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CONTENTS.

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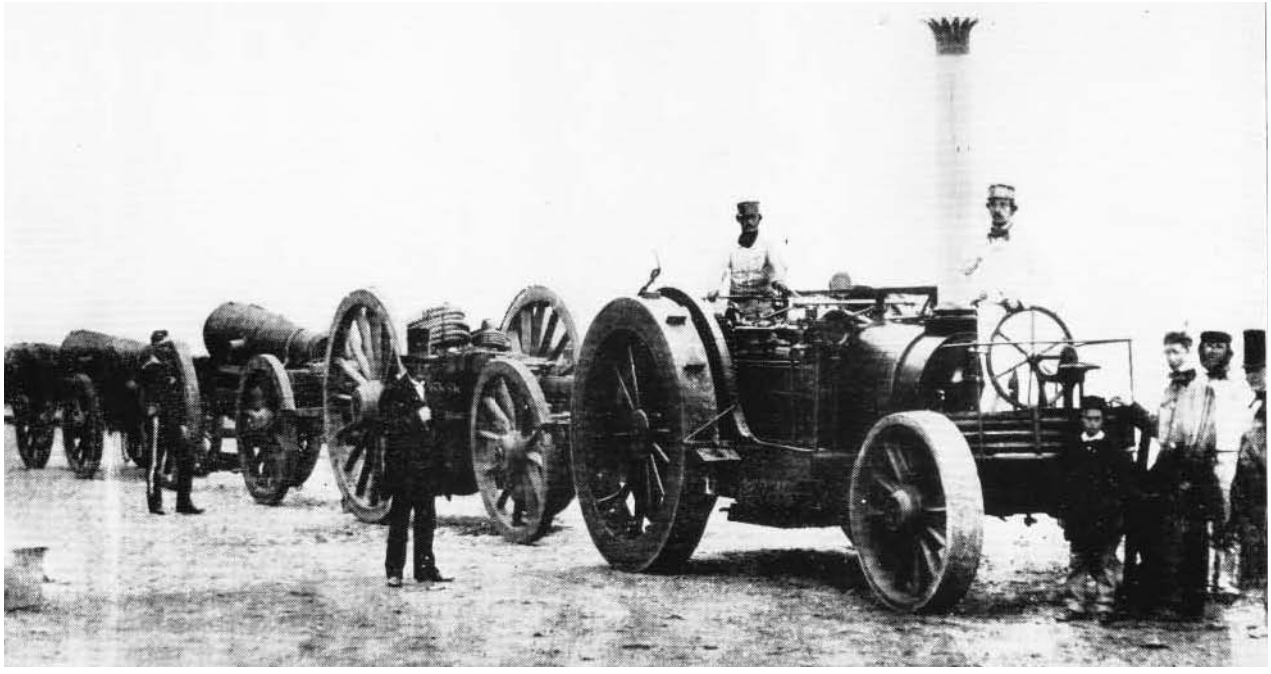

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SOME ASPECTS OF THE SHANGHAI EMERGENCY, 1932.

By MAJOR A. MASON, M.C., R.E.

INTRODUCTION.

IT is not desirable to attempt a history of the Sino-Japanese troubles of the past few months. The military movements have not been of any great importance, though there are, of course, lessons to be learnt from them, and there is not yet sufficient information available for a satisfactory account of them. What is more important is that proper understanding of them would necessitate a voyage into political waters, which are even muddier in China than elsewhere.

There are, however, a few readers of *The R.E. Journal* who know Shanghai and may be interested to hear how this emergency affected the Settlement, and there may be other readers who hope to find in the activities of the British Army in this peculiar station some pointers to the future. The title of this article has been chosen to admit of the narrative being reduced to a minimum, while matters which may be of interest to the Corps are emphasized and dealt with in detail.

PROLOGUE.

Foreigners in China say that Shanghai has an emergency every five years. It is at least true that five years have passed since 1927 when, as will be remembered, the approach of a war between rival Chinese factions threatened to involve the International Settlement, and necessitated the landing of a large British and Indian Force for the protection of British lives and property.

By 1929 the force had been reduced to two British battalions, numbering, with ancillary troops, a little over 2,000, which remained the British garrison until this year.

The Settlement, being international, holds, also, an American garrison of normally about 1,200 men, and a Japanese landing party, which last year numbered about 700. There is a powerful Volunteer Corps of a peace strength of about 1,700 men of many nationalities, commanded by a Colonel appointed by the War Office. Lastly, there is a fine Police Force containing, in addition to Chinese, about 1,000 British, Indians and Japanese, available in emergency for internal security work.

The adjoining French Concession had at the beginning of this year a garrison of about 1,000 French and Colonial troops, making in all a total of 7,600 men, of nationalities other than Chinese, for the defence of the two areas. The Senior Italian Naval Officer also agreed to place a landing party at the disposal of the British Commander should the situation at Tientsin permit.

Of the defences erected in 1927 practically none still remains; but, as a result of the events of that year, the next three years saw a series of steel gates erected across all roads entering the perimeter of both the International Settlement and the French Concession from congested Chinese areas; seven blockhouses were also built at certain cross-roads and bridges in the first-named, facing the Chinese suburb of Chapei.

1931 DEFENCE SCHEME.

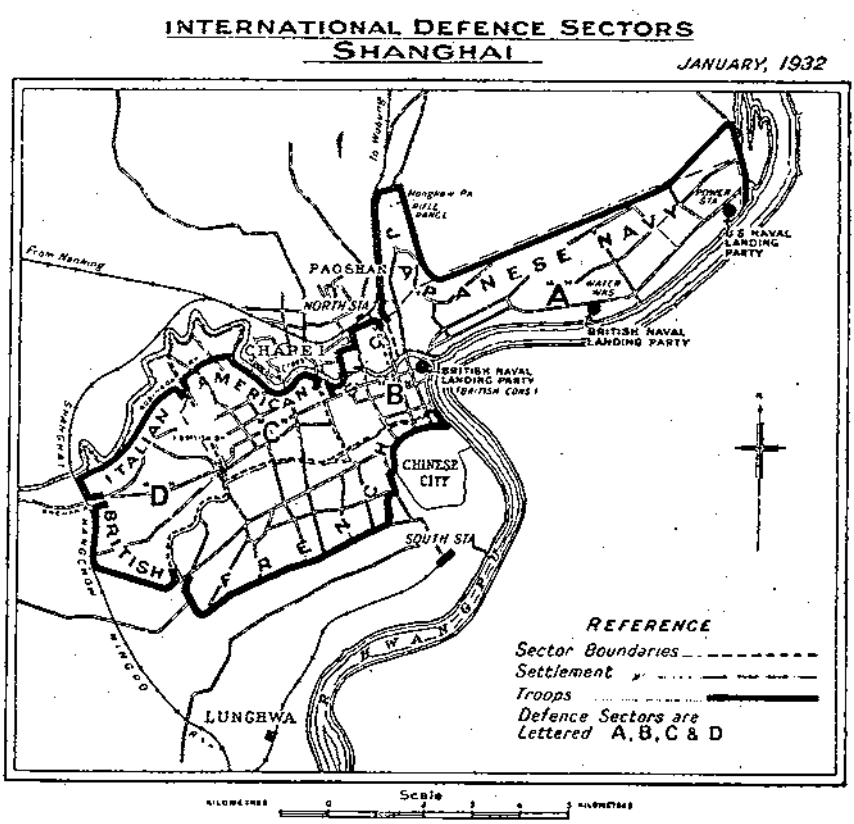
The Settlement was divided by the Defence Scheme into four Sectors, in one of which each of the four commanders who signed the Scheme was to be responsible, both for defence against external aggression and for assisting the Municipal Police to preserve law and order. During the past five years building and development in Shanghai has proceeded very fast compared to European standards, but it was not thought necessary, except in minor details, to alter the defensive perimeter taken up in 1927; this was partly along, but in two areas outside, the boundary of the Settlement; its total length was about 18 miles and the garrison about 5,600 troops, excluding police.

THE FOUR SECTORS.

The allocation of troops to sectors is of necessity more political than tactical where several nations are concerned. The localities through which the perimeter passes can be divided into the following types, placed in order, commencing with that requiring the fewest number of men for its defence.

(*a*) River front. (*b*) Railway front. (*c*) Open country, intersected by creeks and dotted with villages. (*d*) Fully developed city with wide, straight streets. (*e*) Semi-developed suburban areas. (*f*) Slums of back-to-back houses and narrow alleys.

Sector A includes the whole of the eastern portion of the Settlement and an area outside the Settlement boundary known as the Hongkew Salient, where a large number of Japanese live, and where the Japanese barracks and headquarters are situated. This Sector, therefore, became the Japanese responsibility, and its perimeter measures about $7\frac{1}{2}$ miles. Commencing at the east are three miles of (*c*) type country where little trouble was expected, then two miles of (*f*), one more of (*c*) round the north of Hongkew Park, and $1\frac{1}{2}$ of (*b*) back to north Honan Road. The last stretch of railway front is



enclosed on both sides by slums, and this was part of the subsequent battle front.

Sector B includes the business locality and was allocated to the S.V.C. reinforced by one company from the Reserve British Battalion.

Sector C was to be held by the U.S. Marine Corps. The line of steel gates excludes the factory area in the extreme north, but it was decided to defend as a front line the bank of the Soochow Creek. This measures three miles to the Settlement boundary which formed the western boundary of the Sector.

To the west of, and outside, the Settlement; and extending as far as

the Shanghai–Hangchow Railway, is a populous area. It contains factories in the north, and south of them many British and American homes, the British headquarters and most of the British camps. This, therefore, became Sector D, the British responsibility; its perimeter measures five miles or more, fairly equally divided between (*a*) type country along the north and (*c*) along the railway and extra Settlement roads to the west. The left of the British line rested on the French Concession boundary and made touch with the French troops. As the emergency did not yet affect the latter they will not be mentioned again. The Soochow Creek, which assumes some importance in the defence of Shanghai, averages about 80 yards wide, but is always crowded with boats, many of them stationary. It is tidal and unfordable.

THE BRITISH SECTOR.

The British perimeter was over five miles long, and, being on Chinese soil, no permanent gates or blockhouses existed; it was possible to choose a much shorter second line only two miles long, covering the most populous area and all the camps except one. The garrison was to be one British battalion, possibly reinforced by an Italian landing party of about 150 men.

The country is absolutely flat, and the subsoil water often only three feet below the surface; breastworks have, therefore, to be the rule, trenches being impossible except on high spots such as grave mounds or embankments for road or railway. All posts were, of course, to be designed for all-round defence and to have ring obstacles round them in addition to the perimeter wiring. They were to be built by their eventual garrisons.

In the meantime the Garrison Engineer worked out the details of the perimeter wire. The work was divided in depth into half a dozen stages, and the quantity of stores required for each was worked out and tabulated. It was intended that the labour should be working parties from the British battalion in General Reserve, or if this was not available, Chinese labour from the Public Works Department of the Shanghai Municipal Council.

In 1927 wooden piquets had been used for all entanglements, but, in November, 1931, it was decided to obtain a reserve of screw piquets so as to hasten the earliest stages of the wiring.

The infantry had also worked out their posts in sufficient detail for it to be discovered that the stock of sandbags was adequate; these had not deteriorated to any great extent.

Two other enquiries had been made; the first elicited from Command Headquarters that no Engineer reinforcements could be spared; the second discovered that the Shanghai Power Company could produce up to 50 spotlights suitable for use in posts for illuminating the wire, by withdrawing lamps hired out for the flood-lighting of buildings.

The Emergency.

This was the position when, on the afternoon of January 26th (Z-2 day), the Area Commander issued instructions for preparations for an emergency to be made. Peace work was stopped at once, most of the year's allotments having been spent earlier when the exchange was low.

The Officer i/c R.E. Stores laid aside his additional duties as Surveyor of Works and Lands Officer, and became Workshops Officer. Sufficient timber for the first stage of the wiring was ordered on 26th, and on 27th (Z-1 day) the G.E.'s direct labour force of seven Russians, later reinforced by infantry pioneers, and by Chinese carpenters borrowed from the P.W.D., started on the manufacture of knife-rests and the cutting and sharpening of piquets. Rusty barbed wire was drawn from store and found quite suitable for knife-rests.

The three Foremen of Works, each of whom has a motor-cycle combination, became responsible each for one sub-sector of the perimeter; the Garrison Engineer was also given additional staff of one serjeant draughtsman with a motor-cycle, and four others of all ranks, who gladly left their office chairs and became Field Works Instructors.

The first job for the O.C.R.E. was created by the fact that the British Sector was not in the Settlement or in the province of the Municipal Police, but was claimed by the local Chinese Bureau of Public Safety, whose police are picked men and experts in the art of obstruction when told to exercise it. The two easterly bridges over the Soochow Creek in Sector D are isolated and situated in densely-populated Chinese areas; each was to be held by seven men, who had to build their own posts; for one it was desirable to commandeer a room in a Chinese mill, the management of which was reluctant to give admission; the other post was to be at the side of a road where the mere sight of a British soldier might be enough to collect such a crowd as to render work impossible.

It was necessary to get the assistance of the Safety Bureau Police and avoid either their opposition or their withdrawal, which might have led to looting and other trouble. A personal visit to the local Chinese Inspector was made on zero day morning, and, as a result of some hours of talking and some drinking of green tea, he agreed that the British troops were there to assist the Chinese police to keep order and to exclude undesirables, and he offered to escort them into position and hold back the crowd while the work was going on. The time thus spent was not wasted; the local inhabitant took his cue from the police and has remained friendly throughout. It is in this respect that the present emergency has differed from previous disturbances which have been generally anti-foreign in feeling.

The erection of defence posts and wire started on zero day, and proceeded smoothly and without haste, for the Sector remained

quite quiet. There was no necessity for the constant presence of the O.C.R.E., who felt that he was much more needed in the G. Office.

The entire programme of wiring, and some additional work, was completed before the middle of February, although on several days no working parties were demanded on account of reliefs or moves. Generally speaking, the Sector kept well ahead of all the others and became a model for instructional purposes. Some of the entanglements were made throughout of the unserviceable barbed wire, and no doubt any lack of strength was compensated for by its uninviting appearance. Although some details were worked out later, overhead cover was not found necessary. Rainproof cover of matting on bamboos was erected over the occupied posts and, without being too conspicuous, added greatly to the comfort of the men.

About eighteen 220-volt spotlights, mostly of 1 kilowatt, were installed and proved very satisfactory, especially those of less than 45 degrees' dispersion. By their mere existence and occasional use they doubtless were effective in keeping Chinese away from the wire at night, but they did not cover the whole distance from post to post. It was hoped to save them and illuminate most of the wire by a strengthening of the road lighting just in rear and the use of some reflectors which the Power Company had in store; this, however, did not prove satisfactory.

The Public Works Department willingly extended their road-lighting circuits to include all the perimeter roads, and permitted experiments to be made with them; they also constructed one bridge and one culvert, repaired two bridges and improved several lengths of earth road to make them fit for armoured cars in all weather.

LESSONS.

The first lesson learnt was that probably another month, had it been available, could usefully have been spent in working out the details of defence. What had been done was very useful, saved a great deal of worry, and enabled the defences to be completed without confusion. But Sector D happened to be a quiet sector; had it been the scene of hostilities, so that the erection of defences became urgent, it is doubtful whether the existing Engineer staff of three officers and ten rank and file would have been adequate.

The second lesson was that though the infantry are now, by regulations (see *M.F.W.*, Sec. 9), responsible for the design and erection of their own defences and obstacles, their training has not yet reached a state where the designs they produce are beyond criticism. The infantry battalion concerned at Shanghai did surprisingly good work, but their designs should have been examined by the R.E. in every detail if time had permitted. When erection was ordered, there were not enough infantry officers available for

one to supervise each post, and the following criticisms might have been made of the results :—

(1) In some cases the siting was not ideal; the exact position of the automatic weapon should have been fixed before work started, and continually checked.

(2) Most of the posts were too large in plan, and when drainage was feasible, digging was not in all cases resorted to to save height.

(3) Posts liable to require overhead cover should have been specially designed to facilitate its erection; the possibility of sniping from neighbouring houses should, therefore, have been considered beforehand.

Posts in localities so built up that sandbags cannot be filled reasonably near, require sand or other filler; this should have been recorded. Had the situation developed so that organized attacks on this Sector became likely, the construction of "tactical" obstacles for the purposes described in *M.F.W.*, Sec. 34, would have become necessary. Such obstacles require careful co-ordination with m.g. posts and could have been previously marked on the map after examination of the ground.

As regards the illumination, it appears that strip lighting cannot easily be improvised; the necessary circuits should have been worked out and the positions of switches fixed in peace-time. Where the entanglement actually follows the line of a road, the road lighting can be made use of, if reinforced, but the reflectors required to throw the light on to the wire and not on to the posts or the road should be specially designed in peace-time, so that in emergency they can be manufactured and fitted without delay. Shanghai streets are lit by series lighting, a system unsuitable from the defence aspect and requiring special precautions to prevent the illumination scheme being nullified by the cutting of a wire outside the perimeter.

Reinforcements.

On January 29th and 30th, the Italian landing party, of about 150 men and 14 machine-guns, was placed under British orders as part of the garrison of Sector D, and took over the northern half of the perimeter, along the Soochow Creek. They are a very keen and smart body of men, and held this front for over a month without relief, until a special force of 500 Marines arrived from Italy. They have no engineer staff and rely on the R.E. for their engineering needs, which are small.

Fortunately, as part of the normal trooping programme, a Relief Battalion was due, and arrived on January 30th, bringing also, amongst others, a new Garrison Engineer and three sappers.

The new G.E., a stranger to China, landed at 10 a.m., reported at

noon and by 2 p.m. was seeing the Italians settled in, and providing what they needed for their posts and billets; then, as an E. and M. trained man, he was given the illumination of the front line wire to carry out. He took over the maintenance of camps and billets as time permitted, so as to relieve his predecessor of all except pure defence work, and enable the latter to depart when the military situation permitted. The newly-arrived battalion was moved straight into its permanent camps, the outgoing unit having evacuated them, as is done every year, for temporary accommodation in the Race Club grandstands and buildings. These were this year already also harbouring the S.V.C. units of the General Reserve: nevertheless the British Battalion stayed here for six weeks instead of the normal eight days. It came into General Reserve, the relieving battalion taking over the perimeter posts.

At this time there were also about 200 men from Tientsin, awaiting in Shanghai the troopship which would take them home. In view of the lack of accommodation in our regular camps, it had been decided to billet them in a S.V.C. barrack on the rifle range in Hongkew Park. This billet had been occupied before the emergency arose but was now in the "war" area, and, on January 31st, not only rifle bullets but also trench-mortar "overs" were reported to be falling quite close. It was, therefore, decided to withdraw these unarmed neutrals into more healthy surroundings the following morning. A new billet had to be found, and the Majestic Hotel, then known to be in process of demolition, was inspected. The structure was still complete but practically all the fittings except the cooking apparatus had been taken out. It was rented, and the Tientsin troops marched in on February 1st, while the necessary work was being completed. A whole battalion could be accommodated in the building, and that very day news was received that a British battalion and an Indian mountain battery were then leaving Hong Kong for Shanghai in a cruiser.

On February 3rd, these two units marched in, the battalion into the Majestic Hotel, and the mountain battery into some new Chinese houses in the race-course neighbourhood, in both of which billets a considerable amount of work had been necessary. The Majestic Hotel is well known to all Pacific travellers, and it is interesting to record that its world-famous ballroom should at the last be used as a dining-hall for British troops and the adjacent Italian garden as an Institute restaurant.

On February 5th, a regiment of United States infantry arrived from Manila, and were accommodated partly in hired buildings near the race-course and partly in the Race Club buildings.

THE VOLUNTEER SECTOR.

In the meantime the Shanghai Volunteer Corps had been maintaining the neutrality of Sector B, immediately adjoining the Sino-

Japanese battle-zone. This ran northwards in continuation of the boundary between Sectors A and B, so that the Chinese firing line terminated opposite the right flank post of the S.V.C. at Blockhouse "B." The system was extremely useful in that it fixed the position of the front line, and the blockhouses gave ready-made cover, complete with telephones, water, light and sanitation, both for defence and intelligence purposes. Their existence created a feeling of security in this Sector, so that no plans for further defences had been prepared.

On February 1st, the Commandant S.V.C. asked for advice on the engineer work in his Sector, and the following morning an expansion of the duties of O.C.R.E. commenced with a visit to S.V.C. headquarters and an inspection of their front line.

The S.V.C. for many years included an Engineer Company, but it had been largely disbanded late in 1931, and the emergency had now arisen before reconstruction was begun; on February 2nd the staff on duty were a Norwegian major, an American subaltern, and a few N.C.O's, apparently Portuguese, none of whom had any war experience. Volunteer workers, chiefly Russians and unemployed, were coming in so rapidly that this entire staff was required to handle them. The latter, desirable from the point of view of ensuring the neutrality, and assisting in the defence of the Sector, was also necessary to allay the suspicions of both Chinese and Japanese that the Sector, and particularly that portion near Blockhouse "B," might be used by the other side either for offensive purposes or for sniping.

The Public Works Department were rapidly erecting, with Chinese labour, an entanglement on part of the front but, for lack of any liaison with the S.V.C., they had actually carried it outside one gate without any protection whatever from a covering party, and on arrival at the next gate, had been refused admission.

Immediate steps were necessary to provide Field Engineers for liaison with the P.W.D. and to take charge of the volunteer labour. The newly-formed R.E.O.C.A. was an obvious source, and fortunately the Honorary Secretary, a Scot of great energy, was serving as a private in an infantry company then in the line. By 11 a.m. on that morning, February 2nd, he had been located, borrowed as an orderly and, as he had served as a Field Company Captain in Palestine, offered a temporary captaincy in the Engineer Company S.V.C. His roll of ex-R.E. gave a selection from which subalterns could be chosen, and a rapid walk round the perimeter produced a list of work and an order of urgency.

The most urgent work was to give all three parties interested in Blockhouse "B" confidence that it would remain neutral. An all-night working party with unlimited filled sandbags and wire succeeded in doing this. Two subalterns joined the next day, and two more the day after, and by the following night the Sector had two complete

lines of defence. Blockhouses "B" and "C" at either end of Boundary Road saw most of the war; both were shaken by trench-mortar bombs and shells landing unpleasantly close to them. These caused no casualties though later an H.E. shell, that fell between them and inside the Settlement within a few yards of an American sentry, killed two Chinese. Two Russian volunteers were also wounded by "overs" near "B" Blockhouse.

The Engineer Company, therefore, provided overhead splinter-proof cover for all posts, using some part-worn steel sheet piling found in a near-by P.W.D. depot. The blockhouses not having been designed against artillery fire had only light R.C. roofs; in view of the exposed positions of "B" and "C," it was decided to give a greater feeling of security by strutting them internally and covering them with two layers each of sandbagging, and interlocking steel-sheet piling, alternately. This work was done on "B" Blockhouse on February 18th, and by then the situation had improved so much that a party worked on the roof all day, making as much noise as they liked, without anything worse than laughter being directed at them.

INTERNATIONAL HEADQUARTERS.

At the finish of the inspection on February 2nd, a visit of liaison was made to the flank post of the American Marines in Sector C, on the left, and the Battalion Commander happened to be there at the time. In conversation the fact emerged that the U.S.M.C. in Shanghai had no Engineer organization, was unable to find any men who had done engineering courses or had had any war-time engineer experience, and would be very grateful for any assistance in this way from the British Army. A suggestion that an officer be detailed to take charge of all engineer work on the battalion front led to the nearest officer, a machine-gunner, being told off for the job, and it was then arranged that he should report at British headquarters the following morning.

His instruction was combined with a tour of inspection of the British posts, much of which was spent in technical arguments with machine-gun serjeants. From then onwards a steady improvement in the American posts began to appear. In view also of the danger of an unmanageable rush of refugees and the possibility of small bodies of armed men crossing the water and entering the perimeter at night, the American troops indented on the P.W.D. for the construction of long lengths of entanglement on the bank of the Soochow Creek. As these clashed at first with the wiring which the P.W.D. were doing in Sector B, co-ordination was required which was, under the Defence Scheme, a British responsibility.

On February 6th, the Area Commander handed over command of Sector D to the senior of the two Battalion Commanders, and moved, with the Brigade Major, C.R.E. and Intelligence and Cipher officers, to the Administration Building; this held all the municipal offices

including the S.V.C. headquarters, the Police headquarters, the P.W.D. offices, and the Council Chamber, where the meetings of the Defence Committee were held. It seemed that the situation was unlikely to clear up rapidly and that a longer view should be taken; therefore, on February 8th, instructions were issued for the maintenance of British permanent and temporary billets and camps to revert to normal, by the withdrawal of Foremen of Works from the front line. We now saw how fortunate it was that the emergency arrived simultaneously with the new Garrison Engineer, for the latter had double the normal garrison to look after: while his predecessor was catering for the front line needs of two battalions, the Italian naval landing party, and three British naval landing parties.

The first engineer job needing co-ordination, the wiring of the road along the river-bank in Sector C, was completed very rapidly by the P.W.D. The next arrived when the United States Infantry began to relieve the S.V.C. in Sector B, for it then appeared that the American Army, like their Marines, had brought no Engineers to Shanghai, and would be grateful for assistance in carrying on with overhead cover and other necessary work. The Engineer Company S.V.C. by now knew the Sector thoroughly, and as two of its officers had served with the United States Army and Air Force, they were left in charge of the Sector. On February 9th the first of the Engineer Company officers were taken on a tour of inspection and instruction round Sector D. By 19th, the S.V.C. had been entirely withdrawn into General Reserve, except for the Engineer Company, half of which was detailed to work with the U.S. Regiment, and the other half with the British Battalion which relieved it during alternate weeks for the next month. By the middle of February, applications began to come in for openings in the wire entanglements to enable mills and warehouses to get back to work. This was encouraged, within reason, in order to reduce unemployment and the consequent liability of communist unrest, and most of the work was decentralized to battalion commanders.

On March 2nd the Chinese suddenly retired from in front of Sector B, and the noise of the battle faded away up country. The internal situation did not, however, admit of all defences being immediately removed. The front line had to be maintained intact and manned, though in reduced strength. The second and reserve lines in Sector B, which were interfering with normal business, were removed. Some of the wire was recoiled by the P.W.D. and the remainder was rapidly made into handy parcels by the use of a light steam-roller and thrown into ponds.

One last job in Sector B is also left to the P.W.D. to clear up. The front line billets, ranging from the Chamber of Commerce to a Chinese Bathhouse, have been used by S.V.C., Americans and British in turn; some independent authority is required to wind up the account, reinstate damages and allocate costs.

ENGINEER ORGANIZATION.

A scheme for engineer co-operation, which was in the air at the time, came to nothing, and the situation from then on steadily improved; nevertheless, it is worth mentioning because of the very interesting discussions which ensued.

An Engineer officer in each Sector would direct all field engineering work, and submit all demands for work which he could not carry out to a central C.R.E.'s office. Owing to the use of infantry working parties British demands would be few, but in the American and Volunteer Sectors they would cover nearly all the work required. Extra Engineer officers and staff required would be given S.V.C. ranks and would be chosen from the R.E.O.C.A., or from similar classes of volunteers; the necessity for such volunteers in the British Sector was only avoided by the fortunate arrival of the new Garrison Engineer and relief staff.

In the C.R.E.'s office the demands would be classified in order of importance, and execution would be ordered on a central supply organization, either the Public Works Department, the Shanghai Power Company, or, if telephone communications were included, on the Shanghai Telephone Company. If these utilities were unable to function owing to the work being under fire or to inability to get Chinese labour to work in the rain or at night, then it would be necessary to call on volunteer labour and ask, if necessary, for volunteer specialists to take charge of any special work.

Such centralization of supply seemed the simplest and most economic method for a small area amply provided with roads and mechanical transport; the existence of the public utilities, with their supply of regular labour, trained supervisors and highly-qualified officers, is too important to be passed over. The subsequent discussions centred on the nature of the link required between these public utilities and the troops for whom the work was required.

The P.W.D. is the only utility that has been mentioned in the narrative, since the others and the Gas Company either worked on orders issued by the P.W.D. or by their ordinary peace-time routine.

Field engineers linking the P.W.D. and the troops in the line, say the S.V.C., must be embodied in a military unit and give their whole time during an emergency; but they can be recruited in three ways: the first by selecting suitable volunteers and training them in engineering; the second by taking P.W.D. officials and instructing them in military needs and duties; the third from an independent body of suitable men, such as the R.E.O.C.A., widened to make it international, with some knowledge of both aspects, but which must develop its own traditions and training.

The first method was used in the Company just disbanded. In Shanghai, personality is everything, and to ensure success the

officers of the unit must be *persona grata* with the executive of the P.W.D. The *esprit de corps* of the latter is very high and they expect at least as high a standard among those from whom they are to take orders.

The second method is probably the best. Volunteers are not mobilized until an emergency is declared, and when the " war " dies down they become anxious to return to their normal avocations and averse to remaining at work till the last sandbag and strand of barbed wire are returned to store. The P.W.D., on the other hand, function continuously and are in a better position to link peace to war and back again ; the moment when some of them change into uniform is not important but essential work may have to be carried out in the last few hours before an emergency is declared. The difficulty of this method is the selection of men for training ; those spared on one occasion may be too busy in their normal jobs on the next and, unless a special clause is included in all contracts, personal objections may be met with.

The third method is admittedly more difficult as it entails building up in the new organization an *esprit de corps* strong enough to overcome personal considerations. It would have to be done by a careful restriction of entry to men of the right class whether required for field engineers, or available for duty as such, or retained for duty in the P.W.D. or other utility, and liable to have to carry out work under the orders of the field engineers. They themselves must then ensure, for the sake of the work and of the organization as a whole, that the senior would take orders from the junior or the cleverer from the less able, if the latter in each case happened to be one in uniform.

A division of duties between the Field Engineer and the officer in charge of a working party, different from that followed in the British Army, is necessary in any case.

At the moment of writing this question is still unsettled.

Conclusion.

From a Corps point of view this affair has demonstrated the need for a central Engineer organization and for Engineer personnel with every landing party. The need for a reserve of Engineer Stores is not so great in commercial centres like Shanghai, which hold considerable stocks of ordinary commodities.

Owing to excessive deterioration in the damp climate the local commercial stocks of barbed wire are low ; they rapidly ran out and shipments were ordered from Hong-Kong, Manila and Japan, which more than made good the quantity expended.

Attempts were made to get jute mills specially running to turn out sandbags of British Army size ; but the P.W.D. found it cheaper to purchase second-hand bags of commercial sizes. Many thousand wheat sacks were issued to the S.V.C. and Americans, and very

uncomplimentary remarks were passed on them by men who had handled the smaller bag.

The Chinese troops have displayed great indifference to the material of which their barricades are made. Empty boxes, bales of compressed paper, of cotton, silk and rags have all been seen and a parapet made of bundles of books. Their third line barricades were reported to be made of bags full of rice until the hungry populace summoned up enough courage to attack them.

In the open country the Chinese trenches displayed a tremendous waste of industry. A continuous length of badly-sited and highly-visible trench, much of which was never occupied, seemed to be the rule; this trench consisted of single-man recesses leading out of lateral communications of inadequate depth entirely open to enfilade fire. Parapets were not bullet-proof, no head cover was provided and generally machine-guns fired direct to the front. No sign of European supervision was visible. Three strands of barbed wire for a length of about 100 yards was the only obstacle seen on one position about five miles long. In front of Sector B, their barbed wire across the streets was supported on chairs.

The great material damage done by Japanese aerial bombing, both in the town and in the villages, is noticeable, but it is doubtful whether it was of much military value. It does not seem to have shaken the determination of the defenders and it certainly did not facilitate the advance of the attackers.

It is believed that the Japanese naval landing party had no engineers. The army, however, brought 350 sappers per division, and these were largely employed on bridging, and did little other road work. As the outpost line is now largely in undeveloped water-logged country, out of reach of railway or roads, it is only the exceptionally dry spring that has saved them from great difficulty. When the long overdue rain comes their cross-country tracks will rapidly become impassable to wheels.

It is [in April] too early to say whether, within the Settlement, the worst troubles of this year are past; we may only have passed through the first phase. If other phases are to follow, one may hope that they will be cheered by an equally friendly international spirit. The relations between the various defence forces during the past two months have been exceptionally harmonious, and the Italians and Americans, with whom the contact has been closest, have proved not only easy to deal with and free from formality but also genuinely grateful for help and warmly hospitable to visitors.

QUETTA WATER-SUPPLY.

With Special Reference to the Recent Construction there of a 5½-million-gallon Storage Reservoir.

By MAJOR J. W. J. RAIKES, O.B.E., R.E.

N.B.—A lakh = 100,000.

To many people the name of Quetta probably conveys very little —during his recent tour of duty there the writer received quite a number of letters addressed "Quetta, Afghanistan." He does not suggest that any readers of this article hold quite such irregular geographical views. Nevertheless, it is more than probable that the majority look upon Quetta as a most insignificant spot, whereas in reality it is the largest military cantonment in the Empire. The total military population outnumbers even that of Aldershot if Blackdown and Deepcut be excluded. It is, moreover, a place of very considerable imperial and strategic importance.

Once this is realized, it will be granted that the water-supply of any station of such a size must be of considerable importance. But in the case of Quetta, which lies in the centre of an almost rainless tract of country, depending for its water-supply solely upon the winter snowfall on the Zarghun range, 20 to 25 miles away, the importance of ensuring an adequate perennial supply of water must bulk larger than any other single consideration, strategic or otherwise. One winter, some ten years ago, when the station was much smaller than it is now, the snowfall was very scarce and by the following summer the available flow of water had shrunk to such an alarming extent that arrangements were actually contemplated for evacuating the garrison.

When Quetta was first occupied in 1876 drinking water was obtained from shallow wells and springs, most, if not all, of which have since disappeared as a result of a fall in the subsoil water level. This fall followed intensive agriculture, involving additional *karezes* (subterranean water channels) and the sinking of artesian wells; water for animals and for washing purposes was drawn from surface channels or *karezes*. There still remain as memorials of this age in different parts of Quetta elevated tanks of various sizes, with steps leading up to them, which were kept filled by *bhistis* from neighbouring wells or springs, and from which troops drew their supplies. In such conditions it was not surprising that cholera appeared. As a

result of a serious outbreak which occurred about 1885, a 7" cast-iron main was laid in 1890 to Quetta from Urak, at the foot of the Zarghun range, about 14 miles from Quetta and the nearest point at which uncontaminated water could be relied upon. The pipes were jointed with cement and not lead, probably because lead would have proved too great a temptation to the local tribesmen; even now, 1930–31, we have had to erect an unclimbable fence round the cemetery in Quetta to stop thefts of lead which forms an ingredient of artificial flowers so often met with on graves. A two-chamber reservoir, to hold 7½ lakhs of gallons, was constructed at the same time, on what was then the north-eastern fringe of cantonments, now almost the centre, and waterpipes laid to the principal centres of demand. A 25-lakh-gallons sedimentation reservoir was also built at Urak. The main also was expected to carry about 7½ lakhs of gallons a day, which was apportioned in the ratio of 3 : 3 : 1½ to the military; the civil station and municipality; and the N.W. Railway. The population at this time was roughly 7,000 in cantonments and 8,000 in the civil station and municipality. The entire scheme cost rather over 6 lakhs of rupees, including the expropriation of a native village at Upper Urak which might have contaminated the intake. Absolute control of the supply was, by order of the Government of India, vested for all time in the hands of the military. Since we are not concerned in this article with the subdivision of costs for construction or maintenance between the various interested parties, such details are omitted here and elsewhere.

By 1896 it was realized that storage capacity equal only to the daily capacity of the main, and to the normal daily consumption of water, was too small. It allowed no reserve whatever to meet unusual demands, or to cover periods when the pipeline might be out of action for cleaning purposes or repairs. A second reservoir, rather larger than that built in 1890, and immediately above it, was therefore constructed; and, as a result of a serious epidemic of cattle diseases, orders were issued that all animals in cantonments were in future to be watered from the piped supply. This reservoir cost 1 lakh to construct.

By 1900 the situation had again become serious. The population in cantonments had nearly doubled during the preceding ten years, while, as a result partly of increased demand, and partly of reduced flow in the main (this had dropped to 6 lakhs-gallons per day as a result of the combined action of normal corrosion, of lime deposits on the intruded portions of the cement joints, and of leakage past these cement joints), the distribution supply during the summer months, when demands were at a maximum, was only intermittent, and probably for not more than 8 hours a day, while it was cut off altogether at night.

The Enteric Commission of 1898 had insisted that a continuous

supply was essential and, in 1903, a second 7″ main was therefore laid, closely paralleling the first, and a third reservoir, holding just under 5 lakhs of gallons, was constructed at the same time, on the western fringe of cantonments. This second 7″ main and third reservoir cost together about 3½ lakhs of rupees.

The population of the cantonment expanded still farther, between 1903–8, under the Kitchener Reorganization Scheme and as a result of the construction of the Staff College. Two further small reservoirs were therefore added to the system, one to feed the Staff College area, and the other certain new lines situated at too high a level to be fed from any other reservoir. These two reservoirs with their distribution systems cost about 1½ lakhs.

It should be noted that the whole system is a gravity one, there being a steady fall from Urak to Quetta of about 1,050 feet and a further 400 to 500 feet from the top to the bottom of Quetta itself.

In 1915 certain changes were made in the distribution system, and the first reservoir constructed was definitely handed over to the municipality for the sole use of that body and the railway.

The reservoirs were now named, in the order of construction :

The Municipal Reservoir.
The Old Cantonment Reservoir.
The New Cantonment Reservoir.
The Staff College Reservoir.
The Gurkha Reservoir.

Despite this additional storage capacity, from 1916 onwards supply had again to be cut off during the summer months, for many hours out of the twenty-four, and by 1920 the two 7″ mains together only brought in about 10 lakhs of gallons a day, while the reasonable requirements were 30% higher than this. A recommendation was put forward that a 12″ main should, therefore, be laid from Urak to take the place of the two 7″ mains. After considerable discussion the proposal was agreed to, and owing to the relative cheapness, at that time, of Hume concrete pipe made in India as compared with cast-iron, it was decided to adopt the former for the new main, using cast-iron only where the line crossed the more important *nullahs*.

Hume pipe was no doubt cheap in the first instance, but it is extraordinarily vulnerable if laid near the surface, and although apparently intended to stand a head of 50 feet of water, even after it had been laid many years, it sweated in places under heads of 15 to 20 feet and sometimes burst under heads much below 50 feet. It has one great advantage : it does not corrode. Pressure relief valves were fitted at different points in the line, so as to minimize the risk of burst should the outlet valve at Quetta be inadvertently closed, or should an obstruction get into the pipe. These valves have proved their value time and again. Many times also at the

nullah crossings, where cast-iron pipe was not laid, severe spates washed out and smashed the Hume pipe to pieces—the phenomenal spate of July, 1930, tearing it out thus in three separate places, several miles apart, and forcing so much shingle and rubbish into the broken ends at the various breaches that when water was eventually turned on again the pipe burst again in dozens more places. For over a week the water-supply staff wrestled with it night and day before a proper supply was again obtained. Making joints in Hume pipes, with water in the pipe or in the trench round it, is extraordinarily difficult, as any who have tried it will know. Two tips are perhaps worth passing on : 5% to 10% of common washing soda enormously speeds up the setting of cement, if well mixed with it, and although small pinholes are left, they seal themselves in a few days. Washing soda can always be obtained. Much better than washing soda, however, is a preparation known as *sika*, of which there are several brands. The writer only came across this material in 1931, after many inquiries—as a leak-stopper it has truly remarkable properties and the Quetta water-supply staff will never be without a stock in future.

The very severe earthquake shocks which shook Quetta in August–September, 1931, found out a lot of weak points in the pipeline, but beyond causing numerous leaks, some of which took weeks to find, did surprisingly little real damage. Had the main line of shock been across instead of straight down the pipeline, no doubt matters would have been very different.

Between 1921–23, for about 11 lakhs of rupees, the new concrete main was laid, the sedimentation reservoir at Urak properly lined, and a new 20-lakh-gallons storage reservoir built at Quetta.

Now the capacity of the new 12″ main was considerably more than that of the two 7″ mains combined. Its capacity was calculated as a maximum of 28 lakhs of gallons per day—as a matter of fact the calculation appears to have been wrong, being based no doubt upon the frictional resistance and length and fall available between Urak and Quetta—whereas it should have been calculated on the basis of the maximum discharge of a long 12″ pipe flowing full, but this was not found out for some years. It is doubtful if at any time before 1930, when certain alterations, referred to later on, were made at the head works, the 12″ main ever carried more than 22 lakhs per day, and by 1929 the flow had fallen to 19 lakhs per day or lower.

The very considerable increase in the amount of water taken to Quetta by the 12″, as opposed to the two 7″ mains, called for a searching examination into the total amount available, and how this could most equitably be divided, without causing hardship to the villagers and *Zamindars* whose livelihood depended upon their water supply. In the end, a *Jirgah* was held in May, 1922, at which it was decided that the military should have the right, in perpetuity, to

take to Quetta 28 lakhs of gallons per day, *or* what a 12″ main would carry, the balance being reserved for the use of the villagers—with the proviso that when the total flow in the stream fell below 30 lakhs a definite minimum was always guaranteed to the villagers. Seeing that the 12″ pipe could apparently only carry 22 lakhs per day, despite its calculated theoretical capacity of 28 lakhs, this limit of 28 lakhs imposed seemed to cover all contingencies, but it is very fortunate indeed that in the wording of the agreement the alternative "*or* what a 12″ main will carry" was inserted, as the sequel will show.

The laying of the 12″ main occupied some time and, in view of the rocky nature of the country traversed, the gradient to which it is laid is by no means uniform. In places the pipe is actually above the ground surface, merely protected by a bank of stones; at others, 15 feet or even more below ground, and for a stretch of half a mile, 40 to 50 feet below the hydraulic gradient;* six major *nullah* beds had to be crossed, all liable to sudden spates, but only three were considered to be sufficiently dangerous to warrant cast-iron sections.

With the 12″ main in use, the two 7″ mains were not allowed to be used, and it was proposed to dig them up. Mercifully, wiser counsels prevailed and they were left in as stand-bys. Had this not been done there would have been water famines on several occasions when the Hume pipe was broken by spates and the 7″ mains remained the only sources of supply. Although the population both in cantonments and the city had been steadily increasing, the situation from a water-supply point of view, with the 12″ main and the new storage reservoir, appeared to be quite secure, but this apparent security was very short-lived. By 1927 it had again become necessary to turn off the piped water-supply for as much as 16 hours out of the 24 during the summer, and since irrigation water for gardens (it will be recollected that it practically never rains in Quetta) was also deficient and not particularly well controlled, bungalow occupiers not unnaturally developed the habit of leaving taps turned on, in the hopes of collecting any water that might be going. To prevent such irregular consumption of water was, of course, the principal reason for turning the water off at night. In 1928, an evening entertainment was given at the Army Commander's house and, as a special case, water was left turned on a few hours later than usual, with the result that, since all garden taps were open all over Quetta, reservoirs were practically emptied. Exactly the same thing happened in 1929, when a theatre in cantonments caught fire and water had to be turned on for the fire engine to use.

By this date, 1929, the total summer requirements of cantonments, city and railway, for a full 24 hours' supply, had risen to 30 lakhs of

* 300 yds. of this were relaid with cast-iron pipe in 1931, when the new reservoir was built.

gallons daily, while the flow in the 12″ main had fallen as low as 19 to 20 lakhs, and the total capacity of all the reservoirs in Quetta was only a little over 40 lakhs of gallons. Population in the city (in the summer) had risen to 60,000, while that in cantonments was between 25,000 and 30,000, giving a total increase of 600% since the first 7″ main was laid in 1890.

For many months during the summer of 1929, despite the strictest economy and orders prohibiting the use of piped water for gardens, it was only possible to maintain an intermittent supply for 8 to 10 hours out of the 24, and that often at a very low pressure in the higher situated areas, due to persistent low levels in the reservoirs. Air locks were naturally frequent and maintenance costs went up by leaps and bounds. Obviously something drastic had to be done and done quickly. Unfortunately the M.E.S. had its hands already overfull, and it was not until the autumn that it was possible to tackle the problem seriously. Certain alterations were, however, made in the internal distribution system, so as to obtain direct independent control of all reservoirs, enabling what water was available to be delivered direct to the areas where it was most required, instead of it having to be sent through one reservoir to the next.

It will be remembered that when the 12″ Hume pipe was laid, its maximum capacity was calculated to be 28 lakhs of gallons per day, and the agreement with the *Zamindars* allowed this amount (*or* what a 12″ main will carry) to be taken through the pipe to Quetta. Actually, less than 20 lakhs were now reaching Quetta, and investigation of the flow at various points in the Hume pipe showed that nowhere was it running full. Obviously, then, there was something wrong at the intake end. Now when the Hume pipe was laid in 1921–23, it was not carried right up to the intake but stopped about 350 yards short of it, from which point, to the actual intake, there already existed an old cast-iron pipe, put in when the first 7″ cast-iron main was laid. This pipe was of a nominal 12″ diameter, but test holes drilled in it showed that, as a result of corrosion and incrustation, the effective internal diameter was barely 11″ and the inside surface as rough as a barnacled rock. Again, the joints in it were also made with cement (as it will be remembered were those of the first 7″ C.I. main), which certainly at one point intruded over an inch into the pipe, and many joints leaked badly as a result of strains set up by earthquake shocks.

It was, therefore, quite clear that sufficient water was not being delivered to the end of the Hume pipe to fill it. Another temporary feed, with additional head, was superimposed upon the Hume pipe, and measurements at Quetta showed that the daily flow was thereby raised at once from 19 to 28 lakhs, a very great improvement. The temporary connection could not be left on, for various reasons, among them since it prevented either 7″ main being used or the

intake chambers at the headworks being washed out. Sanction was therefore given to relay the 350 yards from the Hume pipe end to the intake and, since the work involved both tunnelling and blasting through excessively hard rock, it was decided to relay the section with a 13″ rather than a 12″ pipe so as to neutralize the effect of corrosion, and indefinitely to postpone the need for a further renewal.

At the same time it was further decided that the intake headworks should be remodelled, the head of the draw-off channel carried farther upstream, so as to increase the static head on the main, and the intake chamber duplicated, so that there would be no interference with the flow when the chamber was cleaned out. It, and the screens in it, required cleaning out at least once in ten days, and while cleaning was taking place (it took 6 to 8 hours) no water could be turned into the main from the headworks at all.

