static load and were also subjected to a dynamic test by means of a vibrating apparatus, consisting of two masses of metal rotating eccentrically round an axis with a velocity of 1,800 to 2,000 revolutions per minute.

The static tests were carried out with loads varying by 100 kg., from 100 kg. to 400 kg. With these loads the following maximum deflections were obtained on the central and outer beams at a distance of 15 cm. from the face of the supporting wall:

Beam No. 1	0·06 mm. (0·0024 in.)
,, No. 2	0·85 mm. (0·0034 in,)
,, No. 3	0·06 mm. (0·0024 in.)

On removal of the loads the deflections disappeared completely.

The load was then replaced and increased until fracture occurred under a load of 1,100 kg. per sq. metre (2,004 lb per sq. yd.). Fracture took place at the centre of the floor, after cracks had appeared in the outer faces of the walls at the points of support.

The deflections of the floor, at the centre, under a load of 1,040 kg. (2,288 lb.), were as follows:

Beam No. 1	1·85 mm. (0·074 in.)
,, No. 2	5·00 mm. (0·2 in.)
,, No. 3	1·85 mm. (0·074 in.)

Dynamic tests were carried out by spinning the vibrator for about 5 hours at a speed of 1,400 to 1,500 r.p.m., and by varying the angular position of the two metallic masses.

The floor stood up to the test well: not a single crack appeared, although the vibrations reached such an intensity that the dry stone wall built over the supports had to be dismantled because it threatened to collapse.

After a suitable period of rest, the floor was subjected to a static test under conditions of free support. Fracture occurred at the centre with a load of 900 kg. (1,980 lb.); the deflections exceeded by 40% those obtained when the ends were surcharged with masonry (1,800 kg. (3,960 lb.) on each support).

Tests were also made to increase the compressional resistance of cement conglomerate by packing it into pipes of asbestos-cement.

By subjecting columns of concrete to compression tests, some plain and some packed into ordinary water pipes, an increase of resistance of 25% resulted in the latter case. Pressure was exerted on the core of the column alone.

OFFICER AND SOLDIER.

By "SENTRY."

IN many military matters it would be logical, though unusual, to place the soldier before the officer. In one subject the officer has definite claims to precedence; this subject is the one covered, some think inadequately, by the terms "leadership," and "power of command." Whatever abstractions may be used to describe what is needed in an officer, one thing is certain; without the best direction from above, the best results cannot be expected from the soldier; as the quality of this direction deteriorates, so the whole purpose of the professional life of the soldier becomes increasingly meaningless and futile.

A recent article in a U.S.A. journal made an attempt to catalogue the components necessary in the make-up of a "Commander" (grade unspecified). The result was not really very helpful; it contained between seventy and eighty qualities varying from "personality," *via* "industry" to "cleanliness." The blend of these qualities into the character of a single individual was admitted to be an unlikely proposition; this difficulty was overcome by arranging the requisite components into an order of priority. As an effort to simplify the problems to be solved by the prospective leader, the article was not altogether a success. It did, however, bring out one point—a most important one—to which reference will be made later.

In the most recent official publication on the relations between officer and soldier, stress is laid on the great importance of an officer being able to obtain immediate obedience to his slightest word of command. In the achievement of this state of affairs lies much of the art and science of the officer's profession. There is no simple formula by which absolute perfection can be obtained by the budding officer; but there is no difficulty whatever for the vast majority in obtaining in their command a really high state of discipline. The number of those who get commissions who are so unsuitable as raw material to be "hopeless" is negligible. On the other hand, there are quite large numbers of officers who, though initially good material, never achieve real success in obtaining an adequate grip of their shows.

It is possible that many are misled by catch phrases such as "the

born leader," or " a commanding personality," with which articles on leadership so often start. The reaction of one type of reader to these phrases is to assume that all is well, and no further effort is needed ; that of another type is to think, " I have never been good at games ; my face is of a fish-belly white ; I'm only about five feet nothing ; how can I ever be even an average leader ? " No reactions could be less justifiable. There is a science and a technique (apart from an art) in leadership which must be mastered in its elements as early as possible ; and in addition much knowledge must be acquired continuously. Anyone can do this, no matter what his complexion or stature may be ; everyone should do it, since there is no greater tragedy than that of the alleged " born leader " who rises to a position—frequently on the strength of real success in lower grades—for which he has not taken the trouble to qualify himself. Sooner or later, the man who relies on purely "natural" qualifications for leadership will find himself in the hands of his subordinates. Setting aside, therefore, any dangerous and loose deductions based on " personality " arguments, what is the best line to be taken by one who wishes to make the best of himself as an officer ?

In this matter there need be little or no searching after intangible virtues ; the attainment of a high degree of leadership, as exemplified by the prompt and *willing* obedience of subordinates, can be achieved by a junior commander—not in a day, certainly, but in quite a short time—by adopting certain lines of conduct and action. The problem becomes thus quite objective.

Before discussing this problem, it is, however, necessary to touch on one abstract quality of the greatest importance.

The subject of loyalties is a most absorbing one. A clash of loyalties produces at the same time the most difficult problems and the deepest emotions. The play " Loyalties," by Galsworthy, is a close study of the subject. The lives of Lord Haig and Sir W. Robertson contain dramatic examples of the dilemmas to be faced by those with great responsibilities. Such pressures will seldom occur in the life of the regimental officer, so for him the problem is generally comparatively simple. For all that, quite simple problems of loyalty are not always adequately solved. Loyalty to superiors and to equals is not only a matter of upbringing, but frequently also of interest ; but this may not be the most pressing loyalty required in an officer's daily life. He must attend also to his subordinates. The more the subject is analysed, the more obvious becomes the vital importance of absolute loyalty to subordinates. It is the basis of the " chain of command," and of responsibility ; it must be the foundation on which the aspiring leader should build. An interesting sidelight on this subject occurred in conversation the other day. An officer was well known for his continuous applications,

on behalf of his command, to his C.O. Hardly a day went by without a request; the officer became a by-word, since the requests continued, in spite of the fact that his part of the unit always seemed to be the "best off." On many occasions, the impatience of the C.O. was obvious. Yet this officer was overheard in the mess to say, with absolutely genuine surprise, "I've got a staggering 'confidential.' After the appalling nuisance I've been, and the rockets I've had from orderly room, the best I expected was something pretty border-line."

Other qualities—most of which are plants which grow naturally if given the right nourishment, and if otherwise left alone—are best not made the subject of introspection. The attitude to adopt is that of a regular Lance-Corporal, aged nineteen, who found three twenty-year-old "Militiamen" in his squad, each with "unearned" advantages in education and finance. He was asked by a friend if, on this account, he had expected or experienced any difficulties in training or discipline. His reply was, "Why the —— hell should there be any difficulties?" He was conscious of being completely master of his job, and of having behind him (if required) the full weight of the "military hierarchy." Incidentally, he is now an officer, as also are the above three privates who received under him their initial military training.

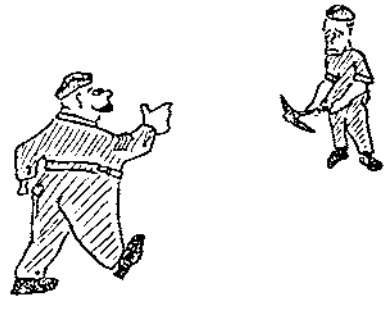
Of the positive and attainable assets, which every prospective "leader" can build up for himself, the first is knowledge. This asset is subject to incalculable subdivisions, but at the moment only two classes need be mentioned. The first class consists of instilled knowledge; the second, of knowledge which must be sought by the individual. The former class will not be further considered; no one can become an officer without what is considered to be the necessary minimum basis; and the individual officer has not subsequently the same exclusive responsibility for obtaining for himself the former class, as he has for obtaining the latter.


KNOWLEDGE

The first item to be tackled is, beyond all doubt, the attainment of the most intimate possible knowledge of subordinates. It is common to hear a man say, "I'm bad at names." It is quite possible for an officer, no matter what sort of brain he has, if he adopts some simple commonsense system, and makes an effort, to learn quickly the names and appearances of very large numbers of men. For instance, with a little system, a X Company Commander, after about two months' command under normal conditions (*i.e.*, when many men are not joining and leaving his unit at short intervals), should know every individual in his company by name and sight; he should have a pretty accurate knowledge of the character and capabilities of all the N.C.O's; and he should know a good deal

about the idiosyncrasies of the exceptional men, *i.e.*, the most promising and the most difficult. Some people would go further than that, stating that, after the above period, a company commander *should* have the above knowledge; they would state that to know less would be inexcusable.

The next important step to take, is to obtain a good working knowledge of the conditions of the daily life of the men. There is no difficulty in acquiring this knowledge unobtrusively, in the normal course of duty, without in any way treading on anyone's toes. During this stage—incidentally, almost of equal interest to the first suggested stage—there will inevitably be opportunities of assisting the men by attending to "routine welfare," and thereby establishing an important link with the men. The sort of points to look for were indicated in a former article.*



THE DAILY LIFE OF THE SOLDIER

These two steps have, of intent, been placed first. They relate to the human element which in any command (however technical) is the most important, the most instructive—an officer can learn practically everything of any use about his unit from one or other of his subordinates—and the most interesting.

Apart from the human element, a unit contains other vital components. It is an essential element of command to know both what the unit should have, and also what it actually holds at any time in military, technical, and administrative equipment. The above knowledge has probably been the subject of some instruction, and of demonstrations; but no amount of book knowledge can replace actual examination, inspection and handling of equipment. Further, if equipment is lacking, a unit commander can frequently to a considerable extent rectify matters by importunity; at any rate, a little investigation will show if shortages are unavoidable. Any unit or sub-unit commander whose unit is short of obtainable equipment is definitely to blame, and should not ease his conscience by dosing it with "outstanding indents." Lastly, since equipment is an essential element in "readiness for war," a unit commander absolutely must at all times know the precise effect of unavoidable deficiencies on the capacity of his unit to fulfil its rôle. It is his duty to know this himself, to instruct his subordinates in the use of improvisations, and to inform his superiors of the precise state of affairs and its effect. Without this knowledge, no commander can claim the necessary background, either to provide essential

* "Soldier and Officer," *R.E. Journal*, March, 1940.

confidence in himself, or to enable him to make quick decisions—or, if in an R.E. unit, quick and workable plans—in an emergency.

Having progressed this far, a certain amount of other useful incidental extra information will have been acquired; but there may probably still be a few major points to tackle. For instance, the examination of the conditions of life of the men will probably have led to a fairly good idea of the practical side of the administration of the unit under existing circumstances. (The " office " side is assumed to be covered under the heading of " instilled knowledge.") A comment frequently heard from the troops is that it takes some days for a unit to adjust itself to a change of environment. During these days, the administrative structure has to be rebuilt, and in the meantime the soldiers are liable to be extremely uncomfortable. This hiatus does not always depend on action that a unit's officers can take; but it frequently does, and it can only be avoided by a very close examination of practical administration under all predictable conditions. No reward for such work is ever forthcoming, except a comfortable feeling of private satisfaction, when the men settle down automatically after a change, taking for granted the complete lack of even temporary disorganization.

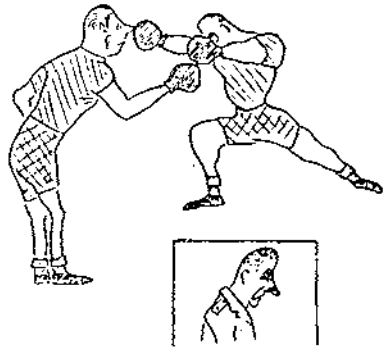
So far, the problems for solution, and the knowledge to be acquired, form an essentially objective study; no question of the development of abstract qualities has arisen at all in discussing the " leadership " business. The work—if it can be called work—is all of the sort that can be " programmed." But most of those who lay down for themselves such a programme will find that not only is little effort of will required to carry it out, but also that " unit life " becomes more and more a matter of absolutely absorbing interest. The writer has watched on several occasions the process of a unit claiming the complete life of an officer, who has been successfully encouraged to start off on the tasks suggested above. No unit which has established this claim on a reasonable proportion of its officers can be anything but efficient and happy.

So far, however, only one of several fields of endeavour has been considered. The field so far investigated relates to what the aspiring leader should know; another part of the panorama consists of what he does—his conduct. This cannot be made the subject of an exclusively objective study, as can that of " acquired knowledge." For one reason, what a man does depends largely on what he is—that is to say, on his " qualities " and " character "—subjects not under consideration here. But it is wrong to imagine that no objectivity can be brought to this matter. It is possible for an officer to set himself certain almost mathematical standards, and gain stature as a commander by following them.

For instance, it seems wrong that a young soldier, on being asked how often his officer (*i.e.*, subaltern) had spoken to him during the

last two or three months should have replied after some thought, "I can't really remember his speaking to me once." It is, of course, of first importance for all officers to have as many unofficial exchanges as possible with their soldiers. If this function is deferred till the front line is reached, it is just possible that motives of sudden friendliness may be misinterpreted. The opportunities for these exchanges are legion in the daily life of a unit; but they must, of course, be selected judiciously, to avoid "pestering" the men in any way. At the same time, it is not a bad idea for an officer to devise some private safeguard against the reproach of having men serving him with whom he has never "passed the time of day."

The threadbare example of "keeping in touch" is that of games playing. In this case, it is quite unnecessary always physically to take part in a game; good refereeing or umpiring is often a better rôle, and watching is far better than nothing. The point is, an hour or two twice a week (as a minimum), in sharing in some way in the unit's games, is time extremely well spent.



KEEPING IN TOUCH

The next class of "doings" to be treated objectively are those connected with routine unit work. The easiest example is the orderly officer's visit to the men's mess. Quite apart from delving to the absolute roots of any "complaint," and thereby ensuring that any justifiable complaint is thoroughly aired, and the matter rectified if possible—the minimum action to which the soldier is entitled—a mere dash through the mess is a sure indication of lack of interest. Not so long ago a company commander observed a somewhat hungry look on his men's faces, and, in the absence of any formal complaints, was at some pains to track down its source. It came out ultimately that, in a laudable attempt to avoid waste, the messing officer had reduced his bread issues. A somewhat unintelligent application of his ruling had resulted in all the men at all times being screwed down to a daily bread issue not much in excess of half that to which they were entitled. The men—all young—did not realize that there were grounds for complaint, and for some months the situation had been generally accepted. These facts (among others) emerged from the company commander visiting every meal for two days, keeping his eyes open, asking questions all round, and taking an intelligent interest in all he saw and heard. That was an extreme case, but no visit to the mess should be unaccompanied by the odd question or two shot at the messing staff,

effort by an officer can greatly alleviate the monotony of life, and at the same time develop the officer's status as a " leader."

For instance, a zest to units' games can be added by occasional variety performances in which an afternoon is given over to an inter-company match (preferably between companies of different units) involving every available individual (including, of course, officers) in each competing company in one—and one only—event. The wider the scope the better ; games from football to billiards should be included. Boxing, followed by a special combined feed, provide the best climax.

A further field of endeavour exists in filling in long evenings. Conditions of life in different units vary so widely that a discussion of detail is somewhat fruitless. The standard palliatives to boredom are concert parties ; the next stage is a theatrical production. But there are other lines. An experiment with a debate (admittedly with a somewhat selected attendance) was a notable recent success ; such an effort requires some ingenuity, and fairly close control over such matters as " addressing the chair." Choice of subject is, of course, the most important matter. In peace, a success was scored by debating the point " Education is vital to the fighting soldier," and appointing the education N.C.O. to lead the opposition. An officer must, of course, know his men intimately to be able to make a success of this sort of entertainment.

It is, of course, possible to multiply examples, but to do so would be somewhat fruitless ; it is the initiation, and successful running of some original activity which is the important thing for the aspiring (and by now perspiring) " leader."

To summarize the points made so far ; the make-up of an officer to whose lightest word the men will respond to the limit of their strength is comprised broadly by what he is, what he knows, and what he does. To this extent the American article, to which reference was made above, was correct ; it brought out the fact that leadership does not depend solely on " what an officer is." This article has purposely stressed the objective problems which can be solved only by the pressure of an officer's own will-power. Incidentally, an examination of the examples given above will reveal that every task tackled will develop one or other of those abstract qualities which are essential in a good officer. To this extent, the pursuit of knowledge and the adoption, after thought, of a particular line of conduct will automatically help to solve the " what he is " component in the commander's make-up.

There is one danger to be watched. The object of the existence of a unit in the Army is not social ; the unit is part of a fighting organization. Welfare, games, variety and so forth, are not in themselves " objects " ; they are " auxiliaries." Throughout all his activities, no officer should be content with *work* from his men which

falls below the highest standard possible in the time available, or at the stage of training reached (in this connection, "training" never ceases). The matter was recently expressed by an officer (who had had considerable experience of service in the ranks) in one of the finest regiments in the Army. He said, "We have the best men in the world; we expect the very highest standard from them; and we ensure that they are the best looked after." The unit had, of course, its quota of "moaners," but, as a community, was a happy one and maintained in all its doings the highest standard of efficiency.

From most of the above, it might be argued that intense seriousmindedness and a strong tendency to interfere were essential, or possibly, unavoidable elements in a commander. To be successful, an officer must treat his job professionally, and to this extent there must be much serious thought. But the successful commander must have lightness of touch in practically all of the subjects treated above. Many of his ideas must be carried out by subordinates who think that they (and not he) produced those ideas. The ideal position, attained by the officers in a highly-disciplined unit, is illustrated by a recent incident. Two small groups of soldiers, belonging to different units, were drinking beer; one group was involved in a somewhat unhealthy grouse about an N.C.O. When this group left, an oldish soldier in the other group said, "I don't think much of that sort of talk. In my unit we've got a good lot of N.C.O's, and the best lot of officers I've ever had." An onlooker asked, "Why do you think that of your officers?" The soldier, a Canadian, replied, "They're such damn good sports."

and similar questions to a few men—complaints or no complaints.

Any tendency to assume that messing complaints form the basis for a battle of wits between the orderly officer and a few troublesome soldiers should be avoided for two reasons: firstly, a soldier who complains is frequently speaking for a very large number of men; secondly, the orderly officer runs the risk of considerably lowering his prestige. For instance, a hungry soldier completed at express speed what he considered to be an inadequate portion; he then "complained" that he had not had enough. The orderly officer replied, "How can I tell you've not had enough if I haven't seen what you started with?" The unit (not only the complainer) took thought, and the next time that officer came round, the same man kept his portion intact, and complained that it was not enough. The officer replied, "How can you tell that it isn't enough if you haven't eaten it?" The unit had quite a good laugh, even if some of the men still felt hungry.

INTEREST IN WHAT HE GETS

One last point to remember is that the soldier is interested only in what is served up to him, and not in the "diet sheet"; the latter may look magnificent, but the soldier is not interested in "paper" meals.

Similar sort of action should accompany other routine visits. If the guard is turned out, it is well not only to consider the guard's contribution — alertness, knowledge of duties, and so on—but also whether the guard itself is getting a square deal. The sort of points that frequently emerge by accident from chance questions are the number of nights "in bed" the men are getting, if the guard get their food hot, and so on. A very raw subaltern inspected a guard one morning fairly recently, and was completely scandalized by the turn-out. He was on the point of ordering drastic action, when he spotted that one of the offenders was a man he knew to be a good soldier. So he took a second thought, and found that for about a fortnight all duties had been found by a very limited number of men, and that the "offenders" had been on practically continuous duty of one sort or another for five days and nights.

The above examples of "doings" need little or no imagination; they follow more or less automatically if a certain line of conduct is decided, and applied to every-day life. But it is possible to go further, and do a bit of initiating. The main possibilities here for a junior officer are in connection with recreational or social activities; training, of course, lies outside the scope of this dissertation. A little

CHITRAL.

By "TEVE."

WE left at midnight. Some capricious staff officer in Simla had planned for us to stop at every station on our 1,700-mile journey, so it was not until five days later that we found ourselves at daybreak moving slowly towards what seemed an impenetrable barrier of mountain.

On either side of the line, green crops stood head-high, in vivid contrast to the parched plains which had stretched endlessly along our route. Such luxuriance owed its origin to the Swat Canal, which pierced the mountain barrier of the Malakand from north to south, and carried a plentiful water supply towards Mardan and the plains below.

Railhead at Dargai is 100 miles from Chitral. The route crosses the states of Swat and Dir and is flanked by the Mohmand country on the west. The rulers of these states receive subsidies and assistance, and arrange for the safe passage of the biennial convoy. The relief of the Chitral garrison is the occasion for sending up new supplies of ammunition and money for the Treasury, and is regarded by the more enterprising hotheads of the districts as an opportunity, not only for private gain but also for blackening their rivals' reputation by planning incidents in neighbouring territory.

In 1936 a motor road from Dargai had been made as far as Dir, and for the first time this stage was to be carried out by lorry, with the exception of two platoons which were to be interchanged by air.

At railhead, the M.T. convoy joined its escort of light tanks and armoured cars, and final arrangements for air co-operation were completed. The next day we moved off at dawn, climbed the winding road to Malakand, with the ancient Buddhist road beneath us, and then descended into the valley of the Swat river, where Alexander's armies had marched and conquered two thousand years ago.

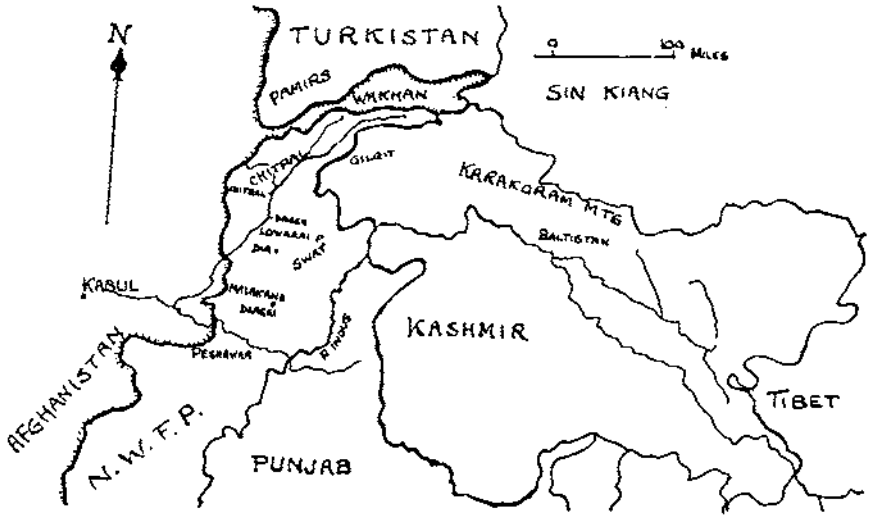
The day was long and uneventful. Afterwards we learned that one or two long-range shots were fired by snipers, more to sustain their reputation than of any malice aforethought.

That night we camped at Dir. As darkness fell, pin-points of fire lit up the surrounding hills, where the Nawab's levies were on guard to protect the camp. By day, the enclosed bowl in which the camp was sited was too hot for comfort, but by night a sharp wind blew

down from the Lowarai Pass, where peaks of 14,000 feet still had snow on their northern slopes.