All these alterations and improvements were completed by the summer of 1930, with remarkable results. The maximum flow in the 12″ Hume pipe was raised to just over 34½ lakhs, over 20% above its supposed theoretical maximum capacity. As pointed out earlier, however, this theoretical capacity was wrongly calculated—the formula which should have been used was :—

$$V = 140\sqrt{rs} - 11^3\sqrt{rs}$$

where V = Velocity in feet per second.

r = Hydraulic mean depth = Area of wet cross-section divided by wet perimeter = $\frac{d}{4}$ in this case for a full pipe.

s = sine of inclination ;

which, for a fall of 1,033 feet in 49,000 feet, gives for a 12″ pipe a maximum capacity of 34·7 lakhs, as opposed to 28 lakhs obtained from the other formula for discharge in a short 12″ pipe for a given head and length.

The maximum capacity of the pipe had therefore been reached, and for the first time it was possible to bring into Quetta more water in 24 hours than the maximum demand. Only with such a balance of supply over demand can the supply in a main, liable, without warning, to be interfered with by spates and not infrequent bursts, be considered safe.

Two further important items in the system as a whole still required to be put right. Firstly, the only means of communication between Quetta and the headworks at Urak was the road. In times of spate this was invariably breached at one or more places, and for hours together was impassable even on foot, while the pipeline as often as not was also breached. Secondly, the total water-storage capacity

in Quetta was still only about 40 lakhs of gallons. Sanction was therefore obtained for a telephone between Urak and Quetta, and this was installed in the autumn of 1930, connecting up the headworks with the offices of the G.E. and of the S.D.O. water-supply, the storage reservoir and the municipal reservoir. At the latter there was a post-office telephone which enabled the *Chowkidar* to communicate with the G.E. at his bungalow after office hours. Plug-in points, similar to those on a rifle range, were provided at three intermediate points on the line in the immediate vicinity of particularly bad *nullah* crossings, where breaches in the 12″ main or road had occurred in the past, or might be expected in the future. The telephone has already fully proved its value. It halved the time which would otherwise have been required for repairs during the one serious breach in the 12″ main, in July, 1931, and showed very clearly that had it been installed before the phenomenal spate of July, 1930, it would have been of untold value to the water-supply staff. They were obliged, as noticed earlier, to work night and day for over a week before normal conditions were restored, and could only keep in touch with Urak and Quetta by messengers, partly on foot and partly on bicycles. The telephone is in daily use now between headworks and Quetta.

The second point, additional storage capacity, presented a much bigger problem. Sound water-supply practice recognizes that in water-supply systems, such as that of Quetta, storage capacity must provide for a reserve of at least three days' maximum demand. The urgent need of additional storage capacity was therefore represented to, and accepted by, the Government of India. In 1931 they sanctioned the construction of an additional storage reservoir for water at Quetta and allotted 2½ lakhs for the purpose. The deficiency in storage capacity was about 60 lakhs of gallons and this figure was adopted as the basis for calculations and estimates.

The obvious site for the new reservoir was immediately on the Urak side of (*i.e.*, above) the existing storage reservoir, and test wells sunk 20 feet showed that the soil was a mixture of shingle, boulders anything up to two feet in diameter, and patches of very hard, conglomerate rock. To allow for the minimum of masonry, which is expensive as compared with excavation in Baluchistan, and of an outlet at a depth convenient for connection to the outlet from the existing reservoir, a depth of water of about 16 to 18 feet was the maximum obtainable.

The original idea was to construct the main outside walls as retaining walls with a vertical or nearly vertical inside face, and an outside batter. Because of the very hard nature of the soil this view was, however, changed, and it was decided to construct the outside walls at a slope of 45° so that the necessity of retaining action disappeared. This, of course, added considerably to the top area

of the reservoir, but on balance more than what was lost in extra roof cost was gained in a saving on masonry.

After construction had actually commenced this view was somewhat modified, and it was decided to raise the invert of the floor level about seven feet. This resulted in bringing the top of the reservoir on half of the two short sides, and the whole of one long side, up to seven feet above ground level, which sloped across the site, and meant that parts of these outer walls had to act as retaining walls after all. Moreover, since the reservoir was to be brought into use long before the filling behind these walls would solidify, they were calculated for stability both against water pressure on the inside and loose earth pressure (by Rankine's theory) from the outside.

The 12" Hume pipe, about three-quarters of a mile on the Urak side of the reservoir, had, to avoid side-long cutting on a steep scarp, been originally laid so that it was considerably below the hydraulic gradient. The raising of the level of the floor of the new reservoir also, of course, raised its intake level, and by still further lowering the 12" main at the point in question below the hydraulic gradient, subjected it to a head of very nearly 50 feet. It was not reasonable to expect the Hume pipe to stand this strain all the time, and it was decided to relay about 1,200 feet in cast-iron, so as to avoid any danger from this pressure. As a matter of interest, before the cast-iron pipe was connected up, water was turned through the Hume pipe into the new reservoir, and after a very few minutes' run the Hume pipe at the lowest point burst with a report like a cannon. The decision to relay the danger section in cast-iron was, therefore, amply justified.

The general details of the construction of the reservoir are shown on the plans at the end of this article and the photographs accompanying it, but since it embodied a number of rather novel points, some explanation of these details is desirable.

It will be seen that the reservoir is divided into three chambers, two called " Main " and one " Spate " chambers. It will be realized that the two main chambers merely divide up the reservoir so that water can be sedimented or the chambers cleaned one at a time, without emptying the whole of the reservoir. The purpose of the " spate " chamber will not be so obvious.

It has been noted earlier that spates down the *nullahs* in Baluchistan occur with alarming suddenness and although they may only last for three to four hours they bring down so much dirt and dust that water remains far too dirty to be turned into the main at Urak, generally for six to eight hours at a time, and occasionally for even longer. During these periods the water has always in the past been run to waste at Urak, since if it had been turned into the main it would, owing to lack of sedimentation facilities, merely have deposited tons of silt in all the reservoirs in Quetta and kept the water

dirty for days. This waste of water will in future be avoided by use of the spate chamber as follows.

The moment a spate is imminent, indicated by the presence of clouds over the valley, the *Chowkidar* at Urak will telephone to the *Chowkidar* at Quetta, who will empty the spate chamber, if there is any water in it, into a service reservoir, but normally during spate periods it will be kept empty. Spates very rarely occur more than once a week and only between mid-December and mid-February or mid-June and mid-August. He will have about five or six hours to do this in; three hours from cloudburst on the hills to the time water reaches Urak, an hour during which it is too dirty to be collected and two hours for its flow down the pipe from Urak to Quetta. As soon as the dirty spate water arrives, he will turn it into the spate chamber. When this is full (it holds about nine hours' full flow of the 12″ main), or the water is again clear, he will turn water back into the main chambers and allow that in the spate chamber to settle, which it will do in 12 to 36 hours, run the water off into service reservoirs, and wash out the spate chamber to be ready for the next spate.

Considerable attention was paid to the design of the heavy partition walls separating the three chambers. At first solid masonry walls were favoured, then careful examination was given to the possibility of building reinforced concrete walls of a cantilever (foot) type. Any walls of a gravity section displaced much useful water. The R.C. design was, however, abandoned, partly in view of expense, and partly owing to the difficulty of carrying out extensive R.C. work really satisfactorily with the labour (unskilled Pathans) available.

Finally, a gravity section of a composite type was decided upon, the skin being B.B.* in cement, each successive 25 courses of the skin on either face forming a retaining wall, calculated to hold up the pressure from the inside, during construction, of the wet plum-lime concrete core. The finished composite wall, which was to be plastered over to give greater waterproofness, being of a gravity section as shown, was calculated to stand water pressure alternately on either face, there being no water pressure on the other. The width and depth of the foundations of these walls were calculated so as to equalize the pressure from the wall or the water on the ground below either. The enormous number of boulders of all sizes and shingle produced during excavation was the deciding factor in the selection of this composite wall, as opposed to one of solid masonry.

The longitudinal walls, 8′ high and 1′ 6″ thick, were introduced as an extra safeguard, acting as buttresses dividing up what would otherwise have been a very long wall. Earthquake shocks are not infrequent in Baluchistan. Actually, the severest shocks ever felt in

* Burnt brick.

Quetta occurred during construction of the reservoir, in August and September, 1931, but did practically no damage to the reservoir.

Another point which called for considerable study was the best method of rendering the reservoir watertight.

Two to three inches of cement concrete over lime concrete, over the whole area was first considered, but discarded in view of the certainty of cracks due to expansion and contraction. Next a layer of pitch was considered. This, however, was also discarded in view of the difficulty of laying it in the very high temperatures which would be met with during the summer. Such heat would hinder the setting on the sloping sides.

Finally, it was decided to use Flintcote, a bitumen emulsion unaffected by heat or cold, the waterproofing layer of Flintcote to be laid over the lime concrete foundation, and itself be protected from wear by a skin of B.B.* on edge in cement.

For those readers of this article who may not be familiar with Flintcote, details of the two qualities used, the method of laying, etc., are given as an Appendix to this article.

As far as possible all sharp corners and angles were eliminated in the design. The four main outside corners from top to bottom, and the whole of the joint all round between side walls and floor, were to be made of cement concrete reinforced with No. 9 B.R.C. fabric, Pudlo being worked into the top face as it was finally smoothed out. The whole of the walls (side and partition) were to be plastered with cement plaster with which, with the object of avoiding cracks, very fine pea-gravel was mixed, with most successful results. The brickwork of the floor, which was to be given an extra coat of Flintcote, and the size of whose unbroken areas made expansion cracks in plaster almost inevitable, was to be pointed with 1 : 3 cement mortar.

A common outlet valve-tower was to be provided, with a double set of valves, for the outlet, wash-out, and overflow (led into the wash-out pipe) of the "spate" and central chambers, a separate valve-tower being built for the other main chamber. The wash-out pipes were to be led through a break-pressure tank to a neighbouring irrigation channel.

The inlet valve-house, common to all chambers, was to be provided on the side opposite the outlet (the floors of the chambers being graded towards their respective outlets), and three separate 18″ valves, made up locally from old valve spindles, sheet iron and sheet rubber, were to control the flow from the entering 12″ pipe to the three different chambers. "Salmon ladder" weirs of brick, faced with concrete, were provided to break the fall of the water into each chamber.

The roof was to be a simple design of curved, 18-gauge C.G.I. sheets

* Burnt brick.

carried on light, curved, angle trusses resting on R.S.J's, which were to be free to slide longitudinally on the brick pillars which carried them.

Further details can be seen from the drawings and photographs.

Work started towards the end of March, 1931, just after the snow had melted, and for three months hundreds of men and donkeys toiled at the excavation, steam shovels and such-like luxuries being unknown in Baluchistan.

As soon as the excavation was complete, including the extra footings for the partition walls, longitudinal walls and roof-supporting pillars, the lime concrete was poured and rammed over the whole floor, slopes being left on either side of the footings of the main partition walls, so that the brick casing could easily be set at the proper batter.

Next, while the concrete on the 45° sloping side walls was being laid, the Flintcote layers were spread on the floor (for details see the Appendix). It will be noted that for greater safety this Flintcote was carried right under the main partition walls and, of course, under longitudinal walls and pillar bases and right up the sides, care being taken that an unbroken Flintcote skin passed under the junction of the longitudinal walls with the side walls. Then, simultaneously, the masonry and plum concrete of the main partition walls and a strip of brick floor round the outer edge of each chamber in succession were laid. This strip formed an anchor against which the bottom edge of the reinforced concrete curve was next laid; two widths of B.R.C. fabric were used, giving a total curve of about 12 feet. Despite the very considerable lengths involved, not a single crack developed in any one of these curves.

Next, brickwork proceeded over all the floors and up the sides, which latter had in the meantime received their Flintcote layer. Pillars and partition walls were rapidly built, as also the reinforced concrete main corners. Plastering was carried over the surfaces shown in the drawing as soon as they were ready to receive it.

At the end of August and beginning of September, a number of earthquake shocks, several really severe, occurred in Quetta, but while in the lower part of cantonments and in the city a great deal of damage was done, the reservoir came off practically scathless, much to everyone's relief.

The floor joints were next raked out and pointed with 1 : 3 cement mortar and the floor kept covered with two to three inches of water for a week or so. A certain number of contraction cracks appeared in the plaster and after the roof was on patches were cut out and replastered, but on the whole such cracks were much less than might have been expected and none was really serious. Meanwhile, pipe work had been going on rapidly, and angles for the roof bent to template. The whole of the trusswork of the roof was thrown up

with no more plant than two 30′ spars and two pulley blocks in ten days, while all the sheeting was set in place and clipped down in just under a fortnight, which speaks well for the Pathan contractor to whom the job had been let, seeing that the area covered was over an acre and a half. All sheets had been ordered from the manufacturers, bent to the proper offset which, of course, saved a great deal of time during erection. Special attention was necessary at the points at which the outlet and wash-out pipes passed through the side walls. The pipe trenches, partly excavated, had formed the means of access to and egress from the reservoir throughout construction. This meant that the partition wall between the centre and spate chambers could not be built into the outer wall close to the outlet valve-house until the pipes were laid and the entrance to the reservoir closed. A solid cement-concrete block was therefore keyed into the broken ends of the side walls in continuation of the faces on either side, and the partition wall keyed into this concrete block at the same time. The joint between the main piece of the partition wall, which had been standing for many weeks, and the new short length was reinforced with lengths of steel rails, so as to give added strength to the joint.

As part of the project, an up-to-date chloronome (Patterson's Manometer type) was installed on the common outlet from the old and new storage reservoirs, to take the place of an extremely *kachā* chlorinating apparatus which had been used in the past. A Venturi recording meter was also fitted to this outlet at the same time, so as to provide a really accurate means of recording water consumption. Hitherto, reliance had had to be placed upon a far from satisfactory empirical formula based upon daily readings of reservoir depths and the number of turns certain valves were opened.

The installation of the chloronome and Venturi meter in their small house, and finishing touches to the various component parts of the job and the dressing of the earth banks surrounding it, leaving a clear passage 20′ wide all round the reservoir, occupied some little time, but the completed reservoir was taken into use in November, something less than eight months after the work had been started, but not before hard winter frosts had already set in. The total cost worked out at just 2½ lakhs of rupees, which, for a total volume of rather over 55 lakhs of gallons, works out at about ·7 of an anna per gallon, almost exactly half the cost per gallon of the first storage reservoir built in 1922.

All the excavation, brickwork, plastering and ironwork was done by contract, while all the specially skilled work, such as reinforced concrete, Flintcote and pipework, was carried out departmentally, so as to allow of more direct supervision.

APPENDIX.

NOTES ON FLINTCOTE AND METHOD OF LAYING SAME.

FLINTCOTE is the trade name applied to a group of asphalt emulsions made of dispersions of selected grades of asphalt in water, held in suspension by a small percentage of a mineral colloid.

There are three main classes in the group :—

(i) Straight emulsions, containing no fibre and used as paints.
(ii) Emulsions containing 4% by weight of wool fibre.
(iii) Emulsions containing 17% by weight of asbestos fibre.

The two last are used as plasters.

Each class is again subdivided into two : (*a*) those made from a hard bitumen, (*b*) those made from a soft bitumen, hard bitumens being used where there is likely to be much wear upon an unprotected Flintcote surface, and soft ones elsewhere. As trade references, the prefix F is used for hard bitumen emulsions and C for soft, while the suffix H.P.C. (hard paint consistency) is used for the straight emulsions, and F or A for the emulsions containing wool or asbestos fibre respectively. The two classes used on the Quetta reservoir were C.13 H.P.C., that is, a straight emulsion made from a comparatively soft bitumen, and F.13 A, that is, an emulsion made from a hard bitumen and containing asbestos fibre.

Once the correct method of mixing and laying has been worked out for the local conditions involved Flintcote is extremely easy to lay, far easier than any hot asphalt preparation. It contains nothing that can cause injury to workmen. If hands (and feet in India) are kept moist and washed before the Flintcote dries on them none will adhere. If allowed to dry, kerosene will at once remove it.

Once the water content has dried out the resultant asphalt is entirely impervious to heat or cold ; the writer applied a naked flame for some time direct to a vertical Flintcote surface, but it did not " run." On the other hand, the emulsion as delivered in barrels contains a certain percentage of water and must be protected from severe frost. If the mixture freezes the emulsion will break down and be rendered useless. Flintcote is applied cold, and only requires clean water for its dilution ; it adheres firmly to any surface, wood, brick, iron, lime plaster, cement, glass, etc., wet or dry ; it is unaffected by water, acids or corrosive gases and mixes very easily with cement and sand for plastering work. One word of warning is necessary, however; on no account must oil in any quantity be allowed to come in contact with it. It should, therefore, never be used as a top dressing for garage floors or other places where much oil may drop upon it.

The best means of explaining how to use it will be to describe exactly what was done in the case of the Quetta reservoir. A reference to the

drawings showing the sections of the reservoir will show that a thick layer of lime and shingle concrete was first laid and well rammed over the floor and sloping sides, extra depth being given under partition walls, longitudinal walls and pillars supporting the roof.

Preparation of Surface. The surface of this lime concrete was first swept thoroughly clean and then completely plastered over with a thin layer of lime plaster, so as to obtain a perfectly smooth surface and one which was not too "hungry." In the case of comparatively small surfaces, it should be possible by using a small excess of mortar in the lime concrete to obtain the desired smoothness, but in the case under notice there was much going and coming, tending to break up the surface; we were dealing with an area of about 1¾ acres and, moreover, we were working in intense heat. This layer of plaster considerably reduced the quantity of Flintcote that would otherwise have been necessary. For ease in laying the Flintcote evenly, the surface to be treated was next divided up into 100 sq. ft. areas.

Priming Coat. A measured quantity of Flintcote C.13 H.P.C. was then poured into a home-made churn, shown in Photo No. 5, and thoroughly mixed with 75% to 80% of its volume of clean water. The normal specification lays down 20% of clean water, but so great was the heat and so rapid the evaporation that 20% was found much too little and at times in the middle of the day even 80% was not enough. Besides being really hot in the summer, Quetta, owing to the absence of rain or cloud, is also abnormally dry. A little water was then sprinkled over the lime concrete surface (in much the same way as for Colas dressing on a road) and the priming coat of diluted C.13 H.P.C. was then poured on to, and brushed over, the surface with long-handled brooms, so that the surface was completely covered, about 1 gallon C.13 H.P.C. per 100 sq. ft. being applied. See Photo No. 7.

Membrane. In order to give a greater strength to the Flintcote layer, a loosely-woven, unbleached cotton fabric was laid over the priming coat. This fabric was delivered from the mills in Bombay in bales of some hundreds of yards in length and six feet in width. Having a marked tendency to shrink, sufficient fabric (or membrane) for a full day's work was placed overnight in a large tank containing a 5% solution in water of C.13 H.P.C., wrung out immediately before use and rolled on to a long spindle, on a home-made apparatus like a gigantic bandage roller. The spindle can be seen in Photo No. 6. The amount of shrinkage amounted to about three inches in the six-foot width. While the priming coat was still wet, the membrane was rolled out over it (the process can be clearly seen in Photo No. 6), and pressed down by hand until it firmly adhered to the Flintcote.

Second Coat. At once a second coat of C.13 H.P.C., diluted with about 50% of clean water (normal specification says "neat," but the heat and evaporation referred to above made this dilution essential) at the rate of 2 gallons of C.13 H.P.C. to 100 sq. ft., was poured and brushed on in exactly the same way, care being taken to ensure a smooth and even coat. With a little practice, even the most unskilled Pathan coolie became quite expert, and though at first it was not possible to keep the amounts down to the right quantity per 100 sq. ft., the right proportions

were very soon worked to. Each width of membrane was given an overlap of about three inches over its neighbour to ensure a complete cover.

Setting. The surface, now covered with what looked for all the world like black Willesden canvas firmly stuck down, was kept thoroughly wet for 36 hours and then allowed to dry.

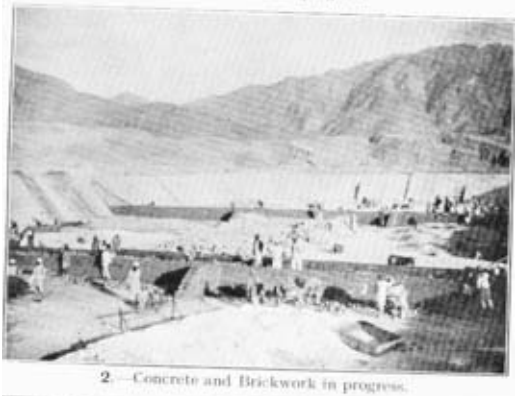
Plaster Coat. After the 36 hours' setting time for the C.13 H.P.C. coats had elapsed, the surface was again sprinkled with water and then plastered over with a plaster composed of 1 volume of cement, 2 volumes of clean water and 6 volumes of F.13 A Flintcote, thoroughly mixed together before being laid. It was found by experience that the best way to mix it was to fill a Flintcote drum to a depth of about a foot, with the proper proportions of ingredients and for a coolie then to "tread" it, until it was thoroughly mixed. The quantity mixed at any one time depended upon the number of plasterers at work; the whole quantity had to be tooled on to the membrane surface before the cement began to set. The thickness of the plaster applied was about 1/32" to 1/16", this thickness requiring the use of 3 gallons of F.13 A to 100 sq. ft. Photo No. 8 shows the Flintcote plasterers at work. Just as in the case of the C.13 H.P.C., so also in the case of the F.13 A plaster; the surface must be kept wet for 36 hours, to allow of complete setting taking place. It will be appreciated that with such an extensive area to be treated joints between one day's work and the next were unavoidable, and where such joints had to be made, a fresh coat of C.13 H.P.C. was given, to ensure a perfect bond.

After the 36 hours had elapsed the B.B. on edge in cement floor was laid over the Flintcote, great care being taken not to damage the Flintcote surface during the process. Bricks had to be laid down gently and not dropped, and all workmen were deprived of their boots.

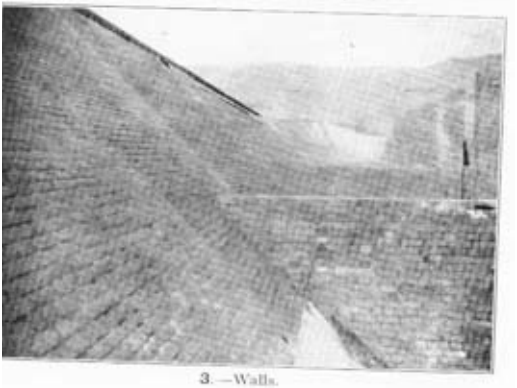
It will be seen that with a little organization it was quite possible to have gangs working on C.13 H.P.C., F.13 A and brickwork simultaneously, following each other at 36 hours' intervals.

Labour charges for the whole process worked out at rather less than rupees 2 per 100 sq. ft.: the Flintcote cost rupees 3 per gallon; membrane, annas 4 per yard run; and cement, rupees 3 annas 8 per cwt. Costs of material in England would no doubt be less, the freight charges to Quetta being enormous; but labour rates would probably be higher.

1.—Excavation in progress.



2.—Concrete and Brickwork in progress.



3.—Walls.

Quetta water supply 1-3

4.—Roof Pillars and Floor.

5.—Mixing in home-made Churn.

6.—Laying the Cotton Membrane.

Quetta water supply 4-6

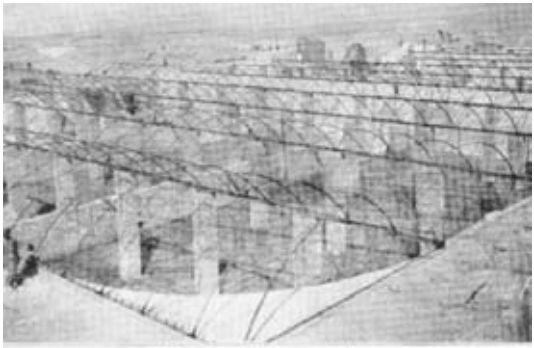
7.—Applying "Flintcote" Work on Corners.

8.—Plastering Side Wall.

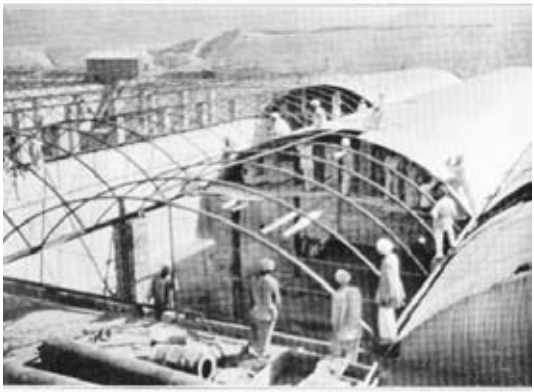
9.—Plastering Side Wall.

(N.B.—Not two photos on one film, but the effect of an earthquake tremor during exposure of film.)

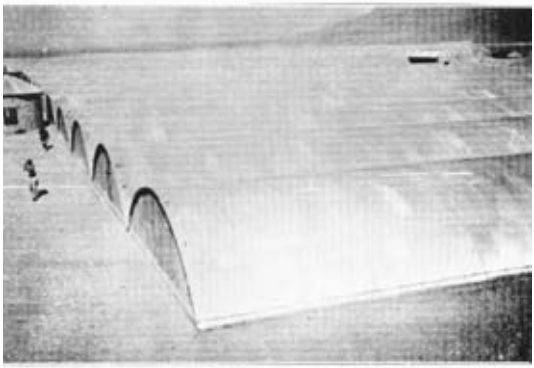
Quetta water supply 7-9.



10.—Roof Girders and Trusses.



11.—Laying Roof Sheeting.



12.—The Reservoir completed.

Quetta water supply 10-12

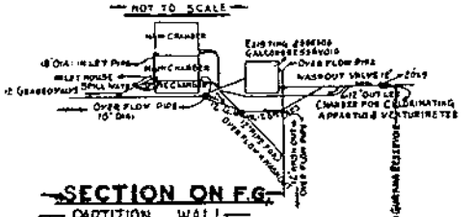
QUETTA

NEW STORAGE RESERVOIR

CAPACITY (APPROX.) 60,00,000 GALLONS

DIAGRAM SHOWING PIPE CONNECTION FOR 6000000 GALLON RESERVOIR

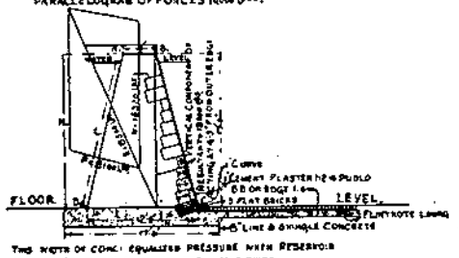
NOT TO SCALE



SECTION ON F.G.

PARTITION WALL

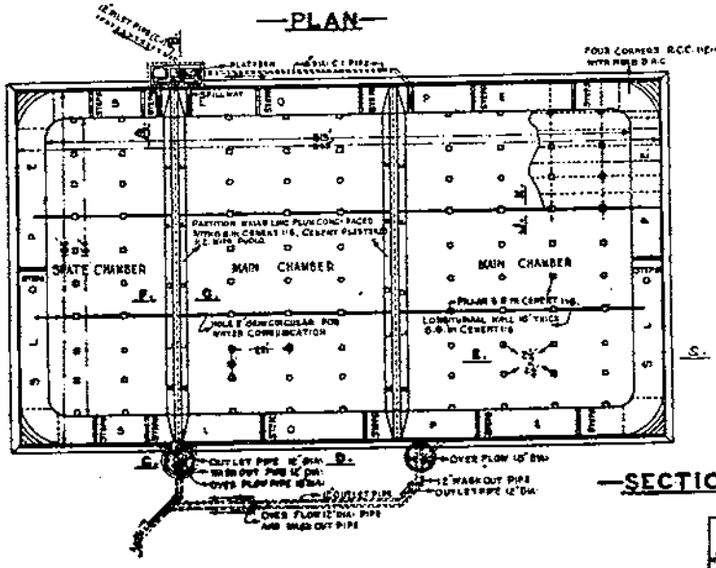
PLUM LINE CONC: FACED WITH B.B IN CEMENT AND PLASTERED WITH CEMENT PLASTER 1:2 WITH PUDLO



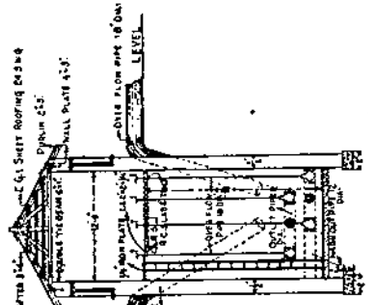
THIS NOTE OF CONC: EQUALIZES PRESSURE WHEN RESERVOIR IS FULL. RESULTANT IS WITHIN THE MIDDLE THIRD

N.B. CEMENT OF PLUM LINE CONC: OR BRICK WORK IN CEMENT = 1CB FT OF CFT

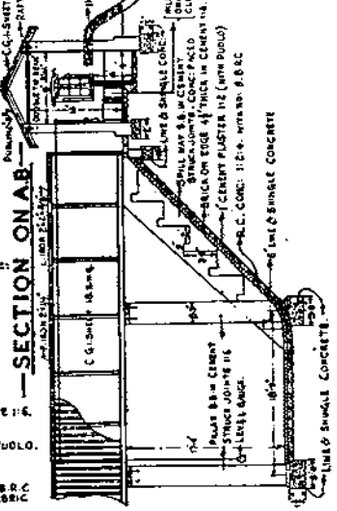
PLAN



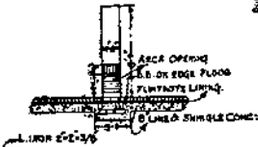
SECTION ON C.D



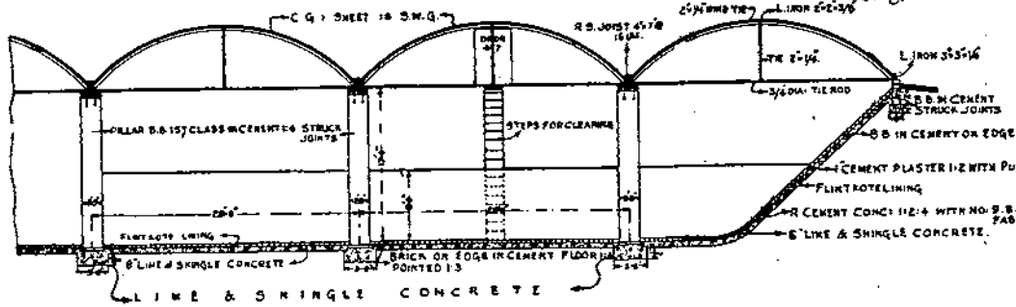
SECTION ON J.K



SECTION ON A.B



SECTION ON E.S



L. Mauleverer
MAJOR R.E
GARRISON ENGINEER QUETTA
3-11-31

PRAN NATH D'MAR.
DRNG. ... 8-11-31

HISTORY OF THE 7th FIELD COMPANY, R.E., DURING THE WAR, 1914–1918.

With a short Record of the Movements and Campaigns since the Formation of the Company.

By CAPTAIN H. A. BAKER, M.C., R.E.

(*Concluded.*)

CHAPTER VII.

THREE RETREATS—THE SOMME, THE LYS, THE AISNE (MARCH TO JUNE, 1918).

MOVE TO EAST OF AMIENS (23RD FEBRUARY TO 20TH MARCH).

Maps II and VIII.

THE 50th Division was relieved on the Passchendaele Sector by the 23rd Division on the 23rd February, and moved to the Wizernes area south of St. Omer, where it formed part of G.H.Q. Reserve. Two sections of the 7th Company were detached on the 1st March for work on the 5th Army Musketry School at Nortbécourt.

On the 10th March the Division moved to the area about Moreuil on the River Avre, 12 m. south-west of Amiens. The 7th Company entrained at St. Omer at noon, detrained at Moreuil at 1 a.m. on the 11th and marched to Fresnoy-en-Chaussée, where it remained till the 16th, when it moved by bus to Monchy Lagache (24 m.) for work under the C.R.E. XIX. Corps troops, with working parties of Italians on the "Green Line" defences in the neighbourhood of Tertry. This was the most retired reserve line in the 5th Army area and was only partially excavated and wired. The Company was so employed until the 21st March, when the 50th Division was moved hurriedly up to occupy these defences which formed part of the Péronne bridgehead.

The Somme Retreat (*21st to 31st March*).

The great German attack on the 4th and 5th Armies commenced at dawn on 21st March, as had been expected for some days. Much aided by thick mists, which just suited the new infiltration tactics of the Germans, it progressed rapidly on the thinly held front of the 5th Army. The 50th Division, forming part of the G.H.Q. reserve, was pushed up by train and march route to the neighbourhood of Beaumetz and, during the night of the 21st/22nd, proceeded to

occupy a part of the incomplete "Brown Line," which was here only spitlocked 6 in. deep and thinly wired. The 7th Company was affiliated to the 149th Brigade temporarily (H.Q. Tertry) with orders to keep two sections in reserve at C.R.E.'s disposal.

At 3 p.m., 2 and 3 Sections went up to assist the infantry in improving their defences in the Brown Line north-east of Coulaincourt. The enemy could already be seen advancing in the distance, but the work was completed by 5 p.m. and the half-company withdrew to Coulaincourt, where they received orders from the infantry commander on the spot to hold the village against a threatened attack by enemy cavalry. At 6.15 the enemy infantry attacked from the north-east and east. At 6.25 the troops holding the line on the right and in the north of the village were forced back and the half-company was obliged to retire in conformity. As the Company left the village, enemy snipers entered and caused several casualties, including 2nd-Lieut. H. A. Benson, Serjt. J. Farrer, M.M., and four sappers.

On arriving at Tertry they were reformed under Major Baker and by order of the B.G. commanding 149th Brigade dug and held a series of posts on the bank of the River Omignon, covering the east of Tertry. Brigade H.Q. turned out every man for the defence of H.Q. but no attack developed.

At 2 a.m. on the 23rd, orders were received from Brigade to form a flankguard in rear of 5th Northumberland Fusiliers as far as Mérancourt, starting at 2.45 a.m., after which the two sections were to join the remainder of the Company, which had proceeded to Mons-en-Chaussée with the transport earlier on the 22nd, in case they should be required for demolition of bridges over the Somme.

During the night 22nd/23rd, Major Baker was instructed to guide the Brigade to the trenches of the Green Line. Unfortunately, the sector they were to occupy was that next to where the Company had been working and was complete. In this sector these defences had hardly been commenced. As the night was pitch dark it was very difficult to find anything except an old German trench which ran roughly parallel to the desired position.

At 6.45 a.m. on 23rd, orders arrived from C.R.E. to cross the Somme at Brie, and to proceed to Villers Carbonnel. The bridges here had been prepared for demolition and were to be demolished by the Army Troops companies who had prepared them.

The O.C. rejoined the Company as they were moving off and a guide was left to bring up the remaining two sections which had not yet rejoined. The Company remained at Villers Carbonnel from 1.30 to 4.30 p.m.

Whilst at this place and surrounded by troops resting each side of the road, three enemy aeroplanes flew low over the crowded fields. One driver was hit in the leg. All the troops in the neighbourhood

loosed off at the aeroplanes and two of them never got out of their dive and were destroyed. It is perhaps too much to claim that the 7th Company brought them down, but they may have done.

The Company then marched to Berny-en-Santerre (3 m.), arriving at 6 p.m., and had no sooner pitched its bivouacs than it was ordered to move again to Foucaucourt (5 m.), where it was employed during the 25th in improving communications in the neighbourhood of Fay and Estrées and bridging trenches to facilitate passage of transport and gun limbers. The H.Q. transport went back to Harbonnières. The dismounted sections held Fay until midnight when orders were received to proceed to Vauvillers (7 m.) for the construction of a chain of defensive posts running north and south to the east of the Framerville–Vauvillers–Rosières road.

During the 25th the O.C. had to cover so much ground on reconnaissance that he worked three horses to a standstill.

During this part of the retreat the Company morale was exceptionally high and a very fine spirit was shown by all ranks in face of much hardship. The Company, when falling in to march off on one occasion at short notice, was compared by a staff officer to a company of guards. The value of mouth organs and singing on the march was very clearly demonstrated, as was the value of all the training in march discipline instigated by the late O.C.

Sixteen platoon posts were commenced at 9 a.m. on the 26th, the Company being assisted by a labour battalion. Work was completed about 12 noon and occupied at once by the retiring infantry which, greatly reduced in strength, was able to reform and fight on this line until forced to retire by outflanking movements on the night 27th/28th.

On completion of this work the three engineer companies were withdrawn under the C.R.E. to a position immediately north-west of Vauvillers, where they formed a retired left flank guard to the infantry holding the newly-dug position. From the 7th Company's position small bodies of the enemy's infantry were seen at a distance of two miles working down the main Foucaucourt–Villers–Bretonneux road and also advancing on Framerville. Information was at once given to advanced D.H.Q. in Vauvillers. The G.O.C. 50th Division (T./Major-General H. C. Jackson, D.S.O.) immediately organized a counter-attack on Framerville by the infantry to hand and with G.S.O.1 (Lieut.-Colonel Anstey, D.S.O.)—both mounted—accompanied the attack, which succeeded in capturing Framerville and driving the enemy back some distance. The left flank being thus established the field companies were withdrawn by 6 p.m. to Wiencourt (4 m.), where the tired sappers who had been marching and working, with some fighting, for five days with little rest were left undisturbed till 5 a.m.

At dawn on the 27th a composite battalion was formed near

Wiencourt, under command of the C.R.E., consisting of the 7th Company R.E., 447th Company R.E. and 350 infantry details of the 151st Brigade and other formations. As these details belonged to many regiments and contained no formed units and only junior officers, they were hastily organized into eight platoons and two companies, one company being placed under the O.C. 7th Company and one company under the O.C. 447th Company. The Composite Battalion was thus about 500 strong, organized in two similar wings, each wing consisting of an engineer company (about 80 rifles) and an infantry company (about 160 rifles), with a small improvised headquarters section of cyclists and runners.

The " Battalion " left Wiencourt at 7 a.m., with instructions to take up a position to the right flank and rear of the reduced 149th Brigade, then holding the southern portion of the Vauvillers–Rosières " line," an enemy attack through Rosières being anticipated. The right wing, under Major Baker, took up a position immediately north-east of Rosières, covering the exits from that village, the left wing under Major Chivers being held in reserve in the railway cutting one mile in rear.

No attack developed on this flank and about 12 noon orders were received for the Battalion to be withdrawn rapidly to co-operate with two battalions of the 8th Division in a counter-attack on the village of Proyart, from a line Bayonvillers–Harbonnières. The left wing under Major Chivers was at once marched north-east through Harbonnières, that under Major Baker being instructed to follow. On arrival of the left wing at Harbonnières the enemy infantry could be seen advancing in successive lines south-east from Proyart over the open country. This wing was directed to proceed up a valley, hidden from the enemy, and to seize and hold a wood one mile to the north-east, whose western face appeared to command the main road to Villers-Bretonneux and the whole line of the enemy's advance. It reached its position with about ten minutes in hand and the advanced enemy lines, checked, lay down and remained inactive.

About this time the left (7th Company) wing emerged through Harbonnières, which was being shelled, and here Major Baker was severely wounded in the left arm and had to be evacuated, the command devolving on A./Capt. Baldwin, D.C.M. The platoons of this wing, under Lieut. Pottle, were formed up under desultory field gun fire and directed to advance in the direction of Framerville, extending into open formation when under rifle fire, with their left flank in touch with the right of the wing under Major Chivers. At the same time a battalion of the 8th Division debouched from Bayonvillers and moved to the northern flank of the composite battalion's left wing, thus securing that flank.

The enemy, on seeing troops advancing from Harbonnières, commenced to retire slowly over the open ground towards Proyart.

The Composite Battalion advanced about 2,000 yards in open order in successive lines, suffering a few casualties from machine-guns and rifle fire. About 5 p.m. the enemy's fire increased, coming mainly from machine-guns in old trenches about 400 yards from the advanced attacking troops, which, having no artillery or machine-gun support, were held up about 1,000 yards south-east of Proyart.

As dusk was falling and a good position for maintenance against counter-attack, namely, an old trench system running north and south across the German line of advance, had been reached, the Composite Battalion was disposed in these trenches with a view to holding the ground already gained. The 7th Company was on the right and in touch with troops in the neighbourhood of Framerville. At this time Major Chivers, commanding the left wing, was severely wounded by machine-gun bullets at short range.

The enemy's advance immediately south of the Somme appeared to have been checked, with prospect of a successful defence being put up during the night and the following day. It was believed that the gap of 1½ miles between the River Somme and the main Villers-Bretonneux road was filled by troops of another division. The situation on the immediate front of the Composite Battalion was reported to advanced Div. H.Q. at Harbonnières as being favourable and a party sent back for more ammunition and rations. During the night the G.O.C. 50th Division visited the position and expressed his satisfaction with the manner in which the field companies and infantry details had operated during the day and commented on the good disposition and general alertness of the engineer outposts and sentry groups.

At 4.20 a.m., however, the G.S.O.2 50th Division arrived with information that the enemy had succeeded during the night in passing between the River Somme and the northern flank of the composite Battalion and troops on its left, and was now advancing in strength on Bayonvillers from the direction of Morcourt, and that the northern flanking troops were already being withdrawn. The C.R.E. was further directed to withdraw the Composite Battalion at once, before daylight, if possible, behind Harbonnières and thence to retire southwards towards Caix, to which place the remainder of the 50th Division was also being withdrawn. As dawn was then breaking no time was to be lost in crossing the 1½ miles of open country to Harbonnières if heavy casualties were to be avoided. Withdrawal was effected in an orderly manner from the left and without casualties. The German scouts followed close after, one being captured. The troops on the right of the 7th Company were not so fortunate and lost heavily in their retirement across the open.

The sections and platoons of the Composite Battalion as a consequence entered Harbonnières somewhat mixed up and not in regular formation. The officers with the leading platoons commenced

to reform their commands as previously ordered under cover of the village when G.S.O.1 (in the absence of the C.R.E. who had not yet reached Harbonnières) ordered the retirement to be continued at once to Caix (2½ miles to the south) without first reforming. As the 50th Division troops from about Vauvillers were also now retiring along this road, the infantry details of the Composite Battalion became merged with them and not readily distinguishable owing to identity of units, with the result that it was only possible, on reaching Caix, to extricate the field companies (7th and 447th) and portions of the infantry platoons.

D.H.Q.'s intention was that the Composite Battalion should, on reaching Caix, reform and advance again 1½ miles northwards and take up a position covering the exits of Guillaucourt. This was now recognized to be impracticable in the time available. It was, therefore, decided that the infantry details should rejoin their own units forming part of the composite infantry brigade already assembled under Brigadier General Liddell, D.S.O., with whom the C.R.E. and two field companies, together with the 7th D.L.I. Pioneers, were directed to co-operate in holding the rising ground on the north bank of the River de Luce, covering the village of Caix.

Certain French territorial details were on the right flank of the composite infantry brigade, the 7th and 447th field companies on its left, with the 7th D.L.I. on the outer left flank. The transport of the engineer companies having to retire during the night from Wiencourt, through Marcelcave on Aubercourt, the sappers were without any form of entrenching tool, but managed in the absence of any natural cover to make small rifle pits with their bayonets.

A narrow valley crossed the front of the position with small woods on the far side. It was not possible to deny these woods to the enemy, who occupied them about 2 p.m., but remained inactive except for desultory fire from light trench-mortars till about 3.30 p.m., when effective machine-gun fire was opened. By the same hour enemy machine-gun detachments (well handled as usual) had succeeded in working well round the left flank of the 7th D.L.I. and in enfilading the whole position from the wooded high ground south-west of Guillaucourt.

The withdrawal of the Composite Brigade through Caix and across the River de Luce was ordered. This entailed retiring over some 200 yards of open ground under machine-gun and rifle fire at close range, the 7th Company suffering about 12 casualties in the operation —casualties which appeared few under the circumstances. Amongst these was Serjt. P. Cheale, M.M., who was severely wounded. This N.C.O. had performed consistently good and gallant work since coming out with the Company in August, 1914.

On the Composite Brigade taking up a fresh position south of the River de Luce the two field companies were directed to rejoin their

first line transport at Beaucourt south-west of Caix, with a view to resuming their more normal engineer duties.

Owing to the enemy's continued outflanking movements from the north, the Composite Brigade (representing the whole remaining infantry strength of the Division) was retired through Beaucourt the same evening (28th/29th) and thence north-west across the River de Luce at Domart, to take up a strong position about Gentelles, facing east. The field companies were consequently directed to Castel on the River Avre during the night 28th/29th, and to Boves on the evening of the 29th, where an engineer reconnaissance of bridges and crossings over the River Avre was made as a precautionary measure.

The Division was in action on the 29th on the Gentelles position —the last position covering Amiens, about six miles distant. On this day reinforcements arrived to secure the flanks, and the enemy, faced at last with the necessity of frontal attack and suffering doubtless from fatigue, confusion and shortness of supplies, was unable to make any further progress.

On the 30th the Division was relieved and withdrawn across the River Avre after nine days' continuous open fighting with isolated or insecure flanks. Its casualties during this period were very heavy.

The 7th Company marched to Sains-en-Amienois (4 m.) on the 30th and to Saleux (6 m.) on the 31st for entrainment to Rue, whence it marched on the 1st April to billets at Ponches, near Crécy, and remained there four days.

The Company's casualties during the nine days (21st to 29th April) amounted to 21, namely, 4 O.R. killed, 2 officers and 15 O.R. wounded. The latter included 3 section serjeants—A. Farrer, M.M., F. Wadkinson, P. Cheale, M.M. A./Major H. A. Baker, M.C., severely wounded on the 27th, had served with the Company since the autumn of 1915. He was succeeded as O.C. by A./Capt. W. F. Baldwin, D.C.M., Croix de Guerre, who had joined the Company in January, 1916. Lieut. F. J. Slattery became A./Captain.

OPERATIONS ON THE RIVER LYS (9TH TO 12TH APRIL).

After a few days refitting in the Ponches area the 50th Division moved on the 4th April to the area immediately west of Béthune, becoming part of the XV. Corps, 1st Army. On the 8th April, Div. H.Q. moved north to Merville and the 7th Company from Lenglet (4 m. west of Béthune) to the Rue du Bois (north-east corner of the Forêt de Nieppe). During the early days of April the Division received large reinforcements, bringing it again to full strength. Thus hastily re-made, it was ordered on the 8th April to relieve the 2nd Portuguese Division in the line about Laventie.