Early the next morning, the loads from the lorries were handed over to the donkey drivers who, with great deliberation and an apparent incomprehension of all orders and entreaties, divided them into curious shapes and sizes, added large stones here and there as make-weights, rolled them in unconvincing nets and finally balanced them precariously on their small and uncomplaining donkeys.

It was only fifteen miles and six hundred feet to the top of the Pass, but, as the donkey transport set the pace, we had to camp



below the top on terraces built upon the steep sides of the valley. It was September; and the troops but a few days back had been sweating in the plains of Central India and the Deccan. So their surprise was complete when at three o'clock, before we reached camp, the sun gave place to an icy wind, and before long hailstones as big as peas were falling amongst us. The tents had not been pitched before a torrent of black muddy water swept down the terraces, swamping the cooking places, overturning the piled rifles and all but carrying away the boxes of ammunition and treasure.

The storm stopped as suddenly as it had begun, but it was now too late for the sun to penetrate into the narrow valley. We settled in for the night under our sodden tents.

The next day's march was steep but the track was good. On our left, a mountain stream cascaded down amongst large boulders; and from it channels were led to irrigate the lower slopes of the hills. These were cunningly terraced, so that every available patch of soil might yield its crop of maize to support the meagre existence of the

hill-folk, whose squat wooden huts clung precariously to the mountain side.

As we climbed, the valley widened and great outcrops of rock showed up between the trees, and finally, on rounding a bend, the saddle came into view. Friends from the garrison at Drosh greeted us at the top and we looked down for the first time upon the great valley of Chitral, dark green against the snow-topped hills behind.

That night we camped beneath the deodars. The sun, filtering through the lofty branches, lit up patches of the mountain side, and soon the dry air made good the damage of the previous night. This welcome from Chitral's first camping ground was repeated by all her people and lasted until the day, eighteen months later, when we ski-ed down the Lowarai Pass for the last time.

Before going to Chitral we had heard much of the variety of its outdoor amusements. Shooting of all kinds, ski-ing, skating and polo are the main occupations, with hockey, tennis, squash and swimming to fill in the odd moments.

We had not long to wait before the first *chikor* shoot of the season took place. A brisk canter seven miles up the valley of the Chitral river brought us to some rocky slopes with sheer cliffs above on one side and with the river down below on the other. The butts were sited in three lines, set back along the slope, with the highest ones just below the cliffs. Soon the first cries of the beaters were heard as they moved forward about a mile away. Then suddenly the first birds came flying over very fast. A few veered towards the cliffs, only to be turned by the "stops," who stood gesticulating and waving their coats high up on the rocky ledges. A few bold spirits crossed the river, but most of the covies came straight and fast; and the novices amongst us, accustomed only to walking up these difficult birds, found our barrels getting hot and empty cases piling up inside the butt, with little to show for them.

November and December passed, and soon the first reports came in from the ski hut, thirty-three miles away. They said the snow was late; only three feet had fallen and the great boulders still showed above the valley floor. So we decided to go skating instead. His Highness the Mehtar of Chitral kindly placed at our disposal the new bungalow he had built at Garm Chashma—the Aix les Bains of Chitral. There, a rink was prepared: rice fields under the shadow of a mountain were flooded, dams built and paths cleared under the stern eye of the Revenue Officer.

This picturesque character was worthy of the most far-fetched romances of the film world. Tall, aquiline and dignified, he had the perfect manners of a bygone age. His charm was pleasantly relieved by a streak of sardonic humour, which, in matters such as horse-coping or Government contracts, sometimes led him from the paths

of orthodox finance. But so gracefully did he conduct his transactions that little resentment was felt by any of his victims.

On this occasion, he spared no pains to make our visit a success. Our three-day journey, towards its close, assumed the trappings of a triumphal procession: at every halt the local notables presented themselves and led us to a neighbouring fort, where cold game, walnuts, pomegranates and other fare awaited us. It would be misleading not to mention that the Assistant Political Agent headed our party and at each stage dispensed *largesse* proportionate to the welcome received.

So, gorged and weary, we came at last to Garm Chashma. The new bungalow was well-appointed and communicated by steps with a large concrete bath, which was fed continuously by the hot springs. Here for three days we enjoyed ourselves skating, hawking and "taking the waters." The homeward march was along a snow-covered track, where walking was preferable to riding. We reached Shoghot at dusk.

Next day, before sunrise, we started on our ponies towards a narrow gorge of reddish rock, through which a torrent of water thundered and whirled amongst enormous boulders. The track crossed the river three times by cantilever bridges of local design, which seemed to hang together in defiance of all engineering principles. The oscillations of the centre spans scared both man and beast, and at times the wind howling through the gorge seemed intent on sweeping both into the torrent below. Once through the gorge, our way led through calmer scenes; terraced fields came down towards the river banks and little orchards of apricot and peach decorated the humble villages. At a turn in the road we looked behind us and saw the dawn breaking on Tirich Mir, dominating the valley in isolated majesty at 26,000 feet.

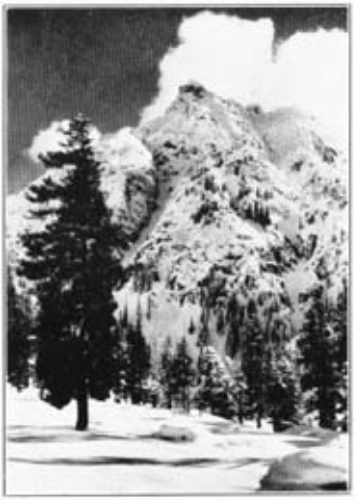
At Chitral we stayed at the A.P.A's house. Though now a Union Jack was flown from the tower, the house had not changed much externally since 1895, when it was occupied by Sher Afzal, one of the pretenders to the Throne of Chitral. Its low squat appearance belied the charm of the interior, where the carved roof beams and pillars combined with the English furnishings to create a vaguely Tudor atmosphere. Magnificent chinar trees overshadowed the lawn outside, which led through terraces of flowers and peach trees to a swimming bath at the top.

On our way back to Drosh we passed a caravan of *hajjis* riding towards the south. They had come from Turkestan over the Shandur Pass, and, in spite of many weeks of hard journeying, still looked fat and cheerful. Round Mongolian faces, with startlingly pink complexions, beamed out from under furry caps. Wrapped up in quilted cloaks, they made a formidable load for their small under-fed ponies, whose raw backs gave sickening evidence of merciless treatment from their masters. To pay their way from Central Asia to Karachi

1.—"That night we camped beneath the deodars."

2.—"Dawn breaks on Tirich Mir in isolated majesty at 26,000 ft."

3.—"The runs go up to 14,000 ft."



4.—"The snow covered slopes of the Madaglasht Valley."

Chitral 1 - 4

5.—"Polo is the national game."

6.—"Every village has its team."

Chitral 5 & 6

and Mecca they carried money, silks, carpets and attractive pieces of old Russian China, which they peddled as they went.

Some weeks later, we heard that the snow at the ski-hut was in good condition and we decided to spend ten days there. The Ski-Club of Chitral was founded some years ago, and now comprises a hut at 9,000 feet, which can house ten people in great warmth and comfort, a miscellaneous collection of skis, two Chitralis "George" and "Albert," who are very fair performers, and a vast amount of "goodwill." The runs go up to 14,000 feet and vary from very easy ones, suitable for the complete novice, to some hair-raising descents calculated to chill the bones of all but the experts. The heat of the sun and the consequent danger of avalanches necessitate very early rising for those who would go far afield.

After ten days of this paradise, the change from the snow-covered slopes of the Madaglasht valley to the terraces and gardens of Drosh was sudden and surprising. The first signs of spring had already begun to appear. The narcissus and daffodils were shooting up and the wild primulas and hyacinths had reappeared in the valleys. The time for polo had arrived.

In Chitral, as in Gilgit, where it was first played, polo is the national game. Every village has its team and every man who can beg, borrow or steal a pony takes part. The polo ground holds the place of the village green. Here the great men of the district mingle with the people, hospitality is extended to visitors and entertainment offered to the officers of the garrison.

Only once in the recorded history of Chitral has the tradition of hospitality on the polo ground been broken, and that was forty-five years ago. The scene was set at Reshun, a pleasant little ground with big chinar trees at one end and with an orchard and some houses at the side. Here, in 1895, Lieut. Edwardes with some Kashmir troops and Lieut. Fowler with his Bengal Sappers, were besieged by the rebel Mohammed Isa after being held up on their way to Chitral. After six days a flag of truce was sent in by the besiegers and Mohammed Isa invited the British officers to play polo in honour of peace. The officers pleaded fatigue and asked that the game should take place without them. On being further pressed, they decided they might safely accept Mohammed Isa's courtesy, as spectators, because those playing polo would be directly under the fire of the Sepoys, and they themselves could arrange to sit under the protection of their men's rifles. So they agreed to go, with the proviso that all onlookers should be removed from the polo ground well to the opposite side. Edwardes and Fowler carefully placed their men, and went to watch the game from a charpoy provided as a seat for them. Fowler, thinking the charpoy was too near the end of the wall, pulled it further into the open. After a short while, the game finished abruptly and the officers were asked if the dancing might begin.

It is the custom in Chitral to dance after polo, and in those days the defeated side had to caper and prance for the amusement of the victors. Not liking to seem discourteous, Edwardes consented and the fun began. The officers had stood up, meaning to go ; but when they agreed to stay a little longer their seat was pushed nearer to the end of the wall, on the excuse of avoiding a muddy patch. As the dancing became more fervid, the spectators from the other side drew nearer, and Fowler noticed that many were coming over to the prohibited wall. He jumped up and told Edwardes it was time to go, whereupon Mohammed Isa threw an arm round each of the officers, who were at once hurled to the ground by a dozen helpers and quickly dragged under the wall, which hid them from their own men. A volley rang out and an overwhelming rush was made from all sides. About a dozen of the Sepoys were made prisoners, and all the rest were killed.

Fowler and Edwardes were kept in captivity for several weeks and eventually, after many vicissitudes, returned safe and sound to India.

Since that day of treachery forty-five years ago, nothing but an occasional free fight has occurred to mar the cordiality of the national game. Here the British officer may meet on equal terms the Princes of the Royal House and the overseers of the road gangs. When he tours through the country, his kit will invariably include some polo sticks, so that he may enjoy the hospitality offered him at the halting places.

At last the time came for us to say good-bye to the polo fields and mountains of Chitral. In conclusion, perhaps it should be said that we had not devoted ourselves exclusively to sport and amusement. But those other more solid achievements have been purposely omitted from this account, which seeks to emphasize those aspects of the country which distinguish it from all other military stations in India.

THE BIRTH OF A HUNT.

By "FOUNDATION MEMBER."

Sic transit gloria Marshii.

WE read in the *Supplement* this epitaph on the R.E. Drag after ten years of an active life. Or can we possibly hope that it is no epitaph, but only the announcement of a temporary retirement?

But the obituary notice has appeared, and it is time for a memoir. There are many people better qualified than I am to write the official history of those ten years, but not so many who were actually present in an assistant capacity at the birth of the Drag. That may serve as an excuse for a few sketchy reminiscences, written without access to records, of the birth and very early childhood of what was then not yet the R.E. Drag, but Mr. Marsh's Draghounds. No names are mentioned, other than that of the central character, lest an injustice be done to those omitted.

It all started, of course, when John Marsh was posted to the Training Battalion, fresh from a hunting Field Company. That was in the winter, the last winter of the pre-drag era. Others had made the same move and deplored the limitations of Chatham as compared with Aldershot or Catterick. None had done much about it, beyond dilating discontentedly on the subject in the Mess and wearing non-regulation breeches, or continuing to drop their g's until the habit wore off. They were not John Marsh.

He wore breeches of regulation colour and said that there could be, and should be, a Drag. As spring drew on, the idea tended to change to a Polo Club, but by late summer it was a Drag again. By autumn the idea had become a fact.

That last sentence bridges an enormous gap. I should like to make this account a text-book on "How to Start a Drag," but I cannot. I do not know how it is done, although it happened before my eyes. I can describe the results of his efforts, and the easier side-jobs that other people did. But the real work on the main issue, the selling of the idea, the propaganda, the picking of brains, the firing of enthusiasm, the recruiting of help, the spurning of obstacles, the conversion of the doubtful and indifferent into energetic co-operators in spite of themselves—John did it all. And on top of that he carried the weight of what he had created on his shoulders until it was so firmly established that nothing short of

war and a complete deficiency of horses could shake it. There must be other ways of starting a Drag, but I know of only one—send for John Marsh.

It must be said that there was no active opposition. But there was inertia and there was scepticism, icebergs which needed fire to thaw them. The idea was fantastic, and it could not possibly work. Such a thing had never been tried before. It would cost a packet, and nobody could afford it. Supporters of the Beagles feared competition, particularly since at that time the Beagles had just suffered a heavy financial blow. If there was money to burn, they felt, it would be better spent on supporting the hunt already established, rather than squandered on a wildcat scheme like this. But even the most die-hard beaglers came to see that this was no rival but a colleague, and in the past ten years there have been many who were ardent supporters of both. And now the Drag has come and gone, but the Beagles we hope . . .

At a suitable stage the proposition was put before the C.S.M.E. He was not the man to give anything but the most whole-hearted encouragement to so laudable an enterprise, but even he was sceptical. He made one stipulation. The hunt must be started as a purely private and self-supporting venture. It would earn the title of the R.E. Drag and be considered for official support only when it had ended a season solvent. The Treasurer realized that there was rough work ahead.

There were some factors which favoured the enterprise, to offset the many that did not. The country was there, the unused corners of the territories of two adjacent hunts, unsuitable for fox-hunting. The hunts were glad to let us use it for a Drag, and even to hunt foxes if we chose. Many landowners already knew and welcomed the Beagles, and the future Master was tireless in gaining the acquaintance and friendship of them all. Without their generous help we could have done nothing. And in the matter of general assistance and guidance for faltering footsteps, the R.A. Drag at Woolwich stinted nothing.

Chatham had not for many years been a hunting station, partly no doubt because it was not a mounted station, and partly because there was little or no hunting to be had within twenty miles. There were only six chargers on the strength. A short while before, three of them had been unrideable and the other three unridden. But there had lately been a certain revival of horsemanship at Chatham, and after a series of rapid exchanges of animals with the Remount Depot, who seemed to need a little time to get used to the idea that Chatham was becoming particular about its horses, we had found ourselves with six very fair potential hunters. The string was augmented by two private horses, and later by one fifteen-bobber, the only one that first season, an equine pioneer. Then there were

horses to be hired from local civilian stables. One of them was a cast charger of ours, sold at auction locally—not up to much weight and a bit doubtful about the knees, but he dealt faithfully with many a dragline. Fields were further swelled by civilians and by officers of the Royal Marines with chargers.

The Marines showed no less faith than anyone else when they doubted the wisdom of parting with good money for a season's hire of a charger, in order to follow a hunt which might fizzle out in a fortnight. There is nothing in the rules, however, to say that an officer may not hack across country in the same general direction as certain hounds, as long as he does not identify himself with the hunt by jumping fences. Consequently, each fence in the first season's lines had to be provided with a way round for the Marines. This must not be taken in any way as an aspersion on a gallant Regiment, for the next season they paid their money and rode with the best.

There was plenty of stabling available, and in later years this was used to house the contingents of fifteen-bobbers who formed the bulk of the following, as had been intended from the first. Drivers were scarce and fully occupied, but the dismounted sapper showed that the job of a groom was not excluded from the list of those to which he could turn his hand.

Besides horses there must be hounds, and the means of maintaining them. Some old stables in Kitchener Barracks were easily converted into kennels, and an old soldier in the Depot Battalion was prepared to act as kennelman in the spare time left from his normal duties as sanitary man. For provender there were leavings from the D.B. cookhouse to be had in return for a modest contribution to the Swill fund.

There was no difficulty about getting hounds. The Master always knew someone who could help, or was prepared to remedy the deficiency if he did not. The word went round among hunts nearby and further afield, even as far as Ireland. They all preferred to draft their old and faithful friends to a Drag pack, if the alternative was putting them down. Telegrams rolled in to announce the arrival of hounds on most trains reaching Chatham, until it was necessary to cry enough. Venerable old age, a single eye, only three sound legs, a nose that had lost its keen edge—these were not necessarily disqualifications for our purpose. But for many we could do no more than perform the sad office from which it had been hoped their transfer would spare them for another year or two. By no means all of them, however, were old crocks. There was one woolly Welsh hound, in particular, with a phenomenal turn of speed, who tried the runner with monotonous regularity.

We learnt that the foxhound yields nothing to any human in knowing when he is on to a soft thing and taking advantage of it. Pack discipline in the early stages was at a discount and rioting ran

riot. There were more often three packs than one hunting a line. We lacked experienced whips, of course. And nobody realizes, until he has tried it, how many fried fish and butchers' shops there are in the High Streets of the Medway Towns, or how difficult it is to extract a hound from one. But by the time Christmas had passed, a full roll-call on return to kennels occurred quite often.

So we had men, and horses, and hounds, but even these were not enough without funds. This was a major problem. The Drag must be run cheaply, or it would die before it was born. Expenses must be fitted to the pocket of the most impecunious Y.O. Yet, starting from scratch, we must end the season with enough in hand to keep hounds through the summer. A careful budget was drawn up, based on utter inexperience, which indicated that, provided nothing unforeseen cropped up, we should be able to work the miracle on a subscription of 7s. 6d. a week per active member, which even at the rate of two men to a horse could not number much better than a baker's dozen, and a 2s. 6d. cap, not to be levied on farmers. To provide starting capital, many people weighed in with generous donations, some of them from people who had no intention of taking any active part, but who wished us well. And there was a long list of guarantors, who were prepared to contribute to the reckoning when the likely crash should come.

It never came, but we hovered very near the brink. Needless to say, much that was unforeseen did crop up. There were bottles of whisky, to be distributed at Christmas to owners of property with which unauthorized liberties had been accidentally taken. There was a matter of some ewes worried when hounds went through the wrong field, which cost a whole fiver. Even the purchase of a long white coat for the kennelman strained the friendship between Master and Treasurer. As for the appearance in kennels of two litters of unintended puppies, demanding puppy food by the barrowload—but that one was solved in short order by the most drastic means.

So the hunt looked like being in debt as the season drew to a close, and means for raising the wind were considered. We would hold hound and hunter trials at Chattenden. Had we really got the nerve to charge a half-crown car park fee, or had we better make it a guinea and get all we could out of the mugs who would probably be the only ones to turn up anyway? We kept it at half a crown and advertised widely, and the profit exactly balanced the earlier matter of the ewes.

Still that was not enough. We were about square, but we must have something in hand. The more cautious shied at the suggestion of a hunt ball, but it was that or nothing. As this is believed to be the only hunt ball which ever made a dead-sure profit, it might be worth while to give the prescription.

Obtain from the Sun Hotel a tender for a dance with refreshments

for 100 people. The tender in this case was 6s. 6d. per head. Next, order on the S.M.E. Printing School 100 tickets bearing the words "Hunt Ball, 10s. 6d." Then distribute these among the members with instructions to sell them or die.

The result was a balance at the end of the season of twenty pounds, and the R.E. Drag was born. Its first activity as such was a combined Farmers' cricket match with the Beagles.

There is still one essential component not yet mentioned. With all the means of hunting provided, one still needs something to hunt. The T.B. is always rich in athletes. Cross-country performers, both officers and other ranks, were pressed into service to tow the "smell." But the foremost of them was the Secretary, who collected the cap before setting off with his old sock and his bottle and his piece of string. Have the offices of Hunt Secretary and quarry ever been combined before or since?

Yet it must not be thought that we were always content with an artificial scent. One day in the first season we not only hunted a real fox, but caught one. It was not a long point, no more than a few hundred yards, but it lay through two wire fences, and by the time the Master got to the kill it was too late to save the brush. Nevertheless, the mask was nearly intact, and it came home in glory tied to the Master's saddle-bow.

The season ended, and the solitary fifteen-bobber went back to the cavalry regiment to which he belonged. He had a slight rub on his shoulder when he left, but the vet thought nothing of it.

Some days later, at noon on a Saturday, the vet came hot-foot with dire news. The fifteen-bobber's rub had spread and was diagnosed as mange—sarcoptic mange. Its origin was an utter mystery, but the Mounted Section spent a blasphemous week-end disinfecting the stables, burning bedding which must not be replaced, and washing down the horses with Izal. Staid and elderly draught horses deeply resented the discomfort and reflection on their personal habits. But their concern was nothing beside that which their masters felt for the reputation of our stables and our fair name with the cavalry regiment, from whom we hoped to get a dozen fifteen-bobbers next season. It was disaster.

Solution and relief came in the form of a letter from the firm who had been entrusted with the mounting of the mask. Not only, they said, was the relic extensively chewed, but it was so riddled with mange that the task was taxing their taxidermists' skill to the utmost.

Not till then did O.C. Mounted Section remember that the Master had ridden the fifteen-bobber home with the mask resting on that shoulder. So it was fox-mange, legitimately and understandably acquired. Our stable management was vindicated. The cavalry forgave us and sent us all the horses we wanted the next season.

The taxidermists overcame their difficulties, and in due course the First Fox Killed by the R.E. Drag took its place in the Mess alongside the First Hare Killed by the R.E. Beagles. It is difficult to say which was the more disreputable. The hare had had many years' exposure to moth and rust and general wear and tear, and its right ear, kept erect with the aid of a medicine bottle cork and a hairpin, rivalled the seamy complexion of the fox. A few years later, they were both purged by a committee appointed to review the Mess trophies.

And now the Drag has come to an end, simply because circumstances made it impossible to continue, at a time when its spirit was at the height of its strength. If those circumstances ever relax, when our present more serious task is done, will it fail to rise again from its own ashes? I think not. If John Marsh is anywhere about, I am sure not.