An early German attack in strength was anticipated, and this

opened on a wide front on the 9th April, after a heavy bombardment. The Division moved forward in support of the Portuguese who retired through it, the field companies moving to positions of readiness between Merville and Estaires.

During the 9th and night of the 9th/10th the infantry brigades were heavily engaged with the enemy south of the River Lys, between Merville and Estaires, and succeeded in checking the enemy's advance in force, and in inflicting heavy casualties. Retirement across the Lys became necessary on the 10th, and on the morning of this day the G.O.C. Division gave orders for the preparation of a rallying line of mutually-supporting platoon posts on a frontage of three miles from near Merville through Neuf Berquin.

The bulk of the three companies were employed on this work, the remainder on the preparation of bridges over the River Lys for demolition and on work to facilitate the passage of infantry transport across the river.

The portion of the rallying line allotted to the 7th Company for construction consisted of 24 platoon posts disposed in échelon and constructed, as far as possible, with a view to concealment, on a frontage of 3,500 yards. Digging commenced at 7.30 a.m. on the 10th, continued till 11 p.m., was resumed (with the assistance of a weak company 7th D.L.I. Pioneers) at 5.30 a.m. on the 11th and completed about 9.30 a.m. The situation being uncertain, it occupied a number of these posts pending the arrival of the infantry. About 10.30 a.m., infantry of the 29th and 40th Divisions arrived to man part of the line, the remainder being occupied at 2.30 p.m. by infantry of the 149th and 150th Brigades in the course of their retirement.

The 7th Company was then withdrawn towards Douriez and was directed later to rejoin its transport at Vieux Berquin. During the night it was moved to 1 m. north-west of La Motte in the Forêt de Nieppe.

The Company incurred no casualties during the operations on the Lys. A notable incident in the doings of the other field companies in the Division was the demolition of a bridge over the River Lys at the west end of Merville by a section of the 446th (Northumbrian) Company, when Lieut. Williams, M.C., blew up the bridge as it was being rushed from the neighbouring houses by an enemy machine-gun detachment which was blown up on the bridge. A few moments after Lieut. Williams was himself killed by a bullet.

THE FORÊT DE NIEPPE (12TH TO 17TH APRIL).

Early on the 12th the Company received orders to organize and construct defences on the eastern outskirts of the Bois d'Aval (Forêt de Nieppe), preparing semi-breastwork posts, clearing glades for fire

purposes, and making wire obstacles. These defences were manned in the evening of the 12th by infantry of the 5th Division in relief of the 50th Division, which had again been greatly reduced in strength during the previous days of severe continuous and successful fighting.

On the 13th, Company headquarters and transport were moved from near La Motte (heavily shelled on the 12th) to Le Parc, and from the 12th to 17th carried out similar defence works between Haverskerque and Le Parc, under the orders of the C.R.E. 5th Division.

On the 18th the Company marched to Glomenghem (8 m.), near Aire, and were inspected there on the 20th by the G.O.C. 50th Division (T./Major-General H. C. Jackson, D.S.O.). Moving on the 21st to Blessy (5 m.), the Company entrained early on the 27th at Pernes for the south.

THE CHEMIN DES DAMES (7TH TO 26TH MAY).

Map II.

During the previous six weeks the 50th Division had carried out two retirements in the face of greatly superior numbers. On each occasion it had fought a series of delaying actions, which had reduced its infantry strength to that of a single brigade or less, the other combatant arms being almost equally reduced. In company with the three British divisions (8th, 21st, 25th), which had undergone a similar experience, it was now dispatched south to what was then considered a quiet part of the front—the Chemin des Dames sector, north of the Aisne—where it formed part of the British IX. Corps acting under French command. The division was again brought to full strength. The last but one great German attack took place on this sector and to the east of it on the 27th of May, when the Division again suffered great losses and experienced a third period of retreat. In this fighting the 7th Company was to lose nearly 70 per cent. of its strength in killed, wounded and missing.

Detraining at Fère-en-Tardenois on the 27th April the Company marched to Coulonges (6 m.), about 20 miles south-east of Soissons, where a week was spent in refitting, etc. On the 5th May it marched to Muscourt (16 m.) and on the 6th to Centre-de Poitiers (6 m.), immediately north of the River Aisne, between Crâonelle and Pontavert, taking over the work and dugouts of the 11/63 French Engineer Company.

The new sector included the eastern (Crâonne plateau) end of the famous Chemin des Dames position and about 1½ miles of low-lying front bordering on the plateau. It was much wooded in rear of the front or outpost system and, owing to its length, could only be lightly held.

The French division relieved on this sector spoke of it as "*une ligne complète*," owing to the extensive nature of the trench systems and strong-points—all strongly wired on a system of machine-gun defence, with deep dugouts for all troops in occupation as well as for machine-gun detachments, headquarters and reserves, together with good subsidiary works. But the readjustments now required, the wooded nature of the country to be defended, and the entire absence of any efficient gas-proofing of dugouts left plenty of work to be done.

The rapid gas-proofing of all dugouts was considered to be of first importance. The 7th Company was employed on gas-proofing of the whole divisional sector as well as on constructing concrete "pill-boxes" for machine-guns. No. 2 Section was employed on the construction of a rifle range in the neighbourhood of Div. H.Q. at Beaurieux.

BATTLE OF THE 27TH MAY, AND AFTER.

The German artillery had become markedly active from about the 23rd May, registering on batteries, etc. On the afternoon of the 26th information was received at Div. H.Q. of a probable enemy attack in force on the following day, this information having been obtained from a prisoner captured in a raid. The Company received a warning order, together with instructions regarding the occupation of its battle position (a strong-point in the reserve line close to the Company's dugouts at Centre-de-Poitiers, some 2½ miles behind the front line) in the event of the enemy penetrating the front system. This position was reconnoitred on the 26th.

At 1 a.m. on the 27th May a heavy bombardment opened, with a high proportion of gas shell, the gas being particularly thick at Div. H.Q., in the artillery positions, and in the woods about the reserve line and the Company's dugouts. Telephone communication was quickly interrupted. The first cyclist messenger, dispatched to order the Company to proceed to its battle position, arrived too late to be of use, owing to his being gassed and to the enemy's rapid advance through the woods to the east of the Crâonne plateau. The Division was holding a wide frontage. The enemy's concentrated gas bombardment from 1 a.m. to 5 a.m. had the effect of generally immobilizing the troops holding the line. Despite strenuous resistance, the enemy succeeded in turning the Crâonne position and penetrating deeply through the wooded country at an early hour.

Heavy Fighting and Casualties.—The O.C. 7th Company (Major Baldwin, D.C.M.) dispatched an officer, Lieut. Pottle, M.C., to reconnoitre and find out the state of affairs and, on his report, proceeded under heavy shell fire to form up the three sections at the Centre-de-Poitiers with a view to occupying the pre-arranged battle position. Whilst so doing Major Baldwin was killed by shrapnel. The enemy

was then found to be advancing in strength through the woods. Confused fighting followed, prior to which Lieut. Pottle, M.C., was wounded whilst engaging the enemy at close quarters, and evacuated. C.S.M. Parker, D.C.M., and many others were killed and the sections overwhelmed. Had they been able to reach their battle position they would undoubtedly have proved more effective in holding up the enemy. Amongst those wounded and captured were A./Capt. F. J. Slattery and 2nd-Lieut. H. F. Sharpe, R.E.

No. 2 Section at Beaurieux, under Lieut. Rebbeck, M.C., received instructions to retire with the infantry remnants to a position south of the River Aisne at Maisy. This section formed the major part of the Company at the end of the day's fighting.

On the same day the 447th (Northumbrian) Company (under Major Rainsford-Hannay, D.S.O.) was also overwhelmed on the Crâonne plateau, after losing heavily from the shell fire concentrated on this commanding position. Owing to the German advance round the eastern side of the plateau the Company was cut off.

A Fine Effort of the 446th (Northumbrian) Company.

This Company (under Major McClellan, M.C.) charged with the demolition of 16 bridges over the River Aisne, gallantly succeeded in destroying 14 of these bridges, incurring severe casualties both before and during the work. These bridges had all been previously reconnoitred and the necessary charges (French explosives) stored at hand. The fine work of the small demolition parties was recognized by the subsequent award of seven French Croix de Guerre to survivors who had signally distinguished themselves.

A record of the 7th Company would be incomplete without such reference to the deeds of its sister companies in the 50th Division, with whom, during three years of war, ties of mutual regard had been formed.

THE RETREAT FROM THE AISNE (27TH TO 31ST MAY) AND AFTER (1ST TO 30TH JUNE).

The experience of the neighbouring British and French divisions on the disastrous 27th May were similar. During the succeeding days their remnants retreated steadily, fighting rearguard actions when possible.

As the passages, in succession, of the River Vesle, River Ourcq and River Marne became involved, it was decided not to commit the remnants of the divisional engineers to further infantry action, as their services in connection with possible bridge destruction or construction were considered to be of greater relative importance. Consequently, the remains of the 7th Company retired on the 28th May through Cohan, 29th Villers-Argon-Troissy, 30th Igny, 31st

Corrobert. During this retirement the Company stood by to prepare for demolition of bridges over the River Camp near Montigny and the suspension bridge over the River Marne at Port-à-Binson (immediately south of Chatillon), but these demolitions were not ordered. It also stood by with the remainder of the divisional engineers to construct a pontoon bridge across the River Marne opposite Troissy, which was not, however, eventually required.

On the 28th certain French reserves had come up and by the 30th the Division was withdrawn from the fight. A single composite infantry brigade was then formed and arrangements made for the divisional engineers to act as a composite field company if required. The Company remained from the 1st to 9th June at Aulineux, from the 10th to 17th at Mondement (the scene of heavy fighting in the battle of the Marne in 1914), and from the 17th June to 1st July at l'Hermite.

After a short period of action in conjunction with French and Italian divisions on the eastern outskirts of the wooded Montagne de Rheims, the 50th Division Composite Brigade was finally withdrawn on the 1st July for entire re-establishment and refitting; the Division having for the third time in ten weeks (21st March to 30th May) been reduced to less than one-third of its fighting strength.

The known 7th Company casualties on the 27th May amounted to 4 officers and 89 other ranks. No record of the relative numbers of killed, wounded and missing is available.

The following awards were received early in May:—Military Cross—Lieut. H. G. Pottle; Military Medal—A./Serjt. J. Bates, A./Cpl. S. C. Kelly, A./L.Cpl. T. Black, Saprs. W. Atkinson, W. Black.

CHAPTER VIII.

REFITTING—THE FINAL ADVANCE—THE ARMISTICE AND AFTER (JULY TO DECEMBER, 1918).

REFITTING AND TRAINING (1ST JULY TO 30TH SEPTEMBER).

Map VIII.

THE refitting and training of the 50th Division took place near Dieppe, the 7th Company, being quartered from the 23rd July to 16th September at Martin Église where it was brought to strength, carried out extensive training and worked on divisional camps (hutting, water supply, etc.). The training included certain engineer tactical schemes for field companies and the pioneer battalion, carried out under the C.R.E. (A./Lieut.-Colonel P. Hall, M.C., appointed on the 30th July, *vice* Major J. A. McQueen, D.S.O., M.C., invalided).

On the 2nd July, A./Major J. McGill joined on appointment as O.C.

Several former N.C.O's and men rejoined on recovery from wounds and sickness. On the 23rd July, Lieut. J. B. Glubb, M.C., rejoined on recovery from his severe wound of the previous August.

Lieutenants T. D. Barrett, W. M. Winstanley, 2nd-Lieut. H. G. Stewart, joined on the 8th August, 2nd-Lieut. A. W. Seels on the 17th August.

On the 16th September the Company proceeded with the reconstituted Division to the 3rd Army area, detraining at Bouquemaison and marching to billets at Brevillers near Agincourt, and thence on the 27th to Esbart and on the 29th to Epéhy. From the 1st October it took part in the advance of the British armies.

THE FINAL ADVANCE (EPÉHY TO SEMOUSIES, 1ST OCTOBER TO 11TH NOVEMBER).

The general line of the attack and advance of the 50th Division was from about Epéhy (15 m. south-west of Bapaume), through Le Catelet (on St. Quentin Canal), St. Benin (on River Selle, 2 m. south of Le Cateau), Landrécies (on Sambre Canal), Marvilles (on River de Tarsy) to Semousies (3 m. north of Avesnes and 8 m. south of Maubeuge)—a total distance of 50 miles. This line of advance crossed at right angles the St. Quentin and Sambre Canal systems and their numerous feeders running from south to north. The Germans in their retreat destroyed many bridges and railway viaducts over roads, in addition to making large road craters, thus rendering pursuit difficult and throwing an immense strain on the British engineers, on whose capacity to restore communications depended in great measure the success of the operations.

The forcing of the passage of the St. Quentin Canal in the neighbourhood of Vendhuille was the first task confronting the Division and was successfully carried out on the 5th October. From the 1st to 5th October the Company was in dugouts east of Epéhy. Reconnaissances of the canal were carried out and bridging stores collected in Epéhy. During the attack on the 5th the Company constructed two footbridges and one medium pontoon bridge over the canal, with the loss of two sappers wounded.

On the 6th the Company moved to Vendhuille and between the 6th and 10th repaired the Vendhuille–Le Catelet road and constructed a bridge to carry all natures of traffic over the River l'Escaut in Le Catelet.

On the 10th the Company marched to Clary (10 m.) and on the 12th to Le Trou-au-soldat, carrying out reconnaissances of the forward area on the 13th, with a view to passage of the River Selle, and constructed a bridge for horse transport west of St. Benin on the 14th.

On the 17th a general attack by the XIII. Corps took place, the

50th Division forcing the passage of the River Selle about St. Benin. 20 infantry footbridges were erected over the River Selle, all field companies being employed in their construction.

On the 18th the Company constructed a pontoon bridge west of St. Benin, and on the 19th was employed clearing the St. Benin–Le Cateau road, where blocked by the demolition of a large railway viaduct.

The 50th Division was relieved on this day by the 25th Division till the 30th, during which period its field companies continued to assist the 25th Division in clearing roads running east from Le Cateau, the 7th Company clearing the block caused by the demolition of the railway viaduct a quarter of a mile north-west of Bazuel.

The 1st to 4th November was spent in making preparations for the forcing of the Sambre Canal, the Company preparing Le Fayt farm for occupation as brigade headquarters, taping out assembly positions and cutting gaps in hedges for the 149th Brigade immediately east of Fontaine-au-Bois, repairing and reconnoitring roads, etc. On the 2nd November, No. 2 Section moved to Bousies for work with the 50th Division artillery and prepared tracks to enable the guns to advance.

The German resistance was now weakening considerably. On the 4th November the Company moved from Benin to Fontaine (6 m.), on the 5th repaired the Fontaine–Landrécies road, and on the 6th moved from Fontaine to Hachette (5 m.), on the southern edge of the Forêt de Mormal, and constructed a length of corduroy road with prisoner-of-war labour and a service trestle bridge of three bays over the River Grande-Helpe at Noyelles, to which latter place Company headquarters moved (4 m.). On the 7th, work was carried out on communications generally and mines searched for at points indicated by civilians.

The Company moved on the 8th from Noyelles to Monceau (4 m.), and on the 9th to Dompièrre (4 m.), to form part of a mobile column under the G.O.C. 150th Brigade.

On the 10th it moved from near Dompièrre to Semousies (5 m.), and with three companies of infantry cleared blocks on the Maubeuge–Avesnes and other roads. Work on a bridge over River de Tarsy was also commenced on this day.

Battle casualties during the operations from 1st October to 11th November were two sappers killed on the 27th October and two wounded.

A severe outbreak of Spanish influenza in the latter half of October caused large sickness casualties, especially amongst the Mounted Section. Of 50 admissions to isolation hospital 30 were drivers, and for a fortnight the horses and wagons were almost entirely driven by dismounted men. This epidemic hampered operations considerably and increased the heavy strain on the short-handed engineer companies engaged on numerous works of tactical importance.

Lieut. Rebbeck, M.C., died from influenza on the 4th November. Drivers L. Light, P. Arnold and Sapper W. F. Bett also died from influenza during the early days of the same month.

THE ARMISTICE AND AFTER (11TH NOVEMBER TO 31ST DECEMBER, 1918).

The 11th November found the Company quartered at Semousies busily restoring communications in that neighbourhood, on that and succeeding days.

Work was cancelled for the 12th November and the Company attended a ceremonial parade for medal presentations held by the G.O.C. 50th Division.

The Company remained at Semousies till the 6th December, when it marched to Taisnières, and on the 20th to Herbignies, and remained there till the end of the year. During this period it continued to be employed on communications, improvements to billets, water supply, recreational training and education classes. Demobilization commenced with that of men of " key trades " (miners, etc.).

Owing to a deplorable accident caused by fire, the deaths occurred on the 3rd December of T./C.Q.M.S. J. G. Church, M.S.M. (who had served in the field with the Mounted Section throughout the war), Sapper S. Hamilton and Sapper A. Girdler.

Space has not permitted much mention of the Mounted Section, but this record would be incomplete without referring to the very valuable work done by them throughout the war. Under Serjeants Armstrong, Church and Orchard the Section never once failed to produce the goods, often under very strenuous circumstances, the difficulties of which are not always fully realized by the dismounted sections. Throughout the war the horses and general turnout were kept up to a very high standard and always created a good impression on the march and at the occasional " horse shows " that were held during periods of rest.

ARMY OF OCCUPATION.

The Company was finally reduced to cadre strength of 2 officers and 40 O.R. in May, 1919.

Early in 1920 it was decided to form a Company to send to the Army of Occupation at Cologne and the 7th Field Company was reformed at Chatham. Lieut. H. A. Baker, M.C., who had served with the Company during the war, was appointed to reform the Company. The only other member of the war-time Company was Driver " Nobby " Clark, who served in the Company throughout the war as O.C.'s batman.

The Company proceeded to Cologne in April, 1920, and was there handed over to the command of Bt. Major B. T. Wilson, D.S.O., finally returning to Colchester to its old Division in 1929 when the Army of Occupation was withdrawn.

APPENDIX I.

7TH COMPANY BATTLE CASUALTIES, 1914–1918.

A summary of the casualties, other than sickness, incurred by the 7th Field Company during the Campaign, lasting four years and three months, is as follows:—

	Officers.	*Other Ranks.*	*Total.*
Killed in action (or died at the front)	5	46	51
Wounded (or gassed)	12	157	169
Accidentally injured during operations		19	19
Missing (including 1 officer, 82 other ranks, who fell into enemy hands on the 27th May, 1918, of whom a high proportion were known to have been killed or wounded, but whose numbers are, however, not ascertainable)	1	86	87
Total	18	308	326

APPENDIX II.

OFFICERS AND C.S.M's WHO SERVED 1914–18.

Officer Commanding.			Second in Command.		
Appointed Date.	Name.	Casualty and Date.	Appointed Date.	Name.	Casualty and Date.
With unit on Mob.	Maj. S. G. Faber	Sick, 3.9.14	With unit on Mob.	Capt. V. P. Smith	Transferred, 8.9.15
3.9.14	Capt. V. P. Smith	Acting to 20.9.14	8.9.15	Capt. K. I. Gourlay	Home, 2.11.15
20.9.14	Maj. C. B. O. Symons	Wounded, 20.12.15	21.11.15	Lt. (A./Capt.) O. D. Atkinson	Wounded, 8.2.16
20.12.15	Lt. O. D. Atkinson, M.C.	Acting to 16.1.16	8.2.16	2nd-Lt. (A./Capt.) J. B. Glubb	Wounded, 15.2.16
16.1.16	Capt. (A./Maj.) J. A. McQueen, M.C.	C.R.E., 6.2.18	15.2.16	2nd-Lt. (A./Capt.) H. A. Baker	Acting to 9.8.16
6.2.18	Lt. (A./Maj.) H. A. Baker, M.C.	Wounded, 27.3.18	9.8.16	2nd-Lt. (A./Capt.) J. B. Glubb	Wounded, 21.8.17
27.3.18	Lt. (A./Maj.) W. F. Baldwin, D.C.M.	Killed, 27.5.18	21.8.17	Lt. (A./Capt.) H. A. Baker, M.C.	To O.C., 6.2.18
27.5.18	Lt. W. H. Rebbeck, M.C.	Acting to 2.7.18	6.2.18	Lt. (A./Capt.) W. F. Baldwin, D.C.M.	To O.C., 27.3.18
2.7.18	Capt. (A./Maj.) J. McGill, M.C.	To Armistice	28.3.18	Lt. (A./Capt.) F. J. Slattery	P. of W. 27.5.18
			2.7.18	Capt. F. B. Kenny	Sick, 4.8.18
			4.8.18	Lt. (A./Capt.) J. B. Glubb, M.C.	To Armistic

APPENDIX II.—*continued.*

Company Officers.			Company Officers.		
Appointed Date.	Name.	Casualty and Date.	Appointed Date.	Name.	Casualty and Date.
With unit on Mob.	Lt. R. G. Wright	Hospital, 19.1.15	18.11.15	2nd-Lt. J. B. Glubb	Wounded, 20.12.15 but returned A./Capt., 9.8.16
,,	Lt. K. I. Gourlay	Capt., 2.11.15			
,,	Lt. G. N. Macready	Transferred, 20.11.14	11.1.16	2nd-Lt. W. F. Baldwin, D.C.M.	Wounded, 9.7.16 Rejoined, A./Capt., 6.2.18
,,	2nd-Lt. W. D. Stavert, (S.R.)	Base, 6.10.14			
2.10.14	2nd-Lt. G. H. Latham	Home, 13.11.15			
5.12.14	Lt. O. D. Atkinson	A./Capt., 21.11.15	14.2.16	2nd-Lt. R. E. E. Chaplin	Killed, 22.4.17
18. 2.15	Lt. E. Bayley	Hospital, 9.3.15	6.4.16	2nd-Lt. J. B. L. Thompson	Transferred, 27.12.16
10. 9.15	Lt. L. J. Tessier	Sick, 13.3.16	24.4.16	2nd-Lt. H. Russell, D.C.M.	Killed, 12.7.16
11.15	Lt. E. Ashcroft	Sick, 8.12.15	15.7.16	2nd-Lt. F. J. Slattery	A./Capt., 28.3.18
10.11.15	2nd-Lt. H. A. Baker	Wounded, 23.4.17	15.7.16	2nd-Lt. R. B. Wade	Gassed, 11.9.16

OFFICERS AND C.S.M's WHO SERVED 1914–18.

Company Officers.			C.S.M's.		
Appointed Date.	Name.	Casualty and Date.	Appointed Date.	Name.	Casualty and Date.
21.10.16	2nd-Lt. C. W. S. Littlewood	Killed, 10.7.17	With unit on Mob.	C.S.M. E. Baker	To 4th D., 13.4.15
7.5.17	2nd-Lt. H. G. Pottle	Wounded, 27.5.18	6.4.15	Sjt. (A./C.S.M.) J. Johnson	To 48th D., 8.5.15
7.5.17	2nd-Lt. W. H. Rebbeck	Died, 4.11.18	9.5.15	Sjt. (A./C.S.M.) H. Russell, D.C.M.	To D.H. Q., 6.8.15
15.5.17	2nd-Lt. H. A. Baker, M.C., rejoined	A./Capt., 11.9.17	27.7.15	Sjt. (A./C.S.M.) R. H. Lauder	Sick, 21.4.17
1.17	2nd-Lt. R. Bruce	Sick, 31.3.17	21.4.17	Cpl. (A./C.S.M.) F. Parker, M.M.	Killed, 27.5.18
13.2.18	2nd-Lt. H. A. Benson	Wounded, 22.3.18	29.5.18	A./C.S.M. R. H. Lauder	To Armistice
17.4.18	2nd-Lt. H. F. Sharpe	Missing, 27.5.18			
17.4.18	2nd-Lt. M. H. King	To Armistice			
8.7.18	Lt. T. D. Barrett	,,			
8.7.18	Lt. W. M. Winstanley	,,			
8.7.18	2nd-Lt. H. G. Stewart	Transferred, 1.12.18			
23.7.18	Lt. J. B. Glubb, M.C.	A./Capt., 4.8.18			
17.8.18	2nd-Lt. A. W. Seels	To Armistice			

HONOURS AND AWARDS, 1914–19.

(Rank shown at time of receipt.)

D.S.O. (2).
Major C. B. O. Symons.
Major J. A. McQueen, M.C.

M.C. (7).
Lt. (A./Capt.) J. B. Glubb.
Lieut. W. H. Rebbeck.
Lieut. E. Ashcroft.
Lieut. O. D. Atkinson.
2nd-Lt. H. A. Baker.
2nd-Lt. C. W. S. Littlewood.
2nd-Lt. H. G. Pottle.

D.C.M. (5).
C.S.M. H. Russell.
Sjt. J. Johnson.
Sjt. J. O'Connell.
A./Sjt. F. Parker.
2nd/Cpl. C. Collings.

M.M. (16).
A./Sjt. A. Farrer.
A./Sjt. P. Cheale.
A./Sjt. J. Bates.
A./Sjt. F. Wadkinson.

M.M. (*continued*).
A./Sjt. G. Frankenburg.
A./Cpl. J. Martin.
A./Cpl. C. Matthews.
A./Cpl. S. C. Kelly.
A./2nd/Cpl. T. Black.
A./2nd/Cpl. D. Munro.
L./Cpl. R. Cutts.
A./L./Cpl. J. Park.
Spr. W. Atkinson.
Spr. W. Rack.
Spr. A. Southern.
Spr. J. Edwards.

M.S.M. (2).
Sjt. F. Armstrong.
Sjt. J. G. Church.

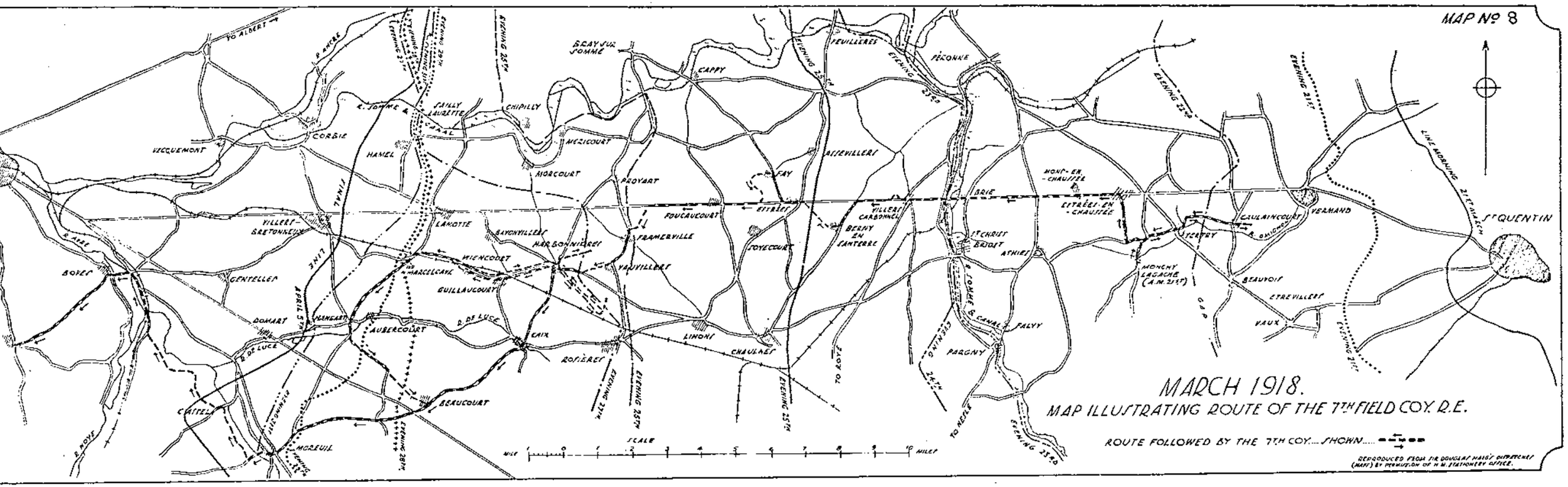
Russian Cross of St. George (2).
C.S.M. H. Russell.
A./Cpl. F. Parker.

Belgian Cross de Guerre (1).
Spr. W. Abbott.

Note.—This list is as complete as it has been found possible to make it. It is, however, impossible to guarantee that all names are included, as no complete record beyond official gazettes exists.

"Mentions" have been omitted altogether owing to the impossibility of compiling a complete list.

MAP Nº 8



MARCH 1918.

MAP ILLUSTRATING ROUTE OF THE 7th FIELD COY. R.E.

ROUTE FOLLOWED BY THE 7TH COY.... SHOWN.....

THE ALCANTARA BRIDGE (1812).

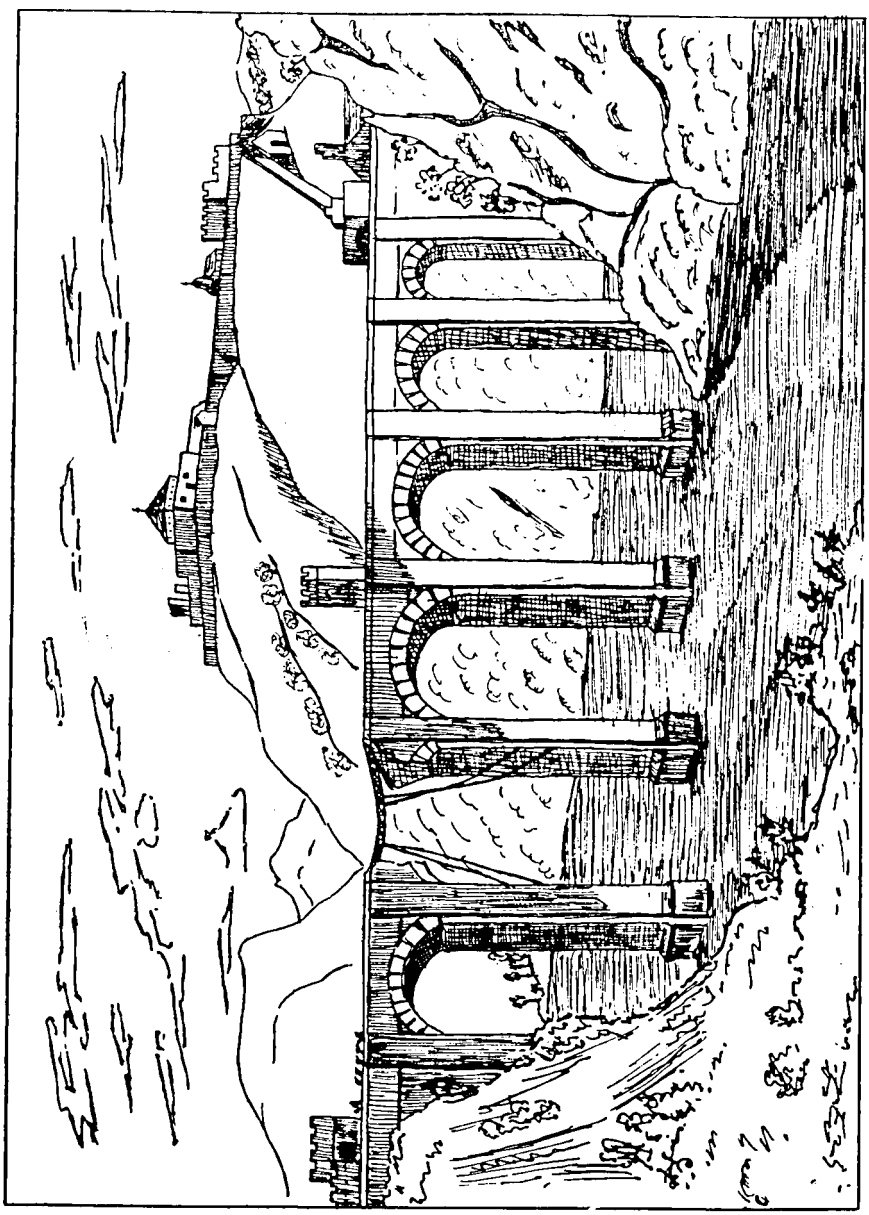
By COLONEL L. CHENEVIX-TRENCH, C.M.G., D.S.O., *p.s.c.*

IN the early years of the second century A.D. the Roman Emperor Trajan, himself a Spaniard, built a great stone bridge over the River Tagus, at Alcantara, to replace the ferry (el Kantara) by which traffic had, till then, passed. For seventeen hundred years the bridge carried Romans, Moors and Spaniards high above the river till, on the 10th June, 1809, the Portuguese detachment, placed by Wellington in charge of it, blew it up to prevent it falling into the hands of the French. This saved the latter the trouble of doing so, and at the same time saved the Portuguese guard, so that everyone was satisfied, except Wellington and, perhaps, the messenger whom he had dispatched to warn the Portuguese that the bridge was on no account to be destroyed. Him the French caught and shot.

For the next three years such little traffic as crossed the river had to use the ferry, as in the days before Trajan. In the dry season that meant a steep climb down to and up from the water, lying over 100 feet below the top of its banks. In the rains, though the climb was far less, the strong deep waters made the crossing a slow and arduous affair.

In May, 1812, Wellington began to put into action the great plans which were to culminate in the battle of Salamanca. It was first of all necessary to render more difficult the existing communications between the Northern and Southern French armies. These crossed the Tagus at Almaraz by a bridge of boats guarded by a strong French force in elaborately fortified positions. General Hill, however, by a daring, if somewhat lucky, feat of arms succeeded in capturing and destroying it on the 19th May. The first part of Wellington's preliminary task was thereby successfully accomplished. There remained the second, which was to improve his own communications to such an extent that he could reach and capture Salamanca before more than a portion of the French could concentrate against him.

At about the time at which Hill was capturing Almaraz, Wellington was having Alcantara reconnoitred; in his letter of 23rd May, to General Graham, he says that he has sent Lieut.-Colonel Sturgeon (Royal Staff Corps) with orders to report to him (Graham), "what the means are of passing the Tagus at Alcantara, and how long a given body would be in passing, and I send an officer down to see the Barcas (boats) at Alconeta and to report to you."



THE BROKEN BRIDGE AT ALCANTARA.

From this it appears that a ferry or flying bridge was the best that Wellington hoped for. With the limited material available it seemed probable that to bridge the broken arch would take so much time as to give the French ample warning of what was intended. Lieut.-Colonel Sturgeon and his assistant, Major Todd, had, however, something better than tedious ferrying to suggest. They went back to Elvas, and there, in the pontoon house, prepared a type of bridge which had not hitherto been seen in European wars.

First of all they erected two trestles, each about 4′ high, and placed them 90′ apart. On each a poplar beam, 30′ x 12″ x 8″, was laid and secured by tackles to holdfasts set in the end walls of the building.

These beams were then joined by 18 lengths of cable, 6½″ in circumference, each length being spaced about 12″ from the next. The two outside cables were then secured at intervals to the side walls of the building and the intermediate ones drawn into each other and tied together in such a way as to form a network.

Next eight cross-beams, or transoms, each 20′ x 6″ x 6″, were cut out, also of poplar, and channelled on the underside so as to fit over and keep in place the 6½″ cables. These channels were charred to smoothness with a heated axle-tree, so that the cables should not chafe. The transoms were then lashed with spun yarn on to their places on the cable network.

The road-bearers were prepared in what is described by Sir Howard Douglas* as "a novel and ingenious manner." That is to say, they were laid single and double in alternate bays. Two double road-bearers, each 12″ x 5″ x 1½″, were secured to each single bearer, 12″ x 5″ x 3″, by a bolt passed through the ends of all three so as to form a flexible joint, and allow the decking to conform as nearly as possible to the curvature of the rope network.

Chesses were 12′ x 12″ x 1½″, with holes at each end through which to lash them down.

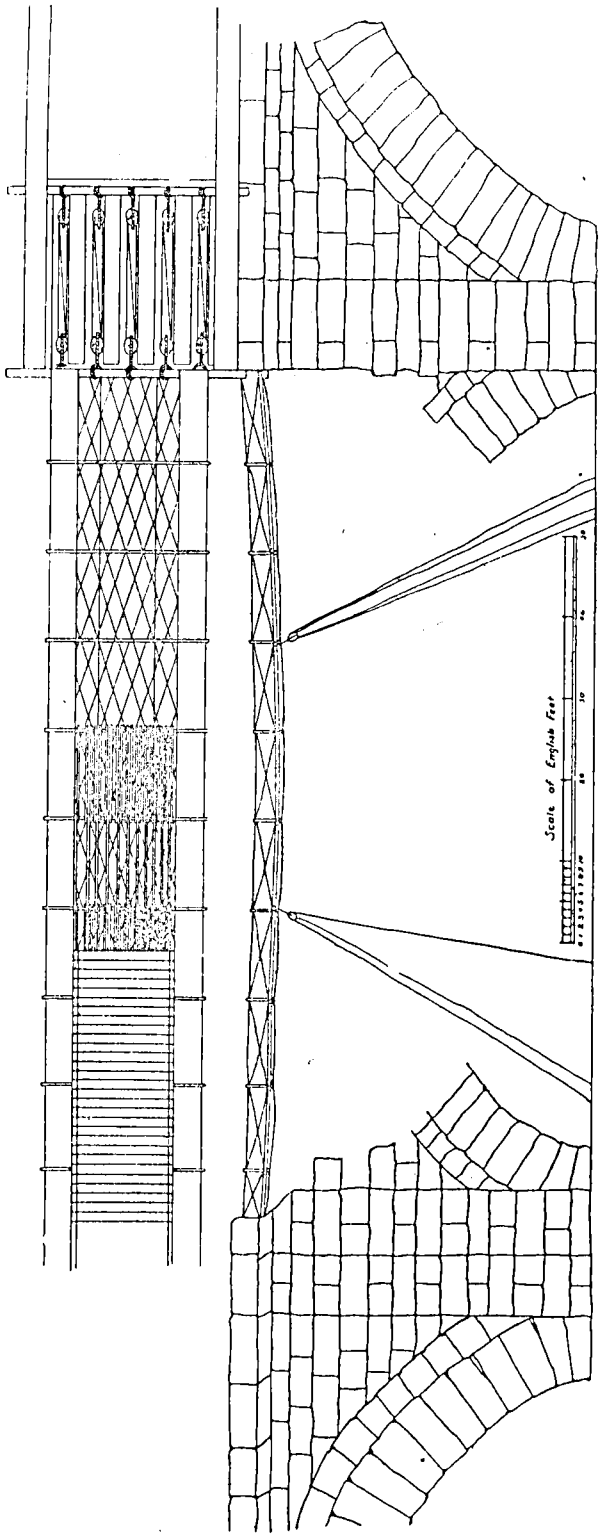
When the whole was finished the net, with the two end beams and the transoms all in place, was rolled up and loaded, according to Sir H. Douglas, on to a pontoon wagon, drawn by six oxen. It seems, however, that the end beams and the transoms must have been removed for transport, otherwise the weight would have been over 3½ tons. In all the bridge required 27 vehicles for its transport.

An officer, Lieut. Perry, was sent ahead with a detachment to cut the channels in the stone roadway on each side of the gap to take the anchorage beams and the straining tackles (*vide* Fig. 2), and to stretch across the gap two 6½″ cables on which to launch the bridge.

The launching was effected without much difficulty and the whole strained as tight as possible by means of the tackles at each end.

* *An Essay on the Principles and Construction of Military Bridges*, by Sir Howard Douglas.

ROPE BRIDGE ACROSS THE BROKEN ARCH OF THE BRIDGE OF ALCANTARA.



Four steadying tackles were slung from points near the middle of the bridge, to holdfasts set into the piers on each side, and wide strips of canvas laid along each side of the roadway, so as to give the appearance of greater width and prevent animals taking fright while crossing. A rope handrail completed the bridge which was successfully crossed by the Siege Artillery train on the 11th June.

The bridge was a notable achievement. It enabled Wellington to effect a surprise and provided an example of suspension bridging which was several times copied during the campaign, notably at Almaraz, the scene of Hill's exploit on the 19th May. Here the gap, similar to that at Alcantara, but no less than 143 feet wide, was bridged with material captured at Madrid.

Again, in a dispatch of 1st December, 1812, Wellington contemplates ordering the officer in charge of the Alcantara bridge " to march away with it," and prescribes labour and transport for the purpose.

It would be interesting to discover any earlier instance of the use of a portable bridge of this or any other type, for carrying the heaviest army loads over a clear span of 90 feet.

There is very little to show how long it took to make the bridge. It was on the 23rd May that Wellington wrote that he *had* ordered Sturgeon to report on the means of crossing. From Alcantara to Elvas is about 60 miles, and Dickson's Siege Train crossed on the 11th June.

There cannot have been much loss of time. In fact, it appears that Sturgeon must have had some such operation in view for some time and have collected material for it.* Otherwise, he would hardly have had such quantities of cable, etc., all ready. On the other hand, co-operation with the navy was so close throughout the whole of the Peninsular War that the use of cables and rope work was probably fairly well known to many of Wellington's officers.

In any case, a 6½" rope was nothing to mention when compared with the 25" rope, containing 3,240 strands and having an " absolute cohesion " of 140 tons, mentioned by Sir Howard Douglas.

Nowadays the Alcantara gap would be spanned by the Standard Box Girder, and though the erection and working of the launching derrick might offer some difficulty, the bridge could probably be completed in two working days.

A model of the Alcantara bridge is to be seen in the gallery of the Royal United Service Institution Museum.

* This is borne out by the notebook of Capt. George West, R.E., in the R.E. Museum, in which it is stated that "in April, 1812, Lt.-Col. Sturgeon was sent from Puente Guinaldo to Badajoz and Elvas to prepare a net of ropes to cross the fracture in the Roman Bridge across the Tagus at Alcantara."

MODERNIZATION OF THE ELECTRICAL AND MECHANICAL SCHOOL, S.M.E.

By MAJOR A. P. A. LEWIS, R.E.

As a result of the development of electrical and mechanical engineering during the Great War, and subsequent years, and the increased military importance of these subjects, it was found soon after the war that the Workshops and the Electrical School at the S.M.E. were no longer equal to our requirements. The shops were in some cases of antiquated and inconvenient design and construction, and most of the machinery was, though still fit for use, quite out of date. In the Machine Shop, for instance, few machines were less than twenty years old; many were thirty years or more.

For some years after the war, retrenchment, together with uncertainty as to future policy, made any attempt at modernization on the scale required impossible; but, in 1925 (shortly after the union of the Workshops and the Electrical School under the name of the Electrical and Mechanical School), a scheme of reconstruction and re-equipment was put forward by the then Chief Instructor, Major G. C. Gowland, and after a good deal of discussion was agreed to in principle by the War Office.

The expenditure of £16,000 was approved, to be spread over a period of several years.

In order to make the fullest possible use of military labour, and to cause the least possible interruption to instructional work, the whole scheme was spread over a period of four years, thus enabling us to do our part of it in our own time, without upsetting courses, etc.

The work was started in 1927–28, for which year an allotment of £6,600 was made, the first item selected for completion being the modernization of the Power Station at the Electrical School. This work was completed during 1928–29, in which year the reconstruction of the Workshops was commenced, being finally completed by September, 1930.

Details of the alterations made are given below:—

MODERNIZATION OF ELECTRICAL SCHOOL.

Up to 1925 the electrical supply for the S.M.E. Main Building, Workshops and Electrical School was generated in the Electrical School Power Station by 75-kW. steam generating sets, consuming 5 to 6 lb. of coal per unit, and the overall cost per unit was about

1/-. In 1923, it was agreed to close down the generating station and take power in bulk from H.M. Dockyard at 3,000 volts 3-phase A.C., the cost per unit being about 1¾d.

At the same time it was decided to incorporate in the scheme the lighting of Brompton Barracks, the Gymnasium and the C.R.E.'s Offices and Workshops, all of which had previously been supplied from the Gillingham Corporation Supply at 6·6d. per unit.

The new supply was completed in 1928, and now results in a saving of several thousands of pounds per annum.

The Power Station was, however, retained for instructional purposes, but during the clearing up in the post-war years a certain amount of second-hand machinery and switch gear was installed from time to time with the result that, in 1926, the Power Station contained a heterogeneous quantity of generating and converting machinery and switch gear, laid out in an irregular manner which bewildered the beginner.

The principal alterations which have been made are :—

(1) Two of the three steam sets have been disposed of, and a 75-kW. Davey-Paxman Heavy Oil Engine Generating Set added.
(2) A 50-kW. Mercury Arc Rectifier has been installed.
(3) The A.C. Switchboard has been replaced by one of modern design which is described in the *Text Book of Electrical Engineering*.

The new lay-out of the Power Station engine room makes clear the separate functions of the various machinery and apparatus.

The two generating sets (Photo 1) are provided with full facilities for testing the efficiency and performance, and although the necessity has not yet arisen, they are available to supply the S.M.E., Brompton Barracks, etc., in the event of the Dockyard supply failing.

Advantage was taken of the circumstances to standardize the A.C. voltage in the School. Where necessary, machinery was rewound to suit the British Standard 400/230 volts 4-wire, 3-phase system now used in the S.M.E. Advantage was also taken of the vacation of two large brick buildings by R.E. Records to provide better facilities for overhead line and cable jointing instruction. Photos 2, 3 and 4 illustrate these workshops.

Other instructional facilities recently provided include a H.V. Rectifying Test Set (40,000 volts).

Workshops.

Some of the workshop buildings are of fairly modern construction, but others had apparently been standing from time immemorial. The foundry and the smiths' shop were both dark and dismal caverns,

and their lay-out primitive. Photos 5 and 7 show what they looked like, though unfortunately it did not occur to the writer to take these photographs until the smiths' shop had been already stripped of its equipment.

The smiths' shop shared with the south bay of the machine shop a wooden truss roof of peculiar and complicated construction, warranted to admit a minimum of light, and allowing much of the dust and smoke of the smiths' shop to pass over the party wall into the machine shop. Owing to the proximity of the forge and foundry, the moulds suffered considerably from the concussions of the power hammer.

The machine shop, apart from the roof over the south bay, was structurally satisfactory, the two north bays having been built in 1906, with a steel-framed saw-tooth roof. The lay-out, however, was entirely devoid of system, machines having apparently been added from time to time wherever space could be found. Moreover, most of the machines being over thirty years old, many were worn out and the rest out of date.

Two steam engines, one an old but reliable low-speed Robey 30 h.p. horizontal, the other a modern Bellis & Morcom high-speed vertical engine, drove—and still drive (1930)—the main shafting, supplemented by electric group drives. These arrangements were satisfactory, but the transmission arrangements called for considerable improvement.