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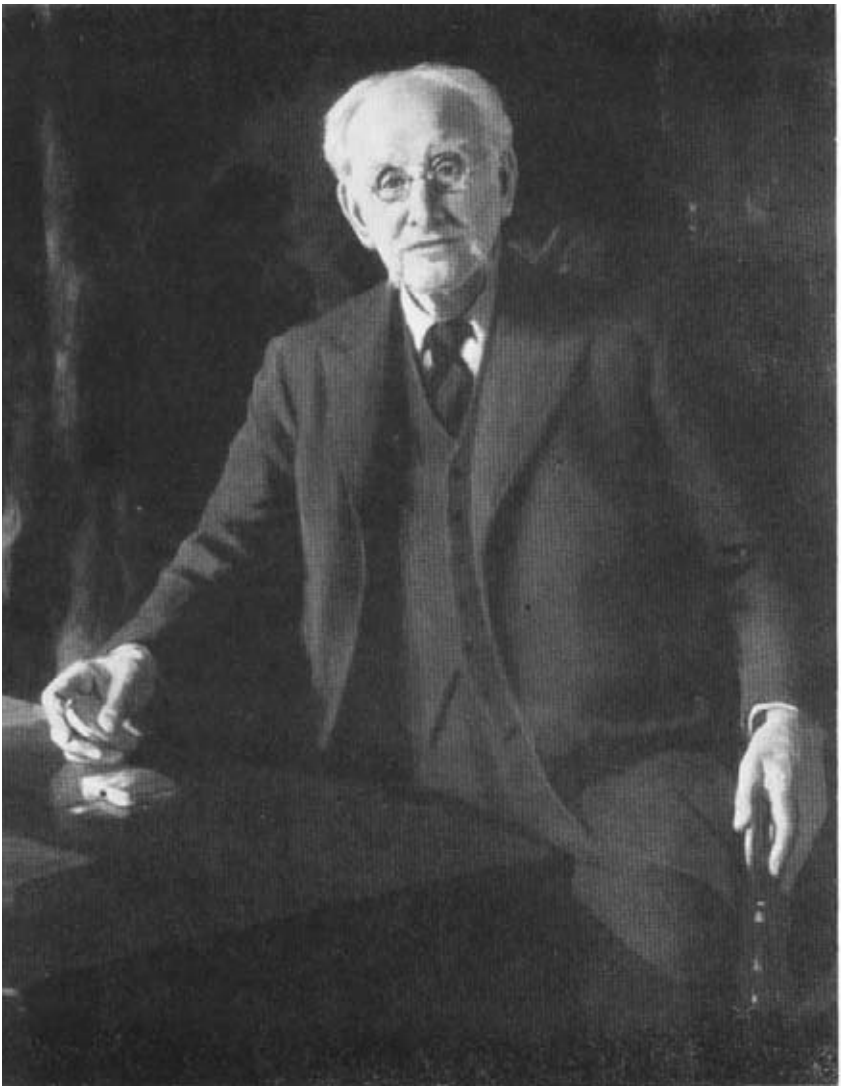

Col Rookes Crompton CB FRS MICE MIMech MIEE

MEMOIRS.

COLONEL R. E. B. CROMPTON, C.B., F.R.S., M.I.C.E., M.I.Mech.E., M.I.E.E.

COLONEL ROOKES EVELYN BELL CROMPTON, an honorary member of the Institution of R.E., who died at Azerley Chase, Ripon, on 15th February, 1940, was born at Sion Hill, Yorkshire, on 31st May, 1845.

After a short time at a preparatory school he accompanied his father, who took out the Second West Yorkshire Militia to Gibraltar in 1855. In 1856 he was appointed a Naval Cadet in *H.M.S. Dragon Fly* and was present at the fall of Sebastopol, receiving the Crimean Medal and Clasp.

On his return to England he went to Elstree School, and then to Harrow until 1860. In 1863 he was gazetted to the Rifle Brigade and after a tour of regimental duty in India, he was appointed in 1868 to the Staff of the Commander-in-Chief in India. He was an extra *A.D.C.* to the Governor-General, Lord Mayo, and then appointed to take charge of the Government steam train for working mechanical transport on the Grand Trunk Road, in which capacity he worked the first engine between Umballa and Kalka in 1869. In 1870 he returned to England to advise on the design and construction of large engines for road transport and returned to India with these in 1871 and remained in charge of them until 1875. The four engines ran a large mileage, some months over 1,000 miles per engine per month, hauling loads of 40 tons at speeds up to 30 m.p.h. These vehicles were the first to be fitted with rubber tyres (6 ft. 2 in. diam., $4\frac{3}{4}$ in. thick).

In 1875 he retired from the Army and joined Dennis & Co. at Chelmsford. In 1878 he founded the firm of R. E. Crompton & Co. In 1881 he became Engineer to the Edison-Swan Co. and obtained the first Provincial Orders for Electric Lighting, the only one carried out being at Victoria Station, Pimlico. In the same year he lighted his own house in London by electricity. In 1883 he installed electric light, 1,600 lamps, in the Law Courts and was also responsible for the installation of electric light in Buckingham Palace and Windsor Castle. In the same year he designed and constructed a central electric power station in Vienna for the lighting of part of the city and the Imperial theatres.

He was instrumental in getting the Electric Lighting Act of 1882 modified, as it was found that the terms hampered the raising of capital for electric lighting schemes. His firm were responsible for the installation of plant for the first London Companies, Kensington,

Westminster and Notting Hill. In 1880 he published an exceptionally practical booklet, *The Electric Light and its Industrial Uses.* In 1881 he read a paper before the Institution of Naval Architects, dealing with the use of searchlights in fog and smoke, and laid down the principle that the observer should be away from the beam of light. He also detailed an imaginary disembarkation of a large army at night, with full use of landing lights on shore with generators and searchlights on the ships.

In 1897 a Corps of Electrical Engineer R.E. (Volunteers) was formed. The first commanding officer, Dr. J. Hopkinson, F.R.S., was killed in an Alpine accident in August, 1898, and Lieut.-Colonel R. E. B. Crompton succeeded him. In March, 1900, a portion of this unit under his command proceeded to the South African War. The unit was equipped with portable searchlights, steam traction-engines and field telephones. The unit was first employed assisting the railway reconstruction parties, but subsequently the engines were organized into a mechanical transport corps for hauling guns, ammunition and supplies. The success of the mechanical transport in South Africa so impressed the authorities that Lord Roberts was asked to send Crompton home to organize the mechanical transport of the Army.

For his services he was mentioned in dispatches and made a C.B. He commanded the unit (now the London Electrical Engineers (Territorials)) until 1910, when he became Honorary Colonel.

Prior to the South African War he had been employed by the War Office to advise on the whole question of mechanical transport.

In 1904 he lectured at the Royal Artillery Institution, Woolwich, on "Mechanical Transport for Military Purposes," giving much practical data on steam- and oil-engine transport for munitions and troops.

He was a member of the committee which drew up the first Wiring Rules in 1882. The formation of the British Standards Institution was largely due to his initiative.

As a result of a paper read by him at the International Exhibition at St. Louis in 1904, he was asked to undertake the formation of a permanent International Electrotechnical Commission. The first plenary meeting was held in London in 1906 and he was the honorary secretary. On the formation of the Road Board, he was appointed Chief Engineer. He was active in the early designs of the tank in the Great War and volunteered his services on mechanization to the War Office in June, 1914. In February, 1915, Mr. Winston Churchill applied to the Road Board for the loan of his services to design armoured vehicles to bridge trenches, then called landships, one idea being that the ship should carry 70 men. The use of chain tracks was advocated and Colonel Crompton made visits to the front for local information. In March, 1915, Mr. Winston Churchill

sanctioned twelve landships of a modified design, but the introduction of the Ministry of Munitions and different views from the front changed the general course of procedure, and the Admiralty was superseded by the War Office in this section of mechanical warfare. The first wooden model of the tank was built in Colonel Crompton's house, and many details were evolved, which were included later in the Whippet tanks.

For many years he was closely concerned with the manufacturing firm, founded by him at Chelmsford in 1875, the business of which was largely concerned with the production of plant for generating stations, as well as motors, switch-gear, instruments and searchlight projectors for use on ships and land. He severed his connection with the firm in 1912, but rejoined it as a director in 1927, when it was amalgamated with that of Messrs. F. and A. Parkinson, and was a director of Crompton-Parkinson's at the time of his death.

He was a member of the Institutions of Civil, Mechanical, Electrical and Automobile Engineers and the Junior Institution of Engineers, and President of the Institution of Electrical Engineers in 1895 and 1908. He was the first President of the Institution of Automobile Engineers. He organized and was the first President of Commercial Motor Users' Association, and was also President of the Junior Institution of Engineers and the Highway Engineers. In 1933 he was elected a Fellow of the Royal Society.

He was fond of cricket and hunting, and up to a recent date was a familiar figure in the squash racket courts of the Royal Automobile Club.

He published his reminiscences in 1928.

Colonel and Mrs. Crompton (she was Miss Elizabeth Gertrude Clarke, of Ripon) celebrated their diamond wedding in June, 1931. Mrs. Crompton died on 27th November, 1939. There were two sons and three daughters of the marriage.

A.W.S.

MAJOR-GENERAL SIR M. GRAHAM E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O. COLONEL COMMANDANT R.E.

SIR MICHAEL GRAHAM EGERTON BOWMAN-MANIFOLD, Lieutenant of the City of London, who died on the 13th March, 1940, was born on 9th January, 1871, the youngest son of Surgeon-General M. F. Manifold, A.M.D.

Educated at St. Paul's School and the R.M.A., Woolwich, he was gazetted 4th in his batch as 2nd-Lieutenant, R.E., on 13th February,

1891. His mathematical and scientific attainments were his strong points in education.

Manifold, from the beginning to the end of his career, was a man who got things done, and did them before he was told to, qualifications which are absolutely essential for an Engineer in war, and most desirable in peace also. The following record of a very successful career of great value to the Empire is due to his foresight, pertinacity and good constitution, which gave him energy and concentration in continuous hard work, and bodily activity and endurance, which enabled him to travel constantly without apparent fatigue on horse-back or camel, or by motor-car and train, long distances under conditions of hardship.

These advantages were reinforced by a strong moral character and the capacity to get the utmost work out of his subordinates, who respected and admired him for his foresight, efficiency and enthusiasm and for his character. His inspections were an inspiration and a help to those inspected and not a terror.

From numerous letters received by his widow, we learn how much his contemporaries and subordinates valued his loyalty as a friend, and the affection which he gained. We find in these letters such phrases as " a most lovable character," " efficiency and abilities," " a great D.A.S., and a very kindly man," " remarkable gift for inspiring respect and affection," " gift of leadership," " the most real friend," " staunch and fine," " true and faithful friend." These are the remarks of men from whom he extracted the last ounce of work for the job in hand, or of men who worked in co-operation with him.

After completing his two years of instruction at the S.M.E., Manifold was posted to the 1st Division, Telegraph Battalion R.E., at Aldershot, an appointment which was destined to mould the whole course of his career, as this Unit was the germ from which was to be evolved the Royal Corps of Signals as it stands to-day.

He was naturally a fine horseman and a lightweight, and, having acquired an excellent mare " Mermaid " when he joined at Aldershot, he succeeded in 1895 in winning the first prize at the Royal Military Tournament for riding and jumping, a cup which was the forerunner of its well-known successor, " The King's Cup " of the Royal Horse Show.

In November, 1895, Sir Herbert Kitchener, Sirdar of the Egyptian Army, ever on the look-out for promising young officers, selected Manifold for appointment to that Force, which he joined at Suakim. In the following March, the Egyptian Army under its great Commander started upon the expedition to Dongola, which was the first phase of the reconquest of the Sudan, which culminated 2½ years later in a decisive victory at Khartoum.

Manifold, a subaltern of 5 years' service, was entrusted at very short notice with the responsibility of creating, almost out of nothing,

Maj-Gen SirMichael Bowman-Manifold KBE CB CMG DSO

and working, a Signal Service for the Force. His position would nowadays be described as Director of Army Signals. He had no British officer to assist him throughout this campaign and it was some time before a very small detachment of other ranks, R.E. from the Telegraph Battalion, later gradually increased, joined him as a much needed and very valuable reinforcement.

The distance from Wadi Halfa to Khartoum by the most direct route is some 600 miles ; another 400 miles of communication to the limits of the Dongola Province were also required. Most of his constant travelling had to be done by camel or horse in a very trying climate and a barren country. He had need of all his energy, activity and endurance of hardship.

Lieut.-Colonel Sandes, in his well-written book *The Royal Engineers in Egypt and the Sudan*, has told us something of Manifold's excellent work and success. Lack of space prevents me telling more than one incident, which explains why so many have stressed his loyalty as a friend. Railhead construction camp in 1896 became a cholera camp, with 30 deaths daily among the Egyptian Railway Battalion. In an attempt to get clear of cholera the camp was moved daily, without reducing the pace of railway construction below the required mile per day.

One morning, two out of the three British officers in the camp were struck down by cholera, and died the same afternoon. Manifold, at Sir Herbert Kitchener's Headquarters a few miles away, saw the telegram reporting these casualties. Realizing the overworked and harassing situation of his friend, the only surviving British officer at railhead, Manifold at once asked for and obtained approval to proceed to railhead camp to help. He rode into the cholera camp that evening and remained until replacement of the casualties could be arranged. The next morning Sir Herbert Kitchener rode to the camp to see how they were getting on.

Manifold was present at the actions of Firket (horse killed under him), Hafir, Atbara, and battle of Khartoum. For his services in the 2½ years of the campaign he was mentioned twice in despatches and received the Queen's Medal, the Egyptian Medal with five clasps, the 3rd Class of the Order of the Osmanieh and the 4th Class of the Medjidieh.

Early in 1899, he handed over his work in the Sudan to a Major and two Captains and returned to England. He now married Kathleen Cecilia, younger daughter of Admiral Sir Thomas Brandreth, K.C.B., an exceedingly happy marriage which gave him great help and support throughout his career. They had two sons and one daughter.

He was posted to the 2nd Division, Telegraph Battalion R.E. in London, under the General Post Office. But in October of the same year (1899) the South African War broke out. Girouard having been

appointed Director of Railways in South Africa, and having observed Manifold's work in the Sudan, secured him for his staff. Still a Subaltern, he was soon made responsible for the task of creating, staffing and working the railway telegraph and signal service for nearly a thousand miles of railway, captured from the enemy in a demolished condition. This task gave full scope for his initiative, drive and organizing capacity. As usual, it was done with the greatest success. Unfortunately, after 18 months in South Africa he was attacked by dysentery of a severe type, so that in August, 1901, he had no option but to be invalided home. It was some years before his strong constitution entirely shook off the effects of this illness.

For his work in the South African War he was mentioned in despatches and awarded the D.S.O. and the Queen's Medal with 3 clasps.

He was now re-posted to the 2nd Division, Telegraph Battalion R.E., under the Post Office, and stationed at Basingstoke. The experience thus obtained of a permanent civilian telegraph and telephone system on a large scale rounded off and supplemented the knowledge he had acquired in two campaigns, and stood him in good stead in after years.

In 1901, circumstances caused him to add the prefix " Bowman " to his name.

It was at this time that he became one of the very few people in this country who used a motor-car for pleasure and business, at a time when it was quite an adventure to start out for a drive in a car. He was afterwards able to smile at the people who ridiculed his prophecies that the Army would have to make the utmost use of mechanical transport, and that every officer would have to be able to drive a car. In 1902, he acted on the Committee of the R.A.C. for the Gordon Bennett race in Ireland and, later, in the Isle of Man.

In 1908, Bowman-Manifold completed two years at the Staff College and was posted as Staff Officer to the C.R.E. Salisbury Plain. In the same year he attended a short course at the Naval War College, and then, in November, proceeded to Russia to learn the language. He later succeeded in qualifying as a first-class interpreter in Russian, and in 1909, was posted as G.S.O.3 to the Military Operations Directorate at the War Office, and advanced to G.S.O.2 in 1912.

On completion of his 4 years at the War Office, he was posted as Staff Officer to the Chief Engineer, Eastern Command, until April, 1914, when he took over command of " A " Signal Coy. at Aldershot. This was a critical posting, since it was about to settle the nature of his employment in the Great War of 1914–18. On the outbreak of this war in August, 1914, he proceeded with the B.E.F. to France as Officer i/c Signals, 1st Corps (Sir Douglas Haig's). As such he played his part in the retreat from Mons, the advance to the Aisne and then

the first battle of Ypres. He was mentioned in despatches and promoted Brevet Lieut.-Colonel in February, 1915, and in the same month he was sent to Signals Training Centre at Biggleswade to help to prepare the Signal Units of the New Army, and the Territorials, for their task. But in March, 1915, his great opportunity came, when, as a Major and Brevet Lieut.-Colonel, he was appointed Director of Army Signals to the Mediterranean Expeditionary Force, proceeding under Sir Ian Hamilton's command to the operations at Gallipoli. He was given the temporary rank of full Colonel; later, Brigadier General. In this amphibious campaign, requiring communications to be maintained with Egypt and Salonika and on the Peninsula, his task was a difficult one, but he mastered it.

On the evacuation of Gallipoli, Bowman-Manifold became Director of Army Signals to the Egyptian Expeditionary Force. This title was changed to Signal Officer in Chief in 1918. He virtually controlled the Egyptian telegraph system and found it necessary to visit the Sudan. He had to establish a Signal Service for a front of 1,000 miles in the western desert of Egypt, and for the great army which, first, under Sir Archibald Murray and, later, under Sir Edward Allenby, invaded Palestine, captured Jerusalem and finally, in 1918, made an enormous advance right up to Aleppo. The Arab force in the Hejaz was also linked up by Signals to G.H.Q.

Bowman-Manifold's uncanny gift of imaginative foresight and tenacity of purpose served him and his commander well. He was always preparing several stages ahead of the operations immediately in hand. While trench warfare still continued at Gaza, his organization and stores for the Signal Service sufficed for an advance to Jerusalem. When the Cabinet had given Allenby Jerusalem as his limit, Bowman-Manifold was preparing for communications to Beirut. This explains how Lord Allenby, in mentioning Bowman-Manifold again in his 1919 despatch, was able to say that "he had overcome all difficulties in a great and complicated system of communications and had never failed to solve the difficult problems created by rapid and long advances—an organiser and administrator of great ability."

The list of awards for his services in the Great War is imposing, and every one thoroughly well earned. Mentioned in despatches 8 times, Brevet Lieut.-Colonel, February, 1915; Brevet Colonel, November, 1915; C.B., 1917; C.M.G., 1918; K.B.E., 1919; 3rd Class of the Order of the Legion of Honour; 3rd Class of the Order of the Nile; 1914 Star; General Service Medal, and Victory Medal.

After the conclusion of the war in Syria and Palestine, he started the organization of the telegraph service of the civilian administration of occupied territories in those countries.

Returning to England in March, 1920, he was posted for duty to

Aldershot and, in August, 1920, was appointed G.S.O.1 Instructor at the Staff College.

While at Camberley he produced a book entitled *An Outline of Egyptian and Palestine Campaigns*, 1914–18. Published in 1922, it ran through seven editions. It was the standard work on this subject until the official history was produced a few years ago.

In January, 1920, he had been appointed A.D.C. to His Majesty The King.

In August, 1921, he was promoted Major-General, and was put on half-pay to wait for employment.

Realizing that there were a large number of officers, who had very distinguished war records, waiting for vacancies in the very limited number of Major-Generals' appointments, and being too young and vigorous for unemployment, he decided to fill in his period of waiting by accepting an offer to be the Foreign Negotiator for the Marconi Company, later Cables and Wireless, Ltd. In 1924, the prospect of further employment in the Army was still very problematic, so he retired and continued in his appointment with Cables and Wireless. For them he carried out important negotiations in Poland, Greece, Egypt and many European countries until 1934, when, at the age of 63, he settled down in his house at Worplesdon, and busied himself with local work as President of the local branch of the British Legion, and as an A.R.P. Warden of the Woking branch.

In February, 1938, he was appointed Colonel Commandant R.E., and in December of the same year he was gazetted to a Commission of Lieutenancy of the City of London, an ancient order tracing its origin back to Saxon times, reserved for distinguished men selected from many walks of life.

In December, 1939, Sir Graham and Lady Bowman-Manifold received a grievous blow by the death in action at the glorious battle of the River Plate of their very promising and much loved son, Lieut.-Commander John Bowman-Manifold, R.N., Navigating Officer of H.M.S. *Exeter*. The courage and resignation with which together they bore this great sorrow is shown by the concluding words of their announcement of the death in *The Times*: "Fear God and honour the King."

Our sympathy is with Lady Bowman-Manifold and her family, who within three months had also to mourn the loss of a distinguished and well beloved Husband and Father.

H.L.P.

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BRIGADIER-GENERAL SIR GEORGE BOHUN MACAULEY, K.C.M.G., K.B.E., C.B.

YET another great Sapper has joined the majority. George Bohun Macauley was head of the Sudan Railways in the transition period following the military overthrow of Dervish tyranny, and the establishment of ordered civil government from the sources of the Nile to the Second Cataract. But his destiny drew him to Egypt, on which ancient stage was played his real part in the world drama, in the culminating and final scene of British control of the land of the Pharaohs, where he was one of the principal actors, whose rôle terminated when the Egyptians took charge of their own affairs.

Born on August 25th, 1869, his early training was mainly at the hands of private tutors, seeing that a weakness in his eyes rendered it advisable that he should not work by gaslight. Undoubtedly, he went to schools, but he seems to have missed the years of rough and tumble that then characterized the life of a boarder at a great public school. This, though having no apparent effect on his manner and bearing in after-life, had two consequences which set their seal on his subsequent career.

At the age of eleven he spent a year in Brussels, which must have contributed not a little to his later fluency in French. This was no small asset. French—or rather, that perversion of a classic tongue nicknamed " Gallo-Syriac "—was the official language of Egypt in his time, a fact attributed by scoffers to the proven assertion that no foreigner can possibly state bald truth therein, and with equal certainty cannot be bowled out for convenient inaccuracy. It was no uncommon occurrence in official dealings to find some flagrant violation of the laws of veracity smoothed over by the soothing explanation : " une petite erreur s'est glissée dans la rédaction."

The other consequence was subconscious. It made Macauley subtly different from the normal output of the public school mill. He thought less with the herd and more to himself. Kipling noticed this type of mentality when, commenting on the known phenomenon that no man has ever possessed a cat, while many men have been possessed by their cats, he remarked as to the latter, " they are aloof and mysterious." It was just this aloofness with its atmosphere of mystery that contributed to Macauley's undoubted exercise of power over his superiors and subordinates.

His father's career and experience must have helped to no small degree in the moulding of his son's character. Lieut.-Colonel G. W. Macauley had played a conspicuously valuable part during the stormy decade which comprised the Indian Mutiny, and his services had many times been brought in most flattering terms to the notice

of the Government of India. Unhappily, as has too frequently happened in the history of those who laid good bricks in the structure of British renown, his overstrained health broke down before he could reap the reward so well earned, but he passed on the tradition of work faithfully done to his son, who, more lucky than he, obtained well-merited recognition throughout his active life.

In 1887, Macauley joined up at the "Shop," where he was one of a batch who had eighteen months' instead of the normal two years' training. His course at the S.M.E. was also somewhat abbreviated, as in October, 1890, he was one of the first two young R.E. officers to profit by that most valuable course of a year's instruction on the London and North-Western Railway. At its conclusion he was sent for two and a half years to the Upnor–Chattenden Railway. This was followed by a year in the Training Battalion, and then came an appointment which apparently exercised a profound influence on his subsequent life.

He spent eighteen months in the Intelligence Department at the War Office. There he had to deal with "hush-hush," and, to a man of his naturally reserved and somewhat secretive nature, this must have been a source of pure delight. He learned so to destroy waste paper as to obviate all possibility of its falling into outside hands, to observe a sphinx-like reticence on official subjects, to conceal confidential notes in unexpected *caches* and undecipherable calligraphy, and generally to keep silence.

Of course, this habit had its transcendent merits, but it was sometimes decidedly trying for his immediate entourage, who never acted for him without inner qualms—not that he would think of letting down a subordinate, but nobody likes to take a decision or give an opinion that commits one's chief to an undesired line of action. Be that as it may, it succeeded in Macauley's case, partly because in Egypt heads of administrations took their annual leave simultaneously at the final period of the hot weather, leaving their deputies with tacit instructions to keep the machine ticking over but not to start any new hares, and partly because he was blessed with a loyal staff throughout his career. It is a policy that works well, so long as the chief concerned has an administration which he can keep under his personal control, as in the case of that grandest of Sappers, K. of K., during the Sudan campaign, 1896–98, which was a one-man show if ever there was one, as the following incident will exemplify.

In the Wadi Halfa mess, the Commandant "Conky" Maxwell (afterwards General Sir John Maxwell, G.C.B., etc.) was talking one evening about the uncertainty of future plans, when one young subaltern remarked that the Director of Military Intelligence would know, being in the confidence of the Sirdar. "Conky" turned on him and said, "My dear boy, there are only two people in the

Sirdar's confidence. One is the Almighty, and the other is the Sirdar ! " Macauley was present, and grinned approval.

His term at the War Office had not ended when there came the offer which decided his whole career. He was given the chance of service in the Egyptian army on the Sudan Military Railway. By the time he reached Wadi Halfa, at the end of 1896, the new line across the 230 miles of desert to Abu Hamed had been begun by Gorringe, who fully appreciated the need for " getting a move on " if the further end was to be reached before the fall of the Nile rendered the passage of boats over the cataracts an impossibility. Macauley was forthwith located at railhead, and was in charge there until the return of Girouard from England, after placing orders for rolling-stock and stores. This admitted of a more permanent reorganization of the Railway Department. Girouard was struck by Macauley's evident ability, and sent him to railway headquarters at Halfa, where he was to be second in command and to take charge of the reception, sorting and distribution of the multitudinous variety of stores that were arriving for the big undertaking.

The task was enough to tax to the utmost the abilities of any man, but in this case it had been complicated by the fact that all stores for the S.M.R. were taken over at the Department of Stores in Cairo, and re-invoiced in Arabic, which, although a rich language in synonyms, was ill-provided with technical terms. The Cairo invoicing clerks, therefore, took the line of lumping together dissimilar steel products, such as fire-bars, parts of lathes, stocks and dies, and steel rods, etc., under the generic title of " bits of iron." The task of the Superintendent of Stores at Halfa was difficult enough in itself, and the invoices he received might have driven any ordinary man crazy, but " Mac " was no ordinary man, and possessed in fullest measure the compensating asset of a sense of humour.

For example, on a summer afternoon, say at 2 p.m., while the fierce heat of 112° in the shade would make most mortals think of what a siesta in hell would do to alleviate their discomfort, when Hanna Effendi, his chief store-keeper, would come to the mess and say, after looking at his vocabulary, " Sare, ze barges have arrived and are now lying in ze offal," Macauley would at once go out, regardless of heat, and return at dusk with many a fruitful story of Cairene nomenclature, after having evolved order out of chaos. By that time, we had all foregathered in the gathering twilight to repeat Mac's most celebrated apothegm, " Nothing matters so long as the ice-machine does not break down ! " Drooping spirits would be revived by other spirits, and very frequently one of the attendant servants would be told to bring the Bimbashi's " wing-wang," by which appellation Mac's banjo was indicated. On this he was a very fine accompanist, and had in addition the most extensive repertoire

of comic songs heard at music halls. Thanks to an excellent memory, he could easily repeat the words and tune of any particularly spicy song he or we had heard, and Halfa guest nights earned a just fame throughout the Expeditionary Force.

The tremendous amount of work done, and energy expended, made time pass on greased wheels, and, before we realized it, the battle of the Atbara had been fought, Girouard had been appointed President of the Railway Board in Cairo, and Macauley had succeeded him. He proved an ideal chief, and when the campaign was over and it became apparent that the railway, as a purely military concern, must be replaced by a civil administration, it was taken for granted that Macauley's hand should be at the helm. What the problems were, what they entailed, and the difficulties surmounted, have been set forth in such masterly fashion in Lieut.-Colonel Sandes' wonderful book, *The Royal Engineers in Egypt and the Sudan*, that it would be redundant to recapitulate them.

By 1906, Macauley's reputation was well-established ; he had been in charge when the Port Sudan–Atbara Railway had been built, for which he had been rewarded with a C.M.G. and he had been on the Divisional Staff at the Battle of Khartoum in 1898, in the *Gazette* for which he was promised a Brevet Majority on promotion to Captain.

Then came the unexpected. The General Manager of the Egyptian State Railways and Telegraphs, Major J. H. L'E. Johnstone, M.V.O., R.E., died, and obviously the man best fitted by ability and experience for the post was Macauley. He severed his connection with the Sudan, retired from the Egyptian Army, and took up his new appointment on October 23rd, 1906.

It is fitting here to describe the conditions under which he thus entered the Egyptian Civil Service. Again, reference must be made to Colonel Sandes' book, but the following points are supplementary. Girouard, in 1898, found the whole system in a deplorable state ; it had been starved for funds for many years, being forced to work on 45 per cent of its gross earnings. With his usual energy and flair, he had awakened the Government to the need for immediate outlay, and for a programme of reform. Some money was granted, but not nearly enough, and the appalling amount of circumlocation, red tape, obstruction and hopeless inertia encountered was sufficient to break the stoutest heart. Against this cage Girouard's fiery genius battered its wings for a year, and then he was ordered off to the South African War.

Johnstone came from the post of Inspector of Iron and Steel Structures, at the War Office, to hold the fort while he was away. Girouard never came back, and Johnstone had to carry the baby. His was no easy task. Doggedly, and working under great disabilities, he plodded on in his quest for reform. He was aided in this by a handful of Sappers, none above the rank of Captain,

who had the merit of enthusiasm and not caring what they said or how they said it. A hopelessly laid-out and badly-equipped line naturally could not stand up to the stress of ever-increasing traffic and some awful accidents occurred. The aforesaid subalterns did not wait to be held responsible, but told the great and mighty that they were gambling with the lives of the public.

Something was done, after a seven-year struggle. Funds were made available, a Supreme Railway Board was constituted with all the powers of the Council of Ministers, and the railways were freed from ministerial interference. The General Manager was given powers far exceeding those of any other official in the country, and this happy result had just been achieved when Johnstone died.

Fate designated Macauley as the man to give value for these extraordinary assets. He did!

He began with his habitual caution, and arrived in the most unobtrusive manner. He located himself in a quiet, unfashionable suburb some miles out of Cairo, and took a house containing two flats, so as to ensure freedom from the proximity of children. There he lived in solitary state, but not necessarily undisturbed. Who could ever forget the back view of the General Manager striding, with ever-hurrying steps, towards his lonely abode, pursued by a small child with a spade calling after him, "Daddy, daddy!" The quickening pace was almost approaching a run when a humorous lady neighbour, summing up the situation, called out, "Hullo, Major, what's this?—Don't they say that a wise child knows its own father?" The pace then increased to a run, and very soon after, Mac transferred to Cairo which, being too unhealthy for families, gave him the security he so much demanded.

With him there came from the Sudan his private secretary—an Egyptian officer, and his *Cawass*—an Egyptian soldier. Of their fidelity there never has been, never could be, a doubt, and with them in his closest entourage he assumed command of the greatest organization in the country.

At first he sat back, watched, and listened. Then, octopus-like, he began to push beneath the depths the feelers of his powerful tentacles, until imperceptibly they had reached hidden positions whence they could grip, and, in due course, they gripped. He had evidently learned much of value as to dealing with Eastern races from his father, for he inclined to the methods of the benign despot. If there is one thing an Oriental likes and trusts, it is the knowledge that his petition or grievance can reach what is to him the throne—the supreme authority—and every morning Mac's arrival at his office door was heralded by a crowd of petitioners whose complaints, mostly worthless, were taken over by Hassanein, the aforesaid private secretary, and the result of whose investigations would be made known directly, and without intermediary, to the chief. Occasionally,

very occasionally, a case would come up in which the General Manager thought it necessary to intervene personally, but usually the papers went on to departments, leaving Macauley to face the serious business of the day.

He began by a perfectly maddening habit of demanding that all inward papers, before being put on their files, should be submitted to him, and only too often he would write his decisions thereon without regard to previous history. In most cases, this saved much labour and delay, but occasionally, the reverse happened, and it fell to his staff to make tactful representations to their chief that he would do well to reconsider his verdict. This was not a pleasing job, until the technique was learned—just an appeal to his never-failing sense of humour. This was his second nature—he could not resist it, and no matter how wrong things might have gone, or how inwardly furious he might feel, a timely *bon mot*, or a story heard at the club, would restore sunshine as by a magician's wand. In this respect, Egypt was *the* country for him, *par excellence*, for in no other save in that land of paradox could heart-breaking difficulties be so compensated by unconscious opera *bouffe*. Much of the business of the country is in the hands of non-Egyptians—Mediterraneans mainly. Many of them would want to put over some unholy deal with the Government, not on the real pretext that they wanted to line their pockets, but simply for the good of Egypt—the country they so dearly loved. It says much for the childishness of such people that they tried to convince Macauley of their entire disinterestedness and altruism. He would look at them with the russet eye of suspicion, but very seldom gave himself away unless one of his staff happened to be present and moulded his lips with the silent utterance of the word " philanthropy," when our chief would have visible difficulty in keeping his countenance.

He revelled in his job, which was undoubtedly most pleasant and interesting, save in one respect. It had certain social obligations, which he loathed. Dinner parties, social functions, and society small-talk were anathema, for in the last resort he was shy. This came out in his attitude towards women, whom he regarded with profound suspicion. In that way he resembled and modelled himself on Lord K., for whom his admiration was unbounded. Both bachelors, however, sometimes had experiences with the fair sex which floored them, and caused outside merriment. There is a story, vouched for as true, of Lord K., when C.-in-C. in India, at a banquet, having on his right a fluffy little blue-eyed bride who suddenly said to him, " Lord Kitchener, they say you hate women. Is that really so ? " K. turned his swivel eye on her and countered sardonically, " Not quite that. It may be that familiarity breeds contempt." The *ingénue* replied, " But, Lord Kitchener, there cannot be any

breeding without some familiarity, can there ? " and the conqueror of the Sudan had to admit defeat.

One of Mac's classic experiences was when he thought he would nobble the Financial Adviser (Lord Edward Cecil) privately, and before the Budget, at a visit to the latter's home. Cecil saw him coming up the garden path, opened the window and called out, " Come in, Mac, you are just the man we want. We have the M's. christening party going on inside, and you can hold the baby ! " What Mac's departure lost in dignity it gained in speed, for he was quickly lost to sight, with the peals of laughter from the mixed assembly ringing in his ears.

Macauley's arrival in Cairo coincided with the great financial slump, which threw Egypt into the depths after the astounding seven years' boom which followed the recapture of the Sudan, the commencement of the Aswan Dam, and the prospect of vastly increased agricultural prosperity.

On the Bourses of Alexandria and Cairo there swooped an evil flock of human birds of prey, starting shoddy companies, fostering the wildest speculation among a nation ever prone to gamble, and generally preparing to " spoil the Egyptians." The bubble burst in the summer of 1906, and unfortunately synchronized with a very unhappy incident, in which a party of British officers, shooting pigeons on their march through the Delta, had been roughly handled by some villagers and one of the officers killed. The vengeance meted out to the delinquents was nothing if not dramatic, too dramatic in fact, and it created cheap martyrs—a most expensive luxury ! A lot of latent political unrest in the country was thus excited, anti-British feeling was fanned into flame by fanatical students and quill-drivers, and the Little Englanders at home contributed their full quota of fuel.

Soon after this, the retirement of Lord Cromer, and the appointment of Sir Eldon Gorst to succeed him, was interpreted by the Egyptians as a sign that the British Government was slackening its hold on Egypt. As might be expected in an Oriental country, where prestige counts for so much, disorders increased throughout the land, and attained their culmination in 1910, when the Coptic Prime Minister, Boutros Pasha, was assassinated, and a strike at the Boulas Railway Shops coincided with an attack on the Upper Egypt express which was passing at that moment. The latter was held up and subjected to a shower of stones, while the passengers ran for their lives. Happily, the crowd did not know that the post van was transporting a large quantity of specie, otherwise the consequences would have been worse.

Macauley hastened to the spot, followed almost immediately by his two senior officers, both R.E. Captains. After a conference, he arranged with the leader of the strike for an immediate return to

duty, and promised the appointment of a Committee of Investigation into alleged grievances. Thereupon the whistle was sounded for work to begin. The railway men behaved well, but the crowd outside, composed of the offscouring of the slums, was in a very different mood. The three Sapper officers were endeavouring to get the train started, when they were subjected to a perfect hail of stones picked up from the ballast. Macauley was saved by his faithful *cawass*, but the other two Sappers had to walk the gauntlet of the disabled train as targets for the crowd. Fire-engines were put out of action, troops had to be sent for, and things were beginning to look serious when a timely charge by police reinforcements scattered the rioters after a short but hot hand-to-hand struggle.

This was yet another attack on British officers, and the authorities at the time took a grave view of matters (but it was nothing compared with the uprisings of 1919 and 1921). The death of Sir Eldon Gorst, in 1911, gave the British Government a chance of tightening things up, and Macauley showed his usual calm judgment by prophesying: "I'll bet any money that K. of K. will come here, and all these people will fall flat." This is exactly what happened.

During the five years 1906 to 1911, Macauley had fostered all attempts to improve the conditions of the employees, while gaining the confidence of those in authority at the various ministries. In both directions he was successful, and therefore began the brilliant Kitchener régime in the happy position of being an autocrat in his own administration, supported by an absolutely trustworthy staff, and having his own highly efficient audit.

Naturally, the privileged position of the railways was an object of jealousy, but so long as the Supreme Railway Board existed, and Lord K's hand held the control levers, they were unassailable.

Very soon in the day, a K.C.M.G. was awarded to Macauley who thus became one of the most eminent and by far the most powerful of officials in Egypt.

It is difficult to describe Lord K's régime without going into superlatives; suffice it to say that it was magnificent. Great projects were undertaken; far-sighted schemes of reform inaugurated; the interests of the peasant safeguarded; and greater efficiency introduced into every department of State.

Needless to say, the railways profited along with the rest during the short halcyon period, and when the war broke out in 1914 were in a peculiarly favourable condition for meeting the emergency.

A rather silly custom prevails of saying that the British Government is always taken unawares by a crisis, that it never looks ahead, and knows nothing of what is threatened. Experience, however, shows that the British Government is not such a fool as it likes to look, and is remarkably well-informed as to actualities. The case of the railways in Egypt was typical. Its three most senior officials

and the Inspector-General of Telegraphs were all R.E. officers of the regular reserve. Years before, they had been told that in the event of mobilization they should report to the G.O.C. in Egypt for orders. This was done in August, 1914. Their instructions were to carry on as usual and not to get into uniform until told to do so.

While every effort was being made to win Turkey over to our side, it must have been increasingly plain to the people in London that the Germans were ahead of them at Constantinople. Unobtrusively, and without fuss, precautionary measures were adopted. An old friend—General Sir John Maxwell—returned to Egypt as G.O.C., and a finer selection could not have been made. His methods were those of Macauley—the less put on paper the better, measures must be discussed privately, and by night, and subordinates must just be told of the particular job they were to perform, with no detail as to identity or task of other performers.

It was vitally important not to awaken the latent fanaticism of Egypt, for the Sultan of Turkey in those days was the Caliph of Islam, and the Egyptian Moslems must not be disturbed. Mac was in his element—here was real secrecy, and he enjoyed himself to the full.

For example, one of his R.E's had commanded an armoured train in South Africa, which had been made of odd railway material. This officer was told to make two of the same pattern, and very soon the Scrap Yard had provided sufficient junk to admit of the trains being built before hostilities opened.

So stealthy was the process that when, in due course, the Railway Shops were expanded to deal with armament, when State Railway stock was converted into hospital trains and the system passed under military control, the staff seemed to take it as a matter of course, pocketed the extra pay earned, and seemed content.

But Egypt is the land of the unknown and unexpected, and 1919 with its unpleasant surprises was yet in the womb of the future.

Macauley rendered what aid he could in the Dardanelles Expedition. One of the R.E's and two engineers were sent to the Peninsula with a view to laying a light railway thereon, but there were no landing facilities. The beaches were under direct artillery fire from the Turks, and the scheme was obviously impracticable.

Later, when the Expeditionary Force had been withdrawn to Egypt, and the advance from the Suez Canal to Palestine was decided upon, his real military work in the war commenced. He became a Brigadier-General at G.H.Q., which was established in Cairo, while continuing to act as General Manager, State Railways, with the rank of Under-Secretary of State.

No Egyptian official is ever likely to have such a position again. Provided he satisfied the military authorities (and he saw well to that) and told the Ministry of Finance how much money they should

provide, he was an autocrat. Thanks to his habitual prudence, he made no show of his power, so all went well.

His greatest friend, and most trusted subordinate of Sudan days, Lieut.-Colonel Sowerby, had returned to Egypt with the evacuated Mediterreanean Expeditionary Force. Macauley placed him in charge of the military railway to be built from the Suez Canal to Palestine, and the two worked in a manner dear to Mac's heart. Ultra-secrecy, and only enough on paper to avoid trouble with the accountants! They got what they could out of the War Office, and, if badly held up, could indent on the State Railways for stock, material, or men under martial law. Thus freed from obstruction and red-tape, it was astounding to note what progress they made.

Macauley made occasional inspections over the military line, and on one occasion was present at the preliminary bombardment of Gaza in October, 1917. On the last occasion, in March, 1919, dramatic events happened in Cairo during his absence. When he returned, he found that his successor in the railways had been appointed, and that he was to be made Adviser to the newly-formed Ministry of Communications.

This had been contemplated for some time. The war had made it apparent that the extraordinary advances in motor transport and aviation had ushered in a new age, and Egypt must follow suit. There had been a marked change in Egyptian public opinion, and it was evident that the days of pupilage under English control were coming up for revision. Macauley's autocracy could not and would not be tolerated under a purely Egyptian régime, and the problem was how to utilize his powers without losing his services. Then came the brainwave to the "Second Eleven" who, in the period of transition, had slipped into the shoes of the greater men who had preceded them. "Let us make a Ministry of Communications, appoint Macauley as Adviser (this rank paralleled that of Minister), and co-ordinate Transport!"

What a useful word is that of "co-ordinate"! It can cover a multitude of anomalies and ramps! The idea had much in its favour. Something had to be done to prepare for the new order, but it involved the abolition of the Supreme Board, and thereby dealt a terrible blow to railway efficiency. At the time, however, it solved the immediate problem of Macauley, satisfied jealousy of the railways, and enabled a few highly-desired transfers and promotions to be made, thanks to the new jobs created! Then arose a hitch.

The country was in a state of upheaval. Fighting was going on in the streets. There was a general strike of Government officials, including most of the railways, and no ministers were in office.

It was too late to change, so Macauley was made—as a temporary measure—Inspector-General of Communications, a title which the

Turf Club, appreciating his known distrust of official and commercial motives, modified into that of " Suspector General."

Later on, after a somewhat abject and unnecessary surrender by the British Government, wearied by the war and infected with the Versailles spirit, a Cabinet was got together, and Mac's usual luck stood with him in the personality of the first Minister of Communications. Ahmed Ziwer Pasha was a magnificent character, very broad-minded, and a splendid chief. The new Adviser initiated many useful and necessary schemes, but here it is only fair to mention one big mistake. We are all liable to make mistakes, and would not be human otherwise, but this was so characteristic, and so much the big error of a big man, suffering from over-caution, that no harm can be done by showing a shadow on the picture.

By the end of 1919, the aftermath of four years' warfare had appeared in a crop of labour troubles, including coal strikes. Little, if any, coal could be got from Britain, and catch cargoes had to be picked up when and where they could be found, at ruinous prices, in various parts of the world. Macauley took an unduly pessimistic view of the future, but was determined at all costs to avert further dislocation and disorder in Egypt, where the fires of revolution had barely died down, and were still smouldering. Against the advice of the railways, he ordered a three-year supply, without much regard to cost. Instead of paying £1 a ton, the railways found the price worked out at £10, and that a million tons of very indifferent coal had been purchased. Ten million pounds had to be found, therefore, out of railway receipts !

As a result, for the next four years, fares and tariffs had to be doubled, much to the detriment of internal trade and greatly damaging the reputation of the railway chiefs.

However, it had one good consequence, as will be seen later on. Egypt was living up to its reputation of being the land where everything is done upside down. Who would have thought that a small nation of this sort would rise against the rule of England just at the time when there were thousands of English soldiers doing nothing in the demobilization camps in the country ? Who would have dared to think that they would succeed ? Nevertheless, they did, thanks to the palsied attitude of the home authorities. The latter surrendered bit by bit all their control, and within five years Egypt was virtually independent, and the British officials were being pensioned off in large numbers.

By 1924 the railways had an Egyptian General Manager, and he assumed office just at the moment when the costly coal had at last been used up, thus enabling him to inaugurate his term of office by an all-round reduction of tariffs and a great increase of facilities.

Looking back over the last sixteen years, and seeing how well Egypt has prospered and progressed under its own national rulers,

one has to recognize the hand of a benign destiny which is shaping that country for an important part which it may have to play in the great world drama now unfolding.

Macauley left, full of honours, in October, 1922, after nearly twenty-six years of service. He obtained a second well-earned Knighthood—the Military K.B.E.—for his services as Director of Railway Traffic, and had also been made a C.B. in 1916. The King of Egypt conferred on him the Grand Cordon of the Order of the Nile, and he could feel that his life of brilliant and devoted service had not passed without recognition.

Unfortunately, his sight had deteriorated and he was thus precluded from further service in his own country, which, in addition, probably lost the work of no mean artist—especially in that rare and priceless direction of caricature! He did what he could by lecturing to the blind, and aiding in the compilation of historical material, and met a quick and merciful end on January 6th, 1940, after a week's unconsciousness resulting from a stroke.

A tablet is to be erected to his memory in that Valhalla of the Sappers—Rochester Cathedral. During life he held Stall No. 8 in the Chapel of St. Michael and St. George in St. Paul's Cathedral. Fit reward for a great patriot!

May the Patron Saint and Guardian Angel of England yet sum up his life's work at the Great Assize with the verdict, "Good and faithful servant, well done!"

R.B.D.B..

BRIGADIER-GENERAL ALEXANDER MURRAY ROLLAND, C.B., C.B.E., D.S.O.

THE son of General Rolland of the Madras Army, Alexander Murray Rolland was born on March 6th, 1871. After passing through the Shop, he obtained his first commission on February 14th, 1890.

His first appointment after leaving the S.M.E. was in the "Submariners" at Gosport and other places in England, whence he proceeded to India in 1895, and was posted to the Indian Submarine Mining Corps, first at Rangoon and afterwards at Calcutta. He joined the M.W.D. (now the M.E.S.) in 1899 and served at Attock, Murree, Rawalpindi and Campbellpore.

In September, 1900, came his first experience of active service, with the Indian Expeditionary Force sent to China for the suppression of the Boxer rebellion. For the greater part of his stay there, he was employed as the British engineer representative on

the cosmopolitan Tientsin provisional government. In this capacity he was concerned in a crisis of some magnitude, when a dispute arose between ourselves and the Russians over the boundaries of our respective areas. Rolland was ordered by the British general to lay down railway sidings in the disputed area as fast as he could, and what he described as "a highly idealized portrait of himself" in this capacity was published in some illustrated papers.