The remaining shops were generally satisfactory, but the lay-out of the saw mill required attention. The machines here had originally been driven by a Diesel engine of great age ; when this engine finally retired from active service in 1925, all machines were equipped with electric drive, the lay-out being unchanged. Several machines required renewal, and it was evidently a good opportunity to revise the lay-out completely.

It was not originally proposed to touch any other shops, but as will be seen, it was eventually found possible to obtain a certain amount of new equipment and carry out various other improvements.

The alterations are briefly described below :—

1. A new smiths' shop (Photo 8) was built. Building work was executed by contract, the old forges and machines being installed by sapper labour. The old Roots blower was scrapped, and a new centrifugal fan and pipe system was installed by Messrs. Alldays & Onions. This firm also installed an exhaust fan and pipe system for removing the smoke and flue gases, with a single chimney superseding the individual natural-draft chimneys of the old shop. These fans were direct-driven by electric motors. This system is a great improvement on the old one ; the air of the shop keeps clear at all times, and the shop is cool in the hottest weather.

Under the same roof is the welding-room, equipped with oxy-

acetylene plant (both high- and low-pressure system), pre-heating furnace, and a quasi-arc motor generator; all the equipment except the motor generator came from the old shop.

2. A new foundry was built, also by contract. (See Photo 6.) This contains practically nothing from the old foundry, except the traveller crane. A 1-ton cupola and a 5-cwt. cupola—the latter a tilting one—each with centrifugal blower, were supplied and erected by Messrs. Alldays & Onions. By building the foundry into the bank which bounds the area on this side, it was possible to get a lorry road up to the charging platform, where stores for coke, pig, etc., were built.

A crucible furnace for brass, etc., was built in brick, the iron-work being provided by our own moulders. The building is bright and airy, and a great improvement on the normal foundry in this respect.

3. Nothing could be done to the machine shop until the old smiths' shop had been cleared, so this part of the work had to wait till September, 1929, when a start was made by sapper labour; the first step was to clear the south bay of all equipment and partition it off so that it could be handed over with the old smiths' shop to the contractors for re-roofing. To do this a number of machines were scrapped or sold, and the remainder crowded temporarily into the remaining two bays, which were kept in commission all the time. The old roof was removed by the contractor, and a new saw-tooth roof of two 25′ bays erected. The party wall was demolished and replaced by steel stanchions. The floor was then tackled by a class of concretors under instruction, who ripped up the old floor with pneumatic tools and laid a new one with machine beds raised 3″ above the rest of the floor. A contractor then completed the work by laying 3″ wood blocks over the floor, thus levelling up to the machine beds. The installation of machinery was then carried out by sapper labour. As soon as the new bays were ready for use, the rearrangement of the old bays was taken in hand. Finally the floor of the old bays was relaid by sapper labour.

Many new machines were installed.

A feature of the new lay-out is generous spacing of the machines and the provision of wide, straight gangways. This space is desirable in any shop—though frequently economy forbids it—but is especially necessary in an instructional shop, in which it is often necessary to collect a number of students round a machine, or conduct them through the shop. Some views are given in Photos 9, 10, 11 and 12.

4. In the saw mill, the old log band-saw, which was a constant source of trouble and of little use to us, was scrapped, and the remaining tools rearranged so as to simplify the handling of timber as far as possible, though the space available did not permit of a complete straight run-through. Timber coming in at the main door goes straight ahead through the rip-saw, but has to be brought back

to pass through the other machines; it does not have to be turned round, however, as it frequently did with the old lay-out. A new thicknessing machine and a lathe were bought, and the tool-room and store moved into the old Diesel engine-room. All machines producing sawdust or shavings in any quantity were provided with a complete suction system.

5. Other improvements are summarized below:—

(*a*) A small ammonia compression refrigerating plant, with an ice-making tank, driven by an electric motor, was purchased second-hand and installed in the vacated pattern store. This is used for instruction only at present, but space is available to make a cold store if desired at a later date.

In the same room was installed a Mather & Platt Electrolyzer for the production of sodium hypochlorite from brine; this solution is used for sterilizing and freshening the swimming bath.

(*b*) A new semi-Diesel engine, a small cold-starter, a portable petrol-paraffin engine, and two second-hand automobile engines were bought for the instructional engine shed, also a Boulton & Paul Water Elevator and a Rees-Roturbo-Watermota Portable Pumping Set—the latter being the machine which has been selected for the use of R.E. field units.

(*c*) A quantity of garage and motor repair equipment was purchased, including cylinder grinding plant—the "Hutto," a tool which can be used in conjunction with either a portable electric drill or a radial drill—and the Black & Decker valve refacing equipment, which obviates all hand-grinding of valves. The shops are now equipped for practically all kinds of motor repair work.

(*d*) A concrete mixer, a portable air-compressor, a pneumatic road-ripper, and a pneumatic rock-drill, were purchased, thus greatly enlarging the scope of the work which can be undertaken by concretors' classes.

(*e*) The steam system was improved by the addition of an electric condensate pump and a C.O. and $C.O._2$ recorder.

CONCLUSION.

The above completes the story up to the end of 1930, when the special allotment was spent and the shops at that date were probably as well equipped as any instructional workshops in the country. Many further improvements, however, have since been made and others are in hand or contemplated.

MODERNIZATION OF THE ELECTRICAL AND MECHANICAL SCHOOL, S.M.E.

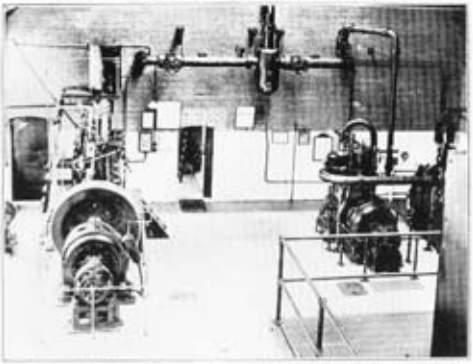


Photo 1.—Power Station, showing Davey-Paxman and Browett-Lindley sets.

Photo 2.—Cable Jointing Shop.

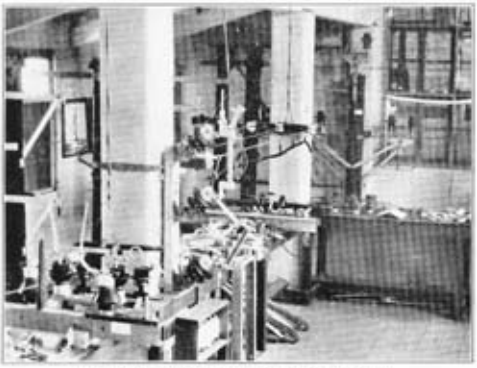


Photo 3.—Overhead Lines, Model Room.

Modernisation of the E&M School, S.M.E. 1-3.

Photo 4.—Overhead Lines Shop, and Specimen Poles.

Photo 5.—Old Foundry.

Photo 6.—New Foundry.

Modernisation of the E&M School, S.M.E. 4-6

Photo 7.—Old Smiths' Shop (forges removed.)

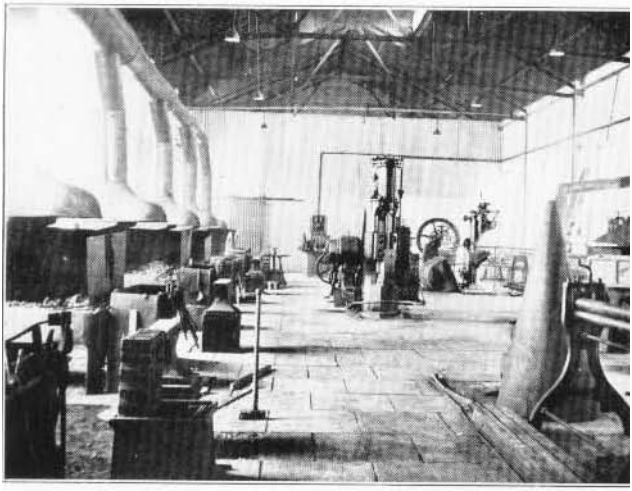
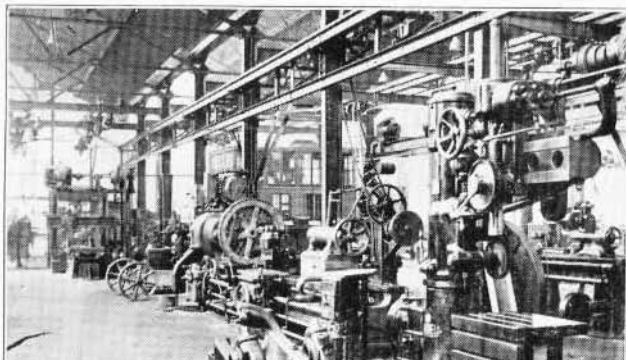


Photo 8.—New Smiths' Shop.



Modernisation of the E&M School, S.M.E. 7-9.

Photo 10.—Machine Shop—second bay and foreman's office.

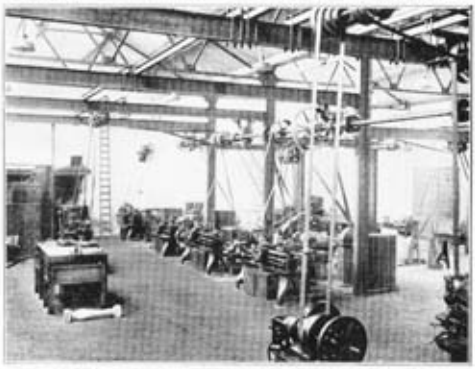


Photo 11.—Main Turning Department, and "odd job" section beyond.

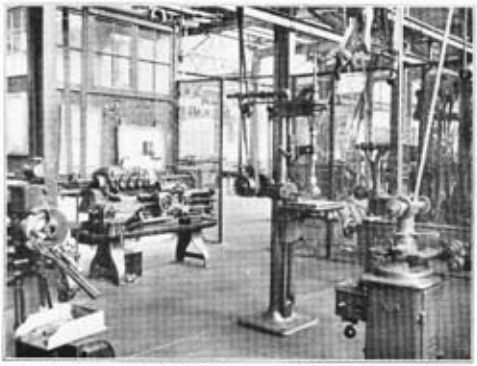


Photo 12.—Tool Room.

Modernisation of the E&M School, S.M.E. 10-12

MECHANIZATION AND DIVISIONAL ENGINEERS.

By BREVET-LIEUT.-COLONEL G. LE Q. MARTEL, D.S.O., M.C., *p.s.c.*, R.E.

EVERYONE must have read Lieut.-Colonel Fitzpatrick's series of articles on "Divisional Engineers and Mechanization" with the greatest interest and it was very valuable to have the whole case put so compactly and clearly in *The R.E. Journal.** There is, however, one aspect which Lieut.-Colonel Fitzpatrick did not touch, and which I did not go into in any detail during the two years while I commanded the 17th Field Company, and during which nearly all this work was initiated. This aspect may be described as follows.

The present organization of the Field Company dates back a great many years and is founded on the idea that the company may normally be called upon to work on its own with a force or in an area which may be very isolated. Hence, we find that the company is very self-contained. As a minor example, it carries spare pick helves and handles for shovels and many other spares which could be quite easily provided from rear organizations in modern war and with modern systems of transport.

Field Company officers grow up with this independent idea, with a result that the Corps accepts it as essential. There will, of course, be plenty of examples in the future where a Field Company will be quite on its own and require to be as independent of outside assistance as possible; but it may be that these will become the more exceptional cases, and that it may be necessary in future to consider Divisional Engineers more as a number of interdependent units and dependent for many requirements on supply from the rearward services, and it will then be necessary to make special arrangements for isolated Field Companies when such cases occur.

It is the increasing use of mechanized transport in the army that forces us to think on these lines. In *The R.E. Journal* for December, 1928, an article appeared by Lieut. Fitzgerald-Lombard, who was then in my Company, describing the work of the Company during some manœuvres on Salisbury Plain.

We had by that time designed and constructed the experimental tool lorry with its small jib, and the special superstructure and trailer for the transport of the pontoon equipment, and also the heavy folding derrick on the 3-ton six-wheel lorry. These were practically in their final form as they exist to-day; minor alterations had, of course, to be made in the detail design as a result of later trials, but a

* Issues of June, September, and December, 1931.

start had at last been made and the Company was by then completely mechanized and ready for any field engineering work. In addition, the Company had six 6-wheel 3-ton lorries with trailers carrying pontoon equipment, and the idea was that these had been sent up from the Corps to be attached to the Company as the Division was approaching a river. The outstanding point which struck us all during these manœuvres was that the mechanized Company was used to carry out more than three-quarters of the work of the Divisional Engineers (there were only two companies operating, of which one was mechanized and one horse-drawn).

The mechanized company was kept back in a fairly central position and rushed out by M.T. to carry out any necessary work, returning as soon as the work was completed. The unmechanized company, with its speed of 2½ miles an hour had, as usual, to be sent out with, or near, an infantry brigade before it was known whether any work would be required in that area, because unless it did so, it would waste hours getting there if work was suddenly and urgently required; and most manœuvres in which both mechanized and unmechanized units have since taken part have also proved this point. The result is that with unmechanized units, the C.R.E. is forced to disperse his units sooner than he would wish to do and he cannot then have them so well in hand when urgent and important work may arise.

At first this merely suggests that all Field Companies should be mechanized, but does it not also suggest that by using mechanized transport we could effect a greater degree of pooling of resources? We cannot overdo this and pool everything, because, although a centralized pool of sappers and equipment can reach any desired spot quite quickly enough under normal conditions, there are many cases where even cross-country lorries are tied to roads and traffic locks may cause congestion. The question of pooling must, however, be considered, and it can be divided up by considering what transport should be provided and where the following should be carried:—(*a*) personnel; (*b*) hand tools; (*c*) power tools; (*d*) demolition stores; (*e*) water supply equipment; (*f*) bridging equipment.

From the point of view of a unit, the ideal is for it to carry anything which it could want in war, so as to keep everything near and handy. With mechanical transport this leads to increasing demands for unit lorries, with consequent congestion on roads, increase in vulnerability from the air, and generally defeats the whole object of mechanization, which is to increase mobility. As regards personnel, there is little doubt that very extensive use will be made of mechanical transport for transporting men in any future wars—big or small. Anything in the nature of a tactical approach in buses or lorries is very difficult and full of dangers, but for troops to carry out a strategical movement on their feet at 2½ miles an hour is ludicrous in modern days. The

soldier is the last man left in the civilized world who walks to his work in this way; even the Pathan on the N.W. Frontier moves by motor-bus in these days. The danger from air attack is often stressed when men are moved in buses, but the target offered is probably much less easy than with men marching in fours. Aeroplanes can only bomb a road; they cannot bomb individual targets on the road, and the percentage of hits on lorries travelling at 20 miles an hour with 60 yards between lorries will surely be small. Yet lorries travelling at that pace and at these distances could carry four complete divisions with all their transport (if mechanized) from London to Brighton down one road, and in about 11 hours. It is, however, idle to suggest that each infantry battalion should have a complete complement of motor-buses as part of its unit transport, so that it can move by bus in this way when required. Without unreasonable financial expenditure, such moves can only be effected by keeping large pools of buses and charabancs in war which will move the units over these long distances and then revert to corps or army control.

This at once raises the point as to whether it would be possible to pool the transport for Field Companies. The answer to this point must surely be in the negative, for whereas the infantry are only moved to places when they are required, the sappers never know where they will be required till after the infantry get there. There can be little doubt that the sappers, like the gunners, must be a mounted arm with as much mobility as possible.

If, however, we want to keep the companies mobile and with their own lorries for the transport of personnel, we must not cumber them with things which they "might" require.

This brings us to the transport of the remaining items mentioned above. Hand tools must obviously travel with the men, in tool lorries for each section, but these should be kept to a minimum and spares eliminated. There are also many artisan tools which are carried in a Field Company, which are only required in stabilized warfare and which could quite well be relegated to the Field Park Company. It is true that only a few such tools are carried of each kind, but it is surprising how they mount up in weight and bulk.

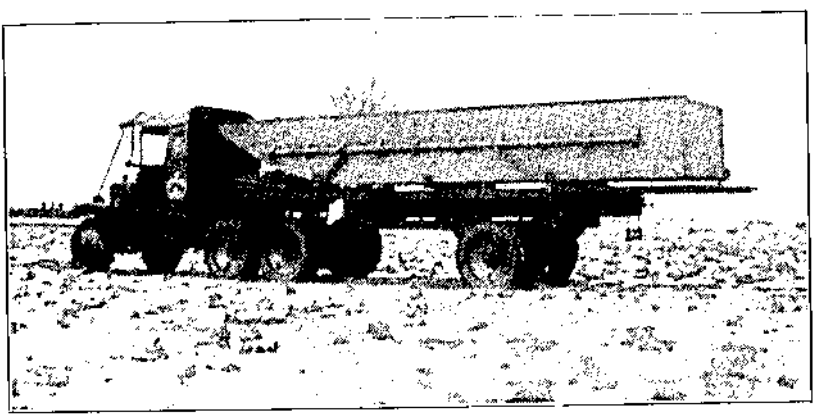
With power tools, the question is more difficult and until we have more experience no one can quarrel with the present policy of carrying some with the Field Company and some with the Field Park Company.

As regards demolition stores, it would seem that we could pool more of our resources with the Field Park Company, and send them up when required. Demolitions of an extensive nature are not usually required very suddenly or unexpectedly, and it would not take long to send them up by lorry from the Field Park Company to the unit concerned.

The transport of water supply equipment was referred to in my article on water supply in *The R.E. Journal* for March, 1931. As these stores are required every day (particularly in the East), and usually at a time when everyone is halting and roads are congested, it is not possible to risk keeping all these stores centralized with the Field Park Company.

Bridging equipment is already centralized. Could we pool the equipment still further? Rivers are not encountered accidentally. Does the division need even the bridging equipment which it carries at present? Equipment can always be sent up by the corps to live with the Field Park Company for a day or so before it is likely to be required, so as to be sure that it will be at once available.

These points are mentioned because they are not raised in Lieut.-Colonel Fitzpatrick's articles. They are only suggestions and merely



written with the idea of stimulating thought. There is much scope for discussion on this subject; only a few of the main points have been raised in this article, and they are only intended as suggestions which may lead to discussion which might be of general interest.

As regards the East, India has not been falling behindhand during this period. Field companies now have six 30-cwt. six-wheel lorries for the transport of water supply stores and water parties, which has proved of great value for this duty which is so important in the East. In view of our possible commitments on the N.W. Frontier, India cannot move too fast towards mechanization, but the H.Q. transport and one of the two sections in each Field Troop have been mechanized.

As regards power tools, India is using a Holman compressor on a two-wheel trailer. A four-wheel trailer is sometimes troublesome on the line of march, but a light two-wheel trailer of this nature causes no trouble. The advantage of carrying the compressor on a trailer is that it can often be manhandled more easily to some site which is inaccessible to a lorry; moreover, the lorry which tows the

trailer has room to carry some useful load as well; then again, any lorry, such as a personnel lorry (which is always underloaded), can, if necessary, be used to tow the trailer to some site where it is required.

As regards pontoon transport, we evolved an alternative type of transport in the 17th Company in 1928. This consisted of a 30-cwt. lorry with a Carriemore trailer, of which a photograph is shown. By this system half a complete bay was carried per lorry instead of the whole bay, which is carried by the 3-ton lorry with trailer. The latter has been selected by the Home Authorities with European warfare in mind, because it occupies less road space and is more economic in lorry drivers. It has, however, been definitely shown that the 30-cwt. lorry is far superior to the 3-ton for transport work of this nature in Eastern warfare. Hence, if the occasion arose to use a pontoon train in the East, it might well be necessary or desirable to revive our 30-cwt. pontoon transport design on the Carriemore trailer.

CORPS ARCHÆOLOGIA.

Economies at the Royal Military Academy, Woolwich, 1823.

In 1823, reductions in the staff at the Shop were contemplated, and amongst other posts the Lieut.-Governor proposed to reduce that of the Dancing Master; he wrote, "I think it right to observe with respect to that of dancing, that as the Art is now of so easy attainment and has so entirely lost the importance it was formerly supposed to possess, I am of opinion it can never commend attention as a part of Military Education, and therefore I recommend its abolition." On this Sir Henry Hardinge noted: "The Board do not concur with the Lieut.-Governor, they consider it [dancing] a part of a Gentleman's education, but are of opinion that instead of a Master borne on the establishment, and claiming increase of pay as he grows stiffer and older, that a visiting Master may be hired as in the case of large Schools and Military Seminaries."

THE PLANE TABLE.

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

IN the early years of this century, when the plane table had, at last, come to its own in English thought—long after, that is, it had been used to excellent advantage in India—the School of Military Engineering set itself to produce the service plane table. That pattern has stood the test of time. Yet it is not without the defects of its prime virtue, simplicity.

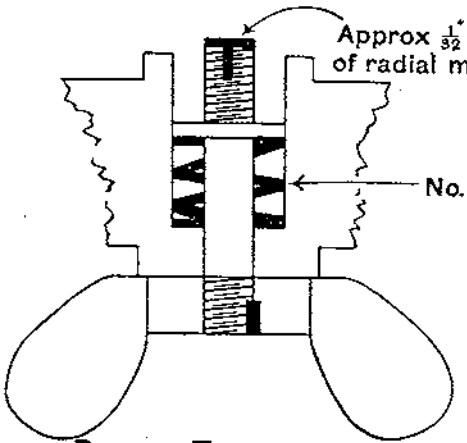
For one thing, legs and board are not so well standardized in manufacture as they might be. It is wise to be perfectly sure before sending a newly-plotted board to Corporal Atkins—some hundred miles away—that it will fit upon his tripod.

Then there are a row of minor improvements some would like to see.

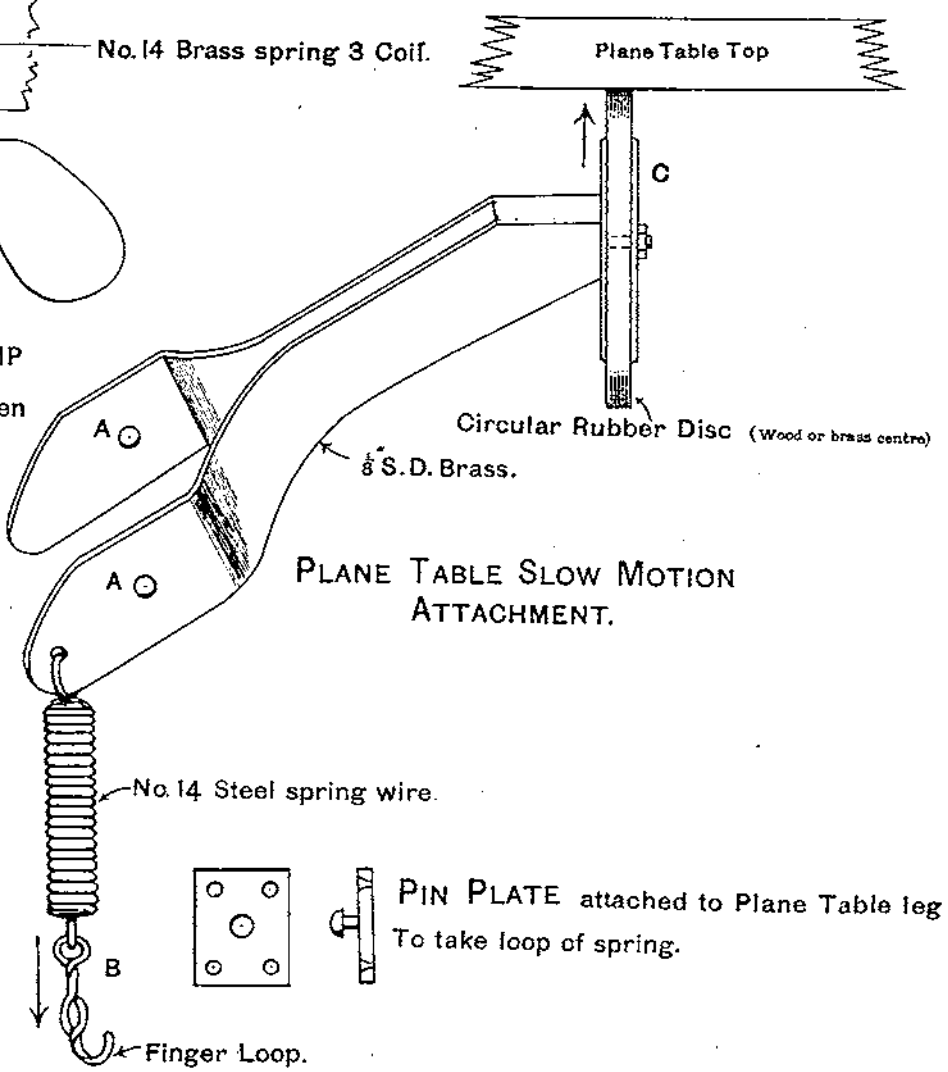
In the first place, the matter of levelling is often mentioned. Engineering plane tables include generally a ball and socket joint. Such a table can be levelled. But the ball and socket may readily be fouled with sand or grit, and although a new model by Messrs. Cooke, Troughton & Simms is nominally free from this defect I should myself be sceptical. Is it important to level accurately with the Indian clinometer which levels itself? The answer is no. The error of direction in rays due to dislevelment is hardly appreciable up to some seven degrees or so. The eye is sufficient guide up to that point. Let us avoid the ball and socket then.

Secondly, some form of slow motion in azimuth is often asked for. Curiously enough the real craftsman would rather be without. He has learnt to control his board so well that he does not require adventitious aids. We are not all experts, however. The slow motion (it need not be very slow) is a help. In war, when the old hands are few and perhaps by that time supervisors rather than workmen, one must legislate for clumsier fingers. So, too, when the Colonial surveyor—rather lonely without theodolite or chain—takes his brief excursion into graphic method.

A slow motion is good. It can be fitted on the service plane table very easily, and as easily removed. The accompanying sketches are ample guide to construction and attachment. Messrs. Cooke, Troughton & Simms can provide. It will be noticed that there is no screw. An ordinary india-rubber heel pad provides a friction drive. The attachment costs about a pound if ordered in quantity.



PLANE TABLE
CENTRAL CLAMP
Showing additions to permit of rotation when clamped.



PLANE TABLE SLOW MOTION ATTACHMENT.

A. Holes for attachment to Plane Table Leg.

B. Loop to be attached to pin plate on Plane Table Leg.

The tension of the spring causes the points A to act as a fulcrum, and forces the rubber disc C into contact with the underside of the Plane Table.

PIN PLATE attached to Plane Table leg To take loop of spring.

Sketches only - not to scale.

77ED-2900/32.

O.S.O. 1931.

Next and most serious comes the graticule. For years we have used paper over linen, or linen mounted. We have cursed the thunderstorms which distorted our work, and measured the distortion before plotting newly-fixed trig. points. The new plotting has had to be postponed till the last minute, the whole board sent off many miles perhaps, and the old board returned. The reviser finds that the boards of his section will not fit on his own tripod, and eventually the draughtsman must replot his trigs. and fit the detail to them in making his fair drawing.

All these troubles are directly due to lack of expansion-free, humidity-proof material. In the immediate pre-war years many experiments were made. Bristol boards were an improvement, but not a great one. The American celluloid and the "blow and bedamned" attachment were tried and abandoned. Grained aluminium seemed to promise, but was undesirable in hot climates, and so at last came the Ordnance Survey plane table, described in the textbook of *Topographical Surveying*, page 116, second edition.* It was not until the war was well over that we realized the unnecessary intricacy of that model. It had an aluminium graticule on one side of which paper was mounted over linen. The cockle of the aluminium at the edges, drawn up by shrinking paper, was kept under by tension from springs in the open frame table. Meanwhile the Swiss had been using aluminium, too, but by mounting paper on both sides and by attaching to the table by strips of ordinary medical plaster, they had kept the metal flat and avoided the weight and cost of springs. In 1927, Captain Schneider, of the Swiss *Landestopographic* sent us full details of his methods, and we can but copy and thank him.

After the war the final design was taken up again. In our British fashion we sought for the proper universal pattern. The Colonial Survey Sections were then in the tropical forest belt. In those damp and difficult places the chain rules rather than the plane table, but still it was there we sent graticules to see how best we could eliminate corrosion of the aluminium. The riddle is still unsolved because reports on a matter which does not interest them is difficult to wring out of the officers concerned, but it shows signs of yielding. The Ordnance Survey can supply data as to the best adhesives to use and how far the corrosion (oxidization) has been overcome. In subtropical or temperate climates, however, this difficulty is either negligible or slight. The graticule has to hold its shape and appearance till survey and revision are done and till the camera has taken its more lasting record. The individual graticules can be cut

* See also *R.E. Journal*, 1914.

(*a*.) "Mounting Bristol Boards and Drawing Paper on Plane Tables."—Captain R. H. Phillimore.

(*b*.) "Plane Tables and Field Sheets."—Capt. H. St. J. L. Winterbotham.

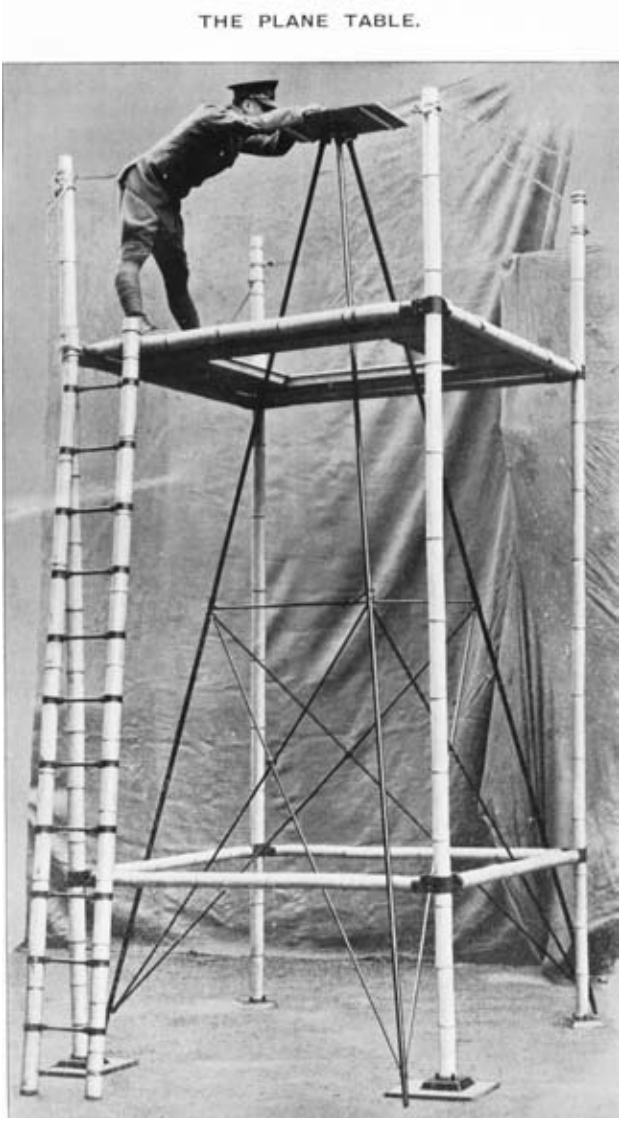
to the plotted edges, held by suction to the copy board and photographed into sheets. The original is now well-nigh finished with and its last job is to act as explanation during the fair drawing.

Now one last point. The plane table is regarded as useless in countries of elephant grass and thorn scrub. Surveys are normally carried out by traverse. The ancient methods of Egypt and Sumeria come to their own, and, of course, the cost goes up in proportion. Yet throughout the drier portions of our tropical African Empire there are enormous tracts of elephant grass or thorn scrub where a fifteen-foot command would pass the ball back to the plane-tabler. In these areas an interpolation and height every half-mile or so would, or might, eliminate traversing, with its gangs of surveyors and labourers. Actually in the wetter forest, I doubt its general application although I have no doubt whatever as to the wisdom of its occasional use. In 1929, correspondence and rough designs were considered by all the surveys affected. In 1931, a " bush plane table " (see illustration) was evolved. In designing this model the first point was to construct a light and rigid tripod. The one illustrated is of duralumin, and was made by Messrs. Cooke, Troughton & Simms. A tripod of this height can hardly be levelled by eye. A ball and socket levelling top is, then, a necessity. So rigid does it seem that experiments were carried out, on the parapet of an exposed high-lying fort and in half a gale of wind, to see whether it could not be used for theodolite work. Under the most unfavourable conditions the theodolite was so steady as to close on the R.O. within the bisection error of the instrument itself (a four-inch micrometer). The tripod then gives a fifteen-foot command and the rigidity required not only for the plane table but for topographical triangulation.

The stand, or scaffolding, built of such bamboos as we could acquire, carries three men at a pinch. The platform is of four light duralumin footboards fitting over bamboo bearers. The whole can be erected in an hour by unskilled labour, or, shall we say, in a quarter of that time by an experienced gang. The whole—tripod and stand —gives some four men-loads.

To the Sapper who has done his boundary commission, or his topo. survey, the value of this " bush " plane table is obvious, for whether the detail is to depend upon plane table or air photo, it will require positions and heights. With judgment and an eye for country this outfit will catch both in almost any country.

The weight of the bamboo staging and duralumin platform is 261 lb. That of the tripod 42 lb. The original model cost £96.



Bush plane table

THE USE OF BITUMEN EMULSION FOR MIX-IN-PLACE WORK.

By BRIG.-GENERAL E. G. WACE, C.B., D.S.O., *p.s.c.*

CONSIDERABLE interest is bound to be aroused by Captain Campbell's interesting article in the June number, and by Captain Noakes' sequel in the September number, of *The R.E. Journal*, describing a rapid and cheap method of constructing roads suitable for the more or less undeveloped areas of the world. Both these articles deal with mix-in-place carried out with road oils, but this type of construction can equally well be carried out with bituminous emulsions. Moreover, bituminous emulsions can be used with damp aggregates, whereas with road oils the moisture content of the aggregate should not exceed 2%, and hence in cases where relatively dry aggregates are not certain of being available, the use of an emulsion has an obvious advantage.

A bituminous emulsion may be loosely described as a suspension of minute particles of bitumen in water; the presence of moisture in the aggregate is, therefore, not detrimental but is actually beneficial as tending to facilitate the dispersion of the binding medium throughout the aggregate. Moreover, the characteristics of the bitumen in the emulsion can be varied so as to use the most suitable grade of bitumen without materially altering the essential properties of the emulsion, and hence without seriously increasing the difficulty of mixing.

Before leaving the theoretical consideration of emulsions, it is as well to point out that the stability of an emulsion can, within limits, be controlled in manufacture; that is, the rate of break of the emulsion can be accelerated or retarded according to the conditions of the work to be carried out. In general, it may be said that an emulsion for mix-in-place work must be highly stable and capable of being diluted with water to an indefinite extent without coagulating. This dilution with water will facilitate the operation of mixing, but it must be borne in mind that most of the water has to escape before the treated aggregate will attain its desired hardness. A happy mean must, therefore, be struck between the desiderata of efficient mixing and of rapid setting-up. The period of time required for the setting of the road constructed with an emulsion depends on the rate at which the water escapes by evaporation, absorption, or drainage. In the hotter countries this rate is relatively rapid, and,

under these conditions, emulsion mix-in-place surfaces set up to a hard condition in a very short period.

A considerable amount of work has been done in different parts of the world using emulsion with various types of aggregate, and a brief mention of contracts carried out in two such distant countries as Canada and Australia will illustrate the possibilities of this process.

In Canada, one length of 5 miles by 20 feet of the Ferguson Highway, Ontario, was treated by the mix-in-place method. The aggregate used here was crushed stone and it was treated with 1¾ to 2 gallons of a special grade of emulsion per square yard. Every operation was carried out by mechanical means and the method of procedure was that described in Captain Campbell's article. The road was rolled after the emulsion had broken and was surface-dressed with standard emulsion and finally chipped up. The Photographs Nos. 1 and 2 illustrate the application of the emulsion from a pressure tank and the operation of the grader. Other contracts were treated in a similar way, using round gravel and crusher-run gravel. The application of emulsion varied from 1 gallon to 1¼ gallons per square yard, the quantity varying with the thickness of the finished wearing surface; in every case the road was finally sealed using emulsion at four square yards to the gallon. All these roads have behaved excellently under traffic, and have been quite unaffected by the severe weather conditions.

In Australia, the aggregate consisted of granite gravel under ½" in size, mixed with quarry dust; the rate of application of emulsion per square yard was 1·3 gallons diluted with water. Efficient mixing was obtained by the use of graders and rolling was carried out as soon as a partial set-up had taken place. At the end of a week, the surface was so hard that the roller could not mark it. In this case no seal coat was applied, as a rather rich dose of emulsion was used in mixing, and the finished surface appeared to be completely waterproof.

As examples of the rate of progress in emulsion mix-in-place work two or three cases may be quoted. In Canada, and with a crushed stone aggregate, half an hour is given as sufficient for one grader to mix a length of 360 ft. x 20 ft. wide. Data from California on one contract, again using crushed stone aggregate, indicates that about three turns with a blader provided efficient mixing. From the application of the emulsion to the final spreading of the mixed material over a length of 800 ft. x 20 ft., the time taken was one hour. With an aggregate containing appreciable fine material such as sand, the rate of progress is, of course, not so rapid, but even so, on one such job in California, three motor graders completed in 8 hours a length of 800 ft. of roadway by 40 ft. wide, *i.e.*, about 3,600 sq. yds. This rate is equivalent to a mile length of road 18 ft. wide being completed in three days.

No. 1.—The application of the emulsion by means of a pressure distributor.

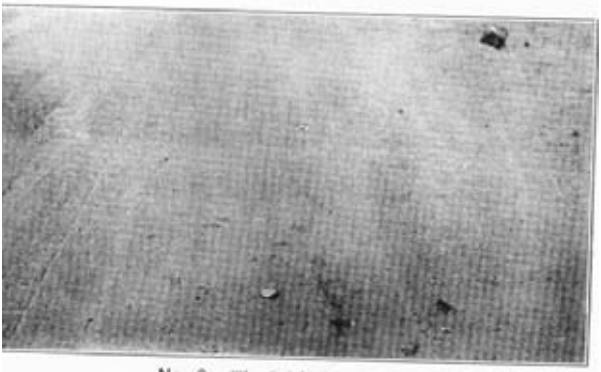
No. 2.—A tractor-drawn grader in operation.

No. 3.—A grader forming a windrow of scarified material.

Use of bitumen emulsion for mix-in-place work 1-3

No. 4.—Mixing with a tractor-drawn disc harrow and spike drag.

No. 5.—Mixing with a self-propelled grader controlled by one man.



No. 6.—The finished surface.

The jobs mentioned above deal with the use of locally-crushed stone or gravel or gravel/sand aggregates, but another extremely useful phase of this method of treating roads, comprises the actual mixing of earth and soils.

In Mexico, several trials were put through on lines similar to those described above, and one in particular was carried out using the actual soils *in situ*. These soils were of various types, such as fine loam, clayish material with good natural binding properties and forest soil containing organic matter. The procedure was to loosen the top six inches of the existing surface material and, after breaking it up with a harrow and drag, to apply emulsion at the rate of 1·2 gallons per square yard. The aggregate and emulsion were then mixed with a disc harrow and grader and, when of uniform colour, the mixture was spread with a grader to the correct levels. Consolidation was carried out by rolling and, after the road had been exposed to traffic for four days, a seal coat of emulsion covered with pea-gravel was applied in the usual way. The use of the disc harrow and grader is illustrated in photographs Nos. 4 and 5, and photograph No. 6 shows the road surface after nine months' use, no maintenance whatever having been carried out in the meantime.

In England, a bituminous emulsion has given very successful results when used in conjunction with a large variety of aggregates, such as earth, sand, gravel, ashes, chalk, and mixtures of these materials, but the size of the areas treated has not warranted the adoption of mechanical mix-in-place methods. The results obtained on aerodromes, footpaths, playgrounds and similar areas carrying light traffic have been so encouraging that experimental lengths have been laid both at Chatham and Aldershot which will be subjected to severe traffic conditions. The ordinary material *in situ* was taken and mechanically mixed in portable concrete mixers. The behaviour of these lengths is being carefully watched and the information derived from the variations of procedure and specification should be extremely useful.

ENGINEER RE-ORGANIZATION IN INDIA.

By CAPTAIN H. B. HARRISON, R.E.

1. The recent decision to abolish Pioneer regiments in India has led to the existing Sapper and Miner organization undergoing certain changes.

It is thought that a short account of these changes may be of interest to R.E. officers who have served or are yet to serve in India.

2. REASONS FOR ABOLITION OF PIONEERS.

(*a*) The main employment for Pioneers in the past has been the construction and maintenance of roads.

Much scope existed for this work in the type of operation in which the Indian Army was engaged in pre-war days, when regular troops were not stationed across the administrative border and our punitive expeditions were of the nature of " burn and scuttle " operations.

Conditions have now definitely changed. Regular garrisons are stationed in a number of cases in tribal territory : roads have been made : raids into administrative territory have almost ceased.

Our general policy, now, is to build roads in tribal territory as opportunity occurs and funds are available, and thus gradually open up the non-administered tracts and so bring the tribesmen under some sort of control and incidentally to civilize them.

Such roads as are constructed are built mainly by contract and with civilian labour. Hence in war or in time of tribal disturbances the necessity for Pioneer units has largely disappeared. For such road work as may still be necessary in war, provision can be made by road-construction battalions raised on mobilization.

(*b*) It is desirable that the Engineer troops of a division should be as far as possible homogeneous in composition. The Sappers and Miners can be called upon to execute or supervise any work that might normally fall to the Pioneers, whereas the Pioneers are not capable of carrying out many tasks within the powers of the Sapper and Miner units.

(*c*) The urgent need for economy makes unjustifiable the retention in the army of any portion of it that is not absolutely essential for war requirements.

3. EFFECT ON SAPPER AND MINER ORGANIZATION.

The abolition of the Pioneers has raised the two following problems :—

(*a*) To what extent, if any, should existing Sapper and Miner units be increased ?

(*b*) In what way, if any, can the Pioneer personnel be absorbed.

(*a*) *Changes in establishment of Sapper and Miner Units.*

The first question has been answered as follows :—

The K.G.O. Bengal Sappers and Miners will convert one Roorkee Field Company into an Army Troops Company, making two Army Troop Companies each in Bengal and Madras Sappers and Miners.

The Chitral Section as a separate unit will be abolished and accounted for as a detached section of a Roorkee Field Company until either 1933 or 1934 (depending upon whether it can be relieved in 1933 or not), when the Section for Chitral will be formed by detaching a section from the Field Company, Royal Bombay Sappers and Miners, normally located at Kohat.

The Divisional Headquarters Companies of the 3rd and 4th Divisions, Meerut and Deccan Districts respectively, will be brought up to the strength of the other two Divisions in personnel.

Detailed peace establishments for all units will be issued by Army Headquarters when finally approved. The main changes, which generally apply to both war and peace establishments, are :—

Field Troop. The addition of a Jemadar, an allowance of men to cover the period of instruction in riding, and an allowance for movement and unfits, *e.g.*, 15 I.O.R's and 14 animals.

Field Company. The addition of one B.O. and 1 section both in peace and war. A small increase in the size of the section. An increase in artificers allowed per company from 24 to 56.

The total Company now to number 320 instead of 234.

Extra transport for extra section only.

D.H.Q. Company. The addition of 1 B.O., 1 B.N.C.O. and 1 section. An increase of from 85 to about 145, no change in artificers, which remain at 50. To be organized as H.Q., 1 Workshop section, and 1 Fieldworks section.

No material change in transport.

Army Troops Company. Re-organization into 2 Sections. No increase in strength, except perhaps 1 Naik ; loses 1 B.N.C.O.

H.Q. and Depots. Completely re-organized into :—

(*a*) Training Battalion of 3 Training and 1 Depot Company.
(*b*) Records unit.
(*c*) Workshops.

Involves an increase of 7 B.O's and 3 B.N.C.O's at Bangalore, 7 B.O's and 2 B.N.C.O's at Roorkee, and 7 B.O's and 2 B.N.C.O's at Kirkee.

No major changes in equipment are proposed as part of this re-organization. Water-supply gear remains as at present. The question of improved pumps, tanks, searchlight, workshop and derrick lorries has been under consideration for some time, and new types can only be introduced as the life of present stocks is exhausted.

The need for all units changing round between outstations and the H.Q. of Corps is accepted.

Army Troops Company. One Bangalore A.T. Company will be located at Quetta from early 1933. One Roorkee A.T. Company will be located at Nowshera in existing Pioneer Lines.

Field Companies. One Roorkee Field Company from Rawalpindi will be located at Nowshera in existing Pioneer Lines. One or two sections, as governed by accommodation at Peshawar, of the Peshawar Field Company, will also be located at Nowshera.

The location of the Madras Sapper and Miner Field Company, if and when returned from Burma, is not yet decided.

The strengths of the 3 Corps on re-organization will be :—

Q.V.O. Madras S. and M.	...	2888 + 630 recruits.
K.G.O. Bengal S. and M.	...	2765 + 600 recruits.
Royal Bombay S. and M.	...	2400 + 525 recruits.

The location of units in each case will be :—

Q.V.O. Madras S. and M.

1 Field Troop	... Sialkot.
1 Field Company	... Razmak.
1 Field Company	... Wana.
1 Army Troops Company	... Quetta.
1 Army Troops Company 1 D.H.Q. Company 1 Field Troop ... 3 Field Companies	Bangalore.

1 Field Company, *ex* Burma, location not yet decided.

K.G.O. Bengal S. and M.

1 Field Troop	... Risalpur.
1 Field Company	... Rawalpindi.
1 Field Company	... Nowshera.
1 Field Company ...	... Peshawar (less 2 sections temporarily located at Nowshera).
1 Army Troops Company	... Nowshera.
1 D.H.Q. Company ...	... Rawalpindi.
1 Army Troops Company 2 Field Companies 1 Field Troop ... 1 D.H.Q. Company	Roorkee.

Royal Bombay S. and M.

1 Field Company ...	... Kohat (less one section).
1 Section Field Company	... Chitral.
2 Field Companies ...	... Quetta.
1 D.H.Q. Company ...	... Quetta.
3 Field Companies ...	... Kirkee.

(*b*) *Absorption of Pioneers.*

This will be carried out as follows :—

Corps of Madras Pioneers ...	About 940 men to be absorbed into Madras S. and M.
Corps of Bombay Pioneers ...	About 160 Meos to the Bengal S. and M. About 133 Mahrattas to the Bombay S. and M. About 160 Lobana Sikhs to the Bombay S. and M.
Corps of Sikh Pioneers ...	About 160 Lobana Sikhs to the Bombay S. and M. About 320 Mazhbi and Ramdassia Sikhs to the Bombay S. and M. About 320 Mazhbi and Ramdassia Sikhs to the Bengal S. and M.

In addition to the above, a number of Pioneer personnel will be given openings in Indian Infantry and in the machine-gun platoons of British Infantry regiments in India.

The Hazara Pioneers are being disbanded and are not being absorbed.

4. Conclusion.

As a result of the abolition of the Pioneers and the increased strength of Sapper and Miner units the working strength at the disposal of the C.R.E. will suffer a reduction of approximately 27%.

It may be argued, therefore, that a risk is being taken in war. It is considered, however, that the present altered conditions on the North-West Frontier will enable all likely obstacles to be overcome by the improved organization and higher skill of the divisional engineers assisted by road-construction battalions raised locally after mobilization.

It seems likely also that mechanical plant such as air compressors, stone-crushing machines, etc., will be available in war to make good much of the loss in labour.

The mixing of Mazhbi and Ramdassias with Jat Sikhs in the K.G.O. and Royal Bombay Sappers and Miners is an innovation which will be watched with interest. It is a step that would have been taken with considerable misgivings only a few years back, but which is viewed now merely as another step in the rapid transformation taking place at the present time throughout political India.

" TEMPORA MUTANTUR."

By " K.S.V."

" ALL Sir Garnet, sir ! "

There must be many older members of the R.E.Y.C. who remember those words and the speaker of them. The Club owned in those pre-war days *Fulmar*, a ten-ton cutter, not without fame in a subsequent ocean race, and as its paid hand Clinker (as we will call him), the subject of this sketch.

Perhaps we as " Y.O's " appreciated his good qualities, perhaps we did not, but there is no doubt that the senior members of the Club, who themselves no longer cared to spend somewhat uncomfortable week-ends exploring the rivers and creeks of the Thames Estuary, thoroughly appreciated Clinker's value as insurance for the safety of the yacht and its younger crews : for any paid hand less reckless, and less ashamed to acknowledge " safety first " as his motto in life, it is difficult to imagine.

" What about running across to Holland to-morrow ? " some brave spirit would suggest when supper was cleared away, and the muddy waters of the Swale were gurgling contentedly past our sides.

" Good idea ! " another would reply. " Let's see what old Clinker thinks about it."

Forrard in the fo'c'sle Clinker would be washing up, a job which he made little pretence of liking.

" Next time I'll bring my blinkin' sister with me," he was wont to murmur very audibly in his beard. It was well known that he had no sister, but the hint that we might use fewer plates, and put less butter on those we did use, had its effect on us for the rest of the cruise.

When the clatter had subsided, and Clinker had borrowed a pipeful of baccy " as you young gennelmen might not like the smell of mine," the Ostend project would be broached to him.

Clinker would finger his beard meditatively. " What's the glass say ? " he would then ask. " High and steady," might be the reply.

" Wind now sou-sou-west—veered a little since mid-day," he would continue musingly.

Then seeing no loophole in the possibility of bad weather, he would carry the war boldly into our country.

"Any of you gennelmen ever bin to Ostend?"

"Not in a yacht," would be the reluctant reply.

"Nasty place to get into—worse still to get out of. When 'ave you got to get back?"

"Monday morning."

"Difficult place to get out of if it blows 'ard. I remember once. . . ." and a gloomy recital of one of his early experiences as a Thames pilot would follow. During this our faces would fall, and Clinker would not be slow to notice the fact.

"But," he would continue with a breezy cheerfulness, "don't let me put you off, gennelmen. I've got no one dependent on me!"

Needless to say, we would content ourselves with Burnham or Brightlingsea the next day.

On one famous occasion, he succeeded in keeping the yacht for five days at her anchor in Portsmouth Harbour, in gusty but perfectly good sailing weather, by persuading a young and inexperienced crew that conditions outside would be "terrible." The sixth day was too fine even for Clinker's ingenuity, and the crew proceeded to weigh anchor . . . to find it foul of the *Victory's* moorings. The day was spent in recovering it, with the costly help of divers, and on the seventh day it was really blowing hard. The crew returned by train, leave expired, with a suspicion that yachting in Clinker's paternal care was apt to be an expensive pastime.

Perhaps it was this crew or merely their avengers, who on a subsequent occasion gained complete and undisputed control of the yacht for some twenty-four hours. In a nasty little lop off the Foreland one fresh morning Clinker parted with his breakfast, to the ill-concealed delight of the crew.

"That black-currant pudden you give me last night lay uncommon 'eavy on my stummick," said Clinker in extenuation. "When you gets ashore in Dover, I'll trouble you to get me a box of X's pills. I've 'eard a lot about them pills."

In due course, we fulfilled the commission and presented him with a box of a world-famous medicine.

Clinker eyed the box somewhat doubtfully, and finally shook a few of the contents into the palm of his hand.

"'Ow many of these little things should a grown man take?" he asked at last.

"A big strong man like you could probably do with a dozen," said the humorist of the party promptly.

Before anyone could intervene, Clinker crammed a small palmful into his mouth, threw back his head, and they were gone. . . .

And, as has been said, for twenty-four hours the crew had complete and undisputed control of the yacht.

On another occasion, *Fulmar* grounded one hot and windless August day on the Ryde Sand, and after a day's bathing and grilling on the shadeless deck, the crew put into Cowes in the evening for liquid provisions.

After an unsuccessful attempt to land at the Squadron Steps—an attempt made in ignorance of the fact that Cowes Week was in progress, and that the Squadron Steps were not accustomed to receive visitors clad in old tweed coats and disreputable grey flannel trousers—the crew got ashore at the Town Steps, just before sunset. Whilst they were ashore the sunset gun was fired, and instantly on every yacht in the anchorage, save one, the burgees fluttered down to the decks.

In the one exception there was no sign of life, and the crew ashore gazed impotently at her, wishing that the waters of the Solent would open and swallow her and her offending burgee before their eyes. But five minutes later Clinker rose to the occasion. The noise of the gun had at last penetrated into his dreams as he lay asleep in the fo'c'sle. Clad only in an old army "grey back," long woollen drawers to his ankles, and grey army socks, he rushed on deck, and after fumbling an eternity with the halliards, hauled down the burgee. Then, conscious of honour saved, he turned to survey the assembled yachts—to see the entire crew of some twenty paid hands of a large racing schooner, all impeccably clad in spotless white ducks and linen caps, watching him from a few yards away. The sight was too much for him, and he dived below, not to reappear until well after dark, when *Fulmar* slunk out of the roadstead.

But those were the days when the R.E.Y.C. did not enter for ocean races, and knew not Cowes, and when the one and only yachting cap in the Club was worn by Clinker.

Things have changed since then.

REPLACEMENT OF VAUXHALL BRIDGE, MONMOUTH.

By CAPTAIN A. J. MACDONALD, R.E.

WHILST there are certain unusual points connected with the technical details of the work which this article purports to describe, its main object is to pay tribute to the keenness and efficiency of the units of the Supplementary Reserve and the Territorial Army which had a hand in it. I feel that it is peculiarly appropriate this year when the normal T.A. and S.R. annual camps have been suspended.

This suspension, though, undoubtedly, a measure of national necessity, is a heavy blow to the part-time soldier, and to no arm more than to the Royal Engineers, who have so little opportunity of obtaining valuable training except during their yearly fortnight in camp. During the course of the article, the names of the units concerned will occur, and it will be obvious that the most interesting and spectacular parts of the work fell to the lot of the Royal Monmouthshire R.E. This unit, therefore, figures prominently and may be said to be in the "limelight." But, in justice to the other units, it should be remembered that the dull donkey work, both before and after the actual launching of the bridge, was just as necessary to the completion of the scheme as the launching itself.

Weather was against the work from start to finish, and it is not too much to say that all concerned displayed an amazing zeal and determination to bring the job to a successful conclusion.

GENERAL DESCRIPTION OF THE PROBLEM.

Vauxhall Camp, Monmouth, is bounded on the north-east and east by the River Monnow, which flows at this point between steep banks. At normal summer level, the river is some ten feet below the bank level.

There are but two approaches to the camp which are practicable to vehicles, one of which crosses the Monnow by Vauxhall Bridge.

Prior to 1931, this bridge (alluded to henceforward as "The Old Bridge") was a wooden structure supported on timber piles. It had been built by the Royal Monmouthshire Engineer Militia not long after the South African War and, in course of time, many of its members had fallen victims to rot, until it had become quite unsafe for any but foot traffic.

It was, therefore, determined to replace the Old Bridge by one of a more permanent nature, and, with this object in view, the Adjutant, Royal Monmouthshire R.E.(M.)S.R., who was the nearest R.E. officer to the scene of operations, was ordered to prepare a scheme.

He was informed that the requisite number of bays of 15′ Rectangular Inglis Bridge, Mark II, to span the gap would be sent to Monmouth; but that, for reasons of economy, enough to form the usual launching tail would not be available.

THE SCHEME.

(1) *Choice of Site.* This was limited to the site of the Old Bridge, since the approach on the N.E. side (farthest from the camp) was a narrow strip of W.D. land, consisting only of the approach road.

(2) *The Gap.* The clear span between the existing abutments was 78 feet. The number of Inglis bays required, therefore, was six, making a total bridge length of 90 feet.

(3) *Abutments and Bank Seats.* The existing abutments, consisting of masonry retaining walls, though in good condition, were not judged strong enough to take the weight of the Inglis direct. It was, therefore, a real advantage to use a 90-foot span since the bank seats could be placed about six feet behind the abutments.

As the bridge was to be a permanent one, it was thought desirable to make the bank seats of concrete. The question was of what size. A massive block of concrete dumped down behind each abutment would merely increase the tendency of the earth behind to force them out into the river. On the other hand, too small a bank seat would not fulfil its duty of acting as a bridge foundation, and would probably sink unevenly. The solution adopted was, first, to try to consolidate the ground by driving in 6-foot lengths of rail and angle iron at a slope of 4/1; next, their tops, which projected some 6 to 8 inches from the ground, were wired together and concreted in.

The length of the bank seats was 18 feet and their other dimensions were kept as small as possible (see Sketch A), the whole idea being, in fact, to reproduce roughly the universal "twelve by twelve" type beloved of "F" exam. candidates, in concrete, keeping the whole thing as light as possible.

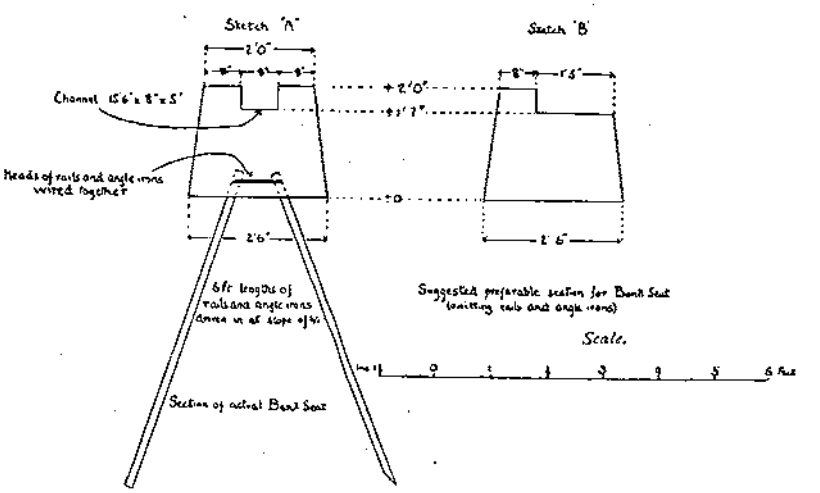
To take the shore transoms of the bridge, a channel, 15′ 6″ long by 8″ broad by 5″ deep, was made in each bank seat. The object of this was to prevent the bridge moving unduly at any time, and to avoid the necessity of bolting it down, while allowing room for expansion and contraction due to variation of temperature.

In practice, as will be seen, these channels were a nuisance; a section, as shown in Sketch B, is suggested as more practical.

One further point should here be mentioned. In order to reduce the angle at which the approaches come on to the bridge, the bank

seat on the N.E. side was shifted some six feet upstream of the Old Bridge abutment, thus altering the centre line of the new bridge as compared with the old. A subsequent extension of the N.E. abutment was thereby involved (see page 664).

(4) *Level of the Bridge.* Owing to the liability of the Monnow to flood, it was decided to raise the bridge above highest known flood level. This was about the level of the middle of the Old Bridge which had a considerable camber, so that, even allowing for the depth of the Inglis transoms, the bank seats had to be raised above ground level, particularly on the N.E. side, where the existing roadway was over a foot below the level of the other bank.



(5) *Approaches.* Raising the level of the bridge involved approach ramps. On the camp (S.W.) bank the ramp had to be fairly short to clear the Monmouth race-course by a good margin (see plan). The original scheme envisaged 1 in 10 ramps on both sides, but this was subsequently modified on the N.E. side (see p. 670).

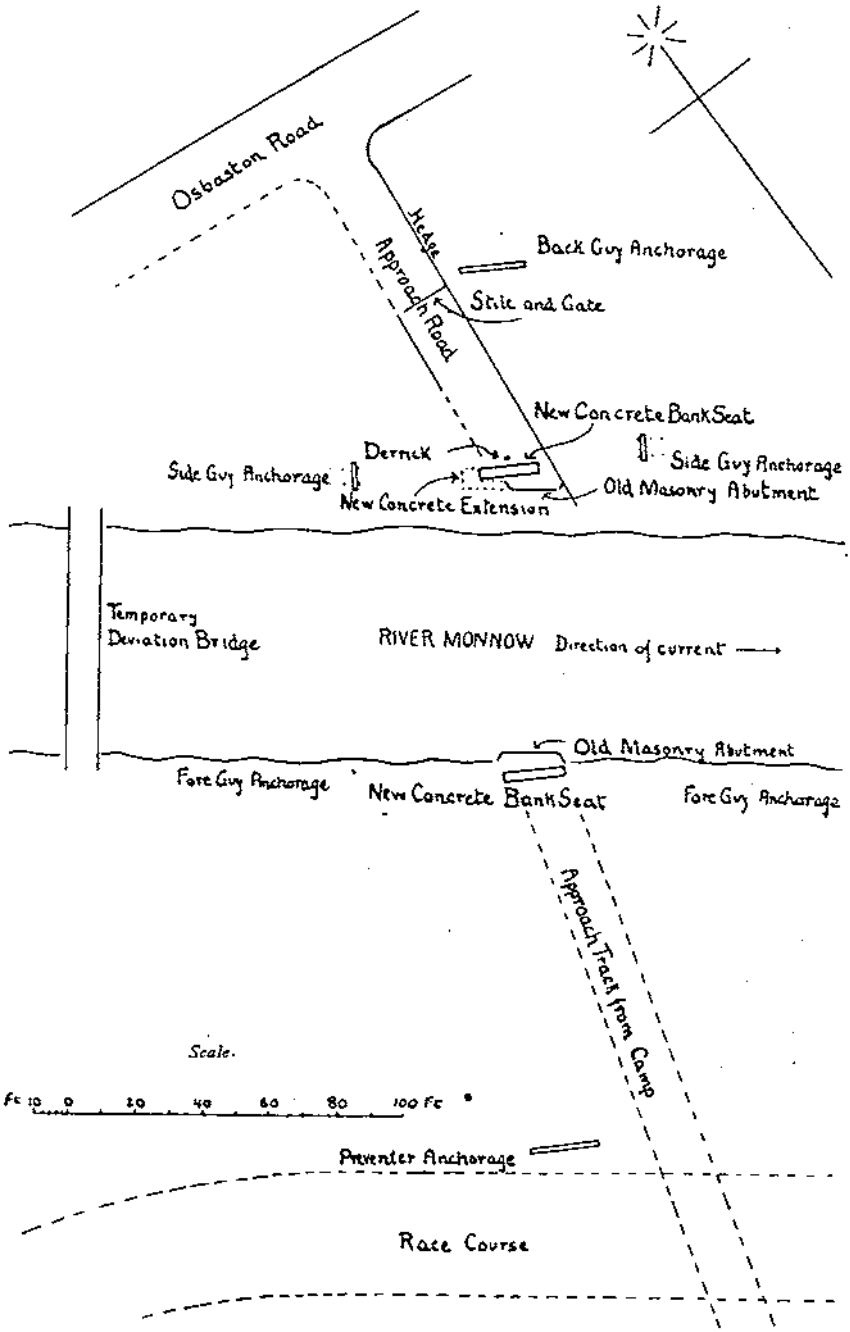
(6) *Method of Erection.* Owing to the lack of the normal launching tail, an unusual method of getting the bridge into position had to be thought out. There were but two alternatives, viz. :—

(*a*) Erection on false work, utilizing the Old Bridge.
(*b*) Assembling on the bank and launching by the derrick and roller system.

(*a*) was judged too dangerous in view of the untrustworthiness of the Old Bridge.

(*b*) had this objection, that Inglis bridges have no continuous bottom booms suitable for use with rollers.

This difficulty was overcome by reversing the plain road-bearers


Osbaston Road
Hedge
Approach Road
Back Guy Anchorage
Stile and Gate
New Concrete Bank Seat
Derrick
Side Guy Anchorage
Side Guy Anchorage
New Concrete Extension
Old Masonry Abutment
Temporary
Deviation Bridge
RIVER MONNOW
Direction of current
Old Masonry Abutment
Fore Guy Anchorage
New Concrete Bank Seat
Fore Guy Anchorage
Approach Track from Camp
Scale.
Ft 10 0 20 40 60 80 100 Ft
Preventer Anchorage
Race Course

(four in number) and placing them beneath the transoms from end to end of the bridge, thus forming an artificial bottom boom.

(7) *Launching Equipment.* In the interests of economy every possible use was made of S.W.R., blocks and other gear already in store at Monmouth. There was a complete set of box-girder launching equipment, and this was used as far as possible. The weight of the bridge in skeleton ready for launching was about 25 tons. One 120-foot girder of the box-girder bridge (the maximum for which the launching is designed) weighs somewhat less than 9½ tons. Thus the box-girder equipment did not go very far.

The two main difficulties were :—

(*a*) Derrick headring and shackles. A magnified edition of the box-girder headring was designed and specially made for the job. The shackles, too, were specially made. *M.E.*, Vol. III, 1928, Plate 24, was of the very greatest assistance here.

(*b*) Rollers. There are three specially designed rollers in the box-girder equipment. These were carefully measured up and *M.E.*, Vol. III consulted once more : bearing in mind that W.D. equipment has a large factor of safety, it was decided to use two of these at the bank seats, and to introduce the Inglis launching wheels under the tail of the bridge to obviate the necessity of other sets of rollers, of which there was none at Monmouth. This scheme, though rather clumsy, worked excellently, and the box-girder rollers stood the strain without showing any signs of weakness.

Note.—Only two of the box-girder rollers could be used, as there are only four plain Inglis road-bearers per bay.

(8) *Anchorages.* As will be seen from the plan, the back guy anchorage and that for one side guy were situated in a field that was not W.D. property. Some difficulty was experienced in persuading the owner of this field to allow use to be made of it, and permission was finally obtained on condition that no digging was to take place. The terms of the W.D. camp lease also prohibited digging on the camp side of the river, so that buried anchorages were out of the question. Combination baulk and piquet anchorages for both preventer and back guy proved entirely successful.

(9) *Demolition of the Old Bridge.* In view of the system of launching decided on, the demolition of the Old Bridge was timed to take place during the assembly of the Inglis—that is, just prior to launching.

(10) *Temporary Deviation Bridge.* Old-pattern pontoon equipment and (timber) Weldon trestles were available. Four trestles and five bays of superstructure were used. This bridge was intended

only for foot traffic as it could not be made available for vehicles without cutting ramps in the banks. Only small stores, therefore, could be sent across it.

(11) *Allotment of Work.* This proved a real difficulty for the following reasons :—

(*a*) S.R. and T.A. units, having only twelve working days to play with, strongly object to spending more time than is absolutely essential in drawing and returning stores. In this case, many stores had to come from Pwlholm Store, a distance of two miles from the bridging site by the only road possible for transport and, even then, difficult of access.

(*b*) The very nature of the work meant that the majority of the stores had to be brought to the site of the work as early as possible, since the launching arrangements had to be prepared during the assembly of the bridge on the bank.

(*c*) Not all units had the same transport facilities. For instance, the T.A. Divisional units had horse transport and, in addition, heavy lorries, while the S.R. has only 30-cwt. lorries and no more than two at that for approximately the same number of men as the T.A. Divisional units.

An endeavour was made to allot the work so as to give each unit its share of interesting and dull jobs ; but unforeseen and, indeed, unpreventable circumstances upset the scheme from the start, and the original programme of work was never worked to at all.

THE SCHEME PUT INTO EXECUTION.

The Delivery of the Bridge. The bridge came from Catterick and, for financial reasons, was delivered before the end of March. The G.W.R. contracted to deliver it *in situ*, and dumped it along the sides of the approach track on the camp side of the bridge (see plan).

Construction of Bridge Seats. G.E. Newport obtained the necessary materials, and the H.Q. Section of the Royal Monmouthshire R.E. provided the labour for their construction, which took place before the arrival of any unit in camp, in order to prevent delay while the concrete was setting. The officer in charge borrowed a level from the Borough Surveyor (to whom many thanks are due) and with the further aid of a steel tape, laid them out and supervised their construction. As he had had no occasion to use a level since the time of his S.M.E. Survey Course as a Y.O., he had considerable secret misgivings on the score of the correctness of his work, but subsequently, to his vast relief, it was found to have been reasonably accurate.

Work on the Bridge Begins. On Sunday, 24th May, the first unit to occupy the camp marched in. This was the 42nd (E. Lancs) Divisional R.E. The C.R.E. was somewhat appalled by the amount

of store humping that faced him, but promised to do his best. But before a proper start could be made there befell a great disaster, the greater because entirely unforeseen.

On the 28th May, the Monnow, which overnight had been at normal summer level, overflowed its banks and flooded the camp, luckily without doing any serious damage.

But it upset the whole of the 42nd Divisional R.E.'s training programme and greatly retarded the work on the bridge.

This unit did, in fact, render great service in bringing up many of the heavier stores, constructing the deviation bridge, putting in the preventer anchorage, and assembling the rear bay of the Inglis: but it was unable to complete the task allotted to it on the programme of work.

Before the 42nd Divisional R.E. marched out of camp a second sudden rise of the Monnow carried away the deviation bridge: one or two trestles were broken and many chesses and other stores irretrievably lost, though salvage parties dispatched by the Royal Monmouthshire R.E. succeeded in recovering some of the lost equipment which had been seen not far from Tintern, some dozen miles downstream.

This was not a good beginning, but the Royal Monmouthshire R.E. determined to retrieve the situation. They marched in on the heels of the 42nd Divisional R.E. on the 7th June. The 100th Army Troops Company took charge of the Inglis bridge operations, and the 101st of the deviation bridge.

Having some time to spare before the arrival of the main body, the Advance Party had undertaken, *inter alia*, to wind on to the preventer winch the preventer cable. This was a 113-fathom length of 2" S.W.R. More will be heard of this later.

From now onwards matters took a turn for the better. The weather was distinctly bad and the river a constant source of anxiety, but the men took a personal interest in the work and it went merrily ahead, despite checks such as that of the launching wheels already described and the non-arrival of certain essential stores, particularly the derrick headring. But for these, the bridge could have been launched at least two days earlier than it was.

The deviation bridge was reconstructed and pontoons introduced beneath the roadway between the trestles. They were not actually *substituted* for the trestles since, at normal water level, they grounded. The pontoons did their work nobly and saved the bridge from destruction on more than one occasion.

As regards the Inglis itself, I cannot speak too highly of the skill and care with which the reversed road-bearers were put in place to form the artificial bottom boom. The success of the whole launching scheme depended on the accuracy with which this was done.

The party responsible consisted of " Riggers " from the Newport Steel Works. These men proved their worth over and over again.

The Corps now boasts the trade of " Waterman " ; would it not be possible to institute the trade of " Rigger " ?

In doing the work, distance pieces of exactly the right length were cut and placed between the road-bearers, which were then windlassed up tightly together with wire and odd lengths of old S.W.R. It was not thought necessary to fix the " bottom boom " very tightly to the transoms. The weight of the bridge itself kept it in place as soon as each bay, in turn, came on to the rollers.

The Launching. Perhaps it was a good thing that there were a few delays in the preparations for the launching of the bridge, because this culminating point of the work fell most tactfully on the day on which the Inspector of Royal Engineers inspected the unit. This was Thursday, June 18th.

The actual launching operation was carried out in two stages :—

(1) Pulling the bridge forward until the centre of gravity was just behind the rollers. The launching wheels were then removed, and the reversed road-bearers at the bay at the head of the bridge were taken off and placed in position at the tail of the bridge. The head was thus slightly lightened, while the tail received a small counter-weight.

(2) The rest of the launching which was designed to be carried out in the normal way. It was not fated, however, that things should go entirely smoothly. Two mistakes were made, both of which might have proved really serious.

In the first place, the length of S.W.R. in the preventer was not checked before the operation was begun.

It will be remembered that the Advance Party had been responsible for winding this on to its winch. The Inspector of R.E.'s experienced eye detected that there was not the required length of S.W.R. on the winch, but the officer in charge had faith in the Advance Party, and General Pritchard's warning was disregarded. When the bridge was about three-quarters over the gap, a cry was heard from the party on the preventer winch : " Sir, there are only four more turns on the preventer ! " Consternation for a moment prevailed, but the 100th Company was not to be beaten. Remembering that the stress in the preventer reaches its maximum some time before the completion of the launching operation, and that, thereafter, it decreases rapidly (see *M.E.*, Vol. III, 1928, Plate 66), it was determined to take off two returns from the tackle, reducing it thus from a 3 : 3 to a 2 : 2. The remaining returns were bulldog-clipped together, the cable taken off the winch, the two returns removed, and the cable rewound on to the winch.

This expedient proved completely successful ; but the launching

was delayed some three-quarters of an hour and, if the cable had been only a few fathoms shorter, there would have been no alternative but to "de-launch" the bridge, replace the short preventer cable with the true 113-fathom length, and start the whole operation all over again.

The second mistake was the failure to see that the upper block of the main tackle did not foul the derrick in the last stages of the launching. This tackle was of 3" S.W.R. and both blocks were trebles. A 3" S.W.R. treble block is no small thing, and is a very different proposition from the cordage blocks which are usually encountered in instructional use of spars. What happened was that the tackle twisted slightly, so that, when the bridge was nearly in position, the side of the upper block became hard jammed against the derrick (a twelve by twelve baulk) and bit into it. The result was that an entirely unforeseen strain was put on to the derrick head-ring, which was twisted badly out of shape and might have given way altogether if the derrick had not been slightly heeled over, thus relieving the strain sufficiently to avoid an accident. It was a nasty moment, for the weights dealt with were big, and a failure might have had serious consequences.

The launching itself was thus successfully carried out.

The next difficulty that presented itself was the fitting of the shore transoms into the channels prepared for them in the bank seats (see above). It was found that the bridge had been launched very slightly skew, and that the shore transom at the head of the bridge to which the shore transom had been attached had been slightly bent. It was thus impossible to lower the bridge to its proper level until this difficulty had been overcome, and in the meantime it remained supported on packing. The jacks, too, at this moment chose to give trouble, and instead of being able to count on four of them in working order, one, or at the most, two at a time, were all that were available. The sides of the channels were chipped away, where necessary, until the shore transoms would fit comfortably into them, and the bridge was then jacked down.

Meanwhile the reversed road-bearers were removed and laid in their proper position, the whole bridge being then decked down.

The deviation bridge was removed, the launching appurtenances cleared up, and the stores returned as far as was possible.

The Royal Monmouthshire Royal Engineers marched out on June 21st, justly proud of what they had accomplished.

They had taken over when the progress made was very much behind the programme: when they left, the progress made was in advance of the programme.

The work now remaining to be done was the construction of the approach ramps and the extension of the abutment on the north-east bank.

The 55th (W. Lancs) Divisional R.E. marched in on July 5th, and were soon at work. They undertook and completed the concrete extension to the north-east abutment (alluded to above), and two dwarf concrete retaining walls on each bank to act as revetment to the sides of the approach ramps.

As has been already stated, the original idea of one in ten ramps on both sides of the bridge was modified on the N.E. side to a long ramp, graded up to the bridge level from the Osbaston road.

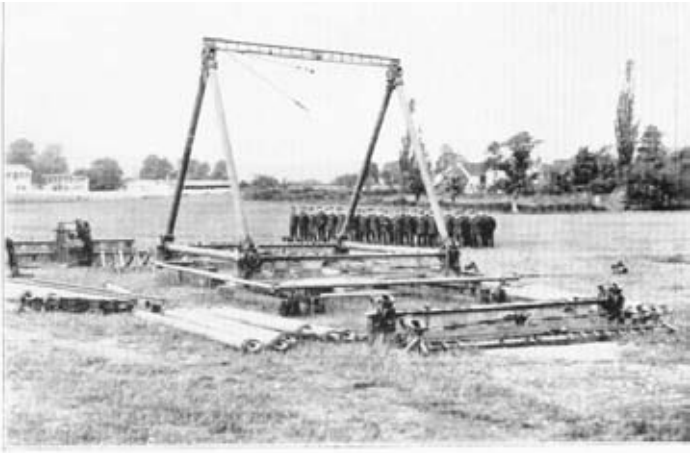
Sufficient road material for this ramp, therefore, had not been ordered, and what had arrived was not very suitable. The additional metal required took a long time in coming, and, when it did arrive, did so in the wrong order, the heavy stone for the soling making its appearance long after the surfacing material.

With the best will in the world, therefore, the 55th Divisional R.E. were unable to finish the ramps, though they did enough to make it possible to drive their tool carts out of camp *via* the New Bridge.

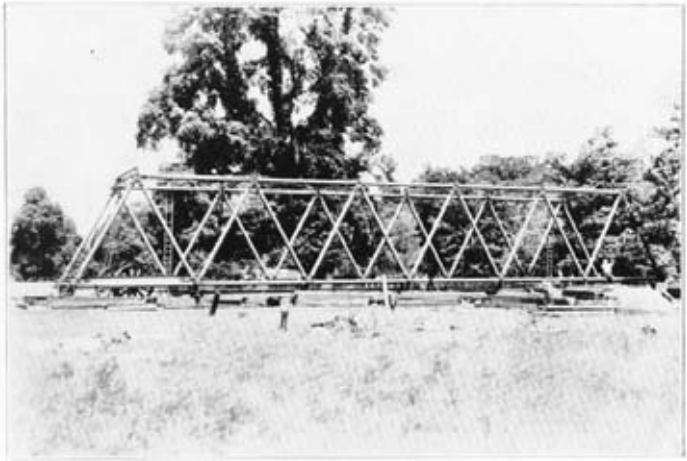
The Lancs (Fortress) R.E. and the 105th (E. & M.) Coy. R.E.S.R., who came into camp together, arrived on the 26th July, and during their fortnight in the camp continued work on the ramps. These were the last units to occupy Vauxhall Camp during 1931.

The final touches, both to the bridge itself (adding handrails and painting) and to the ramps, were completed by G.E. Beachley, though a party of the Royal Monmouthshire R.E. were most anxious to do all the work themselves. But funds were not available to supply their pay and rations.

Thus was completed a most interesting scheme with great credit to all the units concerned. The main point of technical interest was, undoubtedly, the novel expedient of providing an artificial bottom boom for the Inglis. But this article will have failed in its purpose if it has not demonstrated conclusively that the " part-time " R.E., both S.R. and T.A., can tackle a job of real work and utility, and carry it through to a successful conclusion ; that the taxpayers' money that is spent on their training is not wasted ; and that, if and when they are called upon to mobilize, they will prove most valuable and, indeed, indispensable troops.



1.—The Royal Monmouthshire R.E. take over, Monday, June 8th.



2.—The Inglis assembled on the bank. Note the launching wheels at the tail.

Replacement of Vauxhall Bridge, Monmouth 1-2.

Photo 4.—Overhead Lines Shop, and Specimen Poles.

Photo 5.—Old Foundry.

Photo 6.—New Foundry.

Modernisation of the E&M School, S.M.E. 4-6

Photo 7.—Old Smiths' Shop (forges removed.)

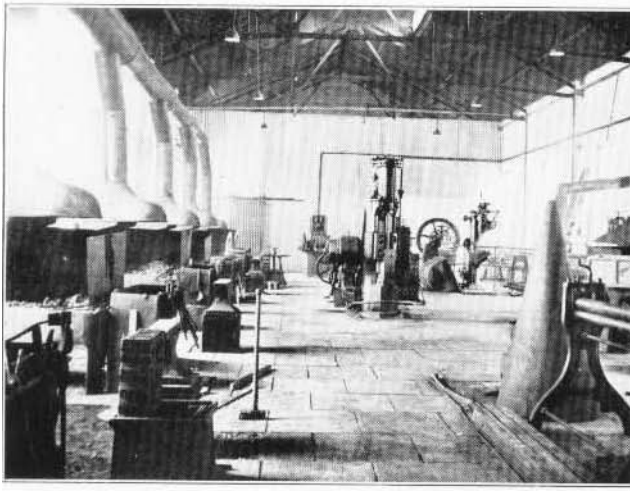
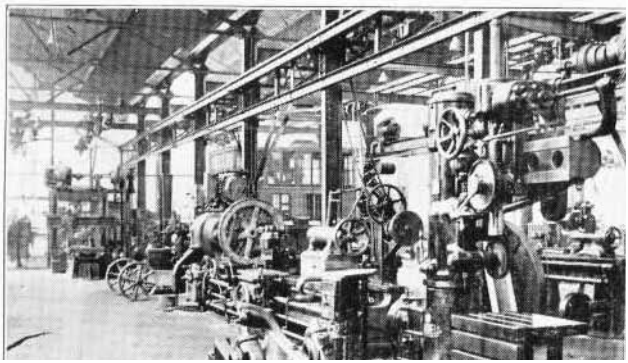


Photo 8.—New Smiths' Shop.



Modernisation of the E&M School, S.M.E. 7-9.

Photo 10.—Machine Shop—second bay and foreman's office.

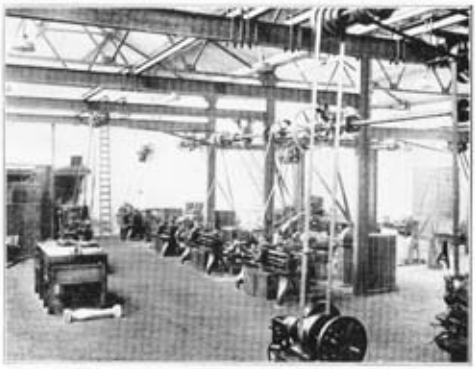


Photo 11.—Main Turning Department, and "odd job" section beyond.

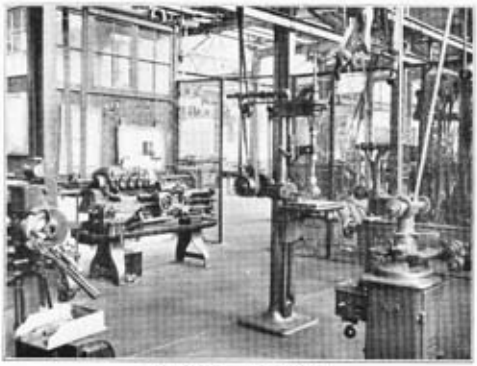


Photo 12.—Tool Room.

Modernisation of the E&M School, S.M.E. 10-12

SHOWING THE FLAG.

By LIEUT. J. V. DAVIDSON-HOUSTON, R.E.

THE Royal Navy, and through them, the British public, know well the anchorage of Wei-hai-wei, that delightful summer refuge from the foul and tepid waters of the South China coast, but not so well known is the other Wei-hai-wei, the leased territory which stands over against the navy's island, and which for many years has been the sole part of the harassed province of Shantung where life and property enjoy security.

In 1927, however, the clouds which hung above the Sacred Province threatened to break in a storm of lawlessness over the hills of the territory. From the hamlets which lay scattered along the sixty-odd miles of frontier came reports of robbery and murder; bands of Hung-hu-tzu (" Red Beards ") were rumoured to be casting a hungry eye on the property of the boundary villagers. It was unfortunate that the great mountain K'uei-chia-shan, the last refuge of the people against the murderous T'ai-P'ings sixty years ago, which lies but twelve miles from the British frontier, was now the stronghold of the outlaws, whence the soldiers of the Chinese magistrate of Wen-tung seemed incapable of driving them.

It was with a certain feeling of excitement, therefore, that a British platoon, accompanied by the Inspector of Police and a Sapper subaltern, marched out of Port Edward with a view to restoring the confidence of the dwellers on the frontier.

At 8.30 a.m. on a sunny September morning the party embarked in the little Government launch which was to land them on the beach at the eastern extremity of the territory. Although the sea was unusually still for the China coast, distress was visible on many faces by the time the beach was reached, and at 11 o'clock the troops paddled ashore with expressions of considerable relief.

The landing place turned out to be a sandy estuary, into which trickled a small stream from the reeds which fringed the shore; not far away lay two shallow lagoons, the rarely disturbed refuge of myriads of teal.

There was no sign of a road; at the water's edge stood two leather-faced Territory Police in their broad-brimmed hats and khaki uniforms, who marched in front, and led the way inland.

The first march was a short one, following a dry water-course for three-quarters of an hour till the village of Pei-cheng-hsi was reached.

It was surprising, among the dirty stone and black brick buildings, to see a Union Jack flying from a bamboo pole.

This was a frontier police post, and presently four yellow-visaged police appeared and presented arms. Haversack rations were opened and the officers sought the cool interior of the Post, where, seating themselves on the hard Chinese beds, they drank a delicious tea flavoured with lemon and the petals of flowers. Quite a large crowd had gathered by the time the force continued its march; rarely were foreign soldiers seen in Pei-cheng-hsi, and the Chinese villager could not miss such an entertainment.

A cart road led to the hamlet of Tou-shan, where, high on a neighbouring hill, stood the stone compound where women, children, and cattle were wont to be shut up on desperate occasions in the days before the *Pax Britannica* was established in this part of Shantung. Here the route took to a mule track, and the men marched in single file. Every now and then an astonished cultivator would look up from his terraced field at the procession of strange foreign soldiers in their stranger helmets, or a laden mule would roar in loud displeasure.

The sun was low when a halt was called at Meng-chia-chuang. Here floated another Union Jack, and here very similar police dispensed the same scented tea, and watched the opening of camp beds with unconcealed hilarity. The men were accommodated in the outbuildings of the police post, but the platoon commander, the Sapper, and "Chan lao yeh" (as the Inspector was respectfully called) were invited to the guest house of the local squire, one Liang.

The bedroom of the guest house consisted of an empty apartment, with walls covered by scrolls, on which were painted the strange characters that appeal to the Chinese far more than pictures. The transport, six country carts escorted by an N.C.O. and two men, arrived with the welcome rations, having come across the mountains by a route which few other vehicles could have survived.

The platoon commander, having carefully examined his men's feet for blisters and blains, the Sapper having justified his existence by scribbling a few illegible notes, and "Chan lao yeh" having produced half a dozen bottles of beer from some unknown source, the officers' mess fell to, only to be interrupted by the entrance of their host. Liang lao yeh was a wizened old man with a face like crumpled parchment, and a pigtail of the consistency of a bootlace. He bowed very low, and being an old acquaintance of the Inspector's, addressed him in Chinese, than which he knew no other language.

Having relieved himself of what was in his mind Liang withdrew, to appear again five minutes later.

"Chan" had most unfortunately gone in search of more beer, so that the Sapper, who had been trying to learn Mandarin from the

office coolie during the past three weeks, had to carry on the conversation.

"Are you well, teacher?"

"Very well, old father. To-day is hot."

"Hot weather. You are an English officer?"

"Yes. You are Liang lao yeh."

"I am that miserable person. What is your age?"

"I am twenty-five."

"Are you married?"

"No."

"How many children have you?"

At this point "Chan" reappeared, and continued the struggle. Liang then evinced a desire to expectorate, and having looked round the room for a suitable place, withdrew fastidiously elsewhere.

An excellent chicken stew, prepared by the Chinese cook over some glowing charcoal and a couple of stones, had just been disposed of when the old man reappeared. Having discussed the weather, the brigands, the police, and the poverty of the soil, he mentioned, as an afterthought, that the troops had just cut down a tree in a grove sacred to his family. "Chan" missed the whole of the next course in expressing his horror at the outrage, and describing the fiendish punishment which would be meted out to the offender. Liang, however, occupied what otherwise might have been a tedious twenty minutes in expressing his desire to forgive the deed, and his shame at having drawn attention to it. He then withdrew for the night.

An early start was made next morning to avoid the heat of the day, and the market of Chiao-t'ou was entered about 11 a.m. The surrounding country seemed full of merchants and buyers bound for the little town. Mules and donkeys, laden high with goods, wound their way down the mountains and along the sandy stream beds; gaily-dressed girls in crimson or blue embroidered coats and trousers passed by riding or wheeled in barrows, while ragged pedlars staggered across the market place carrying their loaded bamboo poles.

Into such an assembly it is the habit of robbers to send their spies, so that they may know how the wealth of the neighbourhood is distributed, and for this reason the men were dismissed for an hour to wander about the market, in the hopes that the presence of thousands of British troops would ere long be reported in the mountains of Shantung.

The local theatre soon began to advertise itself by the monotonous beating of drums and cymbals, and by the appearance of actors in fantastic garments and weird masks. The population having amused itself by studying the Englishmen now turned its attention to the theatricals, so the expedition pushed on to the K'ou Pass, a steep climb between rocky slopes, covered with scrub oak, in the leaves of which the wild Shantung silk is produced.

At the mouth of the pass appeared a man in a grey cotton uniform, the well-known garb that is issued indiscriminately to the troops of every general in China.

The man was stopped, for stray Chinese soldiers are not *persona grata* in British territory, and searched for arms. It was with a certain disappointment that the stranger was released as " armless " (" Chan " perpetrated a pun in this connection), and the platoon moved on. The Inspector, remarking on the slowness of the rate of march, developed the habit of walking a quarter of a mile ahead of the column, while the Sapper, engaged in taking notes of anything which he thought might hereafter be of value, spent his time in doubling to catch up the party.

A half-hour halt was made at the temple in the pass where, beside the door, hung the four characters, " Look heart water moon," to be more explicit—" The examination of your heart should reveal it as clear as the reflection of the moon in the water."

Next came the strange hamlet of Paohsin, alone of all the villages unfriendly to the British. There has been trouble there ever since the attack on the Boundary Commission in 1898, and the inhabitants did not even crack jokes at the soldiers' expense as they went past.

The evening halt was made at Tsao-miao-tzu', a few thatched houses in a pleasant grove hard by a river bed. At sundown a big flight of teal came in from the sea, flying very high, and " Chan " remarked that in the rainy season the air would be thick with teal and mallard, and that the hills were now full of hares. Rabbits, however, were strange to this part of the world. His further recital of the fauna to be found in Shantung, including snow-leopards which had strayed from Manchuria, was drowned by the snores of the platoon commander.

The next morning the party followed a mule track round the shoulder of Wang-shan, scrambling every now and then into the depths of a nullah and up the other side, the transport having disappeared earlier in the day with instructions to be at the rendezvous in time for the evening meal. On the left of the line of march the frontier ran along the crest of the neighbouring hills, marked by slabs of granite at every few miles. " Chan " stated that it was with the greatest difficulty that the natives could be prevented from extending the limits of British territory by moving these stones farther inland each year; at this the officers congratulated the Inspector on the confidence that he inspired in British administration.

The night was passed in the Temple of Hsiao-yen-T'an, the outbuildings of which also served as police barracks, and here the officers were confronted by the grave problem of finding a safe place in which to pitch their camp beds. The temple was unusually full of clay images, brightly painted, and of a size and weight which

would make them oppressive bedfellows should they topple from their stands (which they appeared very likely to do).

At the end of the building sat Confucius, attended by a number of smaller companions, all wearing a more or less benevolent expression. The ante-room, however, was guarded by a pair of deities of obvious homicidal tendencies, an impression accentuated by the fact of one having a blue face and the other a chocolate-coloured one. This part of the temple, moreover, was in use as a store for a number of freshly-filled coffins. The use of the courtyard was prohibited by the presence of a hornets' nest under the tilted eaves of the temple roof, so it was decided to risk a nocturnal attack by Confucius and his friends, and the night was passed without mishap.

The two subalterns were awakened by a sound as of sea-lions at play, and discovered in the courtyard the burly form of "Chan" immersed to his neck in a stone jar resembling those in which Ali Baba's thieves met their unhappy end. The coldness of the water, however, induced the others to follow "Chan's" example, and seldom has a bath been so much enjoyed as that provided by the K'ang filled from the temple well.

The day's march led over a strong and scrub-covered country under the lee of Pan-pi-shan, a mountain which appeared to have been cleft in twain from the summit downwards. The missing half, according to "Chan," was reputed to be standing in Manchuria. Here was obtained the first view of the sea since landing near Pei-cheng-hsi, and far away to the south rose the seven-peaked mass of K'uei-chia-shan, whose caves and rocks formed the impregnable defences of the "Hung-hu-tzu." It was easy to imagine how the magistrate of Wen-tung, regarding the fastness from afar, had muttered "Yu-ming"(There is Fate), and dismissed the subject of banditry from his mind. The Sapper paused on the crest of a hill and made a sketch of the mountain. "Chan" smiled indulgently and plunged through the scrub toward the valley.

At the police post of Lu-t'ao-K'ou the platoon halted for the night, and here it was discovered that the Chinese who had been seen pursuing the column for the last two days was an unofficial "follower" somehow acquired by the troops, who were later seen making him wash himself in a K'ang.

O.C. Troops, who had managed to reach Lu-t'ao-K'ou in a Ford van, came out to see how the force had fared. His arrival caused considerable stir. Never before had a vehicle entered the village without the assistance of ass or mule, and the population gathered round the strange machine. One old man, hearing unfamiliar sounds coming from within, placed his ear against the radiator; his immediate discomfiture was received with peals of laughter from his companions.