Rolland used to relate how on one occasion he asked a Chinese contractor for an explanation of an exorbitant figure he was quoting for some work. The Celestial adduced the high cost of labour, materials, transport and so on, finally adding "and master's ten percenty." He misinterpreted the look of utter astonishment that came over Rolland's features, and queried, "What, ten percenty not enough?" Then followed a lecture by Rolland to the effect that that sort of thing wasn't done, anyway in the British Army.

Rolland received the China medal.

From China he went on leave home in August, 1902. The whole of his second tour in India was spent at Karachi. His third tour took him to Dera Ismail Khan, where he was G.E., and subsequently A.C.R.E., from 1908 to 1910.

On one occasion, when a wire entanglement was being made at Pezu to protect the mules employed in carrying drinking water up to the hill station of Sheikh Budin, the reports received by Rolland in Dera Ismail showed an amount of labour employed, which he suspected was not all present and effective. Being unable to visit the spot, he informed his office staff that he had asked certain officers in Sheikh Budin to observe the work through powerful telescopes. At once the amount of labour stated to be employed fell by 50 per cent.

He did not, however, generally rely on such indirect methods. His energy in getting about to inspect work, even in the hottest of the hot weather, was phenomenal; it must be remembered that, in pre-motor days, the only means of getting about that very wide district were by tonga on the few existing metalled roads, and on horseback otherwise.

After attending the Indian class at the S.M.E. in 1910, he was posted to Rawalpindi, proceeding thence on leave home in 1914. On the outbreak of war, he was sent back to India, returning almost immediately, in company with some seventy other R.E. officers, to the U.K. It is said that he left the ship at Malta and made his own way to the seat of war in France, only, however, to be summarily despatched to Fermoy, to take over the 75th Field Company, which was being raised by Bulkeley. This officer records his chagrin at being superseded by one who had been out of touch with troops for twenty years, but on returning to the same company in January, 1916, had nothing but admiration for the way in which Rolland

had shaped and trained it. Another officer who knew him about the same time has testified that he chose his N.C.O's with unfailing success and trained a very efficient team of officers.

In the summer of 1915, the 75th Field Company was sent to France to form part of the Guards division, and Rolland had his first major experience of warfare at Loos. In the bad weather following, he was unfortunate enough to go down with a severe attack of fever, and still more so on recovery to find himself superseded for the C.R.E.-ship by an officer considerably his junior, who leaves it on record that Rolland served under him loyally and keenly. The Company spent the winter of 1915–16 in the trenches east of Laventie, where its work consisted largely in draining the front line and in deepening the position, which up till then had consisted of little more than a line of breastworks.

In February, 1916, Rolland was appointed C.R.E. 20th Division and served as such, first at Ypres and afterwards on the Somme. The division took Guillemont, and thereafter settled down on the Somme battlefield until the Germans retired in the spring of 1917.

By August, 1918, Rolland, now Brevet Lieut.-Colonel, was C.E. IIIrd Corps, hard on the heels of the great German retreat. The advance was, as is well known, a very difficult business, owing to the thoroughness with which the enemy had destroyed bridges and railways and mined cross-roads. Within twenty-four hours of the first crossing of the canalized river at Tournai, Rolland had thrown a 120-feet Hopkins bridge, capable of carrying tanks, across. Three days later, the same bridge had been dismantled and re-erected thirty miles further on.

For his services in the war of 1914–18, Rolland was four times mentioned in despatches; he was awarded the C.B.E. and D.S.O., and received two brevets, the Legion of Honour and the order of the Crown of Belgium.

Returning to India in 1919, he was successively D.D.G.M.W. at A.H.Q. and C.R.E. Quetta Division. In 1921 he was sent once more on active service as C.E. Waziristan. Although there was at that time less fighting than there was before and than there was to be later in that troublous area, there was always strenuous work for the Sappers, and none of Rolland's energy had abated. He also had a very onerous task in straightening accounts which, as the district had been the scene of almost constant warfare since 1917, were naturally disorganized. The ways of the Military Accounts Department in India are inscrutable, and in 1923 Rolland obediently compiled and presented them with the *budget* for 1922.

For this campaign he received a mention in despatches and the India General Service Medal with two clasps.

His last official job was that of C.E. Southern Command, India, from 1923 to 1927. His was the largest charge in India and he

seemed to know every set of lines in it. He was still an enthusiastic squash player, and his retirement placed him on the shelf when he still had the vitality of many fifteen years his junior. The last and crowning distinction of his career was the C.B., received in 1926.

Rolland lived at Camberley for the last few years of his life, and died there on October 12th, 1939. He had married, in 1893, Annie Maud, daughter of Sir Hamilton Gyll Murray, Bart.; she predeceased him in 1928. They are survived by two daughters.

An officer of the Corps has written an appreciation of Rolland. "He had a very good brain, was exceptionally quick in the uptake and had plenty of foresight. Any work which he undertook was invariably completed quickly and well." To this may be added that he had a profound knowledge of his profession and that, if he had a fault, it was that of over-leniency to erring officers and subordinates.

I am indebted to Major-Generals Fuller and Brough, and to Lieut.-Colonels Bulkeley and Briggs, for much of the above information.

F.C.M.

All Reviews of Books on military subjects are included in the provisions of K.R. 535c (*1935*).

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library at Brompton Barracks, Chatham.)

OFFICIAL HISTORY OF THE GREAT WAR.

MILITARY OPERATIONS, FRANCE AND BELGIUM, 1917.

Compiled by CAPTAIN CYRIL FALLS, late R. Innis. Fus. and General Staff, with a preface by BRIGADIER-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., HON.D.LITT. (Oxon), R.E. (retired), *p.s.c.*, Director of the Historical Section (Military Branch). Maps and Sketches compiled by MAJOR A. F. BECKE, R.A. (retired), HON. M.A. (Oxon).

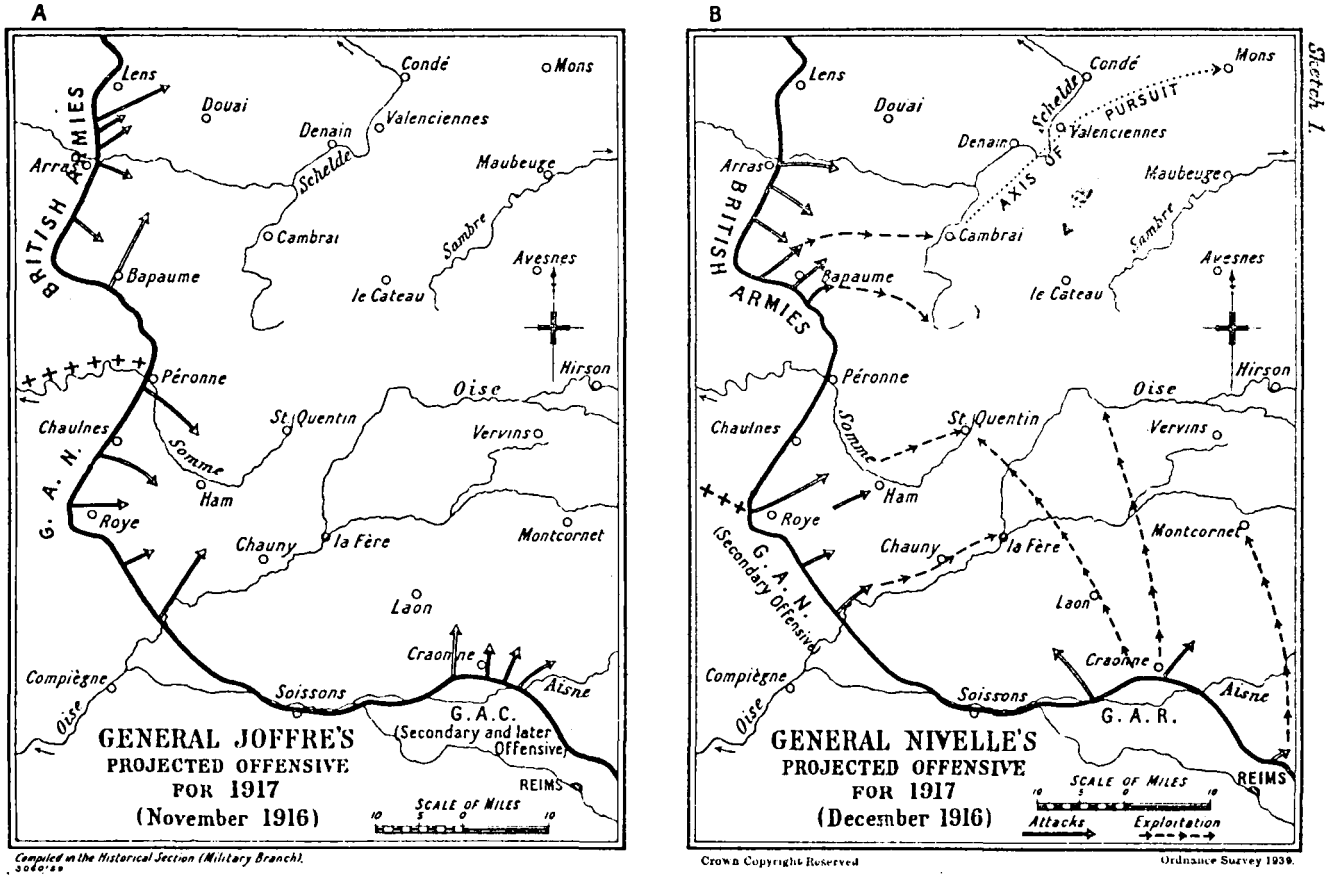
(MacMillan & Co., London. 1940. Price 12s. 6d. net. Separate volume of Appendices, 6s. 6d. net. Case of Maps, 5s. 6d. net.)

The latest volume of the *Official History* covers the first five months of 1917, to the conclusion of the combined operations of the Allies to effect a break-through on the Western Front in the spring of that year. In the first two chapters, accounts are given of the inter-Allied Conferences at which the plans for 1917 were discussed and eventually decided. The first of these took place actually in 1916 on November 15th–17th at Chantilly, while General Joffre was still C.-in-C. of the French Army.

It will be convenient here to recall what General Joffre's plans for 1917 were, and how Sir Douglas Haig proposed to carry out his share in the scheme. It is perhaps unnecessary to remind readers of the friendly relations between the two Commanders-in-Chief. The Official Historian describes them as follows: "The two men, though "one was domineering and the other could be stubborn, were never in their dealings "with one another afraid to compromise, when the higher interests of their respective "countries did not appear to be in question. It was this quality of reasonableness "which made them, in the main, good collaborators." It is greatly to the credit of General Joffre that, although he was the representative of the predominant partner, he was able to understand and respect the British view. Both men had learnt to trust each other.

Before the Conference, the two Generals had already met and come to an agreement as to the broad lines of their combined action in 1917. In a letter to General Haig, General Joffre had written that in order to obtain a decision it would, he considered, be necessary to broaden the front of attack as far as possible; but he had no intention of selecting a new one (referring to the Battle of the Somme, 1916). He suggested that the battle front should be extended to the Oise on the one hand and to Arras on the other, the French attacking between Oise and Somme, and the British between Bapaume and Vimy, a front of twenty to twenty-five miles each, leaving a sector in the centre of about eight miles, from Peronne to about Le Transloy, to be held, in the first instance, defensively. In his reply Sir Douglas Haig generally agreed, with two stipulations; first, that he thought that the capture of the Mont St. Quentin spur (dominating the valleys of the Somme and the Cologne at Peronne) would probably be necessary for the prosecution of any attack within range of it: and secondly, that he had strong objections to placing his right on the Somme, the chief being that the French communications between Cléry and Bouchavesnes ran across the river. He offered, if the French would first of all capture St. Pierre Vaast Wood, to take over the French front as far as Bouchavesnes by, at earliest, January 1st, 1917. General Joffre accepted the new boundary, but not the conditions, nor the time-table. Eventually, the British Fourth Army took over the whole of the additional front to Bouchavesnes on January 12th. General Joffre had given way

Sketch 1.



(Reprinted from the *Official History of the Great War, Military Operations, France and Belgium*, 1917, by permission of the Controller of H.M. Stationery Office.)

to a lesser extent than his British colleague, for General Haig had waived his request for the capture of St. Pierre Vaast Wood ; on the other hand, he had shown moderation, especially in view of the state of public opinion in France, in not demanding a more considerable extension of the British front.

General Joffre's plans included preparations for two secondary operations by the French, one on the Aisne, north-west of Reims, the other in Upper Alsace—both to be surprise attacks after, and dependent on, the success of the main operation.

The Official Historian records, and the fact should be borne in mind in view of the failure of the French to effect a break-through in April, 1917, and the effects of that failure on the French Armies, that the year 1916 was closing on a note of optimism and confidence as regards the Western Front, and this feeling was generally evident at the Chantilly Conference of Allied Commanders in November at which General Joffre presided. The battles of the Somme had saved Verdun. The success of the French counter-attacks at Verdun, which, incidentally, had brought the name of General Nivelle to notice, had also greatly lowered the morale of the enemy ; and though the extent to which the morale of the German Army had suffered was not realized at the time, the optimism of the Allies was justified. For, as far back as September, 1916, the German High Command, fearing that their war-worn divisions, reduced in many cases to not more than 3,000 men each, could not stand up to another hammering in 1917, had decided to provide at least for a retreat, if it proved that retreat was necessary, and orders had actually been given in early October for the immediate construction of the " Siegfried-Stellung," a " defensive zone "—not a " line." It was christened by the British " The Hindenburg Line " when the location of a part of it was discovered—belatedly—by the (British) Air Force in February, 1917.

Before the end of 1916 a veritable disaster occurred. Marshal Joffre was superseded by General Nivelle as Commander-in-Chief of the French Army on the Western Front. This led to a complete change of the plans for 1917. General Nivelle brought with him a new theory of attack ; but that theory was based on experience gained against worn-out Divisions, two-thirds of the effectives of which were, owing to losses, necessarily in the front line, with no reserves to support them and a shortage of artillery and ammunition. The Official Historian writes :—" The founding of a new " theory of attack on experience gained under such conditions showed an unwarrant- " able assumption of the enemy's inferiority."

General Nivelle and General Sir Douglas Haig met for the first time at Cassel on December 20th, 1916, and the latter was informed of the very important change of plan for 1917, and of the coming removal of Generals Foch and Castelnau. The latter was to go with a mission to Russia, with Lieut.-General Sir Henry Wilson as his colleague. The transfer of the former to another command was only temporary.

General Haig did not condemn the " new method " of a surprise blow to " go " right through in twenty-four hours." He felt that the troops might have become too " sticky " owing to the prolonged trench warfare and that a change in this respect was possibly now due.

The object of the Allies on the Somme had been to release the pressure on Verdun and wear out the enemy, with a view to striking an offensive blow elsewhere later on, when his reserves were used up. It might well be, thought Sir Douglas Haig, that 1917 would afford an opportunity for that.

Space does not permit of giving General Nivelle's plans in full : the reader must refer to Chapter II, pages 38 *et seq*. But, what principally affected Sir Douglas Haig was that they entailed the taking over of a far larger portion of the French front by the British Army. Briefly, French forces were to pin down the enemy between the Oise and Somme, and British forces likewise between Bapaume and Arras : then there would be an *attaque brusquée* by the French on another part of the front, followed by the concentration of " Armies of Manœuvre " destined to win a decisive battle and to carry out the exploitation. In this exploitation the British would

participate. Everything would, therefore, depend on the " mass of manœuvre," but as the front was now held, it was impossible for the French to find the 27 divisions required. It would, therefore, be necessary for the British to relieve the French from their left at Bouchavesnes to the Amiens–Roye road, a distance of just over twenty miles in a straight line.

As a sop to General Haig, General Nivelle told him that it would not be necessary for him to continue to the same extent the winter operations to which General Joffre had agreed at Chantilly. This concession, however, did not appeal to General Haig, who believed in the demoralization of the enemy and in the necessity, therefore, in keeping up the pressure relentlessly, even during the winter. Replying, General Haig offered to take over eight, not twenty, miles of front, as far as the Amiens–St. Quentin road, but beginning on February 1st, instead of on February 15th, the date which General Nivelle had originally stipulated. It can be understood how the divergence in views between the two Commanders-in-Chief led gradually to an *impasse*. General Nivelle then decided to ask the French Minister of War for pressure to be put upon Mr. Lloyd George and Sir William Robertson, at a conference shortly to take place in London, to compel Sir Douglas Haig to carry out the relief without delay.

On the 27th December, General Sir Douglas Haig was raised to the rank of Field-Marshal by His Majesty the King, and next day he decided to go and see General Nivelle at Chantilly. The conversation was friendly. Sir Douglas Haig undertook to begin the relief of the French on January 15th and complete it to about the Amiens–St. Quentin road early in February; what he could do after that depended, he said, on the number of new divisions he received from England. General Nivelle appeared to be content with that. Sir Douglas Haig understood him to say " at the " end of March or the beginning of April would be early enough for the relief to the " Amiens–Roye road." It seems certain, however, that Sir Douglas misunderstood General Nivelle on this point; if so, it was not the only occasion on which General Nivelle showed himself less downright in a personal interview than on paper.

It must be remembered that, at the back of his mind, Sir Douglas Haig always had in view the clearance of the Belgian coast during the summer of 1917, a project which Sir William Robertson had impressed upon him was regarded as most important by the War Cabinet; and it was this contingency which may have made him appear reluctant to assent to some of General Nivelle's demands. The latter certainly thought that Sir Douglas Haig was being slow, if not obstinate, in falling in with his wishes; and it is perhaps not surprising that the idea of bringing political pressure to bear on Sir Douglas Haig from London had then suggested itself to General Nivelle. What is certain is that, before the Calais Conference on February 26th, complete agreement on the transportation difficulties, which were worrying Sir Douglas Haig, had apparently been reached by the two Commanders-in-Chief at a meeting at Montreuil, on February 16th, and General Nivelle had promised Sir Douglas that the attack should not begin until British requirements on the railways had been met.

This appeared to make a conference on the railway situation unnecessary, but Sir Douglas Haig was informed that one would, nevertheless, be held on February 26th. He telegraphed recommendations that terms of reference should be drawn up, and that Sir Eric Geddes should attend the conference. In due course he received a document, headed " Questions for Discussion," in which it was stated that the governing factor was that of railways, and that operations in Macedonia would also come under review.

When the Conference met at Calais, the railway breakdown on the British front was first discussed; no decision, however, was reached, and the matter was referred back to the specialists.

General Nivelle then rose, and proceeded to explain his plan of operation. He was followed by Mr. Lloyd George, who remarked that the time had come to speak with the utmost frankness, and that he desired to know what were the disagreements

between the Commanders-in-Chief. General Nivelle replied that there was one only: he had requested that the British attack should not extend so far north as the Vimy Ridge, but should be on a wider front south of the Scarpe. Sir Douglas then gave his reasons for including Vimy Ridge; firstly, that if he attacked solely south of the river, he would after breaking through be confronted by the Hindenburg Line, which was now known to run from south-east of Arras through Bullecourt: secondly, that Vimy Ridge would be of great value as a defensive position (Sir Douglas Haig, it is now known, was also firmly convinced that the Germans would never voluntarily abandon Vimy Ridge, and that here at least there was no fear of an operation being a blow struck in the air.) General Lyautey, who was one of the three French delegates, M. Briand being the third, regarded these reasons as sound. Mr. Lloyd George then requested General Nivelle to put "on paper" the rules which he considered ought to guide the conduct of the two Generals. The meeting then adjourned. After dinner a document was produced by the French representatives; it had, in fact, been brought to Calais with them. Briefly, the French demands amounted to subordinating the C.-in-C. of the British Armies to his French colleague and reducing his status to little more than that of an administrative staff officer.

"No doubt whatever can exist," writes the Official Historian, "that unity of "command was desirable. Sir Douglas Haig would perhaps, without much demur, "have accepted General Joffre as Generalissimo, although the relations established "between the two men made such an official pronouncement almost unnecessary. "Against the grain, Sir Douglas Haig had agreed to fight in the Somme Area in "1916, and he had willingly fallen in with General Joffre's views for 1917, although "he would have preferred to fight in Flanders. But to hand over five British Armies, "root and branch, to a hitherto junior foreign general, of whose methods even his "fellow-generals disapproved and whose scheme Sir Douglas Haig considered "altogether too sanguine, was quite a different matter."

The Conference ended with a compromise, which was amplified at a further meeting. It worked comparatively well, though even the measure of control which it gave to a foreign commander over the military forces of the British Empire on the Western Front may be considered risky. The Official Historian's comment continues with an estimate—based naturally on conjecture—of what would have occurred had the plans of General Joffre been put into effect. "The great German withdrawal "would, it may be assumed, have taken place in any event, and in the opinion of the "Official Historian, the only possible means of taking advantage of it and throwing "the enemy into confusion would have been to anticipate the withdrawal by means "of a resolute attack delivered at the last moment of the preparations. The secret "was so well kept that the British Army, despite its activity, did not discover the "withdrawal until after it had taken place. On the other hand, the *Groupe d'Armées "du Nord* (G.A.N.) had an offensive already mounted between the Oise and Roye, "which would have been immensely stronger under General Joffre's scheme than it "was under General Nivelle's, and it is fairly certain that General Joffre, with all his "attention and all his hopes centred on the Somme front, would have launched this "offensive at the first warning of what was impending. General Nivelle, on the other "hand, ignored the warning of his G.A.N. Had General Joffre succeeded in launching "his attack just before the first marching day (March 16th) of the German retirement, "he would have gained a far-reaching victory. That the method of General Joffre—a "series of attacks extended as occasion offered, with strategic objectives fixed as the "possibility of attaining them became apparent—would have had better prospects of "success than that of General Nivelle, is apparent now. The latter risked all, including "as it proved, the spirit of his troops, upon one blow."

There follows a most interesting dissertation on the improvements in artillery methods, which were actually envisaged by General Allenby's Artillery Commander (Major-General A. E. A. Holland, at that date) early in 1917: were actually adopted

at Riga by the Germans in September, 1917; and used at Cambrai by the British in November, 1917. This is, however, outside the scope of this review (*vide* p. 541 in Chapter XXII, under "Artillery Methods.").

Before General Nivelle could put his armies in motion, the Germans made their retirement to the Siegfried-Stellung, and forced him to modify his subsidiary attacks, although not his main offensive. The Bapaume salient was gone, although only the right of the British Third Army was affected; the British Fifth Army could now help very little, and the French offensive north of the Oise perforce dropped out. The net effect of the political intrigue and of the consequent fiasco was to throw the burden of the war on the Western Front on the British for the rest of the year, while the French Army was rendered, by the mutinies, incapable of any effort for at least six months.

The Battle of Arras.

The Arras offensive was, as has been indicated, part of the much larger plan already outlined. Its object was to assist the French in their great attack between Reims and Roye, which—though originally intended to be launched in March—was not ready till the middle of April. The postponement was mainly due to the withdrawal of the enemy to the Siegfried-Stellung. Although the existence of this defensive position had been known to the Allies since February 17th, its location had not been definitely established till later, except south-east of Arras. The German withdrawal commenced on March 16th, and was timed to be completed in three days. On the morning of March 17th it was discovered that on the whole front of the Fifth and on the right wing of the Third British Armies, the enemy had gone. By the withdrawal the enemy reckoned on shortening his whole front by twenty-five miles, releasing thirteen or fourteen divisions and seriously compromising any Allied Offensive.

Confining ourselves to the Arras Sector, General Gough was quick to realize the situation and immediately organized a pursuit.

Sir Douglas Haig instructed General Gough to press the German rear-guards back to the Hindenburg Line and prepare to attack that position "between Quéant and Ecoust" in conjunction with the attack of the Third Army. It was General Gough himself who had suggested the intervention of the Fifth Army, and he was eager to do all in his power to aid the Third. He could, however, launch an attack on the Hindenburg Line on a narrow front only, because he had not the means to do more: he had been weakened by the withdrawal of some of his divisions and heavy artillery. From Quéant (inclusive) southwards it was known that the Hindenburg Line consisted of a duplicate system of trenches. It seemed, therefore, preferable to attack at or near Bullecourt, where the position was weaker. By Sir Douglas Haig's orders the 4th Cavalry Division was to be passed through the breach, if effected, and join hands with General Allenby's cavalry advancing from Arras—with Cambrai as its general objective. As the first objectives of General Allenby's cavalry were Vis en Artois and Fontaine Les Croisilles, the latter only two miles from Bullecourt, the idea was certainly attractive on the map. But the C.R.A. Fifth Army informed General Gough that it would take six days' bombardment to produce any real effect on the German trenches and wire. Nevertheless, General Gough decided to attack on April 11th. The news of the early and overwhelming success at Arras on April 9th must have heartened him.

It will be convenient here to interpolate a brief summary of the various phases of the battles of Arras:—April 9th–14th, the First Battle of the Scarpe and the Battle of Vimy Ridge; April 23rd–24th, Second Battle of the Scarpe; April 28th–29th, Battle of Arleux; May 3rd–4th, Third Battle of the Scarpe, with the capture of Fresnoy by the Canadians further north; May 3rd–17th, the very desperate Battle of Bullecourt. Monchy-le-Preux was captured on April 11th. By that date the German reserve divisions, which had been placed too far back from the front,

began to arrive, and the battle was virtually over as far as any further advance, much less a break-through, was concerned.

But the British C.-in-C. had to go on fighting, as the French attack in the south—eventually fixed, after another postponement, for April 16th and 17th—had not yet been launched; and there was much to be done to improve the British front line east and south of Monchy and north of the Scarpe.

"The capture of Vimy Ridge," writes the Official Historian, "was not only a "fine feat of arms, but also proved of considerable value when it was decided to with-"draw from Monchy-le-Preux, in order to shorten the line, during the German "onslaught at the end of March, 1918." Sir Douglas Haig was thus more than justified for insisting on the inclusion of Vimy Ridge in his plans for the Arras offensive, on the grounds of its value as a defensive position.

"The later stages of the battle were fought under the shadow which overhung "the French offensive on the Aisne, and General Sir Edmund Allenby, whilst serving "under his old Staff College contemporary, now C.-in-C., and handling for the first "time large masses of infantry in battle, was not at his best." The reviewer knew General Allenby very well. He was essentially a Cavalry Commander, but at his side he had a first-rate General Staff officer in Major-General Bols, an infantryman.

On page 259 are given the telegraphic orders despatched during the afternoon and evening of April 10th to Corps Commanders. The second of these reads: "the "A.C. wishes all troops to understand that the Third Army is now pursuing a "defeated enemy and that risks must be freely taken. Isolated enemy detachments "in farms and villages must not delay the general progress. Such points must be "masked and passed by. They can be dealt with by troops in rear." The Official Historian remarks: "The enemy had indeed been defeated, but it was to be proved "that the conditions were not those of a pursuit. Nor was it a case of masking "detachments, but rather one of defeating and driving back practically a new "army." Early in the morning of April 11th, Major-General Bols telephoned to the VIth Corps (Lieut.-General Haldane) that that was, in the A.C's view, the crucial day, and that, if the enemy could not be kept on the move now, stagnation might ensue.

If April 11th was the crucial day, Monchy-Le-Preux on its commanding hill, with a view of twenty miles all round, was the crucial point, which had to be secured before there could be any pursuit on the Arras front.

Monchy-le-Preux was the objective of the 37th Division. It had bivouacked just west of Arras during the night of April 8th–9th and had passed through the captured zone east of Arras as soon as tracks could be cleared on April 9th. On April 10th its 63rd Infantry Brigade, after a most skilful advance, had occupied Orange Hill. At 5 a.m. on April 11th, the 112th and 111th Brigades moved forward to attack the village. The barrage was late, owing to difficulty in getting the guns forward over the broken ground and through the debris of wire. On the left, the attack was prolonged by the 46th Brigade of the 15th Division, whose objective lay north of Monchy. The 111th Brigade in the centre was met by heavy machine-gun fire from the southern outskirts of the village; its advance was often checked, but, thanks to the action of three tanks of C Battalion, the attack was successful and Monchy was captured with a hundred and fifty prisoners. On the right, the 112th Brigade, also helped by a tank, had reached La Bergère, but a considerable gap existed between it and the troops in Monchy. On the left, parties of the 10th/11th H.L.I. (15th Division), which had lost direction, had penetrated into the northern and north-western outskirts of Monchy, even before the 13/K.R.R.C. and 13/Rifle Brigade of the 11th Brigade had penetrated into the village, its western boundary. By 8 a.m. information that Monchy had been captured was confirmed by mounted patrols from the Cavalry which had followed up the advancing infantry, and three squadrons were immediately ordered forward.

The Official Historian writes: "The capture of Monchy-le-Preux was one of the

" outstanding feats of the whole battle. All the six tanks taking part in the attack " were put out of action, but it is doubtful whether Monchy would have fallen " without their aid. It might not have been held or completely cleared but for that " of the cavalry." There follows a very carefully prepared and accurate account of the events of the day (pages 262–267).

It is impossible for the reviewer to say more than to confirm the verdict of the Official Historian quoted above, but he can add that there was very little close artillery support till much later in the day, when three batteries of the Royal Horse Artillery arrived on the scene. Without the cavalry and its machine-guns, the village could not have been held against an immediate counter-attack. None was made against the village itself, but there were two weak counter-attacks in the afternoon and evening in the vicinity of the Cambrai road. The gap between the 112th and 111th Brigades had been filled by one, and later two, squadrons of the 3rd Dragoon Guards, while squadrons of the Essex Yeomanry, 10th Hussars and Household Cavalry assisted in the defence of the village; and a squadron of the North Somerset Yeomanry helped to beat off the counter-attacks on the 112th Brigade.

The losses of officers had been so heavy in the 111th Brigade that the command of the troops in the village had early devolved on Lieut.-Colonel Whitmore, Essex Yeomanry, who remained there until the evening of April 13th.

The enemy's artillery had been strongly reinforced during the evening of April 10th and when, next day, cavalry were seen advancing from the village, " the concen- " tration of fire on it was such as few observers had ever witnessed." The losses amongst the horses of the cavalry were chiefly due to this shelling, but the heaviest occurred while the 8th Cavalry Brigade was withdrawing in the evening.

The arrival of the cavalry, though it could not fulfil its original mission—to advance eastwards and south-eastwards from Monchy—was thus most opportune. They helped to consolidate the defence till the arrival of the reserve (63rd) brigade of the 37th Division, which was waiting in the west end of Lone Copse Valley and had been ordered forward soon after 8 a.m. to occupy Hill 100, east of Monchy. It eventually established itself on the north-eastern edge of the village. C Battery, R.H.A., came early into action within seven hundred yards south-west of Monchy. It, and G and K Batteries, R.H.A., later put a protective barrage round the village; each battery fired an average of four hundred and fifty rounds that day.

The losses of the 3rd Cavalry Division between April 5th and 13th amounted to 3 officers killed, 38 wounded, 83 other ranks killed, 57 wounded, and 47 missing. Most of these casualties must have occurred on April 11th. The 37th Division was relieved during the night of April 11th–12th by the 29th Division, which included the Newfoundlanders.

The War Memorial of the 37th Division was erected after the war on a commanding knoll in the southern portion of Monchy-le-Preux. On April 11th, 1940, General Sir John Dill, who was G.S.O.1 of the Division in April, 1917, laid a wreath at the foot of the memorial; a British Cavalry Regiment provided the Guard of Honour.

(*To be continued.*) H. B. B-W.

" IF GERMANY ATTACKS."

The Battle in Depth in the West.

By Captain G. C. Wynne, Kings, Own Light Infantry (Retired).

(Faber and Faber, Ltd., London, 1939. Price, 12s. 6d.)

In his preface to the most recent volume of the *Official History*, entitled " France and Belgium, 1917," Brig.-General Sir J. Edmonds mentions that Captain G.C. Wynne, one of his assistants, had been charged with the examination of all published histories of the German regiments, artillery as well as infantry, which took part in the Battles

of Arras, 1917, and had thus been able not only to trace the course of events in more detail than they are given in the official monograph, but had also unearthed and pieced together a great deal of new information about German methods of defence, in principle and in practice.

It will be remembered that, since 1936, a number of articles from his pen have appeared in the *Army Quarterly*, embodying some of the information he had acquired and discussing the lessons to be drawn from it. Sir J. Edmonds suggests that some of those articles might usefully be read in conjunction with the volume of the *Official History* referred to above.

It may be inferred, therefore, that Captain Wynne's book can almost be regarded as an Appendix to the volume of the *Official History*. It is much more than a mere reprint of the articles on the *Army Quarterly*, for, since they were written, the author has had the advantage of studying General Fritz von Lossberg's book, published late in 1939, *Meine Tätigkeit im Weltkriege*, 1914–1918, in which the eminent tactician has recorded his war experiences. As a senior officer of the German General Staff at O.H.L., and later as Chief of Staff of the Sixth Army, Colonel von Lossberg, as he was then, had been mainly responsible, by his personal intervention on the battlefield, for the tardy adoption—belated on that front—of the new system of defence already adopted in other German Armies, which had brought the British advance to a standstill east and north-east of Arras during the latter half of April, 1917.

The title of Captain Wynne's book—*If Germany Attacks*—is intriguing; it is not until the reader reaches the final chapter that he discovers that the title means what it says. The earlier part of the book is a review of the development of the German system of defence from January, 1915 to July, 1917. That system owed its origin to General Falkenhayn, who, in January, 1915—after the stabilization on the Western Front—issued two memoranda, ordering certain measures to be taken forthwith to deal with the dangerous situation created by the decision to transfer all available strength to the Eastern Front to neutralize the Russian Armies. These measures were not completed when the British attacked and captured Neuve Chapelle early in March, 1915. The lessons of that battle were not ignored by the Germans, who "set to work like beavers" to strengthen their defences, and adopted modifications which, when put to the test in the Battle of Aubers Ridge, fought on May 9th, 1915, resulted in a complete defeat of the British attack. The two divisions engaged had 6,340 casualties, whereas the losses of the two German regiments defending the sector amounted to only 902, and those chiefly due to artillery fire.

Captain Wynne, in his comments on these two battles, writes:—"I have tried to emphasize two opposite schools of opinion which appeared at this stage of the war, as a result of the decision of British G.H.Q. after the battle of Aubers Ridge, to depart definitely from the procedure of the previous British attacks and to follow the French method of a long, methodical bombardment of the German defences, followed by attacks limited to a few hundred yards; and, in order to wear down the power of resistance and shake the morale of the enemy, this bombardment was to last at least two or three days and be carried on continuously day and night." In short, surprise was abandoned and the so-called "war of attrition" began. "Surprise," writes the author, "is a first essential in an attack, and a second essential is the need for covering fire, lack of which enabled the Germans to fire at their ease, unmolested, into the succession of British lines advancing simultaneously towards them. Covering fire was not a new idea, for the use of it had been the guiding principle in our company and battalion training in attack. The problem was now—whether the infantry was to have the covering fire and support of artillery and every form of mechanized aid to help its own skilfully organized forward movement, or whether the artillery were to have the infantry to "mop up' what the guns intended first to conquer: whether, in a few words, fire effect and movement should work simultaneously together, or whether fire effect should be followed by movement.

French G.Q.G. and British G.H.Q. adopted the latter, while German O.H.L. kept to the doctrine which all armies had previously followed, fire effect combined with movement; and that distinction is still to this day the fundamental difference between the latest training manuals of the French Army, on the one hand, and of the German, on the other."

In regard to the British failure at Festubert, on May 16th, 1915, Captain Wynne remarks:—"The successful opposition of their isolated shell-hole German garrisons marks the beginning of the idea of an 'invisible garrison' which was to play such a prominent part in the later defensive battles of the war." The battle had demonstrated the importance of surprise, even though a defence system appeared to be shelled to pieces. It might also have indicated that the long bombardment was not the answer to the problem set by the German defence organization.

It will be seen that each battle had its lesson for the organization of the defence, and for the tactics of the attack. Captain Wynne goes on to show that, generally speaking, the Germans were ahead of the British in appreciating and rectifying their mistakes, and that the British were more than slow. Reading between the lines, he attributes this, partly at all events, to the fact that the German General Staff had not only more imagination, but were always on the alert to learn from the experience of others, even their enemy. He tells us of the pamphlet published by Capitaine Laffargue, of the French Army, of his experiences in a different sector on the very day, May 9th, 1915, of the Aubers Ridge tragedy. In it he advocated every effort to obtain surprise and reiterated his firm conviction that the infantry arm could remain queen of the battlefield, if more suitably equipped and given improved tactical methods. Copies of the pamphlet were widely distributed by G.Q.G. in the French Army, but its teaching was never embodied in the French Army training manuals; it was never translated into English. A copy eventually fell into German hands, as did a document, written by the G.O.C. of the Fifth French Army, describing a local defence organization for holding the front trench system by the front battalions. Both these documents were seized on by the junior members of Lieut.-Colonel von Lossberg's staff. They gave them the inspiration they were seeking. The original touch in the French General's instructions was that the main line of resistance, that is the line of picquets, was to be held, not by a continuous line of rifles, as was usual, but by a line of strong points, about 200 yards apart, and constructed for all-round defence and capable of offering a long resistance even though surrounded on all sides. The inspiration it gave the German Staff officers was that the system would enable the front line garrison to be thinned out, and a more offensive spirit could thus be instilled into the rigid or passive defence. The garrisons of the strong points were to hold on until they could be relieved by a victorious counter-attack by the reserves from the third line. They construed it as meaning that a determined attack was almost invited to pass through the line of strong points, and that the defensive battle proper would take place behind the strong points in the 600 yards of ground between the main line of resistance and the line of reserve-shelters. Here the attackers would be hemmed in by the enfilade fire from the communication trenches (constructed so as to provide fire to the flanks), and then counter-attacked by the local reserves.

Captain Wilde has printed the *Instruction* in an Appendix, as he regards it as the conception from which a new defence doctrine was eventually to grow.

There was much discussion amongst the officers of Lieut.-Colonel von Lossberg's staff on the subject: on both sides it was agreed that the defensive battle should be fought for the foremost line, but whereas Lieut.-Colonel von Lossberg maintained that there should be "no invitation to enter" and that the defensive battle should be fought in the foremost line, the junior members of his staff held that it might preferably be fought behind it. The problem eventually became the subject of a first-class argument throughout the German Army.

Shortly after this, Lieut.-Colonel von Lossberg was appointed Chief of Staff

to the Third Army, with the rank of Colonel. "The foundation of his future fame," writes Captain Wynne, "were the ideas, principally those of the advantages of a reverse slope position, and those of a lightly held but deep defence, which he had imbibed during the eight months he spent amongst the reports and documents he had had to study at O.H.L. Thenceforward he was fated to test those ideas on the battlefields of Champagne and put them into practice on those of Arras and Flanders."

Captain Wynne traces the development of the German system of defence in the following order :—

1. *The rigid defence of a line*, as exemplified in the Battles of 1915.
2. *The foundation of a defence in depth*. For this he gives the credit to the Crown Prince Rupert of Bavaria, as being the first to envisage their development early in 1915. He traces its progress in the Battle of The Somme: the Battles in Champagne (September and October, 1916); in the principles governing the construction of the Siegfried Position (Hindenburg Line): and in the Battle of Arras—Vimy Ridge on April 9th to 14th, 1917.
3. *The elastic defence*, as exemplified by the Wotan Position and the battles north of The Scarpe (April 23rd to May 9th, 1917.)
4. *The materialization of the defence in depth*, as exemplified in the Battle of Messines (June 7th, 1917) and the construction of the Flandern Position.
5. *The Flandern Position and the Paschendaele campaign*, July 31st to November 20th, 1917.

It is impossible to discuss each stage in the development of the German system within the limits of this review, but the reviewer can state with confidence that there is something to be learnt in nearly every page of the book. It is remarkable how quick the German General Staff were to anticipate and provide against the ever-growing strength of the British Army in gun-power, in mass production of arms, ammunition and tanks, and in the improvement of its tactics in the attack.

In the final chapter, entitled "The Legacy," Captain Wynne avails himself of the outspoken criticism of the author of *Kritik des Weltkrieges*, written by a German General Staff officer in 1920. While the anonymous author praises the German General Staff for every kind of excellence, he accuses it of one vital mistake; and that mistake is the constantly recurring theme of his book. He affirms that, during the period from its victories over the French in 1870 up to 1914, it had worshipped at a shrine dedicated exclusively to "bravery in battle," and had neglected technical invention and mass production. He ascribes as a major cause of the final German defeat, the underestimation by the German General Staff of the effect of fire-power on even the stoutest hearts, and states that it was not until the autumn of 1916 that the problem of organizing labour for the munition factories was properly taken in hand.

Captain Wynne's comments on the new Siegfried Position of 1939 are illuminating. He writes—"The preparation of a new position on the German model is not a "lengthy process of digging and concrete, so much as the proper concealment and "distribution in depth of the defence force, the actual construction work being "carried out as time allows. The Wotan I Position was organized in three days "between the 10th and 13th April, 1917; on a frontage of fifteen miles. . . . In this "manner the Siegfried Position probably has as unlimited a capacity for expansion "in depth as had the Hindenburg, Wotan and Flandern Positions in 1917." He envisages the possibility that, if any sector of Siegfried I Position be penetrated (it has a depth of 30 miles, so it is said), a Siegfried II, and then a Siegfried III Position will be found organized behind it. He comments again on the fact that, whereas the German doctrine is based on fire-power combined with movement or manœuvre, the French is still based on fire-power preceding movement. He then turns to the Maginot Line, and says—"Against a modern mechanized assault, supported by massed

" aeroplanes, the forts and fortresses of the Maginot Line might in comparison " appear to be the biggest man-traps in history," and he gives the reason for his belief.

His final words, written on or after September 3rd, 1939, are—" It is to be hoped " that by the time Germany delivers her mighty blow next spring (1940) the essentials " of a defence in depth will have been established, and that an array of suitably trained " counter-attack formations will be ready as an *échelon* of reserves behind the " Maginot barrage. If the blow should be struck, and no other idea, such as ' the " sleeping army ' of Loos fame, supplant Weight of Metal, it may then be said with " confidence that none shall pass."

The Index is unworthy of the book, but probably the author was pressed for time. He is to be congratulated on having produced a most instructive volume, and one which ought to be read by every senior Engineer and General Staff Officer. To many officers who served in 1914–18, the book must be a revelation. Its appearance is opportune.

H.B.B-W.

ADAPTIVE COLORATION IN ANIMALS.

By HUGH B. COTT, M.A., D.SC., F.R.P.S., F.Z.S.

(Methuen & Co., Ltd. Price 40s. net.)

Dr. Cott is lecturer in Zoology and Strickland Curator, Cambridge University, but one need not be a zoologist to appreciate and enjoy his monumental work, with its wealth of interesting photographs and drawings.

Camouflage and concealment in Nature are exhaustively considered in this book: army camouflage is a responsibility of the Royal Engineers, and Dr. Cott's book has therefore a special interest for readers of *The R.E. Journal*.

Dr. Cott emphasizes that " . . . there is the closest analogy between the needs " for concealment and deception in nature and in war," and in his preface tells us " . . . the primeval struggle of the jungle and the refinements of civilized warfare, " have here very much the same story to tell. In both realms we see the results of " an armament race and an inventive race which have led to a state of preparedness " for offence and defence as complex as it is interesting. In both, methods nearly " similar are employed; we have the evolution of speed on land, in the air and " under water by pursuer and pursued; the employment of stealth and surprise, of " deception and ambush; the display of warning signals and of alluring baits, the " elaboration of smoke screens, traps, nets, parachutes, of electrocution and booby " traps; the adoption of fossorial and nocturnal habits; the development of poison " and of deadly apparatus in the form of fangs or stings or arrows for its injection " into the bodies of enemies or prey; the protection afforded by armour plating, " spines and barbed wire; the use of chemical warfare which is practised, for instance, " by certain insects; and of poison gas, by creatures like the skunk."

The balloon barrage and submarine net are compared with gigantic spiders' webs, and smoke-screens find their parallel in nature with the concealing screens produced by cuttle fishes.

It would be impossible in this review to attempt to consider the whole range of Dr. Cott's book; nor has the present writer the claims to zoological knowledge which would justify such an attempt.

Chapters of particular interest to the Engineer student of camouflage are those which deal with Obliterative Shading, Disruptive Coloration, Coincident Disruptive Coloration, and Concealment of the Shadow.

In " Obliterative Shading " Dr. Cott reviews those principles of counter-shading upon which concealing coloration frequently depends. Out of doors in daylight, the upper surface of a solid object is more brightly illuminated than its under-parts

which are in shade. Between light and shade we have a gradation of half-tones and accents and the whole visual impression conveys the feeling of solidity, the object being often clearly visible even if the tone and colour of the background corresponds to the local colour and tone of the object.

In Nature, if an animal, bird or fish were of one uniform colour throughout, these principles of light and shade would operate, the creature would frequently be conspicuous in its natural setting, and in relation to its degree of conspicuousness, vulnerable to attack by its natural enemies.

But with obliterative shading or counter-shading, Nature has counter-balanced visual effects of normal light and shade—turns dark to light, and light to dark and produces upon a rounded surface the illusionary appearance of flatness.

Those who have walked upstream on the banks of a trout river when there is nothing doing, know how extraordinarily difficult it is to see the fish, even at high noon and when the water is low; only disturbed shadows, darting swiftly forward, reveal their presence.

But consider the freshly taken trout or salmon and note well Nature's camouflage. The dark upper surfaces which, seen from above, merge into the colour of the river's bed—and the silver belly, which is the ideal tone to fade into reflected and refracted light and reduce the fish's visibility to the pursuing pike or otter.

Throughout Nature, as Dr. Cott points out, we see this principle of protective counter-shading appearing again and again, and in various plates the author demonstrates methods by which the camouflage artist may apply this principle to camouflage of guns or other military objects.