As several hours of daylight remained, the subalterns suggested

that "Chan" should take them shooting. The Inspector was known to be acquainted with the habits and feeding places of most creatures in the territory; it was also noticed that his largest bags were obtained when he went out alone. On this occasion he stated that pheasants were to be found in the scrub on the Chinese side of the lagoon which lay close to Lu-t'ao-K'ou. This expanse of water, some three miles in diameter, was reached by paddling across a mile of salt-pans, in which the neighbourhood abounded. The Sapper had brought his 12-bore from Port Edward, "Chan" carried a stick, while the platoon commander optimistically loaded his revolver.

A sampan was chartered at the edge of the lagoon, and the Chinese shore was soon reached. Half an hour's walk across the sand brought the party to a forest of willows and oak bushes, rendered awkward of passage by reason of the huge spiders, which wove their webs everywhere between the branches.

Now and then a disturbed pheasant would fly from cover, or a hare would dash through the undergrowth; "Chan's" stick could be heard beating its way through the jungle, No. 6 shot rattled in vain among the leaves, while occasionally the Webley discharged itself dangerously from some unknown direction.

At sundown the expedition turned back empty-handed, feeling the want of a few good dogs. Having reached the place of disembarkation, the party was annoyed to find that the sampan was not there. Annoyance grew into consternation when the Inspector explained the impossibility of circumventing the lagoon by land that night, and it was resolved to split into two parties to go in search of the boat. The Sapper, on account of his early training, was assumed to be a search-party in himself, and set forth alone with instructions to fire his gun when the sampan was discovered. The others had disappeared among the sandhills by the time the Sapper found the boatmen; owing to the fall in the tide, they had moved their craft to a creek, whence it would be easy to reach the lagoon at low water. The prearranged signal, however, brought no answering revolver shot. Twenty minutes passed. The Sapper succeeded in bagging a solitary bird resembling an oyster-catcher, but with a teal-like head and separated toes, on each of which grew a narrow strip of web. "Belong walkee-walkee duck," observed one of the sampan men, a student of English. Dusk was falling, and it became imperative to find the others. A three-mile walk over the dunes failed to reveal any trace of "Chan" or the platoon commander; only the tracks of wildfowl were visible in the sand. It grew quite dark. All the 12-bore cartridges had been expended, and the sampan had again disappeared; the Sapper was faced with a solitary sojourn in Chinese territory, and reverting to type, began to dig himself into the sand for the night. Various expressions of displeasure passed through his mind, only to be discarded as inadequate for the occasion.

All at once, a distant call showed the position of the sampan, at the edge of the low water and three hundred yards from its last position. Resolved at all events to return to the police post and collect a search party, the Sapper floundered to the boat, and instructed the men to row across the lagoon. This object, however, proved to be not so easy of attainment, firstly, because intercourse had to be carried on partly in Chinese and partly in English and neither party knew which language the other was trying to employ, and secondly, because the absence of " Chan lao yeh " was viewed with grave suspicion by the Chinese. " Thlee piece man come one time ; this time have got one piece man, what thing ? " " Chan lao yeh and officer no have got. Wanchee go talkee soldier man come this side look see what thing."

Only the vehemence of the Sapper's language finally caused the boat to be pushed off, and for the next hour nothing was heard save the creaking of the single oar in its socket, and an occasional plaintive, " Chan lao yeh tsai shen mo ti fang ? " from the crew. There was neither moon nor stars, and when the craft grounded among the salt-pans the worst part of the journey commenced. The Sapper, occasionally falling headlong in a pan, led the way ; the Chinese, carrying the oar and anything which could be removed from their boat, followed more warily, but an occasional splash indicated that they, too, could have performed the journey better by day. At last there loomed ahead the dark outline of the knoll on which the post stood, and in a few minutes the paddlers, dripping with brine, were ascending the slope.

Suddenly loud cries rent the stillness of the night, and a number of Chinese police dashed from the post. The Sapper was relieved of his gun, his hat and his haversack, and ignorant as to whether he was the victim of arrest or mutiny, was hurried into a room. The first thing he saw was " Chan lao yeh " and the infantry subaltern eating chicken stew, and a number of empty beer bottles told him that he had arrived home late. " Hullo," remarked the platoon commander. " What happened to you ? " The Sapper mouthed speechlessly, and found that his tongue was well-nigh cleaving to the roof of his mouth. " We found a second sampan," added " Chan," " and as we didn't hear your gun, we concluded you had gone off in the other one. When we found you hadn't come in, we were about to send out a search party for you."

" Well, thank God we march into Port Edward to-morrow," said the platoon commander.

The Sapper, still mouthing, reached for the remaining bottle of beer.

BARA BRIDGE RECONSTRUCTION.

By LIEUTENANT M. C. A. HENNIKER, R.E.

1. GENERAL.

BETWEEN the Vale of Peshawar and the foothills of the Tirah lie the Khajuri and Aka Khel Plains. From time immemorial the Afridis, driven from the hills by the winter snow, have brought their cattle to feed on what little grass there is on this strip of No Man's Land. Until the Khajuri operations of 1930–1931, this strip of country was nothing but a stony waste through which the Bara river runs.

Mainly as a result of the tribesmen's exploits in the summer of 1930, it was decided to occupy this area during the winter of that year, and to blockade them in their barren hills.

In order to facilitate the movements of troops, and to control the tribesmen when the blockade ended, a series of roads was constructed all over this inhospitable wilderness. Three brigades of infantry lived and had their being there and a network of roads, blockhouses and garrisoned posts came into existence from Jamrud to Matanni. In two places the Bara river had to be bridged and it is with one of these—the Bara Bridge—that this article chiefly deals.

The Bara river is not the fertile valley and densely populated basin that one usually associates with an oriental watercourse, for the river runs in a ravine varying in width from 90 to 200 feet. At the point selected for the Bara Bridge the gap is 130 feet wide and the banks are some 50 feet above the river-bed.

The original bridge, as built by No. 4 Field Coy. K.G.O. Bengal Sappers and Miners during the operations, is an Inglis Mark I bridge over a clear span of 144 feet between piers. It is a most remarkable affair and deserves more attention than space will here allow; suffice it to say that, in order to prevent excessive stresses in the middle, the bridge is made with counter-weighted " tails " on the shore side of either pier. This arrangement is visible in Photo No. 1.

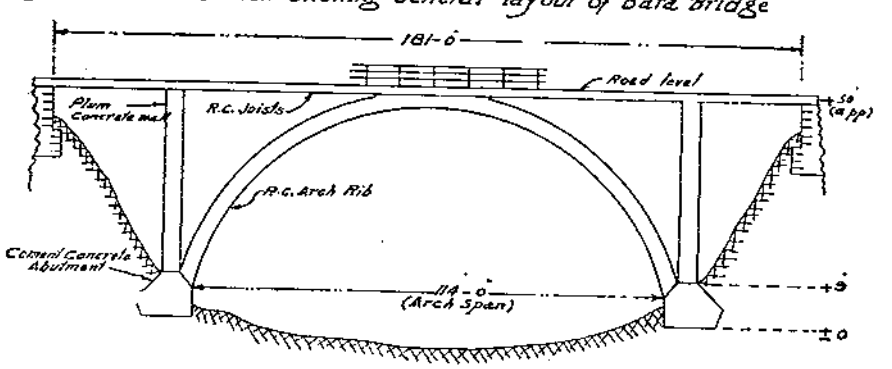
The bridge has been in constant use since its construction and carries A.C's and 3-ton lorries in a most reassuring manner. Nevertheless, to set free the equipment used, it was decided to replace it by a reinforced-concrete arch bridge. The bridge was to consist of a 114-foot central span (see Fig. I) with an approach span on either

side. The arch itself was to be composed of two parallel arch ribs abutting on foundations in the river-bed.

The construction of this was entrusted to a celebrated contracting firm in Bombay who started to erect scaffolding, falsework, etc., on brick piers built in the bed of the river (Photo No. 1). Here it must be observed that, though the river is usually a modest trickle of reddish water, it is not always so. Rain falling on the rocky hills that surround its source is brought down in countless rivulets until the parent river is a roaring spate.

It was, indeed, such a spate that caused the wreckage shown in Photo No. 2. The river rose 21 feet, and in the twinkling of an eye Nature had mutilated the laborious work of man to the extent of many hundreds of pounds. The temporary brick piers, though built on the most massive foundations, were tilted or felled and masses of

Fig 1 Sketch Showing General layout of Bara Bridge



Bara 8/5/1-32

concrete and twisted steel hung like streamers from a Christmas tree.

Disappointing though the wreckage looked, there was one bright spot in this dismal prospect. The foundations against which the arches abutted were unharmed and proved that whatever spates might do to falsework piers and centering, the foundations of the arches themselves would never be likely to be affected by scour. It was therefore decided to start again, but to build all the falsework and scaffolding on an Inglis bridge, erected specially for the purpose. Measurement showed that a 96-foot bridge could be built on two piers as high as 15 ft. 6 in. above the river-bed, and eight bays of Mark I Inglis were promptly ordered from Lahore.

At this juncture the Sappers and Miners appeared on the scene with orders to demolish the wreckage of the arches with explosives and to get the Inglis into the position required. The work of the S. and M. thus divided itself into three distinct phases that are best dealt with *seriatim*.

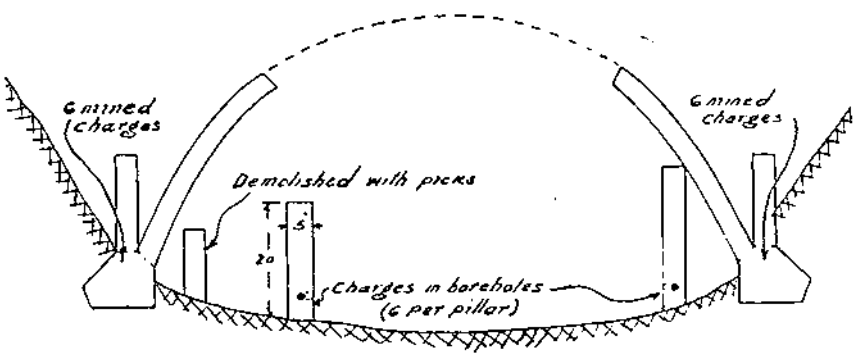
2. DEMOLITION OF THE WRECKAGE.

It will be seen from Photo No. 2 that the arch ribs of concrete, though spoilt, were still standing, being supported on brick piers near their haunches. The intermediate pier played very little part in supporting the weight of the wreckage, but as it was in the way of the final position of the centering of the new arch it was decided to remove it.

Fig. II shows roughly the appearance of the wreckage and the places at which the piers, etc., were attacked with explosives.

The work of demolition, thus, was of two categories. First, to bring the wreckage to the ground—rather after the style of a service

Fig II *SKETCH SHOWING POSITION OF CHARGES*



demolition of an arch bridge—and then to break up the concrete and remove the debris.

There was, however, one radical difference between this and the demolitions one expects to do on service. In this particular job it was essential to limit the amount of damage done. The brick piers were of no particular value, but the reinforcing bars in the concrete arches were wanted intact; and it would have been wasteful to damage the foundations on which the arches abutted.

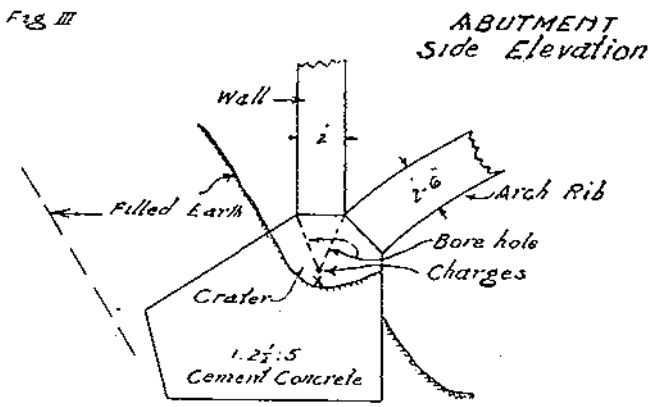
The brick piers were easy game. A series of boreholes was made, as described in *M.E.*, Vol. IV, para. 49. The interesting part of this work (for anyone merely watching) was the time and labour required. It was found that 100 man-hours were taken to prepare for demolition two piers. That is, 12 holes, each 2 ft. 6 in. deep with an average diameter of $2\frac{1}{2}$ in. This figure includes (*a*) the erection of temporary platforms clear of the water for the men to stand on, (*b*) blacksmiths to sharpen boring bars as they got blunt, and (*c*) the time taken to fill in the holes with their charges and test the electrical circuit. Had the holes been vertical instead of horizontal the time would have been less.

A service demolition of brick piers would usually involve all these items and the figure 3·3 man-hours per foot of borehole may be of some use as a guide. *M.E.*, Vol. IV, gives 2·4 man-hours per foot for drilling alone.

It would have been interesting to compare this with the results obtained with a mechanical drill, taking into account the difficulty of getting it into position.

In demolishing the arches it was more difficult to predict what would happen. The arches rested on haunches as shown in Fig. III.

Three holes were bored on each side of the concrete wall at an angle of 30 degrees to the vertical, so as to arrive in the line that appears in section as the point X.



The time taken was eight man-hours per foot of borehole. The concrete was excellent and the position cramped.

The charges, it was hoped, would bring down the arches without damaging the abutments. In three holes a dynamite charge, calculated on the formula $\frac{L^3}{6}$, was placed and the remaining three holes were charged with an equal amount of gunpowder. In addition a double handful of gunpowder was put into each borehole for luck.

The effect was admirable: the arches came crashing to the ground, leaving the abutments scarcely damaged. Gunpowder, though mediæval in many ways, has a magnificent lifting effect. A slab of concrete weighing 25 lb. was thrown 275 yards, narrowly missing an Afridi, who was appropriately enough saying his prayers in the vicinity. This emphasizes the fact laid down in *M.E.*, Vol. IV, that 300 yards may be taken as a safe distance from mined charges. Some people feel safe more easily than others.

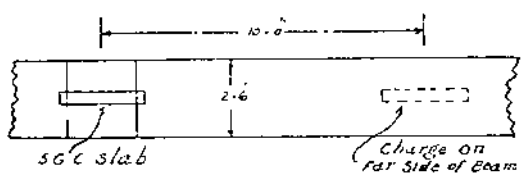
Having brought the arches to the ground the next step was to remove the concrete from the reinforcing bars. The arches may be considered as curved R.C. beams approximately 2 ft. 6 in. square,

containing 36 steel bars $\frac{7}{8}$ in. in diameter. By way of a change from the tedious process of drilling holes in hard concrete, a series of G.C. charges was made up and attached to the faces of the fallen arches. For this particular purpose the most satisfactory way was to make up each charge into a strip of five G.C. slabs end to end. These were placed longitudinally and on alternate sides of the beams (see Fig. IV).

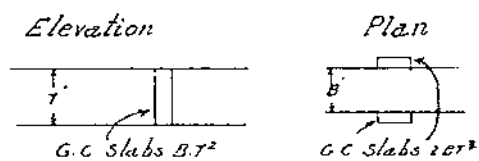
For a service demolition, such an arrangement would be useless; it merely breaks the concrete so that it can be removed with a pick.

Fig IV

G.C charges on R.C. Beam
(For Breaking up Concrete)



SERVICE DEMOLITION OF R.C. BEAM



A better method would be to place two charges, each calculated from the formula BT^2, on opposite sides of the concrete and placed transversely (see Fig. IV).

This was found to remove every particle of concrete from between the charges, leaving the steel exposed for a further attack. *M.E.*, Vol. IV observes that "the major portion of the charge should be placed where the reinforcing is heaviest," in the hope of cutting some steel as well. This may hold good for heavy charges calculated from the formula $20\,BT^2$. When more economical charges were used, the steel and concrete so far supported each other that neither was much damaged.

By this method 105 lb. of G.C. were fired electrically and at one time. The contractor was, however, so impressed by the expense of this process that he volunteered to bore holes in the remaining arches wherever we suggested. Whereupon he was instructed to bore a series of holes each 12 inches deep at 4-foot intervals along the upper face of the concrete. It was found that for cracking

up the concrete the following is a guide to the quantity of dynamite required :—

Depth of borehole : half depth of the beam.
Distance between boreholes : four times depth of each borehole.
Charge of dynamite : 1·25 ounces per inch depth of borehole.
The formula $\frac{L^3}{6}$ was found too gentle.

Moreover, it was found that by increasing the charges slightly an occasional reinforcing bar was cut. It seemed that they snapped from tension—their ends being fixed. Research in this direction might well produce some useful results, as the ribs of most concrete bridges are easily accessible, and with a mechanical drill it would not be difficult to achieve a quick and effective demolition in this manner.

Although every successful work of demolition ends with a glorious crash, it is curious how soon man sickens of destruction and hankers to do some building instead. But before going on to the building, some notes on the contractor's methods may be of interest.

Every steel reinforcing bar cost the contractor about 25 shillings delivered at the site. With the exception of three that were broken, he got every one back—all badly bent and twisted. Nevertheless a Sikh blacksmith with two Pathan coolies squatting on the ground hammering, shouting and yelling, straightened out each 40-foot $\frac{7}{8}$-in. bar at an average cost of twopence each.

Authorities on reinforced concrete can seldom agree as to whether the concrete should be a wet or dry mix. Laboratory experts aver that the drier the mix the stronger the result. Practical exponents often point out that unless the concrete is wet it never gets home to the holes and crannies where it is wanted. Experience of this particular concrete showed that it was excellent and it was certainly put in dry. The solution to this apparent paradox is that the contractor personally supervised the ramming of every ounce of concrete put into the bridge.

3. Construction of the Inglis.

Fig. V shows the Inglis in its final position relative to the river-banks and the R.C. arch, the centering of which it was to support.

From this it is clear that the normal position for building and launching a bridge was not practical in this particular case. The only practical plan was to build the Inglis in the river-bed parallel to its final alignment, and then to hoist it into position.

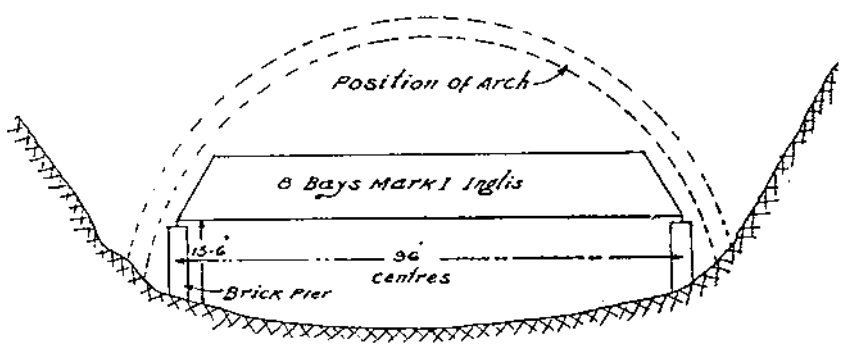
While the river was practically dry there was no great difficulty in such a procedure, but February is often a wet month in Peshawar, and even as the decision was being made rain clouds were visible on the horizon. The risk was certainly a heavy one, for an Inglis

bridge is an expensive piece of equipment. However, the *mullah* of the local village assured us that Allah would not let us down again, so a petrol can was tied to the first transom of the bridge as an earnest of our determination not to lose sight of it altogether and work was begun.

Amongst the debris of the wrecked bridge were a number of R.S.J's and sleepers out of which a temporary level platform could conveniently be constructed. The finished platform with the Inglis standing on it is visible in Photo No. 3. It was 18 inches above water-level with water passing in three channels beneath.

The erecting gear supplied with the bridge was of the old ladder type—as obsolete as the bridge itself, but just as ingenious and

Fig 1 SKETCH SHOWING FINAL POSITION OF INGLIS



efficient. The process of assembling the parts, however, was retarded by the fact that several of the tubes were as much as an inch out of measurement and had to be filed into shape. Some were also deformed.

While the work of assembling the bridge and the hoisting gear was in progress the contractor was hurriedly building brick piers for the Inglis to rest on.

The work thus became a triangular contest between the Sappers and Miners, the contractor, and the rain clouds gathering over Tirah. The rain was unlucky to lose by 1½ hours.

4. Hoisting the Inglis into Position.

Eight bays of Inglis in skeleton weigh about 14 tons which, with proper lifting gear, is a trivial weight. Even with adequate stick and string gear it presents but few difficulties, but such as there were may be of interest.

The formation of the ground made it necessary to raise the bridge vertically 14 feet, passage it 13 feet to one side and rein back 7 ft. 6 in. (see Photo No. 3).

Photo No. 1.—Showing the old Inglis Bridge and the false-work for the new R.C. Arch Bridge.

Photo No. 2.—The wreckage caused by a flood.

Bara Bridge Reconstruction 1-2

Photo No. 3.—Showing the Inglis Bridge on its temporary platform and the piers on to which it is to be hoisted.

Photo No. 4.—Showing how the contractor was able to support his centering on the temporary Inglis, well clear of another spate.

Bara Bridge Reconstruction 3-4

It would have been convenient to have placed the derricks midway between the initial and final positions of the bridge, so that they would have to lean the same amount in either direction. This, unfortunately, was not possible as only the most flimsy holdfasts for side guys were possible on the downstream side. Consequently the derricks had to be placed so that their final positions were vertical and they began at a most sinister slope, particularly as it was impossible to give them foot ropes. A pile of boulders was placed against the foot of each derrick, and in a country consisting of stones as far as the eye can see, this seems a simple and efficient precaution.

There was some shortage of suitable pulleys, winches, steel wire rope, etc., as many of the normal stores were in use at a bridging camp 50 miles away. Enough stores, however, were collected from the railway breakdown train and various sources to make one derrick more or less orthodox except in the matter of winches. Beyond the Indus, it seems that winches are extremely difficult to come by and are seldom up to weight.

The lifting tackles on the other derrick were two differential pulley arrangements obtained from the power station and the R.A.F. workshop respectively. They gave constant trouble as they were not designed to lift weights anyhow but vertically.

The principal lesson of this project was the importance of knowing not only what stresses various gear is *meant* to take but what it *will* take. The derricks, for instance, were made for the Dacca ropeway and were designed to take 5 tons. Although they assumed rather curious shapes owing to the eccentricity of the loading, 7 tons on each was not really excessive.

Several teeth, on the other hand, were neatly sheared off one of the winches, though it was only 2% overloaded. That overloaded pulley blocks refuse to turn at all is a well-known fact.

It seems, then, that gear may be overloaded in inverse proportion to the amount it is expected to move under the load. When stores are short, material may be saved from holdfasts and guys which it is hoped will not move at all, whereas stinting materials from moving parts seems a poor economy.

5. Time and Men.

Excluding men employed on guards, etc., the strength of the section on work was :—

1 B.O.
1 I.O.
39 I.O.R's.

Also a British N.C.O. in Peshawar who collected most of the gear. The time taken was 12 days.

SHAN HAI KUAN AND ITS TOY RAILWAY.

By MAJOR E. F. TICKELL, M.C., R.E.

YOU ask, " Where and what is Shan Hai Kuan ? " (which being interpreted from the Pekinese means " Hill-Sea-Defile ").

It is the name of an ancient walled city in North China—a city through the centre of which passes the Great Wall itself, when, having descended from the mountains, it spans a narrow spot in the coastal plain, to end proudly on a small bluff, and plunge into the sea. It is a city of beautiful surroundings and ancient history. It is also the delightful summer training station of the British Garrison in North China.

Through the city, and through the Great Wall, pass the old Mandarin road and the modern full-gauge railway, as they traverse the Defile on their way from Mukden to Peking.

What a tale of the passage of armies could be told by this Khyber Pass of China—a tale extending from the advance of the ancient invading hordes to the all too frequent passing to-day of the armoured trains, which escort the retainers (both military and domestic) of the modern Chinese war lords, who cannot decide whether to remain " inside " or " outside the Wall."*

What a history of fortification could be written round the ruined defences, which literally jostle one another on both sides of their ancestor, the Great Wall itself. Where it crosses the plain it is faced with mere brickwork, but what brickwork ! (The bricks run two to the cubic foot, and some are as good as new.) Though now with but a travesty of its former grandeur, it proudly passes by, and even sometimes carries on its back, the ruins of nearly every other type of man-stopping device. Guarding the defile is the walled city itself, with its natural moat, and high gates, honeycombed with archers' loopholes, shooting down into the courtyards formed by the curtain-walls outside them. The gateways themselves still contain the cages in which were displayed the heads of former malefactors. There are loopholed masonry watch-towers with vaulted roofs. There is every type of earthwork fort and perimeter camp, with

* At the moment of writing (Sept. 1931), yet another horde is passing the defile —the civil and military refugees from the Japanese *coup* at Mukden.

The eyes of the world are turned upon this distant land, but will the League of Nations itself be able to prevent a repetition of history, or will the Wall once more become the boundary of China, and the great provinces "outside" revert to a foreign power ? It is useless even to guess, in this part of the Unchanging East.

their arched doorways and the ubiquitous "devil-screens," and sometimes with well-built masonry keeps. There are the old trenches of Wu Pei-fu just as his troops left them in 1924, when outflanked by Chang Tso-lin, who turned his lines by a march through the hills. There are pill-boxes and barbed wire; and among the ruins, the Chinese soldier practises his trench-mortar drill, and the foreigner fires his annual classification.

Not only do British troops migrate annually to Shan Hai Kuan, but the French, Italian and Japanese also take advantage of this locality for their summer training. Although only 180 miles from Tientsin, the temperature is invariably many degrees cooler—in fact, so cold are the winter winds that the sea (tepid in summer) is frozen for 20 to 30 miles out.

The British troops are accommodated under canvas in a semi-permanent camp, with their families in huts and tents in the adjacent "British Fort." The mess is in a deserted temple, while married officers hire the few bungalows along the sandy beach.

This annual foreign invasion mainly dates from the Boxer Rising in 1900, when the beach at Shan Hai Kuan, owing to its proximity to the railway, was selected as a landing place for an allied force. A small base was formed, and each nationality took over a camping area or fort. The "British Fort" occupies the bluff at the actual end of the Great Wall itself, and together with the "British Foreshore," where our troops first landed, forms what is perhaps the smallest and least-known component of the British Empire. The present British Camp, about half a mile away, was originally German, and now includes a twelve-target range.

In 1900 the allied force laid about three miles of 60-cm. light railway track, in order to connect the base with the full-gauge railway station.

This little railway has been maintained ever since by the British Army, although it is used by the other nations, and (on payment) by civilians and certain contractors. As a gentle reminder of this philanthropic work, all our trollies carry a Union Jack, which provides them with right-of-way at all times—a right which promotes extremely patriotic feelings on a wet day, when the driver of an unadorned trolly is watched unhooking and reversing a pair of refractory mules, in order to return to a crossing place, unwittingly overrun.

In its present form, or rather uses, the tramway is in some respects unusual, and it is thought that details might be of interest, as perhaps similar, or modified, systems could be employed elsewhere (*e.g.*, in training camps or even hutted areas in peace or war, where there is difficulty in providing fall for sewers, etc.).

In addition to the main line and the foreign sidings, there are branches to all important points in the British Fort, foreshore, camp

and stables, and the system as a whole fulfils the following duties in the British area :—

(*a*) It transports all stores and supplies from the full-gauge station, and assists enormously in pitching and striking camp. It should be noted that there are practically no roads in the vicinity, and the camp itself is upon soft sand.

(*b*) Conveys all personnel to and from the station by day and night, and clears stretcher cases from the camp hospital.

(*c*) Distributes all drinking, and much of the washing, water to the camp cookhouses and to the married quarters and messes.

(*d*) Removes all rubbish, stable litter, night soil and the foul water from kitchens and washing places.

The technical details are as under :—

Traction.—This is by unit and garrison transport mules, the harness consisting merely of a neck piece and breast collar attached to rope traces. They are driven by enlisted Chinese muleteers, by long rein from the front of the trollies. The normal speed is a steady trot, and during last summer the average daily run was 230 mule-miles.

Track.—This is now of 16-lb. rail, spiked to local hardwood creosoted sleepers. The sleepers are buried in a kind of disintegrated granite to the level of the bottom flanges of the rails, and are found to outlast by many years the original type of steel sleeper, which appears to be attacked by salts in the soil. Passing spurs are provided every few hundred yards.

Trollies.—There are two standard types of frame—an eight-wheeled bogey flat (deck 12′ 6″ by 5′ 6″), drawn by two mules, and carrying some two tons ; and a four-wheeled, one-mule trolly for passengers and light loads. One of the flats has a removable canvas roof on bamboo hoops for hospital cases. A standard wheel and axle, with " outside " roller-bearing boxes, has been found far superior to all others, any type of " inside " box being useless on account of difficulties in dust exclusion. The frames are locally made of rolled-steel sections, and are fitted with a central steel buffer and foot brake, operating on to four wheels. Double buffers are avoided in order to keep the feet of the driver clear in case the locomotive considers that the layout of the track does not provide the most direct route to the stables. For the same reason, the passenger trollies are built very low, with " side-car " seating, which enables the travelling public to leave their seats with the minimum delay. Derailments, however, of the steel trollies are uncommon on the present heavy track, but the same cannot be said of some of our allies' rolling-stock.

Bridges.—During summer spates almost the entire system is liable

1.—The British Fort, where the Great Wall of China runs down to the sea.

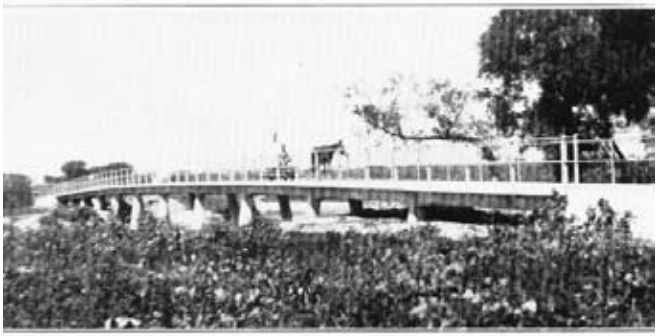
2.—The Guard-room, British Camp.

3.—Rolling Stock.

Shan Hai Kuan and its toy railway 1-3

4.—New Bridge under construction.

5.—Under Test—foreman at mid-span.



6.—In use.

Shan Hai Kuan and its toy railway 4-6

to temporary immersion by at least two feet of moving flood-water, and this fact prohibits all but the lowest embankments, as others would certainly be liable to washouts. On the other hand, there is, at such times, a very considerable water velocity at the river crossings and this calls for bridges above flood level, or at any rate ones which offer a small resistance if submerged. It recently became necessary to replace the longest timber pile bridge, which was thought to be incapable of repeating its 1930 performance, when it withstood a flood, which topped the handrails and at the same time removed some three miles of our sister line—the full-gauge to Peking. Trial designs were made for (*a*) a steel bridge on heavy rolled joists, (*b*) a lattice "through" bridge with longer spans, and (*c*) a concrete bridge of eleven 24′ spans. The last was finally chosen on account of cheapness. It was completed in 1931, and has already experienced one heavy flood. It is monolithic and of normal design, the footings most liable to scour being cast on to the heads of concrete piles, driven in the dry season. The track is carried on steel sleepers cast into the deck slab, which has a coating of asphaltic concrete. Such a coating on local reinforced-concrete roofs has been found to assist in preventing temperature cracks. These occur, not, as would be expected, in the intensely cold North China winters, but as the result of cold and sudden rain in the hottest weather.

Camp Water-Supply.—As in many dune localities the best water supply is from shallow wells on the foreshore. The two main drinking-water wells have brick well-houses containing coolie-operated pumps, discharging into tanks on the R.C. roofs. After chlorination in these tanks, which are used in rotation, the water is drawn off by gravity into fresh-water trollies, and conveyed to storage tanks adjacent to all cookhouses, messes and quarters.

Camp Sanitation System.—This is of recent introduction, and replaced an insanitary method of removal by coolies. Soak pits for ablution-water were, as usual, far from successful, and long distance combined with lack of fall made any form of piped sewer quite impossible. The tramway was therefore called upon, and now operates very satisfactorily as follows :—

A frequent service of sanitary trollies visits all refuse-producing points. All liquids are removed in a 400-gallon tank on a flat, fitted with a diaphragm pump ; the flat also carrying a few metal dustbins for solid debris. Another flat is fitted with six removable boxes, each capable of holding five standard camp buckets, and on the lids of these boxes can be stacked the dustbins containing all other solid rubbish. Refuse of all kinds is then carried to a disposal centre just outside the camp. This contains a Horsfall destructor, and also has a short 4″ pipeline to the neighbouring tidal river mouth, for the disposal of liquids. Part, however, of the soapy ablution-water is first discharged into tanks (actually the skips of old tip-trucks) for

use in washing buckets and bins before disinfection and return. The system is unobtrusive, and has met with marked approval from the medical authorities who have seen it in operation.

Throughout the bitter winter months the deserted trolly line is in the hands of a few Chinese caretakers, but on a summer evening it attracts a strangely cosmopolitan community. Returning to Chin Wang Tao (the neighbouring small coal port, where the Americans have their camp) is a party of cheery British sailors on shore leave, and some "doughboys," who have come over to see the Wall. A British trolly, piled high with chairs for this evening's concert, is passing a load of French *sous-officiers*, driven by one of their cone-hatted Annamites. There, in a cloud of dust and waving limbs, go a trio of *Italiana Regia Marina*, in their strange olive-green mixture of naval and military attire, determined to get a full dollar's worth from their hired China ponies. Through a group of pestering donkey boys and coolies carrying unbelievable loads, a company of half-naked little men trot back from hours of *ju-jitsu* and swimming drill on the Japanese beach. Here, on donkeys, come their officers in "drill order with swords." They disdainfully ignore a stray Manchurian soldier in his untidy grey uniform, and a slightly smarter local policeman, armed to the teeth. A puggareed Indian is taking an airing from the regimental tailor's shop, and a pretty Russian nurse is returning with her sunburnt charges from a donkey picnic. A rather thirsty sapper and his long-suffering Chinese groom trot back with their plane table from a day after contours in the hills. But here comes the king of it all—the T.C.'s foreman (the fattest man north of the Yangtze), who has "made all proper" for over 30 years, and won't believe that there is still something to be learnt about plate-laying.

The trolly line leaves its memories. Those night rides back to catch the "up" mail train to steamy Tientsin—rides beneath the clear starry sky, and between the high crops which line the track, obscuring the ancient surroundings, but not the white British boundary stones planted in such a very foreign soil. Who can ever forget that delightful change at dawn from the hot Chinese "down" train into the waiting British trolly, *en route* for breakfast, the sea, and a tour at Shan Hai Kuan, which may include riding, shooting, bathing, tennis, and most other things that man can desire.

A FIELD COMPANY'S TWO AND A HALF YEARS IN WANA.

By LIEUT. E. F. R. STACK, R.E.

No. 9 Field Company, Q.V.O. Madras Sappers and Miners, did not have an auspicious introduction to Waziristan when it relieved No. 13 Field Company at Manzai in October, 1929. For some reason it used to be considered that the metre-gauge troop train from Kalabagh, on the Indus, to Manzai had done its day's work after completing the 70-odd miles to Tank in 7 hours. It could not face the remaining 20 miles to Manzai the same day. Consequently the Company had to spend a night during the malarial season sleeping on the railway line at Tank, famous for its mosquitos. As no facilities for fixing mosquito nets existed, it is not to be wondered at that nearly 100 men developed malaria during the next fortnight.

The intention had been to move the Brigade which then occupied Manzai up to Wana, 60 miles nearer the Afghan border, in the spring of 1930. The M.E.S. had been building a road on to Wana from Sarwekai, garrisoned by a wing of the South Waziristan Scouts, for some two years, and it was very nearly completed. However, as Nadir Khan had just succeeded in overcoming Bacha-i-Saquo, it was possible that the more adventurous local spirits who had been participating in the struggle might cause trouble when they returned. To avoid this it was decided to move the Brigade up on November 6th. The Company had arrived on October 10th and malaria had started its ravages on about the 20th.

In the short period during which the Company was at Manzai, every available blacksmith was turned on to making oil cookers. In the part of Waziristan round Wana and Manzai, firewood is very difficult to come by, and cooking is almost invariably on oil cookers. The question of a suitable pattern had been under discussion before the Company came up, and there was not a sufficient stock available for the column. Carpenters were put on to making wooden moulds on which to build brick fireplaces; it was already growing chilly in Manzai, and Wana was 3,500 feet higher.

The Brigade moved out on November 6th, accompanied by No. 9 Company, less a depot left behind for forwarding stores and equipment, and it arrived in Wana seven days later without incident. Wana was established as a militia post in 1895, but had not been permanently occupied since the 1919 debacle, except for a short

time in 1920 and 1921. All that was left when the column moved in was the old "keep," which contained the well which was to supply water for the Brigade. The M.E.S. had installed an old steam pumping engine which, although it was expected to burst at any moment, did yeoman service for nearly two years.

The Brigade occupied a temporary camp while the site of the permanent one was selected. It was decided not to include the old keep in the camp, because the ground round it was broken and required a good deal of levelling. The fort itself, having been inhabited by Wazirs for some time, was not too sanitary. It was to be held by *Khassadars*, tribesmen in the pay of the Political Department, and the risk of their possible treachery while holding the water-supply was taken. They have since been replaced by a permanent platoon piquet, a safer and more sanitary arrangement. The fort has been generally cleaned up and the M.E.S. have built themselves a palatial suite of offices there.

After about ten days in its temporary camp, the Brigade moved into the present site, some 300 yards from the fort. The Company then began work on making Wana inhabitable, and had very little leisure for the next few months. The first thing to do was to put the camp in a state of defence. A double-apron barbed-wire fence was put up under Sapper supervision, and a shallow trench dug round inside it with a small parapet in front. Perimeter piquets, of which two were found by the Company, spent their nights there with the temperature a long way below zero and wind whistling down the trench. Tentage was at war scale to begin with, but E.P. tents were slowly coming up by convoy from Manzai. As soon as possible the perimeter trench was replaced by a wall of stone in mud.

A portable electric light set, the property of the Manzai Brigade, soon arrived and was installed. It consisted of a 6-h.p. Petter engine direct-coupled to a dynamo rated at 27 amps output. A corrugated-iron shelter was built round the engine, and current distributed over the camp by single-wire lead-sheathed cable. This system proved very difficult to maintain in running order. The lead cable was in small pieces, having been used previously when the Manzai Column was out, for camp lighting. It was difficult to make a reliable joint between the two lead sheaths, which acted as a return wire for the current. The wire was only buried about one foot deep in order to get it laid quickly, and units kept moving their tents over the distribution lines and digging down right through the wire without mentioning the fact. The Manzai engine was soon supplemented by another, the property of an infantry battalion which had joined the Brigade from Razani. This engine was in poor condition, having been used for some years on lighting similar camps. It disintegrated completely later.

The winter 1929–30 proved to be abnormally cold and wet in Wana. Rain or snow used to fall solidly for three days, by the end of which the place was a morass. Roads had to be used by A.T. carts drawing water from the fort and rations from the supply depot, and, being flat, soon became almost impassable. As soon as possible they were given a large camber and two inches of gravel rolled with a steam-roller borrowed from the M.E.S.

To shelter the piquets round the perimeter, some 30 posts were built and roofed with Sapper supervision and assistance. Forty corrugated-iron cookhouses were put up, and 100 fireplaces made with bricks salved from the ruins of old buildings in Wana. With infantry assistance, two bricklayers could start work on a fireplace at 9 a.m., using a wooden mould and burnt bricks, and have a fire burning the same evening. These fireplaces were built in gaps left in the side walls of E.P. tents. An extemporized bath-house was also made, capable of giving hot baths to 600 men a day.

As it was known that the Brigade was to spend some years at least in Wana, four hockey grounds and three tennis courts were started in January, 1930. The troops were fully occupied in housing themselves and making the camp inhabitable, so coolie labour was employed on this work. A Wazir landowner was given the contract for levelling the grounds, which were then rolled by the M.E.S. steam roller and given a coating of two inches of mud plaster. Incidentally it was very strongly suspected that the Wazir had been enabled to set up as a contractor by his quickness off the mark in 1919, when he was first into the militia treasure chest after the evacuation of Wana. However, the M.E.S. had let bygones be bygones, and given him several contracts. The hockey grounds were never very satisfactory, as nothing short of bricking would prevent the stones from working through, and there was no money available for it. The levelling work was done under Sapper supervision.

Meanwhile work was proceeding on oil cookers. As the column had on several occasions to go out on pack transport, a suitable pattern had to be designed for making up into a mule load. A " Poona " pattern portable cooker was tried out, but it was found that the numerous straps, buttons and hinges were very liable to damage, and oil cookers are not treated gently when issued to the infantry for use on columns. Accordingly a " Bangalore " pattern was evolved. This was more robust, and proved satisfactory on pack although a clumsy load to look at. The Brigade was eventually completely equipped with this pattern of oil cooker.

As soon as the frost ceased, the whole Brigade started making mud bricks as protection against the next cold weather. The wind had been found to penetrate a single E.P. tent wall with remarkable ease, and it was hoped to get all tents walled before winter returned.

Doors and windows were made on a large scale for walled tents, 120 being completed during 1930. In June the remainder of a Pioneer battalion moved down from Razmak to join one of its companies then in Wana, and was of assistance in making roads and bricks. Bath houses were commenced at the scale of two per battalion. These were made of corrugated-iron supported on spars, with concrete floors. Partitions were made inside, giving accommodation for twelve men at a time. The cookhouses, which had been very hastily put up in November and December to keep off the rain, were rebuilt. The old and leaky corrugated-iron was replaced by new, and they were flyproofed. Overhead cover was provided for cavalry horses and officers' chargers, as the weather was becoming hot.

Up till now the watering arrangements for the Brigade had been very elementary. There was a long row of eight or ten steel tanks about 4′ x 4′ x 4′ outside the fort, which were filled by the pumping engine from inside. A.T. carts were sent up by units to draw water in mule tanks. The result was that the water point was always in chaos, no police in the world could keep some 20 or 30 *bhistis* in order. The *bhistis* themselves worked unceasingly from morning to night.

Two large storage tanks were erected under M.E.S. arrangements just outside the fort. The Company then put in the rest of the system. Two 4-inch pipes were led down from the tanks and connected through a meter to a 6-inch main, about 1,000 feet long, from the fort to the camp. Here a 4-inch main, some 3,000 feet long, distributed water round the camp. Infantry working parties dug the trenches, Sappers laid the 6-inch and half the 4-inch mains, the other half of the 4-inch main being laid by the Pioneers. Valve pits for 4-inch and 6-inch valves were made of concrete with iron covers, and for 2-inch and 1-inch valves of wood. Simple and effective standpipes were made by running the 1-inch pipe up through a short vertical piece of 4-inch pipe, in one side of which a hole was bored for the horizontal arm. The 4-inch pipe was then filled with sawdust, which made a very effective protection against frost. Standpipes were provided at the scale of four per bath-house and two per cookhouse. All exposed pipes were carefully lagged against frost, and no trouble was experienced during either of the following winters with burst pipes. After the installation of piped water-supply the incessant rattling of A.T. carts filled with mule tanks ceased, and *bhistis'* lives became bearable again.

Having now got the more essential requirements installed, the Company was able to turn its attention to other amenities. One thing which was obviously desirable was a swimming bath for Indian troops. A suitable site was found on a shelf in a valley south of the camp, down the lowest portion of which a small stream ran. A hole was dug in this shelf with infantry labour under Sapper supervision,

and some 300 cartloads of stone brought from about three miles away. Economy in construction was essential, very little money being allotted for the work. A constant flow of water being available, leaks were not of great importance, and the bath was made of coursed rubble in lime mortar with cement pointing. Foundations were omitted. Fresh water was ensured by having a permanent outflow through a 2-inch pipe at the bottom of the deep end, and a surface overflow at the top. To avoid working below water-level in the ground, the top of the walls was about three feet above the stream. A water channel at a slope of 1 in 150 was dug, tapping the stream 100 yards farther up. The size of the bath was 45 feet by 18, 6 feet 6 inches deep at the deep end, and 4 feet 6 inches at the shallow. It proved very popular with the Indian troops, who, however, could never be induced to leave their soap behind.

After this the Company was able to turn some of its attention to its own comfort, and all the Sapper tents were walled with mud bricks. The next thing which was required was workshops, all the work up to now having been done in the open air, or in two E.P. tents which contained a circular saw, driven by a 5-h.p. Petter engine, and a carpenter's bench. It was thought then that a cantonment would eventually be built in Wana, and the M.E.S. agreed to give the Company the contract for building workshops which could later be pulled down and re-erected in their permanent site with burnt bricks. A lump sum was therefore handed over to the Company for this work.

The design was based on *Barrack Synopsis* scales, but except for the engine and store-rooms, interior walls were omitted to make supervision easy. Any joints which would need to be undone for pulling down and re-erecting were bolted instead of riveted, the trusses being so designed that by undoing five bolts they could be divided into two parts for loading. As in fine weather some men work out of doors, the front wall was not bricked in, but hanging corrugated-iron shelters, hinged at the top, were fitted. These could be swung open and supported on folding legs, or bolted to the main stanchions from the inside to lock up that face of the workshops. Clerestory lighting was provided above these shelters. The size of the workshops was 110 feet by 28, 12 trusses being used.

All material came up by rail in standard sizes from Karachi to Manzai, and by road from Manzai to Wana. All cutting, drilling and riveting was done on the site. At first work was by hand, but a power hacksaw and drill were purchased and their arrival speeded up the work tremendously. The fact that the angle-iron was badly rolled and far from straight did not make work any easier. Cutting gussets by hand and then filing them turned out to be a slow job, and the bends in the angle-irons made the assembling of trusses difficult.

However, after the first one, a system was evolved by which one truss was completed per day. A corrugated-iron roof was soon fixed and working in the open in inclement weather was at an end.

Machinery, bought from Corps funds, now began to arrive. A 24-h.p. Crossley engine of the crude-oil burning semi-Diesel type was installed, a task which gave excellent practice in handling heavy loads. Power was distributed from the engine by 80 feet of 2-inch shafting, supported by 12 self-aligning bearings in a trench two feet six inches deep. The sides and bottom of the trench were made of reinforced concrete, and the cover of ¾-inch timber. "Duxbak" belting with scarved and cemented joints proved most satisfactory. After their train and road journey, three of the lengths of shafting were found to be bent, and gave no little trouble before they were straightened satisfactorily. A small 5-h.p. Petter engine which had been brought up from Manzai was used as a stand-by engine for the main shafting when only a light drive was required. Actually the Crossley proved to be so very economical to run that the small engine was rarely used.

Machinery installed included a 30-inch circular-saw planing machine, hacksaw, lathe and drill. Underground countershafts were used for the saw and planing machines. A countershaft, raised about three feet directly above the main shafting, drove the lathe and hacksaw, while the drill was connected direct to the main shafting. The Sapper and Miner workshops, being the only real building in Wana, were soon commandeered for other purposes. They were utilized at different times as a church, cinema, lecture hall and even barracks. They were christened "Raspberry Hall," on account of the habit of collecting officers there after columns and exercises and pointing out the various mistakes that had been made.

One of the last technical tasks undertaken by the Company was the re-electrification of Wana Camp. As mentioned before, lead-sheathed cable had never proved satisfactory, and there seemed to be something in the soil which reacted chemically with lead, eating it away. The two small engines which had worked gallantly for two years without a day's rest were getting old. The M.E.S. had installed an electrical pump in the fort to replace the old steam engine, and so could produce current which they agreed to sell to the Brigade. Accordingly, about 800 yards of overhead bare copper wire were erected as a main-line feeder from the fort to the distribution station in the Sapper and Miner lines. Hence five distribution lines, also overhead bare copper wire, radiated over the camp, totalling about 1,800 yards. Sub-circuits were fed by V.I.R. cables supported on spars, leading from fuze boxes on the main poles.

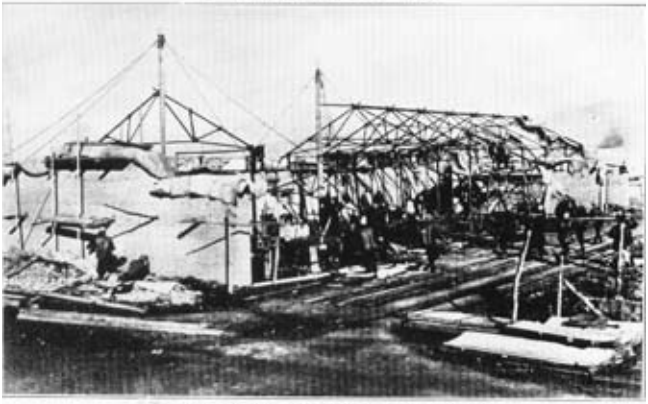
1.—Wana Camp in December, 1929.

2.—Wana Camp in June, 1931.

3.—Walled Tents in the Sapper and Miner Lines.

A Field Company's two and a half years in Wana 1-3

4.—The Old Workshops in 1930.



5.—The New Workshops under construction.

6.—The New Workshops completed, but without machinery.

A Field Company's two and a half years in Wana 4-6

Some 220 points were in use, and the Brigade paid for the current supplied and cost of installation from the monthly charge of 3 rupees 8 annas per point. A distribution board was made in the workshops of *shisham* wood. A new mud-brick distribution station was built to replace the old corrugated-iron structure, and one old Petter set was purchased by the Company to light the Sapper lines.

Besides technical work the Company had plenty of collective training with the Brigade on columns and exercises. The standing order in Waziristan District is that the Brigade must spend at least two nights a month out, and either a section, or the Company less one section, invariably accompanied the Brigade. Water being scarce, the water party nearly always had to erect troughs for the animals, of which about 1,200 used to go out, besides drinking water tanks. These had to be pulled down and taken inside the camp perimeter before retreat, and very often erected to water the Brigade before moving on next morning.

There was often work to be done on roads and tracks. One column was particularly interesting, when the Brigade went out to deal with some tribesmen west of Wana who were giving trouble. There being no road, camel transport was hired to supplement mules, and the Company had the unforgettable experience of loading awkward loads, such as barbed wire and angle-iron pickets, on camels at six o'clock of a winter's morning, when it was pitch dark and freezing hard. Later, working with three companies of Pioneers between the advanced and rear guards, eight miles of track were made in three hours across fairly easy country intersected by small valleys. The road was then four miles short of the camp site. Next day the same party, with 800 infantry, worked for three hours and completed the road. This work necessitated ramping down into valleys and clearing boulders, and when it was finished the road was fit for M.T., which replaced the camels, to everyone's delight. The Sappers had the unexpected task of acting as police and stopping a fight which suddenly developed between the camel drivers, who had been paid off, and the local Wazirs.

Towards the end of 1931, a party of Sappers under a B.O. had the very interesting experience of accompanying a punitive party of the South Waziristan Scouts, which was going out to deal with some recalcitrant Mahsuds in a village called Waspas Kalai. The Sapper party moved down to the scouts' post at Sarwekai the previous evening by lorry, and borrowed five of the scouts' mules next morning to carry equipment and explosives. The total distance marched was 23 miles across broken country, and while the scouts always wear sandals and travel light, and are renowned for their speed across country, the Sappers were fully equipped and wearing boots. In spite of this they managed to keep up, although they were working all the time in the village and the first halt or stand easy of the day

occurred half-way back. In the village, one compound and residence was demolished, the largest charge used being 50 lb. of guncotton.

As regards general military training, the Field Company held two piquets on the perimeter, of which it was allotted some 200 yards. There was naturally not much time for Fieldworks training, but the musketry course was fired annually, and two N.C.O.'s cadre classes were held during the two and a half years.

After two years, Wana had become quite well equipped as far as sports were concerned. For the troops there were four hockey grounds and one football ground, a running track and a swimming bath. For the officers there were three tennis courts, a 15-hole golf course and a drag, of which the Master has up to now always been a member of the Gunner and Sapper Mess. In the first Wana Point-to-Point, the inter-unit event was won by the Field Company team. The Company quite held its own with the infantry battalions and other units, winning the football league in 1930 and inter-unit hockey in 1931. In the 1931 hot weather inter-company hockey tournament, the Sappers entered two half-company teams, which met in the final.

It is now extremely doubtful if Wana will be occupied much longer by regular troops. It was originally intended to make a permanent cantonment there, and in some respects it is ideal. Unfortunately, Wana has turned out to be bad from the point of view of malaria, a very large percentage of the Brigade succumbing to it during the hot weather of 1930.

No. 9 Company was extremely lucky to be with the Brigade when Wana was re-occupied, as instead of ordinary routine, it had two and a half years of most interesting constructive work, and gained invaluable experience in just the kind of work required to be done in war. The whole atmosphere of the Brigade was most friendly and helpful, and one felt that the Brigade was very much more of a "team" than the ordinary peace-station unit, concerned merely with training and routine. When the Company was relieved in March, 1932, one felt that one was leaving a home one had built for oneself, though the troops were naturally glad to be returning to their homes in Southern India.

Colonel B. C. Battye, D.S.O., A.M.
1916.

BC Battye

MEMOIR.

COLONEL BASIL CONDON BATTYE, D.S.O., A.M.

BASIL CONDON BATTYE was born at Abbottabad, North-West Frontier of India, on September 24th, 1882. He was the youngest son of Major Leigh Richmond Battye, 5th Gurkha Rifles, and Margaret Fanny Jane Moffat, daughter of General Moffat, of the Bengal Staff Corps.

The "Fighting Battyes," of whom Basil was one, may well be proud of six of their number who have been killed in action. Lieut. Quintin Battye, of the Guides, was mortally wounded before the walls of Delhi in 1857. Major Wigram Battye was killed in 1879 near Fatehabad in Afghanistan: "he fell dead at the head of the Guides from a shot in the chest, having previously received a wound through the thigh, which, however, had not deterred him from still leading his men" (*Official Account of the Second Afghan War*). Battye's father was killed in a skirmish near the Black Mountain on the North-West Frontier of India, in 1888. Lieut.-Colonel Frederick Drummond Battye was killed while leading his regiment (the Queen's Own Corps of Guides) at the action of Panjkora during the relief of Chitral in 1895. These four were brothers. Of Basil's own family, one, Lieut. Richmond Moffat Battye, of the 6th Bengal Cavalry, was killed in the Tirah Expedition of 1897, and one, Major Hedley Morton Battye, in Gallipoli in 1915.

After the death of her husband, Mrs. Leigh Richmond Battye took her family to Clifton, where Basil went to a preparatory school. As a boy he was interested in carpentry and similar pursuits—and, even in those days, to say that he was interested in a subject meant that he put his whole heart and soul into it. He was fond of games and a good gymnast; he was very venturesome at climbing, and the cliffs of the Avon gorge were the scene of some wonderful exploits. It was in these early days that he met the lady whom he afterwards married—Miss Edith Lilian Cole. Later on, he went to St. Lawrence School, Ramsgate, whence he passed into the Shop in 1899.

Battye passed out head of his batch, obtaining his commission, before he had reached the age of eighteen, in August, 1900. On completion of his S.M.E. Course, he remained at Chatham in various posts.

Battye's first experience of active service was in Somaliland. A demand had been sent home from the expeditionary force there for

young R.E. officers to look after water-supply at various places on the L. of C., and Battye was among those selected. Before starting, he cabled on his own initiative to the Egyptian Geological Survey for all the information they could give him, on the subject of the water-supply of Somaliland, to meet him at Port Said. Battye remained in Somaliland from November, 1903, to the end of the operations in 1904, and was awarded the African G.S. medal and clasp.

After a short period of duty at Chatham, he was sent to India, where he was posted to the M.W.S. at Ferozepore. During his residence there, he distinguished himself at the putting out of a very serious fire in the Arsenal. Some cordite started to ignite spontaneously, and the Ordnance authorities, amid a series of tremendous explosions, set to work to clear the adjoining cells of explosives. Battye posted himself on the roof of one of these, where some three million rounds of S.A.A. were stored; although these rounds were already beginning to explode, Battye, through holes made in the roof, directed the fire hose on to the boxes below, and succeeded in saving the bulk of the ammunition. These operations were carried on within 100 feet of a magazine where 120 tons of gunpowder were stored. Battye's heroic deed was recognized, somewhat tardily it is true, by the grant of the Albert medal.

In 1907, he was sent to England for the E. and M. course, being the first officer to do it. Soon after his return to India, he was posted temporarily to the staff of the D.G.M.W. at Simla. His great knowledge of the electrical side of his profession led to the requisitioning of his services by the Punjab Government for the Simla hydro-electric scheme, the first of its kind to be carried out in that province. From start to finish, Battye was in charge of the work, a forerunner of the very much larger task he was to undertake after the war.

August, 1914, found Battye on leave in England. He was at once sent out to India, only to be immediately dispatched thence to France. Arriving there in November, 1914, he took over command of the 21st Field Company, 3rd S. and M. (now Royal Bombay Sappers and Miners), which had just lost all its British officers, and a large proportion of its Indian ranks, at the first battle of Neuve Chapelle.

It was not long before Battye made his presence felt. He got electric searchlights going in the trenches, and lights and radiators in every officer's dug-out in his sector. It was at this time that he invented the "Battye bomb," later known as the "Bethune bomb," a much cheaper and hardly less efficient weapon than the Mills bomb which superseded it. When part of the Indian Corps had been driven out of Givenchy, in the latter part of December, 1914, and the Guards Brigade was detailed to recover it, Battye turned

up at 1st Divisional Headquarters and asked if he could help; the operation was successfully carried out—at night and in pouring rain; Brig.-General Schreiber, who was present as C.R.E., has recorded his opinion that it would certainly have failed but for Battye's guidance.

During the intervals when his company was "resting," Battye was busy on the manufacture of trench stores, and in running a divisional school for bombing, field works, and trench warfare. He had a list put up in the company mess of "problems to be solved to defeat the enemy." His brain never seemed to tire, and he would often turn up in the morning with some brilliant idea he had pondered over in the night.

He commanded the 21st Company with signal success until, in April, 1915, he was wounded in the thigh, and sent back to England. As soon as he was passed fit, he got busy giving lectures on trench warfare to new English divisions and to the recently-arrived Canadians. He got out a pamphlet, "Minor tactics of trench warfare," which was eventually absorbed almost *in toto* in official publications, although at the time higher authorities were apt to look askance at it. Battye always looked ahead, and was nearly always right.

August, 1915, found him once more in France, this time as Adjutant, R.E., of the Lahore Division; a few weeks later, he became G.S.O.3, and in the succeeding February, Brigade-Major of the 141st Inf. Bde. After the Germans attacked the British position on the Vimy Ridge in May, 1916, and there was danger of their penetrating between the right flank of the brigade and the neighbouring formation, Battye, at great personal risk, reconnoitred and was largely instrumental in readjusting the situation. For this act he was awarded the D.S.O.

The following month, Battye became G.S.O.2 of the 3rd Corps, with which he served throughout the battle of the Somme, remaining with the Corps until just after the battle of Cambrai, for which he wrote out the orders for the tank attack.

Major-General Fuller, under whom he was serving at the time, records that "in all the arrangements we made for the concealment of the troops prior to the attack, he was invaluable, full of resource, and always anxious to see for himself how things were going." After the battle, and before the German counter-attack (which he had foretold), Battye left the 3rd Corps to take up the organization of a tramway system, under A.H.Q.

In April, 1918, Battye was employed on the construction of the "Hindenburg line" for use in case the field army was driven back farther. It was, as we know, not used, and Battye, now G.S.O.1, was available to take part in the advance to Mons. The fighting at this time he described as very severe, and for the first time a conditional note crept into his letters; "*If* I return home safe . . . ."

Battye's services during the Great War were rewarded by six mentions, two successive brevets, the D.S.O., the Belgian War Cross, the Legion of Honour, 5th Class, and the three war medals.

Immediately after the war, the American Y.M.C.A. Secretary in France (an old Simla friend) applied for Battye's services to do *liaison* work between British and American troops. It was characteristic of Battye that he accepted "as a thank-offering for having come through the war safely."

Battye was twice offered a nomination for the Staff College, but he preferred to revert to the engineering side of his profession. The Punjab Government again applied for his services in connection with hydro-electric schemes. He carried out a comprehensive survey and worked out a 80,000-kW. development on the Sutlej. In 1922, however, another site, on the Uhl river, a tributary of the Sutlej, was discovered, and found to be a better proposition for first exploitation. This scheme, which may fitly be called the crown of Battye's life-work, is a development of 36,000 kW. capable of ultimate extension to 112,000 kW.

It is hoped that a full account of the project will one day see the light; what follows can only be regarded as a meagre summary.

The waters of the Uhl river are to be led through a mountain range, by means of a tunnel 14,200 feet long, to pipes which convey the water to the turbine house at Joginder Nagar, 1,800 feet below. Thence the 132,000-volt trunk line runs to Lahore, 190 miles distant, from where the power is to be distributed over a large portion of the S.E. Punjab.

One of the first problems to be tackled was, naturally, the transport of plant and materials to the site; railhead at the outset was at Pathankot, 90 miles away, whence only a hill road was available to the site of the work; but all difficulties were successfully overcome. To facilitate work on the tunnel, a haulage way capable of carrying 15 tons was built up the hillside from Joginder Nagar to tunnel mouth; the two ends of the tunnel, above which the mountain range rises to a further height of 2,600 feet, were connected by two more haulage ways, 5 tons in capacity, and a light railway, which, being as it is 8,300 feet above sea level, is believed to be the highest railway in Asia. Work on the tunnel itself was unusually difficult, owing to the nature of the rock encountered, which necessitated very heavy concrete lining. The tunnel was completed early in 1932, and officially opened by H.E. The Governor of the Punjab. It is hoped that the whole plant will be running by March, 1933.

Battye, in spite of periods of indifferent health, was the life and soul of the undertaking, meeting all difficulties, political, financial and technical, with characteristic energy, cheerfulness and determination, winning the admiration and respect of all ranks, British and Indian, under him.

Battye was killed in a motor accident while on tour near Batala, in the Gurdaspur district of the Punjab, on May 16th, 1932. It is thought that the accident was due to a burst back tyre, while the car was travelling at high speed. Battye was killed instantaneously. It is pleasing to be able to record that the other three occupants of the car, though seriously injured at the time, and unable to give an account of the accident, have recovered and are at work again. Two were Indian servants and the third was Major Aylward, D.S.O., M.C., who had been associated with Battye since the beginning of the war; he was largely instrumental in discovering the Uhl site.

If it is possible to add a deeper note of tragedy to the circumstances of Battye's death, it is that he died on the eve of the completion of his great work, and that he was looking forward to retirement when it was finished.

Battye is survived by his widow and three sons and two daughters. The eldest son, Basil Wigram, was for some time in the Gunners. A nephew, Stuart Battye, is in the Corps.

Busy as he was, Basil Battye always found time for helping others; he was a keen Rotarian—a past president of the Rotary Club of Lahore. He was, as we have seen, keenly interested in the Y.M.C.A. He was a man of deeply religious feelings, and a brother-officer who shared a billet with him during the war tells how Battye, however tired he was after the day's work—and Battye's days were usually 15 to 17 hours long—always used to read a portion of the Bible before turning in.

It is difficult to think of another who has done so well in both the military and civil sides of his profession. His whole heart was in whatever he did. He was absolutely tireless, and if he had a fault it was that he sometimes forgot that his subordinates were not as tireless as he. While he had what he himself described as "the fatal gift of seeing both sides of a question," there was nothing hesitating about his conduct when he had made up his mind as to which was the better course. He was one to set precedents rather than to follow them. He was always cheerful with a cheeriness which was infectious. All who served with him in the war have testified to his utter fearlessness and complete disregard of self. He was a loyal subordinate, an able staff officer and a capable leader. Above all, he was, in the true sense of the word, a Christian.

F.C.M.

THE LATE COLONEL SIR EDOUARD PERCY GRANVILLE GIROUARD, K.C.M.G., D.S.O.

IT is hoped to publish a memoir of the late Sir Percy Girouard in *The R.E. Journal* for June, 1933.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

EYEWITNESS.

By MAJOR-GENERAL SIR ERNEST D. SWINTON, K.B.E., C.B., D.S.O., R.E. (retired). (Hodder & Stoughton, Ltd., London. 1932. Price 25s.)

In this very interesting volume the distinguished Sapper who is now Chichele Professor of Military History at Oxford University describes not only his experiences as official Press Correspondent at G.H.Q. in France from the end of August, 1914, to June, 1915, but gives us also a full account of the origin of the tank, for the success of which he was so largely responsible.

Major Swinton's war appointment was Deputy Director of Railways, but no sooner had he taken up those duties at Longmoor than he was suddenly ordered to France, where owing to General Joffre's dislike of Press correspondents at the front very meagre information of the operations of the B.E.F. was forthcoming. What he saw in France started his brain working at the problem of how to overcome the German machine-guns. Even if he may not have been the first to conceive the idea of the "machine-gun destroyer," he was easily the first in the field with the new engine of war which was to solve the problem of the break-through on the Western Front and eventually bring about the defeat of the enemy. That the tank can justly claim to a large share in the final *débâcle* is supported by a quotation its inventor gives us from German sources: "And therefore I consider," writes the military historian General der Infanterie A. D. H. von Zwehl, "that we were not beaten by "the genius of Marshal Foch, but by 'General Tank,' in other words, a new weapon "of war, in conjunction with the widespread reinforcements of the Americans."

Sir Ernest Swinton gives us another quotation, this time from a French source: "A unique idea flashed into somebody's brain one day, I do not know whose, for "who can say that the man who is being congratulated to-day was really the sole "inventor. The idea was perhaps not entirely original, but it was admirably "adapted to the object in view. I refer to the tank, from which victory was to "come as Pallas came from the head of Zeus." Monsieur Jean de Pierrefeu, who wrote these words not long after the war, was the opposite number to "Eyewitness" at French G.Q.G. during the whole war. He had possibly in mind not only the collaborators of Sir Ernest Swinton in the development of his idea. Mr. Winston Churchill and the Admiralty had worked hard to produce a land ship; and the author tells us that a French officer, Colonel Estienne, had been seized about the same time as himself with the idea that some kind of machine in the nature of the tank was necessary to help the infantry. Colonel Estienne eventually produced the *char d'assaut*, a machine in Sir Ernest's opinion more handy perhaps than the tank, but in climbing and cross-country work far inferior to it. The French *chars d'assaut*, however, were not ready to take the field till 1918, long after the tanks had received their baptism of fire and proved their worth in France.

It is interesting to note that, whereas Sir Ernest Swinton hoped that the tanks would form a unit under the engineers, the French *chars d'assaut* made their appearance organized as a battalion of artillery under the command of their inventor.

Sir Ernest Swinton tells us how the idea of the tank originated in his brain. From early days, before the South African War, he had always been interested in the machine-gun. His experiences in that war, of which he relates a good story, turned

that interest into a firm belief in the future of the weapon if it could be rid of some minor defects and made fool- and weather-proof. Later, as compiler of part of the *Official History of the Russo-Japanese War*, he realized that the machine-gun had more than made good. When he was ordered to proceed to France as "Eyewitness," at the end of August, 1914, it was not many days before he saw that the power of the machine-gun in defence was largely responsible for the state of siege warfare which had developed on the Aisne when the Germans for the first time had to show what they could do on the defensive. Some months previous to this, in July, he had heard from a comrade of South African days in the Railway Pioneer Regiment, of which he was Adjutant under another distinguished Sapper, Major-General Sir John Capper, now Colonel Commandant of the Royal Tank Corps, of his discovery at Antwerp of a new American invention which he thought would greatly assist transportation in uncivilized countries far from railways—the Holt caterpillar tractor—which had surprising powers of crossing country. It was the conjunction of these two items of knowledge—the machine-gun and the caterpillar tractor—in his brain that gave birth to the tank. "I believe," he wrote, "that the idea which had come to me "that morning (October 19th, 1914) on my way to London will prove the solution "of the problem of dealing with Germany's machine-guns." He got to work immediately on his arrival in London, but it was a terribly slow process to persuade the "powers that be." Fortunately for us, Lieut.-Colonel Swinton resumed in 1915 his pre-war duties in the office of the Committee of Imperial Defence, where he had the advice and active sympathy of the Secretary, Major, now Sir Maurice, Hankey, and was able to get access to those in authority.

Before describing the evolution of the tank it is necessary to say a word about those German machine-guns which Sir Ernest was striving to destroy. The Germans who had done so much in the training and development of the modern Japanese Army, were quick to recognize the lessons of the Russo-Japanese War. Sir Ernest tells us how it was discovered that they almost immediately set about forming a huge reserve of Vickers guns, and states that it is believed that by 1914 they had accumulated at least 30,000, and possibly many more (the Americans say 50,000), of them.

In this country, on the other hand, although our military *attachés* had called attention time and again to the effectiveness of the Japanese machine-guns—to say nothing of their trench-mortars and hand-grenades—in Manchuria, the information made no impression on our military authorities, and although there were several firm believers in the machine-gun outside the War Office, *e.g.*, Generals Smith-Dorrien, Monro and Congreve, nothing was done by the War Office to push the weapon. Economy was in the air. We know the result. Our infantry battalions arrived in France in August, 1914, with two machine-guns apiece, and there were no trench-mortars or grenades. The failure to learn the lesson of the Russo-Japanese War is accentuated by the fact that our military *attachés* and observers abroad regularly reported on developments in foreign armies and had called special attention to the subsequent increase of machine-guns in the German Army. In 1905, mounted machine-gun batteries were to be seen at German army manœuvres, and information as to the number of machine-guns which were eventually to be allotted to various units was forthcoming. But nothing was done, possibly because of the obvious efficiency of the British soldier with his magazine rifle. The names that have been quoted above are, however, those of officers who were all musketry experts!

Non-receptivity towards new ideas is a commonplace in official circles, and there is no more glaring example of it than the reception accorded to a proposal of the R.E. Committee that experiments should be carried out with trench-mortars. The suggestion was summarily turned down by the M.G.O.'s Department, and the Engineers were told to mind their own business and leave guns to the Gunners. The mention of hand-grenades reminds the writer of a distinguished Guardsman who,

during the winter of 1914–15, one day remembered he had seen some globular articles called " grenades " in Ordnance Store at the Tower. On leave in England, he asked the O.O. at the Tower for an issue. He was told there were 18 in store. " I'll take the lot." " No," was the reply, " you can have six only, the others may be wanted by someone else." Pocketing his six, he sold two by auction for a tenner each at a bazaar in aid of the Red Cross, and took the rest to France. They were of the pattern with which R.E. officers were trained at the S.M.E. up to 1885, and were relics of Crimean days like the white sandbags that adorned the parapets of the Kimberley forts in the summer of 1899–1900. Sandbags were rare at the beginning of the South African War; these had evidently come from the bottom of a pile commenced in 1856, when sandbags were made of white material so as not to show up in the winter snow of the Crimea!

To return to the tank. The story which Sir Ernest Swinton has to tell of his difficulties in getting anybody to take an active interest in the development of his idea of utilizing the caterpillar principle is told at some length. Eventually the first tank, " Mother," was completed and, on 29th January, 1916, took a preliminary canter over a specially prepared course in Hatfield Park before a number of officials from the Admiralty and War Office. The official trial took place on February 2nd, before Lord Kitchener and several other members of the Government. Mr. Balfour, Mr. Lloyd George and Mr. McKenna were enthusiastic at the results achieved. Lord Kitchener was sceptical, but agreed to the request of the representatives of G.H.Q. for some of the new machines. A week later another demonstration took place before His Majesty, who expressed his satisfaction. Four months before these trials, Sir Ernest Swinton had written a memorandum, which is given in full, laying down the principles on which tanks should be used. This memorandum was finally completed after the official trials and shows how much was foreseen in those early days. " It was upon the lines therein laid down," he writes, " that the Battle of Cambrai was fought on the 20th November, 1917, twenty " months after it was written, although it is a strange and remarkable fact that the " staff of the Tank Corps headquarters, which drew up the plan for that battle, had " no knowledge of the existence of the memorandum, then nearly two years old, in " spite of copies having been sent to the W.O. and G.H.Q. in March, 1916."

At Cambrai the tanks were given their first chance; for fourteen months previously they had been consistently misused. About their alleged premature use on September 15th, 1916, in the Battle of the Somme, Sir Ernest Swinton naturally has a good deal to say, but whether it was premature or not the success they achieved was decisive as to their future, and large numbers were immediately asked for by Sir Douglas Haig. Sir Ernest Swinton tells us that the German first-line troops had been warned previous to the 15th September that some kind of armoured car was going to be used against them. If the enemy did get wind of something, he writes, it was at the last moment, and to all intents and purposes it was a complete surprise. That it was so reflects everlasting credit both on those who were responsible for the elaborate precautions taken both in England and France to keep the secret, and on all those who had to do with their manufacture and trials in England.

No one who reads this book can lay it down without coming to the conclusion that whoever invented the tank, and there is little doubt now who did, it is to the initiative and pertinacity of Sir Ernest Swinton that we owe the finished article. He would be the last to fail to give credit to those who helped him, and if there is one man more than another who should be mentioned, it is Lieut. A. G. Stern, Armoured Car Division, R. Naval Air Service, now Lieut.-Colonel Sir Albert Stern, K.B.E., C.M.G. But there were many others. Last but not least, mention must be made of the Sapper to whom Colonel Swinton handed over his Tank Companies in France. No outstanding success was obtained by Divisions in the line, in 1918, without the assistance of the tanks. But there were never enough of them to go round: casualties were very heavy. The gallantry of the tank crews was patent to all; it was only the

few who realized that there must be a wonderful example and driving force behind them that inspired them to make the sacrifices they did. As a Divisional Commander the writer of this review cannot allow the opportunity to be lost of recording what a debt the army owes to both our brother officers, the inventor of the tank and the distinguished Commander who " made " the Royal Tank Corps.

The author has also published an edition of his book in the United States.

H.B-W.

WAR MEMORIES.

By Princess Marie de Croÿ.

(Macmillan & Co., Ltd., London. 1932. Price 8s. 6d.)

This is a book which cannot be put aside till one has read it from end to end. In the early part of the Great War, the author, whose home is at Bellignies, on the Franco-Belgian frontier near Mons, rendered invaluable service to the Allies, and especially the British, during the German occupation of Belgium. She turned her house into a hospital on the outbreak of war, and later was instrumental in succouring and concealing a large number of soldiers, wounded and others, who were missing after the retreat from Mons. With Nurse Cavell she worked day and night to help many of them to get across the frontier into Holland. Eventually she was arrested and sentenced to ten years' penal servitude by the German court martial which sentenced to death Nurse Cavell, Monsieur Baucq, the Comtesse de Belleville, Mademoiselle Thuliez and others. Her treatment in a German prison when more than seriously ill and her description of the Germans with whom she came in contact both before and after her arrest for helping enemy soldiers to escape, is an indictment of German mentality which it is as well that we should never forget.

The writer has been in the room in the ancient tower of the château at Bellignies in which she hid many of the soldiers she saved from German prisons. Access to it was obtained through the back of a cupboard in the 'embrasure' of the window in the ground-floor room used as a dining-room, and soldiers were actually concealed in a low windowless room above while German officers dined below and compelled the author to eat with them to ensure that their food was not poisoned.

H.B-W.

KAMET CONQUERED.

By F. S. Smythe.

(London: Victor Gollancz. 419 pp. 48 plates. Maps. 16s.)

This book, written by the leader of the expedition that reached the summit of Kamet, will be of very great interest to officers of the Corps who have followed the earlier attempts and who take an interest in high Himalayan climbing and exploration. It will be remembered that the late Lieut.-Colonel Morshead gave an account of his attempt with Dr. A. M. Kellas in 1920, in *The R.E. Journal* for April, 1921. Kellas and Morshead followed up the previous successful reconnaissance of Mr. C. F. Meade in 1913, and, as he did, attained the saddle that bears his name between Kamet itself and Eastern Ibi Gamin, at 23,500 feet, though they were insufficiently prepared and equipped to go higher. Morshead's conviction, expressed to the writer of this note on several occasions, was that the summit of Kamet was accessible from Meade's Col, provided a sufficiently careful organization was made. Meade's success was achieved on his third attempt and was partly the result of his earlier expeditions and partly due to the reconnaissances of his predecessors. As Smythe says in his account, no less than ten expeditions had prospected routes on the mountain or attempted to climb it. All these expeditions have contributed something to the ultimate success.

The great peaks of the Himalaya, it is now realized, cannot be rushed. Success is only to be achieved by careful and intensive reconnaissance, by the most deliberate preparation, and by the most steadfast determination in the final stages. Mountains in the high Himalaya are certainly not climbed by looking at them, but they equally are not to be climbed without looking at them from every possible angle. Alpine training, used intelligently, is of the utmost value, but is only part of the equipment required; and Alpine experience must be fitted to the Himalayan scale. Above all, success depends on the tact and sympathy displayed towards the native porters and on the patience of all members of the expedition, from the leader downwards. And expeditions of to-day owe a deep debt, not always fully recognized, to the mountaineers of the past, who have built up the confidence of the porters and gradually overcome their instinctive fears and superstitions.

Smythe's expedition was a triumph of organization. His party was selected with the utmost care; every detail was thought out, every eventuality considered; advice from past-masters of the game sought and utilized; and the lessons of recent Himalayan expeditions absorbed. To say that success was inevitable with ordinary luck before ever the party set out from Ranikhet is not to belittle the actual achievement, but to pay tribute to the excellence of the preparations. As Smythe rightly says, "Other mountains may forgive mistakes, but not the Himalaya."

As a book of travel and adventure this account is of intense interest, and there are many shrewd observations that will be of value to future aspirants to Himalayan honours. It may be divided into four parts, each roughly of about a hundred pages: the first part is devoted to accounts of previous expeditions and to the journey as far as the Base Camp; the second to the siege and attack of the great peak; the third to the journey to Mana and the subsequent exploration of the Arwa valley, a tributary of the upper Saraswati; and the fourth to observations on the physiological aspects of high climbing, to the botanical results, and to appendices giving details regarding weather, food, equipment etc.

In the opinion of the reviewer, the whole of the first part might have been usefully curtailed to make room for more details of the exploration of the head-glaciers of the Gangotri and the Badrinath range. Many of the early descriptions are very fine, but the country was well known and is travelled every year by British officers and others. There is nothing new here and the reader is inclined to skip these pages to get to the Base Camp. Nor is the author quite accurate in some of his introductory remarks, particularly with regard to his statements of the altitudes of the great Himalayan peaks (p. 4). As far as we know at present, K^2 is the second highest mountain in the world and Kangchenjunga is the third. The same careful investigations that have been made by Dr. de Graaff Hunter into the old observations for the height of Mount Everest and Kangchenjunga, have not yet been made for K^2, and the officially accepted height of the latter is still 28,250 feet and not 28,187 feet. It is safer for authors who do not understand the complications of refraction and deflection of the plumb-line to accept the recognized altitudes of Himalayan summits, Mount Everest 29,002 feet, K^2 28,250 feet, and Kangchenjunga 28,146 feet, until these are officially altered. Nor is it correct to say that Kamet is the second highest mountain within the British Empire. The Indian States that acknowledge the sovereignty of the King-Emperor are surely part of the British Empire; and, if so, there are very many, of which Nanga Parbat, Rakaposhi and the Masherbrums are perhaps the best known, that exceed Kamet in altitude.

The second part, while giving an absorbing account of the actual climb, contains a number of useful hints and observations on ice conditions at high altitudes; for instance, the frequency of ice avalanches in the early morning and late evening is noted and probably explained correctly on pages 125–6. Colonel Morshead's faith in the trustworthiness of the Bhotias of Niti and Mana is shown to be amply justified by the behaviour of Kesar Singh (p. 214).

The third part, the exploration of the Arwa valley and of the Badrinath range, is

disappointingly brief. Much of this work was real pioneering in totally unknown regions, yet while some forty pages are devoted to more or less trivial incidents on the passage from the Niti to the Mana valleys, Captain Birnie's investigation of the head-glaciers of the Gangotri system is very superficially dismissed in a page and a half. Captain Birnie's map, made with the means and in the time at his disposal, was a very fine performance, to which perhaps more reference might have been made.

The concluding chapters and appendices are of value and interest, and a careful study of them should be made by anyone following after. Dr. Raymond Greene's contribution on the physiological aspect of the business is particularly important, and coupled with his fine performance with Captain Birnie on Kamet has fully earned him his place in the forthcoming expedition to Mount Everest.

It is impossible to do justice to this book in a brief review, or to do more than touch on a few points; but mention must be made of the excellent reproduction of the very beautiful photographs and of the wisdom shown in including both Morshead's map of the eastern approaches to Kamet and Birnie's sketch map of the Badrinath and Arwa–Gangotri watersheds. On the other hand, the "minor additions" by the author to the Royal Geographical Society's sketch map of the expedition's route might have been inserted with a little more care.

K.M.

"PASSING IT ON."

By General Sir Andrew Skeen, K.C.B., K.C.I.E., C.M.G.

(Gale & Polden, Ltd., Aldershot. Price 5s.)

Few men are more qualified to write about Indian frontier fighting than General Skeen. As a subaltern in a first-class Indian regiment he first saw active service in the N.W. Frontier operations of 1897/98; and, after much experience of warfare in various parts of the world, he commanded the Derajat Column in the Mahsud–Waziri Campaign of 1919/20, which produced some of the stiffest fighting ever known on the Border.

Passing it On is almost unique in one way, in that it is a book written by a general officer for subalterns; and shows, in every page, not only a most intimate knowledge of detail, but a deep sympathy with the junior officer in his daily work.

General Skeen lays down very clearly that his book is only meant to "fill in the chinks" in the official *Manual of Operations on the North-West Frontier of India*; and, to get full value from his book, the *Manual* must first be thoroughly studied.

The author's conversational style makes very easy reading, and his word-pictures are admirably clear. *Passing it On* will be read with much interest and pleasure by the "old hand," and with very great profit by the newcomer to Frontier warfare.

Chapter I gives a picture of the *terrain* of the Frontier, remarks on the fighting values of various tribes, and vivid descriptions of incidents showing the mobility of the tribesmen, their infinite patience in preparing an ambush, and their quickness to take advantage of any mistake.

It is interesting to see that the Mahsud is, in General Skeen's estimation, the most formidable opponent. Great stress is laid on the necessity for training one's men to "use their eyes"; the necessary preliminary is, of course, that they must be taught what to look for. On my first visit to Baltistan, I found it difficult to see an ibex, *with glasses*, that my shikari had spotted quite easily with the naked eye. Later, when I knew what to look for, I could see game almost as well as my man.

Chapter II is very interesting, as it traces the changes wrought in tribal tactics by the introduction of smokeless powder and long-range rifles, and the evolution of our own tactics to meet these changes. From 1897 to 1915, our rifles were superior to those of the tribesmen; but in the latter years of the war, there was a definite flow of modern rifles to the Frontier; and in the Mahsud Campaign of 1919/20, our

opponents were as well rifled as ourselves, though the advantages of artillery and machine-guns remained with us.

The Engineer officer has much reason to be thankful for the introduction of the 3·7 (pack) howitzer, as a round or two will clear the enemy out of a fortified tower or building, and allow him to blow it up, or force an entrance, with comparative impunity.

I remember an incident in Waziristan in 1903, when two Ghazis stood at bay in a strong tower, and caused over 30 casualties before being finally dealt with. And the taking of certain fortified places in Thibet in 1904 resembled the storming of the castle of Torquilstone in *Ivanhoe*, except that the Black Knight had guncotton instead of an axe!

One result of the better arming of the tribesman is that an advance into the enemy's country is a far more methodical and deliberate business than in old days. Piquets have now to be posted at much greater distances from the line of march, to protect the advancing column; and, being more *en l'air*, have to be much stronger numerically.

It often pays to make "permanent piquets," and the R.E. have to lend a hand to make these as impregnable as possible.

Chapter IX gives fuller details of "permanent piquets," and page 91 describes the work required of the R.E. in connection with them.

A deliberate advance is all to the advantage of the Sapper, as he then gets a chance of making a good road on the line of march.

And, as General Skeen points out, the best way of conquering, *and* civilizing, a wild country is to drive really good roads through it.

The important question of Transport is dealt with in Chapters IV and X.

Before Lord Kitchener became C.-in-C. in India, second-line transport was hardly organized at all, but was hired, or otherwise collected, for the operations. I remember being in a brigade in the '90's, which had mules (very few), camels, ponies and donkeys for second-line transport. Four elephants were also offered to the brigade commander, but he wisely refused them!

Untrained transport adds enormously to the work of the R.E. on a frontier road, as a properly-led animal will go easily over a place where a casually-driven one will fall over the khud.

Sappers may well note what General Skeen says about "hair-pin bends."

Chapters V and VI deal chiefly with the details of piqueting; VII and VIII with camps, including many details useful for the R.E. to bear in mind. The Sapper must realize that, in frontier warfare, his work is only just beginning when he gets to camp. Water supply, roads, the more expert part of the defences, and many other "odd jobs" will require attention. But let the O.C. company, if humanly possible, leave enough men to get their own camp ready. Men will work with a much greater will if they know they have "something to come back to."

Chapter XII should be carefully read by R.E., as it deals with demolitions. These may consist of miniature forts, towers, houses, etc., and the day's work may, or may not, include destruction by fire.

The senior R.E. officer present must know his column commander's plans, and especially what time is available for work.

Every charge must be laid with the greatest care, as nothing is so wasteful of time (and sometimes dangerous) as a misfire.

I once knew the retirement of a brigade delayed for half an hour on account of a misfire in an important tower. And this extra half-hour cost several lives in the retirement.

Destruction by fire sounds simple, but needs the most careful arrangements. (See page 126.)

Premature firing means a loss of visual communication through smoke. I remember an instance in 1898 when this had most serious consequences.

Although *Passing it On* is written mainly for the infantry subaltern, it is full of interest for the R.E. A frontier brigade or column is a band of brothers, living in constant contact with one another for months at a stretch. All should be " out " to help one another as fully as possible ; and you can help the other fellow far more if you have a working knowledge of what his job is. S.H.S.

WATER DIVINERS AND THEIR METHODS.

By HENRI MAGER (translated by A. H. BELL).

(G. Bell & Sons, Ltd. Price 16s.)

When Colonel Bell translated *The Modern Dowser* he supplied a long-felt want, a primer for beginners in the art of Dowsing, and he has now, by his translation of M. Mager's *Water Diviners and their Methods*, given us a more advanced treatise on this subject which, although it has been in practical use for centuries, has only comparatively recently attracted the notice of scientists. In 1910 M. Mager set himself the task of finding out the reasons for the movement of the rod. Whether his claim that he has succeeded in doing this is correct is a question which I must leave to the future to answer, but he has, at any rate, broken fresh ground on the subject in a manner which cannot fail to be of great value to his successors.

According to his explanation, given in a very interesting introduction, the forces actuating the movement of the rod are set up by the atomic energy given off by *all* bodies of whatsoever physical nature. In fact, he bases his theory on the physical properties of matter ; a sound basis which should appeal to even the most sceptical.

The first part of the book is occupied by a description of most of the well-known pioneers in the search for the cause, or causes, in the movements of the rod, or pendulum, and by stories of their achievements and observations, but I am sorry that M. Mager says nothing about the rod behaving differently with some people, and it would have been useful to have had his opinion as to whether or no the theory is correct that this is the result of some diviners being of opposite polarities.

I must confess that Chapter II on " Intuitive Perception," in which a method of finding underground streams and springs by working a pendulum over a map is described, will take some believing : I was, myself, very sceptical until I heard that the official diviner to the British Columbian Government had actually indicated the outlines of lead and copper deposits, and that these had been confirmed by a mining engineer ! I then tried it, and found that, to a certain extent, I could do it myself.

I cannot say, however, whether this is not psychic, and, if so, it has nothing to do with the subject under discussion.

The pioneers have used various methods but on one point they all seem to agree, viz., the difficulty of accurately calculating the depth of an underground stream. This seems to be the greatest obstacle to be overcome whether the Dowser be pendulist or rhabdomancer.

After these historical observations M. Mager passes to the reasons for the movement of the rod and the effect of light and other conditions on the " Planes of Force," and it will be news to many that for accurate work the best time is between 9 a.m. and 3 p.m., and that in a strong wind the position of an underground stream shown by the rod may vary from the actual by 20 metres or more.

It is when M. Mager gets to his own work that the book becomes most interesting. Starting with the hypothesis that, as all colours have vibrations, so all matter has vibrations, he has worked on these lines, and explains how, by painting the rods various colours, they can be used to show only those particular bodies whose vibrations respond to those colours ; his chapter on the method of analysing water, when a stream has been located, by the use of the various rods used for potability should be of inestimable value to anyone searching for drinking water, and especially to the work of the Royal Engineers in the field. The diagrams on this part are clear, though they may, at first, seem complicated, and are most helpful in explaining his

meaning. I wish that something more definite had been said as to the method of finding military galleries and buried metals. Both these matters are just mentioned, but there the subject is left, which is merely tantalising.

On the other hand there are numerous diagrams and pages of information about the manifestations surrounding a bottle of water, and about M. Mager's work in the thermal regions of France. A few, perhaps, will follow these up and from the basis of these laboratory experiments may evolve fresh and useful knowledge to give to those who are endeavouring to solve the many problems surrounding this subject; but the majority of his readers, and especially those whose work is closely connected with military galleries and such practical matters, would have preferred that this branch of "Dowsing" should have been dealt with in rather more detail.

Nevertheless, the book is one which anyone interested in the subject of "Dowsing" should study, and many who are not at present actively interested may become so after reading it. W.H.T.

PEOPLE OF THE BOOK.

By MAJOR A. J. POTT.

(Wm. Blackwood & Sons, Ltd. Price 5s. net.)

To the best of our knowledge, this is the first collection of stories of military life in that most fascinating country the Sudan which has appeared in print. Major Pott (whose recent death is to be regretted) has produced a book which will be eagerly sought after by every officer who has ever served in the Sudan, and which will interest any man with a taste for life in what used to be called the Outposts of Empire.

The only criticism which can fairly be levelled at the author is a tendency to use rather too many of those Arabic phrases which, in the Sudan, have almost been included in the English language, but which are meaningless to the ordinary reader.

Perhaps the outstanding feature of these stories is the fidelity of their local colour and description of incidents. Any officer who has served in the Egyptian Army could have written "Mohamad the Walad" or "The Making of Markoi" had he had the gift; their incidents are within everyone's experience. "He Brought Them Out Safely" and "Fantasia" (everybody in the country, when this story was first published, recognized Hillet Moya Ketir, so much better described under this name, "an excess of water," than under its real one) are masterpieces of description, while the two historical articles are accurate and entertaining accounts of the incidents of "savage warfare."

"John Slimmer" is an interesting study of the reactions to the problems of the country of the wrong type of man, and is probably founded on the only recorded instance of the deliberate murder of a British officer. Only in the three remaining stories does the author definitely embark on fiction, and in each case it is the plot and not the attendant circumstances which is imaginary.

It is interesting to read, in "The Hillmen of the Sudan," Major Pott's comments on the rivalry which existed between the commanders of troops recruited from different tribes, but it is significant that he does not refer to the much greater rivalry which existed between the advocates of the Arab as against the Sudanese. People have come to blows over this question, yet throughout the book the author makes only one reference to the Arab soldier; undoubtedly, to the commander of one of the regular Sudanese battalions, the irregular Arab units simply did not exist.

Since his day, the pendulum has swung the other way, and to-day the vast majority of units of the Sudan Defence Force are entirely Arab. This is due, not to any marked superiority of the Arab over the Black, but partly to the fact that the officers responsible for the reorganization of the S.D.F. came exclusively from Arab units, and partly to the fact that the Arab is better adapted to the irregular organization which has been introduced in recent years. No officers who have soldiered with the old Black regiments can, however, regard their passing with anything but the very deepest regret. F.E.F.

THE ANCIENT EXPLORERS.

By M. CARY, D.LITT., and E. H. WARMINGTON, M.A., Readers in Ancient History in the University of London.

(Methuen & Co., Ltd., London. 270 pp. with 15 maps. 12s. 6d.)

This is an admirable single-volume account of the explorations of antiquity from very primitive times to the second century A.D., in fact, until the issue of Ptolemy's Geography about the middle of that century. The authors deal first with the exploration of the oceans, the Mediterranean, the Black Sea, the Atlantic, Indian waters and the circumnavigation of Africa. They then describe the exploratory land journeys of the ancients in Europe, Asia and Africa; and finally sum up the results of the discoveries described.

The book is packed with information and is well provided with maps. It is, in fact, a kind of condensed encyclopædia of ancient travel and exploration. It is well indexed and provided with ample notes of reference to the original authorities; it has, indeed, many hundreds of references which testify to the learning and wide reading of the authors. They describe for us, amongst other adventurous voyages, those of Odysseus, of Himilco, of Pytheas, Hanno, Nearchus, Eudoxus; they tell us how Ptolemy denied the possibility of circumnavigating Africa; they discuss briefly the march of The Ten Thousand, and the epoch-making expedition to India of that great explorer Alexander the Great. There is an excellent short summing up of the whole subject and a brief section dealing with the Influence of Ancient Explorations on Posterity. Altogether a book to be in every geographer's library.