In the chapter, Disruptive Coloration, the author reviews those concealing principles more commonly known as dazzle painting. The normal appearance of form is destroyed by bold patterns or designs which cut directly across the outlines and masses and, at a certain distance, destroy the characteristic shapes. Amongst others, diagrams Nos. 6, 7 and 11 tell the whole story to the student. Figure 14, a delightful pen drawing of a nest of Ringed Plover, with eggs and newly-hatched young, depicts an amazing example of natural camouflage, the birds being almost invisible in their setting. If I may again quote the author, "The coloration of these "tiny down-clad chicks incorporates in a wonderful way the three fundamental "principles of colour resemblance, counter-shading and maximum disruptive con-"trast. As regards the last, the chick has its form optically broken into two pieces "by a collar passing through the eyes and round the back of the head. This does "not consist merely of a dark band breaking up the intermediate tone of the head "and back. On the contrary, this narrow black band is accentuated by another "band of white immediately behind it and it is the combination of the two bands "one black and one white, and both in contrast to the general tone of the upper "parts, which produces so deceptive an appearance. With some individuals this "effect is repeated at the back of the body—a black mark on the flanks dividing "the greyish upper parts from the white down of the belly."

It is not easy successfully to apply the principles of natural camouflage to army camouflage. Many living creatures of the forest and plain are textured with feathers or soft fur.

The weapon or vehicle is constructed of hard steel, which has no texture and reflects light.

The animal's form is built of smooth-flowing planes, while tanks and other A.F.V's and vehicles are constructed with opposed planes at variance with natural surroundings in the field.

Nature often reserves her most dazzling disruptive patterning for the smaller birds and beasts and fishes, while the elephant and hippopotamus and rhinoceros move in sombre hue, as Dr. Cott has already pointed out. Dr. Cott says of disruptive contrast and its application in war:—

"The principle is one with many applications to modern warfare. . . . The

" essential function of dazzle painting is to break up continuity of surface by means " of violently contrasting tones rather than by mere differences of tint. The latter " are relatively unimportant, the former all important.

" Various recent attempts to camouflage tanks, armoured cars and the roofs of " buildings with paint, reveal an almost complete failure by those responsible to grasp " the essential factor in the disguise of surface—continuity of contour.

" Such work must be carried out with courage and confidence, for, at close range, " objects properly treated will appear glaringly conspicuous. But they are not " painted for deception at close range, but at ranges at which big gun actions and " bombing raids are likely to be attempted. And at these distances, differences of " tint—mere blotches of brown and green and grey, like those commonly used for " camouflaging army vehicles—blend and thus nullify the effect and render the work " practically useless."

May it be suggested that the present system of army camouflage painting is not intended to be dazzle painting, nor is it designed only against long-range observation. It would appear that Dr. Cott advocates that a very much stronger and more definite tonal contrast should form the basis of army camouflage and that it is immaterial if the objects are " glaringly " conspicuous at close range, as the camouflage need only be effective at long range. But the modern development of the air arm, the use of low-flying aeroplanes in attack, demands that camouflage should not be glaringly conspicuous at comparatively close range. If the enemy obtained a temporary local air superiority in any area containing numerous vital objectives camouflaged in a glaring manner, the " camouflage " would obviously be of the greatest assistance in guiding the bombers to the vital point.

Dr. Cott is on very firm ground when he stresses the need of bold patterning, as niggly small patterns are useless. But a pattern may be very definite and yet in harmony with its setting, both in colour and form, and therefore not unduly conspicuous at close range.

With reference to army camouflage in the field, general staffs of all armies are relying more and more on forms of structural camouflage and the skilful use of natural concealment, rather than on disruptive painted patterning.

Nets of various types, garnished or ungarnished, local vegetation, etc., have all proved to be more useful than paint in defeating the enemy observer from ground or air observation.

In a gun position the gun itself is a comparatively minor point. Emplacements and bare spoil, tracks, blast marks and other indications of activity are the betraying signs, and these can only be concealed by structural camouflage or siting and track discipline.

Conspicuous patterning of tanks, armoured cars and other A.F.V's may be effective under certain limited conditions, but it appears to be questionable if such patterning could be universally applied as a standard method of treatment. But it is obvious that, when A.F.V's are in action, the general use of structural camouflage in the form of nets, etc., is ruled out, and dependence on paint is necessary to make the A.F.V. as little conspicuous as is practicable.

One of the tank's greatest enemies is the anti-tank gun. The anti-tank gun is a high-velocity, low-trajectory weapon, very deadly at close range and never designed to fire at great range. A moving tank painted with a powerful dazzle pattern may be difficult to see at long range, but at comparatively low range, unless seen against a broken background it might present just the sort of target an anti-tank gunner dreams of.

If a tank is between the anti-tank gunner and a strong light or if the light is falling diagonally from behind the tank in the general direction of the gunner, the target will be again obvious, as the greater area of the tank will be in shadow and the disruptive painting will have very little effect.

It is a matter of general knowledge that European armies to-day are using muddy

or non-conspicuous colours for standardized painting of A.F.V's. transport vehicles and weapons, and it is probably assumed that anything in the form of specialized patterning or dazzle painting necessary for exceptional local conditions should be the responsibility of the local camouflage officer in the field. Khaki has proved to be an excellent colour and tone for military use under practically all conditions and its selection as a basic colour for military camouflage appears to be a sound one.

But the ideal camouflage is yet to be found, and it is to be hoped that Dr. Cott will continue his research and pioneer work, from which modern students of camouflage have already so greatly benefited. JOSEPH GRAY.

FOUNDATIONS AND EARTH PRESSURES.

By C. HYDE WOLLASTON.

(Hutchinsons' Scientific and Technical Publications, Paternoster House, Paternoster Row, London, E.C.4. Price 21s.)

Many books have been written and many specifications have been compiled on the properties of such materials of construction as timber, steel, concrete, etc.

It is claimed, however, that soils are the most important materials of construction and that heretofore few books have dealt with their properties in detail.

The aim of the author of this volume is to inculcate in the minds of members of the engineering profession the importance and desirability of treating "soil" as a material of construction. There is no doubt that, in many cases, for large buildings where heavy unit pressures will be brought on the bearing soil, a good deal more attention should be given to whether the soil is actually suitable to carry the loads contemplated.

The properties of soils are described and individual tests for cohesion, compression, permeability and load-carrying capacity explained.

The author points out that a clay soil need no longer be considered suspicious, since the "water content" of clay is a sure criterion of its strength against compression.

The first part of the book is devoted to the classifying of and descriptions of methods of testing sub-soils. A chapter is devoted to the behaviour of soil when treated as a material of construction. Earth dams and the danger of undue seepage or percolation through the body of the dam at, or under, the foundations is discussed.

A good deal of space is devoted to piled foundations and pile-driving.

For underpinning concrete foundations, the author suggests the use of R.S.J's as needles, similar to those used when cutting out shop front openings, although the normal method is to underpin in short lengths not exceeding 5 ft. long, when the use of needles is unnecessary.

A good deal of valuable information is also given on bridge foundations, reservoirs and reinforced-concrete footings.

The second part of the book is devoted to the theory of earth pressure, cohesion, the distribution of the pressures from structures to soil and the problem of designing retaining walls.

In the last part of the book extracts, are given from the London County Council Building By-laws concerning reinforced, concrete as they relate to foundation work and to examples of designs and calculations.

Calculations are given for a single column footing in brickwork and on a reinforced concrete base; a wall footing in brickwork and on a reinforced-concrete base; combined footings, both rectangular and trapezoidal in section; a cantilever footing and a steel grillage. Calculations are also given for masonry and reinforced-concrete retaining walls; the stability of a bridge pier on a reinforced-concrete caisson and on a brick wall, and the stability of twin piers.

Unfortunately, the calculations have been worked out at the old working stresses for concrete and steel instead of the higher ones of 750 lb. per sq. in. and 18,000 lb.

per sq. in. respectively, which have been permitted since the recommendations for a Code of Practice were issued in 1934.

The draughtsmanship displayed in the 200 figures with which the book is illustrated is not quite up to the standard one expects to find in a technical publication and, in a few cases, the drawings have been reduced to a size which makes them very difficult to follow.

The author has been able to draw on his large experience on public works in India to provide a text-book which gives a fund of information in a very readable style. The book can be confidently recommended to any engineer who requires to obtain knowledge on the nature and bearing capacity of soils.

W.B.C.

ON THE APPLICATION OF THE BRUNSVIGA TWIN 13z CALCULATING MACHINE TO SURVEY PROBLEMS.

By L. J. COMRIE, M.A., PH.D.

(Scientific Computing Service, Ltd., 23, Bedford Square, W.C.1. Price 5s.)

This is the second edition of a pamphlet, published by the Scientific Computing Service, Ltd., describing their methods for the mechanical solution of problems of survey, of elementary field astronomy, of interpolation and of elementary trigonometry. In the title to the earlier edition, published in 1938, the application of the machine was directed to *Artillery Survey*, and it still appears that the work is mainly designed to aid artillery officers, but the writer claims that our military forces have adopted the machine and methods for both artillery and survey companies. The methods are fully exemplified in this pamphlet and their value may be gauged by the fact that, on questions of machine working, Dr. Comrie is recognized as a leading authority.

G.T.McC.

WHAT IS WRONG WITH THE OFFICIAL SHELTER POLICY?

The Association of Architects, Surveyors and Technical Assistants have published as a pamphlet, a Report which appeared in the *Municipal Journal*, April, 1940, and which they have forwarded to the Minister of Home Security, embodying their criticisms of the official A.R.P. measures and proposals for improvements in policy and design. They consider that the number of shelters is inadequate and the standards of protection too low, while some forms, such as trenches and strutted basements, are unsuitable, and recommend a policy of large communal shelters, both on the score of economy and as giving greater safety and comfort than scattered small shelters, while also giving facilities for gas protection. The pamphlet can be obtained from the Association of Architects, Surveyors and Technical Assistants, 113, High Holborn, London, W.C.1, price 9d. or post free 10½d.

F.E.G.S.

CAPTAIN TOBY, F.S.I. OR THE SURVEYOR AT WAR.

By C. E. KENNEY, F.S.I.

Mr. Kenney has presented to the R.E. Library this delightful little book, which he has had privately printed. It happened that he was reading at the same time *Tristram Shandy* and *Les Travaux de Mars, ou L'Art de la Guerre*, by Allain Manesson Mallet, a contemporary of Vauban. The *Travaux* was profusely illustrated and Mr. Kenney has reproduced copies of some 25 of the old woodcuts, dealing chiefly with the survey of fortifications, and has accompanied them with descriptive explanations from the text of that and other contemporary publications. But he has not forgotten Corporal Trim and his uncle Toby and their learned discussion on the fortification of a town or "citadil." "Your Honour understands these matters," says Corporal Trim, "better than any officer in His Majesty's service."

F.E.G.S.

MAGAZINES.

THE MILITARY ENGINEER.

(*January–February*, 1940.)—*Germany and the Defences of the Lowlands.* By H. M. Cole.

The writer discusses the various possibilities open to Germany to effect a decision on land in the present war. In order to turn the Maginot Line, a way round might be sought through Switzerland or *via* the Belgo-Dutch frontier. Switzerland presents great difficulties; the Belgo-Dutch frontier offers a better prospect of success. Both Belgium and Holland possess a much stronger front against an invasion than they had in 1914, but the reasons for invasion are now more compelling than they were 25 years ago.

The writer concludes that the first hours of such an invasion (should it take place) would probably see the Belgians and Dutch fighting alone behind their own defences, but the conflict would almost inevitably reach the Maginot Line at its weakest point, and the strength or weaknesses of the Belgo-Dutch breakwater would perhaps determine whether the Allied defences held or crumbled.

Stereovision—an Aid to Reconnaissance.

Captain H. D. Vogel describes how stereovision can be used for reading photographs, its employment in aerial photography, and the instruments that facilitate its use.

Military Bridges.

Captain P. W. Thompson compares the bridging equipment of Germany (1938), Britain (1936) and the U.S.A. (1939).

TYPES OF BRIDGE EQUIPMENT

Use	German	British	American
Personnel afoot ...	Pneumatic boats	Kapok bridge	Foot bridge Assault boats
Loads to 5 tons ...	Light P. & T.	Folding P. & T.	—
Loads to 9 tons ...	Standard P. & T. Box girder —	Standard P. & T. Box girder Tubular scaffolding	Light P. & T.* Box girder —
Loads to 20 tons and over ...	Standard P. & T. —	Standard P. & T. Box girder	Heavy P. & T. Box girder

* American 7½-ton Pontoon and Trestle equipment, soon to be superseded by 10-ton P. & T. equipment.

Lightest Equipment.

For the lightest type the Germans use a pneumatic boat, *i.e.*, a ring-shaped bag made of rubberized fabric, inflated for use in the water, and deflated for transport.

There are two sizes, the larger has a buoyancy of about 2 tons, the smaller of 650 lb.

The Americans have abandoned the old kapok foot-bridge in favour of a new foot-bridge and a new assault boat.

5-ton Equipment.

For their 5-ton equipment the Germans use a new type of pontoon and trestle equipment. The pontoon is made of wood, is about 12 feet long and is gunwale loaded. Two pontoons join end to end to form one bridge pier. The superstructure is of special interest. The baulks and chesses are joined together to form units about 20 ft. long (the length of a raft) and about 2 ft. wide. The superstructure of a raft consists of four such units laid across the gunwales of the pontoons.

The Americans have no counterpart of this type of bridge.

9-ton Equipment.

In the German and American bridges each pier consists of a single pontoon; in the British bridge the pier consists of two pontoons, locked square end to square end. The spacing of German, British and American piers is, respectively, 10 ft., 21 ft. 2½ in., and 16 ft. centre to centre. For the superstructure the German and British baulks are steel I-beams, the American baulks are wooden timbers. The British pontoons are decked, the others, being open, are more suitable for ferry boats.

With regard to weight, the American bridge is lightest, the German bridge is by far the heaviest.

The Germans include in their equipment several motor-boats and out-board motors.

20-ton Equipment.

The German and British 9-ton equipment can be re-arranged to carry 20-ton loads; the American 7½-ton equipment to carry 15-ton loads.

Strategic Mineral Supplies in the U.S.S.R. (Russia).

Major G. A. Roush has made a careful study of the mineral supplies that Germany may be able to draw from Russia during the present war. He considers that Russia was nominally capable of supplying all Germany's requirements of manganese, platinum and asbestos, not more than a third of the petroleum and 5 per cent of the iron needed by Germany, and little of anything else.

But, as a consequence of the Finnish campaign, it is unlikely that Russia will now be able to supply more than a minute fraction of the raw materials that Germany requires.

Military Lessons from the Chinese-Japanese War. Part II. By Captain C. Rodney Smith.

What is the explanation of the present stalemate in China? How is it that the highly-trained Japanese army has not succeeded, after two years of fighting, in winning a decisive victory over the poorly-equipped Chinese? The writer puts forward, amongst others, the following suggestions.

The Japanese failed to appoint a supreme commander for a cohesive effort. They under-valued the degree of Chinese nationalism and fighting power. They concentrated on geographical objectives, seizing or destroying Chinese communications, but, although they won many battles, they failed to achieve the destruction of the enemy army.

At the battle of Taierchwang, in April, 1938, the Chinese succeeded in winning a decisive victory. It was the first time in modern history that a Japanese army had ever suffered a great military disaster. The victory was due to sound strategy, and, by destroying the myth of the invincibility of the Japanese army, it raised the morale of the whole Chinese people.

Monolithic Concrete Construction for Hangars. By J. E. Kalinka.

The writer points out how domed structures, if properly designed, are very economical and offer a maximum resistance for a body built from a given quantity of material. Domed surfaces on roofs are mainly in compression, and concrete is an economical material for such loads.

Mr. Kalinka goes on to describe the outstanding features of the ZD system of roof construction, which are: the monolithic character of concrete slabs and framing, and the fact that these slabs are stiffened at intervals and along the edges.

A series of sketches and photographs show various types of hangar roofs constructed on these principles, with spans from 115 ft. to 318 ft.

(*March–April*, 1940.)—*Modern United States Cavalry.*

Lieut.-Colonel K. S. Bradford describes the changes that have taken place in recent years in the organization and equipment of the United States cavalry. Fire power has gradually taken the place of shock action.

The Corps Cavalry Regiment consists of a mechanized squadron and a horse squadron. The Mechanized Cavalry Regiment has no horses at all, but has three squadrons of light fast tanks. The Horse Cavalry Regiment has two horse squadrons, armed with pistols, semi-automatic rifles and light machine-guns.

Designs and Construction of Siphons at Marked Tree, Arkansas. By Majors D. Noce and J. D. Andrews.

A set of siphons was constructed to take surplus flood water across a levee of the St. Francis River. It consisted of three steel pipes, 9 ft. in diameter, and reinforced-concrete inlet and outlet basins, besides other accessories. A difficulty in connection with the design was the fact that little is known about siphonic action in large pipes. The experience gained in this case may be of use to engineers faced with a similar problem. The "priming" of the siphon was accomplished by exhausting the air from the summit by means of an air pump.

A.S.H.

REVUE MILITAIRE SUISSE.

(*October*, 1939.)—*L'instruction individuelle du combattant dans l'emploi des armes lourdes.* By Lieut. Reisser. A series of short practical lessons in the use of ground, with numerous sketches. The object of the lessons is to develop an instinct for making the best use of cover in advancing, so as to bring the weapon of fire into the most favourable position with the least exposure. The first four exercises deal with the movement of the individual; the next four deal with the team of an anti-tank gun; and the last four with a trench-mortar team.

Le Général de Steuben. By Colonel Lecomte. General Steuben, whose services to America have been commemorated in many ways and compared with those of Lafayette, was little more than a Prussian adventurer, whose advent to America was heralded by a lie.

His early career, as one of Frederick the Great's officers, was not without distinction. He gained wide experience, and for a time appeared to have won the royal favour. But when the Seven Years' War came to an end, and Frederick disbanded the greater part of his army, Steuben lost his employment, and fell upon hard times. He managed to procure a small post with an imposing name in one of the minor principalities of Germany, where he led a life of gaiety and contracted a load of debt. An English sympathizer with America introduced him to Benjamin Franklin, at that time American delegate to Paris. General George Washington was in need of an organizer for his volunteers and militia, and it seemed to Franklin that Steuben was the man. But Steuben was only a captain. It was necessary to invest him with greater importance. So he was then and there made a Lieutenant-General, and sent to a Paris tailor. As a bogus Lieutenant-General of the army of Frederick the Great he entered America, and was welcomed with warmth by Washington. The deception was kept up, and even reinforced by autobiographical fictions. But Steuben rendered good service to America.

Commentaires sur la guerre actuelle. Editorial. This month's commentary begins with observations on the campaign in Poland, remarking on the complete success of the German air tactics. The overwhelming air attack, carried out incessantly and directed, not only against the armies, but also against the vital centres of the nation, deprived the Polish Army of its power of resistance before it could recover from the first shock. The first wave of the attack was the air force; the second was the armoured divisions. The infantry followed up behind—a long way behind—to collect the prisoners and the plunder. The artillery played a minor part.

It was a striking example of a *blitzkreig*; and its technique should be closely studied. The simultaneous paralyzing of the system of command, the means of communication and the arteries of civil supply can only be effected if there is also paralysis of the anti-aircraft defences. The Polish counter-measures were unready. They had very little fortification; their anti-aircraft defences were scanty, and their A.R.P. measures were hastily improvised. On the German side, as usual, there had been meticulous preparation; concentration and surprise were the prime factors in the plan. The aggressor can always hold this advantage; he completes his plan behind a mask of duplicity, and can pounce at his own chosen moment.

On the Western Front, the French held the Germans under the threat of an offensive, and compelled them to withdraw troops from Poland; too late to save the Polish Army, but probably in time to allow the Polish guerillas to exact some toll of the invader. The steady pressure on that part of the Siegfried Line which is opposite the French frontier caused the enemy some loss, expended his land-mines and traps, and stung him into counter-attacks which were repulsed with serious losses.

The commentator remarks on the conspicuous anxiety to economize infantry on both sides. The French have made use of tanks and artillery; the Germans have employed machine-guns in front of their line, electrically controlled. The abstention of both sides from air attacks on the concentrations, communications and convoys is remarkable.

(*November*, 1939.)—*Les deux "Mob."* By Major de Traz. A comparison between the mobilizations of the Swiss forces in 1914 and 1939. The Swiss do not escape the burden of embodying a large part of their militia to guard their frontiers. As in 1914, so to-day they have large forces in a state of preparedness. The writer played a part in both mobilizations. He remarks that in 1914 Swiss opinion about the war was divided. To-day it is unanimous. The war was long expected. The necessity for putting an end to aggression is realized.

Commentaires sur la guerre actuelle. Editorial. Covers the period October 10 to November 10, during which there was little military activity. The French receded from their advanced position over the German frontier, without molestation. The Germans kept contact, but exercised no pressure.

The activities of the artillery were largely confined to preparation for raids or for some specific harassment. The French technique in raids appears to be superior to the German.

(*December*, 1939.)—*Sommes-nous capables de nous défendre?* By Colonel Frick. A transcript from a lecture given by the author before the war. He reminds us that in the past the Swiss have proved themselves capable of heroic resistance to invaders, and have shown the highest moral virtues in the field of war. Are the Swiss of to-day capable of equal achievement?

All the best weapons, the strongest fortifications, and the most modern aeroplanes are of no avail without men of indomitable will and courage to use them. The Swiss have little regular training, but they are hardy and valiant. They have survived many attacks. And to-day, they have had, at any rate, five months of practical mobilization, manning their frontier posts and training their militia. Their nation, it is true, is composed of races differing in language and culture, but long centuries

of independence have taught them to hold together, and when danger has threatened they have met it as a single people.

The author has no doubt that if and when the time comes the Swiss will not be found wanting.

Un poste d'hivernage alpin: Expériences et perspectives. By Lieut. Vuille. An account of an experimental mountain camp during the winter of 1939, from which several lessons likely to be of use to polar expeditions could be studied. Originally established for scientific purposes, the little Alpine post could be utilized in a variety of ways, such as a military observation post, a frontier guard post, a weather observation station, a first aid post, etc. Details are given of the camp equipment, loads, etc. Only a single tent, or sometimes an igloo, was used.

Commentaires sur la guerre actuelle. Editorial. The chief subject of this month's commentary is the Russian attack on Finland, which had just begun when the article went to press. The aggression against Finland followed the German type—diplomatic pressure, newspaper invective, lies and poisonous propaganda, and then the onslaught. A greater disparity of potential forces between two nations at war has scarcely been seen in history.

On the Western front there has been little for the commentator to remark. Behind their impregnable lines, both sides are intensifying their training and preparations.

(*January*, 1940.)—*Nos chefs a l'épreuve.* By Major B. The Swiss preparations for war and the present state of alertness have given rise to a number of articles of this type. The qualities of the leaders can really be proved only in war; or in some difficult crisis, such as rarely occurs in so peaceful a country as Switzerland.

L'instruction individuelle du mitrailleur et du groupe de mitrailleurs pour le combat. By Capt. Warnery. A series of simple exercises enunciated with an objective, and illustrated with a few elementary tactical situations, designed for the instruction of N.C.O's and men of machine-gun detachments.

Commentaires sur la guerre actuelle. This instalment deals exclusively with the Finnish campaign. The early Finnish successes are described. The contrast between the operations of the German Air Force and those of the Russian Air Force in Finland is emphasized. In Poland, the German air action was swift and decisive. It was thoroughly worked-out beforehand, and carried out with ruthless efficiency. The Russians, on the other hand, have attacked ruthlessly but intermittently, and not yet in masses. Their raids seem to have been without plan, and with sufficient intervals between them to allow time for the civil population to resume their daily routine. The Russian airmen seem to be lacking in manœuvring capacity, and had they been opposed in sufficient numbers by the more daring Finnish pilots, they would have suffered more serious losses.

The terrain was not suited to motorized units. The Russians were tied to the few roads, while the nimble Finns hovered on the flanks and took heavy toll of the ponderous Russian masses.

The indefatigable qualities of the Finns and the primitive mentality of their opponents attract attention.

Once again, the easy conquest of a victim's country was held out as a lure to the aggressor by unscrupulous, misinformed and treacherous counsellors.

(*February*, 1940.)—*L'Officier d'infanterie et la fortification de campagne.* By Colonel Lecomte. The veteran sounds a somewhat pathetic note, and tells us how he tried throughout his long career as an Engineer officer to inculcate the teaching of field fortification to the infantry. Successive editions of the Field Service Regulations omitted the subject altogether, or regarded it as tending to kill the spirit of the offensive. For thirty years Colonel Lecomte lectured to infantry schools. He prepared training manuals, but they remained among the pigeon holes. But at last came the day when the rôle of the infantry in protecting themselves in the field was recognized and laid down; and to-day the almost mobilized Swiss Army is

being trained in the arts of protection, concealment, camouflage, use of ground, types of field-works, and ways and means of executing works.

Le cours de répétition d'hiver de la brigade de montagne 11. By Lieut.-Colonel Erb. Describes a winter exercise carried out in February and March, 1939, by a company of the 11th Mountain Brigade in the Bernese Oberland, by the officer who directed the exercise. This instalment gives a brief diary of the exercise. The lessons learnt are dealt with in the next instalment.

Commentaires sur la guerre actuelle. This month's commentary deals with the third month of the Finnish campaign; and describes the shifting of the scene to the severe fighting in the Karelian isthmus, where the Russians were beginning their massive attack. The Russian tanks were unable to smash their way through the Mannerheim defences. The attack became a purely frontal one, recalling the heaviest battles of 1914–18. The Russians evidently thought that their invasion of Finland would follow the lines of the German campaign in Poland, and they paid very dearly for this rash assumption.

In the middle sectors, the Finns were able to continue their successes in the Suomossalmi region, where they practically annihilated three Russian divisions by cutting them off from their supplies.

In the middle of January, the Russian airmen began to intensify their attacks on the interior of Finland, endeavouring to paralyse civilian life, after the manner of the Germans. The parachute method of invasion, however, proved a failure, and the landing parties were all rounded up or shot.

For the Swiss, the gallant resistance of the Finns has encouraging hopes. A small people, well prepared and determined, may resist a much superior adversary for a long time. And in that time, the situation elsewhere may turn decisively in its favour.

W.H.K.

RASSEGNA DI CULTURA MILITARE.

(*November*, 1939.)—*Le forze armate dell'Italia fascista.*

This is a review, by General Scala, of a book with the above title, by Tomaso Sillani. The volume in question records the expansion of the army during the World War, and the enormous development of the army, navy and air force under the Fascist regime. In addition to this feature, industries and the mercantile marine have made a phenomenal growth. The Italian empire has expanded in Libya, Abyssinia, and Albania.

L'alimentazione della battaglia.

Lieut.-Colonel Cappuccini traces the increase in size of the larger units from the division, in the time of Napoleon, to the army corps, the army and the army group of more recent times, and points out the difficulty of supply in battle, both in th way of men, munitions, and the various indispensable means necessary to obtain decisive result.

La guerra in Europa. By Lieut.-Colonel Blatto.

A résumé of the main events of the second month of the present war.

The most surprising turn of events is that neither of the belligerents show any anxiety to attain a prompt decision by means of arms. The passing of the Neutrality Act by the United States senate means that Germany will lose the only real superiority that she possesses, that of aviation.

On the eastern front, the defeat of the Polish forces is complete. The main reasons for the Polish collapse were (1) the preponderance of German mechanized and motorized units, (2) the complete freedom of action permitted to German divisional and corps commanders, (3) the co-operation of the air force with the army, (4) the impossibility of utilizing the Polish cavalry as in former wars.

There is little to record on the western front.

At sea, the main items are the measures taken by the Germans to counter the rigorous Franco-British blockade. The Germans have scored a success by sinking the *Royal Oak* in Scapa Flow. Two of their pocket battleships have appeared in the Atlantic as raiders. German merchant ships interned in neutral ports have escaped; one large ship, the *Cap Norte*, being captured by the British. The case of the *City of Flint* has given rise to international complications.

Impiego e rendimento dei mezzi radio nella campagna per la conquista dell'impero.

Colonel Casola describes some of his experiences in connection with radio work during the campaign in Abyssinia.

It was discovered at an early date that waves in excess of 100 metres (frequencies less than 3,000 kHz) were greatly disturbed by atmospherics. The disturbance was greatest from the early hours of the afternoon until after midnight; in the late afternoon, correspondence became almost impossible. Altogether, with a continuous daily service, the efficiency of the radio service was only about a third of that obtainable in the home country.

All radio equipment was made as light and mobile as possible, as the usual method of transport was on mules.

Dry batteries gave good service in the hills, but in the heat of the plains their life was approximately halved.

Some of the stations used hand- or pedal-driven generators. It was found impossible for a man to work a hand-driven generator for more than 5 to 10 minutes, so that numerous reliefs were needed. A pedal-driven generator of German manufacture gave good results, but it was found difficult to maintain a constant speed.

Oil-engine-driven sets proved satisfactory, but were not entirely suited to continuous non-intermittent work.

(*December*, 1939.)—*La nostra grande guerra nei rapporti con gli ex alleati*. By General Corselli.

The writer describes the relationship of Italy with the Allies during the World War from the Italian point of view. Italy has always maintained that she received anything but fair treatment from the Allies. She entered the war of her own free will; she saved the Entente, first by her neutrality, then by active intervention; she made the greatest sacrifices for the benefit of the coalition, and, finally, when peace was declared, and afterwards, she was looked upon as a rival, or, worse still, as an enemy.

No one will wish to deprive Italy of the credit of having made enormous sacrifices for the Entente during the World War, but the writer's method of arriving at the proportion of men called up and of losses to the total population is somewhat misleading. He bases his calculation upon the population of each country, including that of its colonial empire. In this way Britain and France, with their huge colonial empires, show up very poorly in comparison with Italy.

La guerra in Europa. By Lieut.-Colonel Blatto.

A review of the third month of the war.

On the western front we are faced with the strange phenomenon of two armies, ready to fight, armed with the most modern machines, securely entrenched and animated by a traditional warlike spirit, facing each other with no apparent intention of offensive action. Such a state of affairs was foreseen by Moltke as long ago as 1887. The writer considers that the clash must come sooner or later, but that the pause is justified on the grounds of the enormous expenditure of energy that modern warfare entails.

Other events during the month under review have been the threatened invasion of Holland and Belgium, and the Russo-Finnish war. In the latter, the Finns have made a successful stand against the invader.

At sea, both Britain and neutral countries have suffered heavy losses from mines. In the writer's opinion, all offensive and defensive measures are justified if they

hasten a decision. Magnetic mines have been experimented with for some years, and are well known.

Impiego e rendimento dei mezzi radio nella campagna per la conquista dell'impero. By Colonel Casola.

Continued from the November number.

In July, 1935, the plant for three permanent radio stations was received in Eritrea. After some changes in the original plans, the final distribution of radio stations in Italian East Africa was as follows:—

The central station was fixed at Asmara. Here two transmitting stations were erected. One was able to connect with Addis Abeba and the various headquarters of Government in the empire for the whole 24 hours. It could also transmit short-wave messages to Rome for 12 hours out of 24. The other station could transmit short-wave messages to Rome for the whole 24 hours.

Smaller stations were erected later at Mogadiscio and Harrar.

The writer pays a high tribute to the excellence of the material supplied and the good work done by the N.C.O's and sappers under his orders.

Colonel Casola had the satisfaction of announcing the Italian occupation of Addis Abeba to Rome and to the whole world.

(*January*, 1940.)—*Copertura di Pace.* By General Bobbio.

Under the title of "Cover in Peace-Time," the writer dwells on the importance of the Alps as a protection against an invading enemy, and of keeping the inhabitants of frontier mountain districts happy and contented. The tendency, as in most other countries, is for the peasantry, who have a hard struggle for existence, to migrate to the large towns. This tendency should be counteracted by grants of special concessions to those who remain on the land, by the construction of mountain roads, and other works that would provide employment on the spot. Inhabitants of sparsely populated districts should also be given opportunities of seeing more of troops. This would encourage a patriotic feeling and a military spirit.

Il pensiero militare italiano dalle guerre napoleoniche ai nostri giorni. By General Maravigna.

The writer deals with the second half of the nineteenth century. The Prussian victories over Austria in 1866 and over France in 1870 made the German army a model for Continental nations to follow. Italy got her ideas from Germany, but did not copy them slavishly; adapting them to her Latin temperament and ideas. Later on, the Boer War and the Russo-Japanese War changed many pre-conceived views, which the Italians took advantage of, without, however, going to extremes.

La guerra dei 23 giorni.

Under the title of "The 23-Day War," Brigadier-General Castagna gives a summary of the recent campaign in Poland.

The Polish plan of campaign, which had, perforce, to meet an enveloping attack from three sides, provided for:—

(*a*) Defence of the Corridor to the last ditch;

(*b*) An offensive against East Prussia;

(*c*) A defensive attitude along the rest of the frontier.

From a military point of view, (*a*) was of doubtful value, and should never have been attempted. (*b*) was a mistake: the Poles were not strong enough to carry out an offensive movement, and it meant a diversion of forces that could have been employed elsewhere. (*c*) defensive arrangements should have been properly organized on a pre-conceived plan, *e.g.*, along the great rivers: the Narew, the middle and lower Vistula, and the Wartha. The central marshy region of Kutno need only have been kept under observation. The actual dispositions involved a dispersal of forces that were weak everywhere. "He who would defend everything, defends nothing."

The writer describes the German plan of campaign: an enveloping pincers-like movement carried out by four armies, totalling 60 to 70 divisions, assisted by an overwhelming air force. It was well-timed and brilliantly executed. Big risks were

taken—there were large gaps between the armies—but the risks were worth while. The Polish forces were unable to take advantage of them. The campaign was over, to all intents and purposes, before the Russian intervention.

La guerra in Europa.

Lieut.-Colonel Blatto continues his comments on the European war, dealing here with the events of the fourth month. The war in Finland is the main event on land. The gallant defence put up by the Finns comes in for universal admiration.

At sea, the scuttling of the *Graf Spee* after the battle of the River Plate is considered unworthy of the traditions of the German navy, and comes in for scathing criticism. The end of the *Graf Spee* compares very poorly with that of the *Emden* and *Scharnhorst* in the last war.

A.S.H.

ANNALI DEI LAVORI PUBBLICI.

(*October* 1939.)—*Leonardo da Vinci e l'idraulica del Rinascimento.*

Le oscillazioni e vibrazioni nel suolo nei fabbricati e nelle macchine.

Professor Oddone describes a number of seismographs and accelerometers for measuring the oscillations and vibrations caused in the ground by earthquakes, by mines, by heavy machinery, and by the passage of trains and heavy vehicles.

An interesting comparison is made between accelerations caused by earthquakes and those caused by artificial means. The vibrations caused by disastrous earthquakes would, if caused by artificial means, prove relatively harmless. The writer has evolved a formula establishing the relationship between the two.

(*November*, 1939.)—*Nuovo originale segnalamento luminoso dei canali della Laguna di Venezia.* By Dr. Alessi.

A new lighting system has just been installed in the navigable waterway of the Venice lagoon, to mark the dredged channel between the basin of St. Mark and the Lido. The channel is marked out by groups of piles (three in a group) at distances of 50 metres. The piles are painted white. Each group is surmounted with an electric light, hooded so as to throw light down on the piles only, and giving a minimum of reflection from the water surface. The system is said to give excellent results, both at night and in fog.

(*December*, 1940.)—*Norme, materiali e strutture per la limitazione dell'impiego del ferro nelle costruzioni.* By Dr. de Simone.

Economic conditions in Italy, dating back to the "sanctions" of 1935, have necessitated a restriction in the use of iron and steel for constructional purposes. The present policy is to render the country independent of foreign imports. Italy produces no iron whatever.

An economy has been introduced by modifying the regulations, so as to increase the permissible safe tensile strain of homogeneous iron from 1,200 kg. per sq. cm. to 1,400 kg. (16,950 to 19,775 lb. per sq. in.) and that of steel to 2,000 kg. (28,250 lb. per sq. in.). By substituting steel for iron the amount of metal required can be reduced by about 30 per cent.

Various types of building materials have been introduced, with the same object in view.

One of these is pumice-stone, quarried on the island of Lipari, in different sizes, from large blocks down to small grains. It is very light—72 per cent of its mass consists of voids—and although spongy in texture it absorbs very little water. Blocks of pumice-stone make excellent masonry. Small pieces can be made into conglomerate blocks. The material is so light that the weight of a building can be reduced by about half; it is also an excellent non-conductor of heat.

Bauxite is an Italian product; the use of aluminium and its alloys is consequently encouraged. The addition of copper gives additional strength, but increases the

liability to corrosion. Aluminium can be used for bridge girders, provided that great strength is not required. In America, aluminium lattice girders have been made with spans up to 30 metres.

The employment of two other valuable materials, bamboo and asbestos-cement, is discussed here at some length. It is considered of sufficient general interest to make it the subject of a separate article in this issue of *The Royal Engineers Journal*.

As a result of the new regulations in Italy, the quantity of iron used in civil construction was reduced to 200,000 tons in 1938, and has since dropped to 100,000 tons annually.

(*January*, 1940.)—*Sogno e Realtà dell'Architettura di Leonardo*. By Professor Pica.

A description of some of the buildings designed by Leonardo da Vinci, with photos of some of his original sketches and models. Leonardo's designs are perfect examples of the Renaissance style.

Il Regime idraulico del Lago di Vrana. By Professor Cecconi.

A description of Lake Vrana, situated on the island of Cherso, on the Dalmatian coast south of Trieste. The lake lies in a basin surrounded by rocky hills, and has no overflow. In spite of this fact, the water is clear and sweet, and only slightly impregnated with chlorides. The water surface is 19 metres above sea level: it covers an area of 5·75 sq. km.; the bottom of the lake is about 40 ft. below sea level.

It is proposed to draw off about half a million cubic metres of water annually from the lake for the water supply of the islands, and it is believed that this amount will only lower the water level in the lake by a trifling quantity.

Le temperature massime assolute in Italia e quelle del luglio 1939. By Professor Eredia.

A comparison of the maxima temperatures in July, 1939, in different parts of Italy, with the maxima in previous years.

Breve esame critico dei sistemi e metodi di fondazione in terreni cedevoli. By Dr. Cannavo.

A study of foundations in yielding ground, *i.e.*, on wells and piles. The piles referred to here are mainly of reinforced concrete.

A.S.H.

REVISTA GENIULUI.

(*November*, 1939).—*Present events; observations, remarks and suggestions*. By Major Iowescu Antachi. Referring doubtless to Poland, the writer states that large modern armies will to-day seek victory by attacking an enemy's mobilization arrangements and overwhelming him before he is ready. He then advocates the following measures for a small country liable to attack by a great Power.

A system of *road-blocks* must be prepared in peace-time, on the following principles:—

(*a*) The points blocked must be those through which an enemy's advance must pass, unless he is prepared to make a long détour.

(*b*) The blocks should lie in defiles, *e.g.*, cuttings, embankments, marshes, woods, bridges.

(*c*) Deviations should be difficult and lengthy.

(*d*) Blocks should be made in advance of the first line of resistance of the covering troops, so that the artillery can engage targets some hundreds of yards in front of the blocks.

The system must include the following works:—

(1) Obstacles which will delay the enemy on the main routes long enough to permit the completion of other necessary works in rear.

(2) An alarm system at the frontier.

(3) Mixed detachments of infantry, pioneers and perhaps artillery, to put the blocks in action and to cover them with fire.

As regards deliberate demolitions, charges should be placed in peace-time and the detonators inserted when diplomatic tension nears breaking-point. Fuzes or leads should be connected when the alarm is given at the frontier, and the charges fired when the enemy arrives before the obstacles described in (1) above.

After completing the block, the detachment holds a prepared position, 200–300 metres in rear, and remains there until further orders.

In order to deal with the advance of mechanized forces, a thorough *demolition scheme* is needed throughout the network of communications. The Polish campaign has shown that belts of demolitions (10–15 km. deep and at intervals of 10–15 km.) are now out of date, since mechanized formations can move 25–40 km. in a day, and could advance rapidly by bounds over the ground between belts. The area of demolitions must now extend 150–300 km. behind the frontier. Owing to the more rapid means of repair now available to the enemy, a greater density of demolitions will be required in future. The preparation and firing of the charges should be the province of the Higher Command (G.H.Q. or Army), which should have pioneer units under its direct orders. The firing of charges should be made the responsibility of a staff officer in charge of a demolition zone; this officer must be in signal communication with the Higher Command.

When the enemy main attack develops, the greatest attention must be devoted to *A/T defence*. This is grouped under two heads, *active* and *passive*.

(1) *Active*. (*a*) Infantry.

Tanks are so blind that individual men are invisible to them if more than 100–150 metres away, and if dug in, cannot be seen at all. Infantry should therefore hide at the approach of tanks, when they will be in a position to attack them at close quarters with grenades, burning petrol, etc. It must also be borne in mind that the crew of a tank cannot hear small-arms fire, and that small-arms fire from tanks is not very dangerous. It is suggested that a proportion of light automatics and machine-guns be allotted to deal with light or medium tanks, but that the remainder of the infantry weapons should remain masked and wait for the enemy's infantry attack.

(*b*) Field Artillery.

In armies not possessing sufficient A/T weapons, field guns must be used for this task, firing over open sights. Experiments have established that a field gun can knock out a tank with 5–6 shots at 800 metres.

(2) *Passive*.

It is pointed out that the volume of excavation required in digging an anti-tank trench, of a given width and maximum depth, is reduced if the trench be sited on the slope of a hill.

J.V.D-H.

LE GENIE CIVIL.

(*19th August*, 1939.)—*La situation actuelle des Chemins de fer allemands*. By L. Pondeveaux. According to a memorandum drawn up by the author and supported by German documents, the Reichsbahn has been for several years a prey to a crisis affecting both engines and other rolling-stock. Its park of locomotives fell from 24,089 units in 1929 to 20,711 in 1937, a reduction of 14 per cent.

The number of passenger coaches, which had reached 67,025 in 1932, had fallen in 1937 to 60,629, in spite of the increase in traffic.

Trucks numbering 574,999 showed a reduction of 7,254, i.e., 11.2 per cent, since 1929. In addition to this, in age the trucks averaged 21 years, while the normal age for scrapping them is 20 years. From 1930 to 1937, about 1,700 trucks were ordered each year, which represents only 2.3 per cent of renewals against an authorized

scrapping of 3 per cent a year. This diminution of quantity and quality leads to a considerable increase in repairs.

According to the memorandum above mentioned, some time before the war a vast programme of repair and extension of the rolling-stock should have been undertaken but there appears to have been difficulty in financing it. At the same time, it was doubtful if the industry was able to undertake so vast a work, which should have been spread over at least four years. Another problem for later consideration is that of renewing the rails.

F.E.G.S.

THE INDIAN FORESTER.

January, 1940.—Vol. LXVI, No. 1.—One reads with envy *A Flying Visit to East Africa*, by Mr. H. G. Champion. He mentions heather 30 feet high and lobelias growing to tree height, and records a view of 500 hippos and 300 crocodile seen on one day on the shores of Lake Victoria and, lest he should be accused of exaggeration, states that he counted 80 hippo in sight at one time, and 50 crocodile at another.

Counter-Erosion in Gujerat is another tale of the struggle of the Forest Department to reclaim land laid waste by destructive deforestation and by the thoughtless methods of cultivation in the foothills of the Himalayas, here, unfortunately, in Kashmir territory, where civil control is not immediately available.

The leaves of the Indian lilac have been found to produce a decoction which acts as an infallible deterrent to locusts, but is harmless to men, animals and to the vegetation on which it is squirted to keep off locusts.

February, 1940.—One is sorry to learn, from the narration of a distressing example, that elephants suffer from tuberculosis.

Another item of interest is that sugar can be extracted from certain English softwoods, such as sycamore and birch.

From the latest administration report on the forests of Burma, we learn that *yon* handles are being exported to England for tools.

March, 1940.—An article on forest protection from fire, begun in a previous number, is concluded. Ordinarily, forests near villages do not suffer as much from accidental fires as those at a distance, as the villagers remove leaf litter and small sticks which would otherwise serve to spread a conflagration.

The Use of Treated Wooden Poles in India gives coal-tar creosote an easy first place in value as a preservative. The average life of a pole treated therewith is given as 26 years. The figure for the U.S.A. is higher, 50 years, but there a greater quantity of preservative is used.

River Training Works, by Mr. J. R. Harrison, gives the results of a good deal of experience in connection with prevention of erosion by alluvial streams in Assam. On the Hel river, one abutment of a forest tramway bridge was protected by a row of piles revetting corrugated iron sheets. At the base of these were placed sausages of wire nets filled with stones, and further out still, a protection of wooden piles interlaced with wire was made. Photos show how admirably the arrangement succeeded. At another place, the author protected a concave bank subject to erosion by a series of spine-shaped wire entanglements jutting out obliquely upstream. The object, of course, is to produce still-water areas where silt will be deposited. Many of the author's conclusions are opposed to the suggestions in *Military Engineering*, Vol. III, Part I, and, it may be added, to the reviewer's experience in boulder-bedded rivers in Northern India. But what is suitable for one type of river may not be so for another.

F.C.M.

CORRESPONDENCE.

DUTIES OF ENGINEER UNITS IN MASSED TANK ATTACKS.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

I was much interested to read in the March issue of *The R.E. Journal* the account of damage caused to Allied tanks in 1918 by our own forgotten mine fields.

In March, 1918, I was with the H.Q. R.A., 16th Division, near Ronssoy, and was to some extent concerned with the laying of anti-tank mine fields.

In September, 1918, in command of the 83rd Bde. R.F.A., 18th Division, I advanced over the same ground and in one of the attacks on the Hindenburg line I noticed in the operation orders one night that the tanks were to advance straight over or very close to the position where I knew the mines had been laid in March.

I rang up the Division and reported as far as I could recollect the position of the mine fields, but I never heard if my message reached the tanks or if the position of the mine fields was already known.

However, when we advanced ourselves across the fields, they were still unexploded and much the same as when I last saw them six months before.

Actually, they were fenced in by us when they were laid to prevent men straying in among them and getting blown up.

One Gunner was killed when laying them, but how the accident occurred we could not discover, probably due to a faulty gramophone needle, as these were used to retain the striker in position till broken by the weight of the tank.

Yours truly,

C. BARTLEY-DENNISS,

Lieut.-Colonel (late R.A.)