There are two small errors which should be corrected in the next edition: Abyssinia was not explored by Sir Evelyn Wood, he was never there, though he had hoped to go on Lord Napier's expedition. And Sir Garnet Wolseley had nothing to do with the exploration of Nigeria.

C.F.C.

RACING TACTICS IN QUESTIONS AND ANSWERS.

By MANFRED CURRY.

(G. Bell & Sons, 1932. 18s. net.)

This book is composed of a series of problems on yacht-racing tactics, such as occur many times during any day's racing. Diagrams giving the relative positions of the yachts and marks, direction of wind and course for each problem are printed on the left-hand page, and the recommended solutions on the opposite page. A loose card is provided and this can be placed over the solution whilst one is studying the problem and deciding what one would do if one was the helmsman of the yacht in question. The author prefaces these problems by an introduction of some dozen pages in which he analyses critically and accurately the qualifications necessary for a successful helmsman. The problems themselves are arranged in groups according to the point of sailing being studied—Racing Rules, the Start, the Windward Leg, Wind Abeam, Before the Wind, and Rounding Marks—there being some ninety-seven problems in all.

The racing tactics propounded by the author are largely based on the theories and deductions set forth in his previous book, *Yacht Racing—the Aerodynamics of Sails and Racing Tactics*, published in English two or three years ago. One of the main theories of this book was that a yacht was propelled through the water not so much by the wind pressure on the weather side of her sails, but more by the suction on the lee side, and the author produced many diagrams showing the windstreams in connection with this theory. The next deduction therefrom was what the author has called the "Hopeless Position" and the "Safe Leeward Position," and the racing tactics of the book now under review are based on either obtaining or avoiding one

of these positions relative to the opposing yacht. These positions may be summarized as follows :—

Hopeless Position.—When the overtaking yacht is either dead astern or close on either quarter of the yacht being overtaken; the latter is then interfering with the wind of the former to her disadvantage.

Safe Leeward Position.—Obtained by bearing away sufficiently to be able to overtake to leeward clear of the disturbed wind area caused by the sails of the leading yacht, and then luffing up sharply so that the sails of the overtaking yacht and the wind spilt therefrom will interfere with the overtaken yacht to her disadvantage.

In studying the problems, the yachtsman, and especially the beginner or one with only slight experience in a keen class, must bear in mind that they are primarily for small racing boats such as the 14-foot dinghies and the 12 square-metre class recently introduced into this country, and suchlike. When the student is sailing a larger yacht which naturally possesses considerably more momemtum and which, owing to its larger sail area and consequent " bigger pull in the ropes," takes very much longer to manœuvre, he must be prepared to modify the solution accordingly. Moreover, the tide and its effects is in no case considered, and this, of course, may very seriously affect one's action in any given circumstances.

Some of the solutions appear to be near the borderline of our interpretations of the I.Y.R.U. Rules, and a close study of these rules in conjunction with the suggested solutions is recommended. In this connection it is a pity that what is to most amateurs one of the most difficult of the rules—Rule 30—Risk of Collision—is not considered more fully by the author. If this were done it is thought that some of the solutions might be modified. Rule 31—Overlap—might also well be considered in more detail.

The book is profusely illustrated, many of the photographs being really good, and studying these on a winter's evening is more than sufficient to make one impatient for the next yachting season. On the last page of the book is a record of the author's successes in yacht racing—in all some thousand prizes since 1912—and averaging over seventy per cent. of flags to starts—a record of which anyone might well be proud, and a book on the tactics employed to give such striking results must surely deserve the closest study not only by the enthusiastic beginner but even by the most experienced of helmsmen.

J.H.D.B.

THE TESTING OF HIGH-SPEED INTERNAL COMBUSTION ENGINES.

By A. W. JUDGE.

Second Edition. Revised and Enlarged.

(Chapman & Hall. Price 25s.)

The testing of internal combustion engines is nowadays a matter of paramount importance, both in production and research. The increasing popularity and usefulness of the motor-car and the world's growing interest in aviation have been the principal factors in the rapid development of the petrol engine. Efficiency in the one case, and power : weight ratio in the other, have been steadily improved year by year, and this improvement has only been rendered possible by the adoption of test methods of a most elaborate kind. The book we are dealing with is a detailed exposition of the technique of such testing, which the author treats principally from the point of view of the petrol engine—on the subject of which he is a recognized authority. The methods he describes are the very latest as practised in the leading experimental laboratories of this country, as for example in the Ricardo laboratory at Shoreham.

The book starts with a chapter on General Principles, in which is set out the broad theory of petrol engine performance, with a wealth of useful curves and other data drawn from the author's experience, which are indicative of the kind of results to be expected. One undoubtedly wishes that some of this valuable information had special reference to the high-speed compression-ignition engine; so little has yet been written on this subject.

Then, in separate chapters, are given an outline of test procedure, and a detailed description of the several methods of measuring and testing all the important variables —fuel, exhaust gas, water and air. An excellent chapter follows on brake-horse power measurement, giving accounts of all the best known forms of dynamometer.

It is interesting in this connection to notice the ascendency of the electric dynamometer in the automobile world. Whether it be of the swinging field or the electric absorption type, it has the great advantage of being able to run as an electric motor, and so to drive round the newly-erected motor-car engine on the test bed until it is "run in," while measuring its friction losses at the same time. We are told that dynamometers of this kind are actually mass-produced to meet the demand of the various car engine manufacturers in the country, and that they have been elaborated to such an extent that they will perform all their functions at the bidding of simple push buttons. These instruments show their power readings on a single dial, calibrated direct in B.H.P., and light up different coloured signal lamps under different conditions to show the unskilled attendant how things are going on.

The most valuable section of the book seems to be that dealing with high-speed pressure indicators and indicator diagrams. About ninety pages are devoted to this subject; the Farnboro', Hopkinson, and no less than ten other high-speed indicators are carefully described.

The remaining chapters deal with the testing of automobiles as a whole, and the testing of aircraft engines, including a special chapter on the famous Rolls-Royce engine that won the Schneider Trophy in 1931; an account is also given of miscellaneous appliances used in research.

It is an excellent and comprehensive work; the subject is treated systematically in very clear and simple terms, with a large number of good illustrations. The only complaint we can find to make against it is that it deals so little with the new-born high-speed compression-ignition engine, which we feel is destined ultimately to supersede the petrol engine in a great many of its present applications. One must, however, bear in mind that the first edition of the book appeared in 1924, when the high-speed compression engine had not reached the stage of being a commercial proposition. It is probable that such an important subject could not adequately be dealt with in the process of revision, and we can only hope that the author will take it up separately in a later work, as we feel sure he will do it well.

W.M.B.

EXPLANATORY NOTES TO ACCOMPANY A NEW GEOLOGICAL MAP OF THE COMMONWEALTH OF AUSTRALIA.

Based on Maps already published by the Geological Surveys of the various States, etc.

By Sir T. W. Edgeworth David, K.B.E., C.M.G., M.A., F.R.S., etc., and Professor Emeritus of Geology, University of Sydney.

(Edward Arnold & Co. Price 20s. unmounted, 42s. mounted. Postage extra.)

A new and revised geological map of Australia, including New Guinea, in four sheets, on a scale of 1/2,990,000 (1″ to 47·2 miles approx.), has recently been issued, accompanied by a volume of explanatory notes. It is intended to replace the older maps on smaller scales, also the mandated territory of New Guinea has been included for the first time. The notes are contained in a book of 177 pages and are, in fact, a summary of Australasian geology brought up to date from all the latest available sources by that eminent geologist and explorer, Sir T. W. Edgeworth David.

Australia is geologically one of the most stable regions on the surface of the globe, although immediately adjacent to the north lies New Guinea, one of the most unstable portions of the earth's crust, which is being pressed and crumpled against the continental buttress. Almost all geological formations known elsewhere find representatives in Australia. Meteorologically it is a region of great contrasts. To the north the dense tropical forests of New Guinea and to the south the abundantly-watered Tasmania, while in between lies the great desiccated areas of Central Australia.

If we were to select for mention an outstanding feature of Australian geology, one which has produced the most far-reaching effects on the climate and economics of the country, it would be the great geological stability of the continent. As a consequence "folding has ceased in Australia for the most part, except in Eastern Queensland, since the end of Paleozoic time." There are no young mountains, but prolonged denudation, through geological ages, has exposed the plutonic intrusions of highly-metalliferous ore-bearing rocks, yielding gold, copper, zinc, lead and tin.

Another interesting consequence of stability is that there are living representatives, comparatively little changed, of fossil types which have long since become extinct in other less stable lands. Not only are fossils well preserved but there are still primitive surviving forms of their descendants.

Of much practical interest is the summary of economic geology to which geologists, in these days, rightly pay a great deal of attention. There is a unique feature of Australia, which probably affects the economic situation more than any other, and certainly affects the well-being of large numbers of the people—we refer to the great artesian basins which occupy upwards of a million square miles of the country. From this source, through the numerous bore-holes that have been put down by government and private interests, water has been obtained enabling the raising of stock, and in a lesser degree the utilization of land, which would have been otherwise impossible.

As to the origin of the pressure under which the water in these basins is maintained, authorities appear to differ and no altogether satisfactory explanation has been forthcoming.

The whole question of the occurrence of artesian water in Australia is a complicated one. Its importance, however, cannot be exaggerated in areas where the rainfall is less than ten inches per annum.

A peculiar and noteworthy feature in Australia is the occurrence of a formation known as the "duricrust." This is a hard layer of mineral matter forming a mantle over vast areas of low rainfall, which acts as an obstacle to the ordinary mineral prospector. It should be possible, however, by means of modern geophysical methods to locate ores under it. These methods have been extensively tried in the Commonwealth, under the auspices of the Council of Scientific and Industrial Research. The success of a geophysical survey depends on a close study of geological conditions.

The notes conclude with a trip in Well's "time machine," in which we are given a cinematographic view of the Australasian Continent from the earliest geological times.

We think an index would have improved what is a very clear and concise account of Australian geology.

It is understood that the author has under preparation an elaborate treatise on the geology of the Commonwealth of which this is only a forerunner.

The map is clear and the colours well reproduced; the lettering is well selected and not overcrowded. Eleven sections showing the geological structure are displayed around the margins, together with an index to the formations.

Sir Edgeworth David has been for many years an Honorary Member of the Institution of Royal Engineers.

H.L.C.

WAR AND WESTERN CIVILIZATION, 1832–1932.

A Study of War as a Political Instrument and Expression of Mass Democracy.

By Major-General J. F. C. Fuller, C.B., C.B.E., D.S.O.

(Duckworth, 3 Henrietta Street, W.C.2. 1932. Price 10s.)

This is the latest work from the pen of that prolific writer, Major-General Fuller. Its object, as described by the author, is "To reflect on the experience of the last hundred years in order that we may fashion a little candle which will light us through the next hundred." To this end he brings an intense searchlight to bear on a hundred years of war. The result is a potted description of all the wars which have taken place between 1832 and 1932, interspersed with comments on the mistakes made by politicians and soldiers. This is to enable us to study the past, with all its errors, in order to avoid the pitfalls of the future. We believe, however, that man has been engaged in this pastime from time immemorial without very much result. Anyhow, so far as the abolition of war is concerned.

In an appendix, which we are asked to read first, is a chronology showing that not a year has gone by during the period without the occurrence of some war or upheaval in the world, yet this has been a time of political, industrial and scientific progress. All these have done for the world is to make the last war the worst of all, and probably the next, when it comes (unless we see to it that it does not come), will be more terrible still.

Who is responsible for all this?

For 150 years endeavours have been made to deprive kings and governments of the right to make war and peace, because it was thought that with the coming of an era in which war would depend on the people's will peace would prevail throughout the world. In actual fact, General Fuller considers, the exact opposite was the case. It was public opinion, and above all German public opinion, which was responsible for the World War, "not in 1914 but from Sedan onwards." After pointing out the enormous increase in expenditure on elementary education during the latter part of the last, and early years of the present, century, he remarks, "the increased education of the masses does not necessarily tend towards peacefulness."

During the first 40 years of the period 1814-1914 there were 13 wars of importance, while during the last 60 years there were no less than 33. "This is scarcely an earnest for the peaceful nature of democracies."

But is it right to place all the blame on the masses? Is it not the evil influence of a small number of so-called statesmen that is the chief cause, rather than the will of the people as a whole, which, if left to itself, would be in favour of peace?

We have before us the example of Soviet Russia to-day, where if all we can learn be true, the few in power have obsessed the people with the idea of war and are constantly fostering a warlike spirit quite alien to the people themselves. The making of war may be no longer in the hands of kings and governments; it has been transferred to the few who have the gift of speech, and to the Press.

There is not much use disparaging politicians—however bad they may be—for they have come to stay. The same applies to democracy, unless one can suggest something better, and no one has, so far, been able to do this.

Since the industrial revolution the foundations of all political actions have been economic. It is economic grievances, fancied or real, that have led to wars. It was to enforce her economic policy on her neighbours that Germany created an immense army, and for the same purpose she built up an immensely powerful navy to enforce her will on her overseas competitors. Every time a hostile tariff was raised against her, she said she was being encircled and must have her place in the sun. In future wars operations will be directed not so much against the actual army as against the sources from which it derives its supplies—the civil industries, and against the civil population. Industrialization leads to disagreements, and

eventually to conflicts, between nations. This has been the case with Germany and will not something of the same kind arise, the author asks, when Russia and Asia, with their cheap labour, become industrialized?

Europe will be compelled to set up tariff barriers against products from these parts of the world. The only hope of resisting this economic pressure is a combination among European countries. But this will necessitate a formidable European army, that is a continental army will replace national armies. This is the author's vision of the future. Great continental combinations will be brought about by force of economic circumstances, since countries have become interdependent and no nation is now self-supporting.

The immense range of the author's reading is displayed, not only in this book, but in his other published works. We think to condense the lessons of a hundred years of wars into a single volume of some 270 pages tends to bewilder the reader—they follow each other in such rapid succession—and tending to obscure the issue gives us no time to grasp what the author is driving at. As a book of reference which summarizes the salient features of the last century of wars the work is excellent, for General Fuller possesses the art of describing a whole campaign in a few pages. The book is fully documented throughout, which adds to its value.

H.L.C.

LIST OF BOOKS RECOMMENDED.

Recommended by Lieut. J. S. A. Salt, R.E.

ECONOMIC DEMOCRACY
SOCIAL CREDIT
CREDIT POWER AND DEMOCRACY
THE MONOPOLY OF CREDIT

By Major C. H. Douglas (Cecil Palmer).

In these days of economic crisis, when the plight of many countries is in some ways akin to war, the danger constantly increases that in the struggle for existence the nations will shortly break out again into a world cataclysm. Professional economists produce a bewildering multiplicity of counsel and indeed live by taking in each others' fallacies, while bankers and financiers have repeatedly proved themselves not only intellectually incapable of understanding their own problems, but devoid of any enlightened civic sense. The ordinary man who takes up the study of the subject at all thoroughly must sooner or later come across the works of C. H. Douglas. In 1919 he published a book, *Economic Democracy* (Cecil Palmer), which, to an unprejudiced student, must appear as the most penetrating, revolutionary, and vitally true piece of economic analysis yet produced. Why, then, is the book and its author so little known or quoted, and why has no politician taken up these ideas in order to restore his country to prosperity?

The answer lies in the fact that the cause of the present crisis is of purely financial origin, and the Douglas analysis exposes the essential rottenness of the present financial system. Since, however, the holders of financial power also control the Press and politicians, they have been able to secure effective boycott of the Douglas ideas, or Social Credit, as they are now usually termed. At the present time, for instance, there are study-groups on this subject in nearly every town, but since the ordinary channels of publicity are closed, the effect of their work tends to be confined to small circles. Though the mere assertion of a widely-spread boycott savours of detective romance, to those who study closely such an item as the discrepancy between public speeches as made and as reported in the London Press, the existence of a state of general censorship is beyond all doubt, and its authorship is clear.

The ideas underlying Social Credit are best studied in the works of its originator, the chief among which are noted above.

An excellent weekly paper devoted to the subject is *The New English Weekly*, edited by A. R. Orage, whose "Notes of the Week" offer a brilliant commentary on current affairs.

MAGAZINES.

REVUE DU GENIE MILITAIRE.

(*June*, 1932.) 1. *Un groupe de sapeurs de chemins de fer.* General Gauzence de Lastours continues his series of articles on the employment of railway sappers. In Chapter IV he deals with the most practical and economical methods of throwing up high railway embankments, using a network of Decauville track. He takes as an example an actual instance that occurred of a chord line constructed to connect two existing railway lines. The embankment was eight metres high. The most economical way of taking the spoil out of the borrow pits and running it up on to the bank, keeping the skips in use the whole time, and avoiding any congestion of empty ones, is worked out very carefully.

The writer prefers a 0·50 m. gauge track to a wider one, and prefers manhandling the trucks (which should not hold more than 1/3rd of a cubic metre) to hauling them by engine or horse.

In Chapter V he describes some of the types of temporary buildings erected during the war. For sheds covering large areas the French favoured a saw-tooth-shaped roof of 5-m. span, with light roof timbers, carried on uprights 3 m. high. These spans could be multiplied indefinitely to cover as large an area as might be required. Instances are quoted showing that work has been carried out more promptly by sapper labour than by contract.

(*July*, 1932.) *Quelques réflexions sur la guerre de mines.* General Thomas relates his personal experiences in mining warfare, as commander of divisional and of corps engineers at the Somme and in Champagne in 1914–15. He admits that mining warfare is wasteful of material and that it does not lead to important tactical successes. But it was forced upon us by the enemy, and we had no alternative but to take up the challenge. The principle was held on both sides that not an inch of ground should be surrendered, if it could be helped, and that to retire was an acknowledgment of defeat.

Several instances of mining warfare are described in detail. The largest charge mentioned was fired in September, 1915, under the salient of the Butte de Mesnil. Fifteen tons of explosives were used and fired from a depth of 35 to 40 metres. The shock was felt for a distance of several miles, and the result was that all the trenches were filled in and all dugouts collapsed.

Counter-mining has proved very useful to protect salients or observation posts from the enemy's mines. There are two kinds of galleries: deep ones, at least 20 metres below ground level, to keep off all enemy mines, and shallow ones, from 8 to 10 metres deep, to destroy surface works as economically as possible.

Whatever the purpose for which they are intended, they must help to sustain the morale of the troops in the trenches. The *camouflet* is the arm of the defence *par excellence*, and the deeper the charge is fired the more effective will it be.

The writer considers that the mining materials placed at his disposal during the war were never sufficient. He discusses the question of ventilating and lighting tunnels, the supply of oxygen apparatus, etc. As regards explosives, black powder is not as efficient as a high explosive (cheddite was ordinarily used), and containers should not weigh more than 25 kg. each when full.

2. *Un groupe de sapeurs de chemins de fer.* General Gauzence de Lastours continues his article on railway sappers. Chapter VI deals with the erection of ropeways. Two ropeways were put up in 1915 in the Vosges—at the Valtin and Hohneck—partly by contract and partly by military labour. The contractors undertook the erection of the standards: these were of wood resting on concrete bases.

Two ropeways were erected at Kruth and Bussang respectively by groups of sapper companies. The Kruth ropeway was 2,379 metres long, with a difference in level of 600 metres. The standards were made of round fir logs felled on the spot, and masonry work was avoided. In spite of delay due to bad weather, snow and other causes, the work was completed in 86 days. The line at Bussang was much longer, viz., 6,200 metres, and the standards were higher: light steel pylons were used. The work was completed in 103 days.

Chapter VII deals with railway work, and a comparison is made between contractors' methods and military methods. The progress of construction is not regulated so much by the speed at which the rails can be laid as by the rate at which ballast trains can deliver their supplies. Bridging material can be delivered at site on lorries or tractors. The writer concludes with interesting accounts of railway work carried out by the Russians in 1877 and by the Germans in 1870.

3. *Une mission d'étude de chemin de fer à la Guyane.* This is an account by Colonel Dewulf of a railway reconnaissance carried out in French Guiana by Captain Refroigney and a party of engineers. The first chapter is devoted to a description of the colony, its history, climate, natural products, communications, etc. The communications are practically limited to a coast road running westwards from Cayenne, and to a few miles of light railway. The rivers are the only means of communication leading into the interior. The country is covered with dense forests, the rainfall is very heavy, and the climate is unhealthy.

(*August*, 1932.) 1. *Un groupe de sapeurs de chemins de fer.* General Gauzence de Lastours continues his series of articles. In this number he describes several railway works carried out by sappers during the war. The system generally adopted is what the writer calls *la méthode par tranches*. Starting from each level crossing of the section of line to be constructed, the bridging material, ballast, sleepers, rails, etc., are brought by lorry to the level crossing, and construction is started in both directions.

The alternative to this system is the *méthode par avancement*, in which work is started from one end of the line only. This system was adopted only when lorries and roads were urgently required for purposes other than railway work.

The allowance of ballast was 0·750 cubic metres per metre of track, but where time was not pressing, it was increased to 1 cubic metre. It was found that a section of 16 road-construction lorries, of 3 tons capacity, making 4 trips a day, could deliver at one distributing centre 180 tons of ballast, enough for 120 metres of track.

2. *Une mission d'étude de chemin de fer à la Guyane.* In this second article, the writer describes the work carried out by the mission under Captain Refroigney. The mission, consisting of four officers and ten N.C.O's of the Engineers, disembarked at Cayenne on the 30th July, 1906. Their instructions were to make a reconnaissance from the coast to the central *massif* of French Guiana, following either the valley of the Comté or that of the Approuague. There were no reliable maps of the country; the interior is covered with dense forests, and no supplies are obtainable anywhere. Light canoes were available for transport for a short distance on the rivers; after that, everything had to be carried by coolies. The only labour available for carrying loads and clearing the jungle was convict labour, which proved fairly satisfactory.

Preliminary operations in establishing a supply base at the highest navigable point upstream began on the 16th August and ended on the 19th September. A second supply base was prepared farther up country.

Survey work went on for several months until the mission returned to Cayenne on the 3rd March. The rains set in early in November, causing a considerable amount

of sickness. The party suffered from *beri-beri* and other fevers, and a number of men had to be evacuated to Cayenne.

In spite of climatic difficulties, the different parties of the mission covered a total distance of 805 km., of which 95 followed existing roads or tracks, 11 crossed open plains, 302 followed rivers, and 442 passed through virgin forest. A provisional alignment for the railway was plotted on a scale of 1/5,000 of a strip 100 metres wide and 105 km. long.

A.S.H.

RIVISTA DI ARTIGLERIA E GENIO.

(*April*, 1932.) *Esercitazione di distruzione di manufatti stradali.* Captain Pietravalle gives a brief account of some demolitions of bridges carried out by the 3rd Regiment of Engineers in the Spluga plain. The opportunity occurred last year, when the construction of a dam and reservoir in connection with a hydro-electric scheme caused a portion of the old trunk road from Stuetta to Monte Spluga to be submerged. The Engineers were thus enabled to get some practice in blowing up a few bridges and culverts on the abandoned section of the road.

A masonry bridge with two arched spans was blown up by means of two charges placed in each abutment, and three small charges (each of 2 kg. of tri-nitro-toluene) in the pier. Each abutment charge consisted of 18 kg. of T.N.T. or 14 kg. of pentrite.

Similar abutment charges were used in blowing up a steel girder bridge of 12 metres span. In this case care was taken not to damage the girders, which were required for use elsewhere.

A culvert of 0·8-metre span was blown up with a charge of 36 kg. of T.N.T. Here the object was to damage the road embankment over the culvert as much as possible.

The tamping was done with water, and the charges were fired electrically by means of a Cantono exploder. The results were considered satisfactory, but the writer considers that in actual warfare it would be advisable to use heavier charges.

Motori veloci ad iniezione per autoveicoli e loro applicazioni nell' esercito. Captain Balanzino discusses the problem of the design of a heavy automobile of Italian manufacture, using fuel obtainable in Italy or the Italian colonies. Similar problems are being dealt with in France and Germany, and the possibility that each country may, in the event of war, have to be self-contained as regards supplies, is not being lost sight of. Experiments have been made with fuels having an alcoholic base, with products derived from lignite, with oil distilled from asphaltic rocks, etc.

The writer describes the general principles of the Diesel engine, and shows how much more efficient and economical it is than the Otto engine. He then asks how it is that the Diesel engine has not superseded the petrol engine in the past thirty years. The foremost motor-car manufacturers have realized the advantages of a light, high-velocity injection motor, and have succeeded in obtaining an engine with small cylinders and high power, with a cycle intermediate between that of the Diesel and that of the Otto, with an injection pump furnishing the minute quantities of fuel necessary for small cylinders, complete combustion, easy starting and efficient brakes. The technical automobile directorate laid down eighteen conditions for a heavy military lorry with an injection engine. Of the firms that competed, the Fiat and the Lancia were most favourably reported on. The latter was fitted with a Junkers engine, a type of outstanding quality.

(*May*, 1932.) *Riparazione e ricostruzione di ponti in guerra.* This is the first part of an article by Captain Leonardi dealing with the repair or reconstruction of damaged bridges in war-time.

The points that have to be determined are:—(1) when it is advisable to build a new bridge; (2) when it is advisable to repair the old bridge, if it has been partly or completely destroyed; (3) when it is possible to do both (1) and (2); (4) what type of bridge should be adopted, and what materials used.

The first duty of an engineer officer who may be called upon to restore an interrupted communication is to make a careful survey of the damage. The damage to an arch or girder will usually be obvious: that done to piers or abutments will be more insidious and dangerous, especially if the stability of the bridge depended upon the equilibrium of lateral thrusts in the complete structure. As a rule, it will not be practicable to rebuild the piers or abutments in masonry, unless they happen to be comparatively low. The best method will be to rebuild them partly in concrete, reinforced, if necessary, and to embed wooden uprights of suitable section in the concrete, rising to the full height of the piers. It is assumed, in this case, that the roadway will be carried on plain girders, either simply supported or continuous.

The next point is to examine carefully the damage to the girders or arches. If the arches are of masonry or reinforced concrete, the only course open is to utilize as much of the bridge as has been left intact. In practice the majority of large bridges will be of steel. If the girders have not been entirely destroyed or badly twisted, it will usually be possible to raise the broken portions to a horizontal position with hydraulic jacks, to connect them together and replace broken parts.

A series of photographs is given, showing bridges destroyed on the Austro-Italian front. In one case, the Italians destroyed the first of a series of masonry arches in a bridge over the Meduna in 1917. The Austrians replaced the arch by means of a pair of steel girders of 27 metres span. They destroyed these again in 1918. The Italians repaired the span with one new steel girder and a second girder made up of pieces of the Austrian girders. It is not always possible to make use of a damaged girder, but sometimes a temporary girder may be made partly of wood and partly of steel, leaving room for a permanent girder alongside it. In certain cases intermediate piers may be erected as supports to the girders, usually as a temporary measure. It may be necessary to change the site of a bridge, and an instance is quoted of a bridge that was exposed to the fire of Austrian guns being rebuilt under cover a short way downstream.

(*June*, 1932.) *Riparazione e ricostruzione di ponti in guerra.* Captain Leonardi continues and concludes his article on the repair of bridges. He gives a list of the most important requirements for work in the field:—

(1) Detachable metal transoms and interchangeable legs of limited weight, that can be made up into trestles of two or three standard types.
(2) Plant and material for temporary bridges.
(3) Continuous girders. The Italian Army have two types of Scarelli bridges, with articulated girders. There is a light type for spans from two metres to forty metres, in sections of two metres; and a reinforced type for heavy loads, in spans from two to thirty metres. The writer had occasion to use several of these bridges during the war, and he made up a continuous girder out of the material in building a bridge over the Piave. He found that by making the girders continuous he could save a third of the time ordinarily required for erection.
(4) Suspension bridges. Bridges of simple type were built during the war. They are specially suitable for large spans where the roadway is high above the bed of the river. Great progress has been made in recent years in the design of suspension bridges, and the knowledge so obtained should be turned to account in the design of military bridges.
(5) Machinery and tools and plant. Amongst the many requirements mentioned are portable workshops mounted on lorries, oxy-acetylene blow lamps, lifting and traversing jacks, and suitable means for illumination at night.
(6) Lastly comes the training of specialists and a special course in repair of bridges for engineer officers.

(*July*, 1932.) *Concetti di costruzione e di manovra di un equipaggio teleferico.* By General Maglietta. This is a description of a standard type of wire ropeway used

in the Italian theatre of war. There are three types of wire ropeways for military use, employed over distances ranging up to 1,000 metres, 1,500 metres and 2,000 metres respectively. The same material is used for each. In each case there is a double ropeway, *i.e.*, a fixed carrying rope and a moving hauling rope, and a single load ascending on one cable with a single load descending on the other. A petrol engine provides the motive power.

The general particulars are as follows:—maximum length of ropeway, 2,000 metres; maximum gradient, 45°; maximum load, 600 kg.; number of conveyors (1 ascending, 1 descending), 2; weight of conveyor empty, 120 kg.; speed of working, 2 metres per second; greatest length of rope without intermediate supports, 500 metres; dead load due to hauling rope over maximum unsupported length, 90 kg.

The carrying rope is made of crucible steel wire, 23 mm. in diameter, and requires a counterweight of 5,200 kg. The factor of safety is 8·3. The hauling rope is 10 mm. in diameter and has a factor of safety of 10.

Standards, 5 metres in height, are allowed for at intervals of 100 metres. The whole ropeway, with its accessories, is divided up into loads suitable for transport on wheeled trucks.

(*August*, 1932.) *Studio generale sulla motorizzazione.* By Colonel R. After a brief account of the development of mechanization during the Great War, the writer gives a description of the present position in Great Britain, U.S.A., Germany and France.

In Great Britain two branches have been formed:—(1) armoured fighting vehicles employed with normal formations, *e.g.*, an infantry division and a cavalry division; (2) an independent formation, known as the experimental armoured force. The organization of the former is based on the six-wheel car. It is hoped that the six-wheel lorry will be extensively used commercially, and that, on mobilization, it will be possible to requisition a large number of these lorries. As regards infantry, a battalion is to consist of three companies of riflemen and of one company of machine-gunners riding in six-wheel lorries. An experimental brigade has been formed, consisting of three battalions as above, and of a battalion of light tanks. Details of the Experimental Armoured Force are given. The composition of a division of the 1918 type, with 60 guns, 96 machine-guns, and a daily range of movement of 20 to 25 km., is compared with the present force with its 65 guns, 404 machine-guns and a daily range of 80 to 100 km.

The United States are working on the same lines as Great Britain, but are proceeding more slowly. Six-wheel lorries and caterpillar tractors form the basis of the system of mechanization.

An experiment is being made with an entirely mechanized infantry regiment.

In Germany a very careful study is being made of mechanization, with a view to obtaining a small but extremely efficient army. Work on behalf of the land army is being carried out in foreign countries, *e.g.*, Sweden, Russia, Switzerland and Holland. Special tractors on caterpillar tracks have been designed for 90-mm. gun-howitzers, and for heavy 150-mm. howitzers in the Bofors works in Sweden. Motor-omnibus companies are encouraged and subsidized; investigations are being carried out in the production of cheap motor fuel and synthetic rubber.

In France mechanization has been based very largely on the Citroen-Kegresse metallo-plastic track. The cavalry Schneider machine-guns, mounted on Citroen-Kegresse chassis, and fitted with these tracks, have a speed of 50 km. per hour. The track has not proved quite as satisfactory with the Renault cars. Various kinds of tanks have been experimented with: a light tank to accompany infantry, medium tanks constructed by the Renault, St. Chamond and Schneider companies, and a 70-ton heavy tank protected against 75-mm. guns. The technical section of French industry is second to that of no other country.

A.S.H.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*June*, 1932.) 1. *La Belgique dans la guerre aérienne.* Major Van der Donckt draws attention to the unfavourable position of Belgium in aerial warfare. The distance from Brussels to the German Rhine is only 180 km., to London 300 km., and to the French frontier less than 100 km. To an aeroplane of 1,000 h.p., travelling at 200 km. per hour, the shortening of a journey by 100 km. (200 km., coming and going) is worth the addition of ½-ton of projectiles.

The writer does not hold the theory that the next war will be decided in a few days by mass attacks of bombing planes. No great power has a sufficient number of giant planes to carry out such an attack. The combined air forces (naval and military) of Great Britain, France and Italy have only 10% of bombing planes, and their total number consists of 400 aeroplanes or hydroplanes of 900 h.p., capable of carrying an effective charge of 600 kg. to a distance of 500 km.

Major Van der Donckt recommends the development of an anti-aircraft artillery force. The velocity of the 75-mm. guns should be increased, and guns of 100-mm. calibre introduced.

Passive methods of protection should consist in training the civil population to take precautionary measures against bombing and gas attacks. Smoke screens are considered to be of little value. The role of the army should be limited to giving advice, the execution of the precautionary measures being left to the civil authorities.

(*July*, 1932.) 1. *Un centenaire oublié. La campagne des dix jours de* 1831. Under the above heading, Lieut.-Colonel Baron Verhaegen commences a series of articles on the short campaign between the Dutch and the Belgians that took place between the 2nd and the 12th August, 1831.

The writer touches briefly on the political situation between 1815 and 1830, during which period Holland and Belgium were united under the rule of King William of Orange. After the revolution of 1830 the Belgians demanded a separate government, and the throne was offered to, and accepted by, Prince Leopold of Saxe-Coburg, in 1831. Feeling ran high between the two nations, and eventually hostilities took place, which ended disastrously for the Belgian forces.

The field of operations is described. The northern part of the Netherlands is unsuited to operations on a large scale, but is suitable for guerilla warfare, and the possession of the dykes and sluices means the command of the whole country.

The personnel of the Netherlands' army was partly Dutch and partly Belgian. In the cavalry nearly half the officers were Belgian, in the infantry only one-sixth of the officers were Belgians, and in the artillery only a very small proportion. Out of 66 generals only seven were Belgian, and only nine officers of the General Staff were Belgians.

In October, 1830, the officers of Belgian birth were released, by royal decree, from their oath of loyalty to the King of Holland, and the provisional government set about the formation of a national army.

By June, 1831, the Belgian forces had been grouped by the Regent into four armies: the army of the Meuse (General Daine), the army of the Escaut (General Tiecken), the army of Flanders (General Wautier), and the army of Luxembourg (General Goethals). The effective strength of the army was about 40,000 men; together with the Civil Guard it may have numbered 45,000 or 50,000. It was very short of officers, and the staff was almost non-existent. The distribution of the troops is shown on a sketch plan.

A report, written by Prince Frederick to the Duke of Wellington, in October, gives the total strength of the Dutch Army as 35,000 men. An appeal from the King brought a loyal response from the whole nation, and it was hoped to increase the Dutch forces to 90,000 men by the summer of 1831.

The Dutch plan of campaign, as actually executed, is described briefly. As

regards the Belgian plan, there was none. There was no supreme command; the government did not believe there would be a war and made no preparation for it. Each army commander acted on his own initiative.

The course of the campaign, which contains little of interest, is described in the two following numbers.

A.S.H.

REVUE MILITAIRE SUISSE.

(*May*, 1932.) *Cavalerie moderne: ses possibilités actuelles.* Major de Muralt discusses the value of cavalry in modern warfare. All the great powers have reorganized their cavalry arm completely since 1918. The modernization of weapons —armament, aviation and motorization—has modified the conditions of cavalry work, but has not suppressed its *raison d'être*, in spite of what its detractors may say. Instances are quoted of the valuable services rendered by cavalry in the Great War. In April, 1918, Marshal Pétain declared: "The army has saved the country, but the cavalry has saved the army."

Armoured cars are intended to increase the power of cavalry fire. Tanks are a unit of reinforcement to cavalry. The collection of information depends upon the co-operation of the air force and cavalry, it is not the exclusive province of either.

The British Army has pushed motorization a long way. This, the author considers, is due to shortage of personnel and absence of budget restrictions. General R. T. Collins is quoted as saying: "Motorized forces can operate on most varieties of ground, except forests, mountains and swamps. It is impossible to replace the horse in all circumstances."

(*June*, 1932.) 1. *Manœuvres et réorganisation de nos divisions.* By Colonel Lecomte. In future, divisional manœuvres are to be held in Switzerland, every four years instead of three. The writer thinks it would be better to suppress them altogether, pending the reorganization of divisions as such.

The experience of the World War has led the French to abolish the infantry brigade, and their divisions now consist of three infantry regiments, each of three battalions, and two regiments of artillery, as the chief units. The Swiss have done precisely the opposite and have increased the number of their battalions in a division from 13 to 24, so that a Swiss division is practically the same as an Austrian Army corps of 1866.

The writer quotes General Debeney as laying down the maxim that the division is the one unit in which all arms can be trained together. In Switzerland this function is allotted to the brigade.

Colonel Lecomte would cut down a division to something between nine and fifteen battalions. The Swiss Army consists of six divisions: these comprise 110 regular and 30 *Landwehr* battalions. He would convert the 110 weak regular battalions into about 80 strong battalions, grouped in eight or nine divisions, each of ten or nine battalions.

As regards manœuvres, he compares those of 1931 with those of thirty years earlier, and considers that modern manœuvres are not conceived or carried out on satisfactory lines.

(*July*, 1932.) *Emploi de l'aviation en temps de guerre.* By Major Ackermann. As an arm, the air force is a creation of the Great War. In spite of four years' intensive work and sustained effort, it had barely come out of the period of formation at the end of it.

Since the war there has been considerable divergence in the doctrine of aerial tactics between the great powers. France has based its armament and organization on the experience of the war. Italy has elaborated a new doctrine somewhat similar to that adopted by Germany during the war, but differing entirely from that of France

or Great Britain. Great Britain, as an island, requires a special organization of its own, and its air force, though small, is well equipped and trained.

In all countries there is uncertainty as to the lines that a future war will take. The three main objects of aviation in war are: (1) reconnaissance and observation; (2) fighting the enemy's air and land forces; (3) breaking the enemy's will of resistance.

For the first purpose, there are heavy reconnoitring planes for long-distance reconnaissance, and light planes for short-distance reconnaissance and artillery observation; for the second, fighting monoplanes and biplanes; for the third, heavy bombing planes for night work and medium planes for day bombing.

Economy has compelled the powers to reduce the number of types of planes, and in France, for instance, there are only three main types. Great Britain has two different types of fighting monoplanes, an "interceptor fighter" capable of rising rapidly to great heights (for the defence of London), and a fast plane for work in connection with the field army.

(*August*, 1932.) *Emploi de l'aviation en temps de guerre.* In this number, Major Ackermann continues his interesting study on the future of aviation in war-time. There is no such thing as permanent command of the air. Command of the air is only temporary and local. Having defeated the enemy, an air force commander is obliged to return to his base to re-fuel. Moreover, it is always possible for one adversary to avoid a decisive battle. At sea, a fleet can refuse a battle and yet can carry on a war of destruction with its submarines and destroyers. In the air, such tactics are still easier to carry out.

None of the great powers have enough aeroplanes to bring a war to a decisive finish. Excluding hydroplanes and aeroplanes in the colonies, France has 1,060, Italy 652, and Great Britain 789 war planes. These numbers are barely sufficient for the use of the army alone. During the war France built 70,000, and Germany 50,000 aeroplanes, and yet neither side ever had enough for the many duties that devolved upon the air force.

The amount of damage that can be done by an air force has been enormously exaggerated, and the writer produces figures to show that the bombardment of towns, whether by airships or bombing planes, does not pay. Germany built 78 Zeppelins during the war; out of these 73 were lost from various causes. Zeppelins carried out 72 raids against England: with the result that 830 people were killed, 2,000 wounded, and damage was done to the extent of 30 million marks. These raids entailed a loss to Germany of 1,250 men (all specialists) and material costing 160 million marks.

The efficiency of the British anti-aircraft service is highly spoken of. What with the progress made in anti-aircraft defence and in fighting planes, the heavy night-bomber has become almost unemployable and will eventually have to make room for a lighter and faster plane. The bombing plane is totally unsuited for aerial combat, and its best protection is in invisibility.

As regards aerial attacks with toxic bombs, their probable effect is enormously exaggerated.

A.S.H.

REVUE MILITAIRE FRANCAISE.

(*July*, 1932.)—The second instalment of *La lutte pour l'Hartmannshillerkopf*, by Chef d'escadron Dupuy, describes the various efforts during the end of 1914 and in 1915 to gain control of the summit of this hill. Two German attacks are described, each of which was successful to start with and each was pushed back eventually. It was clear by the end of this period that neither side could hold on to the summit if the other was determined to drive them off. A crest of this kind cost many thousand men to the French, and probably also to the Germans, although it was far from the main portion of the front.

Chef de bataillon Pots completes *Considérations tactiques sur la guerre au Maroc en* 1925 in this number. At the beginning of this year the French had a system of mobile columns, based on their camp or garrison, and returning to it after an expedition into the enemy's territory. As more tribes rose against the French, the actual garrisons were surrounded however, and it was found that nothing was less mobile than a mobile column! The French therefore extended gradually farther and farther forward into the enemy's country, taking care to build up lines of communication as they advanced. This was followed by expeditions on a large scale, say two or three mixed brigades, which could not be stopped by hostile tribes. As a result it was found much easier to defeat the tribes in detail. At the same time attention was paid to defensive posts, and it was found that a post in the enemy's country should consist of a battalion with accompanying artillery. A post of a company should only be sited in friendly territory. All the above correspond to what the Indian Army has found on the N.W. Frontier. It is interesting for us to see how the French problems in Morocco are much the same as our own.

Capitaine Carrias continues *Comprendre*, with a number of excellent maps and diagrams, describing the surprise of the French 4th Corps at Ethe and Virton. These villages are at the southern exit to the Ardennes and were on the front of the French 3rd Army. The writer visited this country some years ago and saw how on the north it was forest and on the south it was open. The French advanced with no idea that the Germans were in considerable numbers in the woods, were met with an immediate check and were driven back. There is no space here to give Capitaine Carrias' description of how the French could perfectly well have known approximately what the Germans were doing. It was by failing to carry out reconnaissances and by failing to use the 2nd Bureau that the Commander of the 4th Corps was caught unawares by the Germans.

In the third instalment of *Flaucourt*, Général Abadie discusses the various regulations published by the French higher command during 1916. The plan for 1st July, 1916, was too rigid; as a result the necessary exploitation could not be provided about Flaucourt on 3rd July. Général Abadie gives extracts from the instructions of January and December, 1916, dealing with these plans, and it is quite clear how it took the Somme fighting to show how exploitation must be possible and therefore plans must be reasonably elastic. At the same time, surprise was hardly mentioned in the French instructions. It is interesting to see how the British suffered from the same disabilities.

Général Duffour finishes *L'élément terrain en stratégie* by a final consideration as to how the country as well as numbers still affects modern strategy. In fact, country nowadays becomes more and more important, and the French at the outbreak of the Great War failed in their original plan by their failure to realize this when the plan was drawn up.

(*August*, 1932.)—In this number appears *Le rôle de l'aviation dans la défense nationale*, by Lieut.-Colonel Langevin. The article is written because there is a feeling that the French need to revise their thoughts on aviation on account of recent Italian air manœuvres. For these manœuvres Italy was divided into two countries separated by the Apennines, and a violent attack was made by the country stronger in the air at the outbreak of war. Colonel Langevin points out that the situation is quite different in France, where there are hundreds of miles of open frontier. Italy is protected throughout by the Alps, while France may be invaded from the start. France must therefore consider her air forces in quite a different way from Italy and Italian manœuvres should not affect French thought on the subject.

The third instalment of *La lutte pour l'Hartmanshillerkopf*, by Chef d'escadron Dupuy, appears in this number. The attack took place in December, 1915. Here the writer deals entirely with the orders and instructions, which began over four months before the attack. It is rather extraordinary that, at this period of the war, such an enormous time should be given up to preparation for an attack on not a large

scale and away from the important part of the front. It is only by reading all the orders that one can see how very carefully any attack was staged during the trench warfare period on the Western Front.

L'infanterie en présence du problème offensif is an interesting article by Chef de bataillon Baurès. He points out at first, what has generally been realized, that there is a gap between the first advance and its continuation and that ordinary artillery cannot fill this gap. He then goes on to consider Stokes mortars, close support artillery and other weapons, concluding with a suggestion of a machine firing grenades as being one of the best solutions provided that there is some means of keeping up the supply of ammunition. The article is well worth studying by anyone interested in this important and difficult problem.

Capitaine Carrias finishes *Comprendre* in this number by considering what the 2nd Bureau should have discovered in the 4th Corps before they were surprised at Ethe and Virton. The intelligence portion of the General Staff certainly developed greatly since the outbreak of the Great War, and it is interesting to see how the various ways in which information becomes intelligence might have been developed here. There is little doubt that the 4th Corps should have known far more about the enemy than they actually did, and, as Capitaine Carrias points out, a commander must first of all " understand " if he is to command his force properly.

Général Abadie finishes *Flaucourt* in this number. The instalment is interesting, not only on account of the writer's view that insufficient scope was left to the commanders of the lower formations, but also because he reproduces a conversation between himself and a company commander who took part in the attack. This company commander was also convinced that much more could have been done if the whole operation had not been so controlled from up above and has many reasons to give for his opinion.

(*September*, 1932.)—*Le but des opérations de guerre*, by Général Brossé. This article considers the various phases of the Great War and the effect of these phases on the different countries. At the outset the writer admits that the German plan was of Napoleonic greatness and that it nearly achieved its general object of driving the French back to the Loire. This was prevented by the Marne, which, although it did not gain very much ground, stopped the Germans from advancing on Paris. After this Général Brossé considers the other attacks up to 1917, how the British and French tried to break through the German lines without success and how the Germans were similarly unsuccessful on the west.

In the fourth instalment of *La lutte pour l'Hartmannshillerkopf* Chef d'escadron Dupuy describes the attack of the infantry on 21st and 22nd of December, 1915. The action of the 66th Division is well described, and illustrated by maps. Général Serret realized that further reinforcements were required behind the advanced line of infantry, as it was found that the German counter-attack had insufficient forces to stop it. In his report to the 7th Army, Général Serret candidly expresses this opinion, saying: " There seems to me no doubt that the 152nd regiment, after its brilliant attack . . . found itself very strung out and lacking in depth. . . .

" This is the result of an initial mistake on my part: insufficiency of infantry on the front to be taken. . . ."

Chef de bataillon Albord has an article entitled *Réflexions sur l'organisation des communications et ravitaillements aux armées* in this number. The writer does not pretend to produce a complete solution to the problem of administration, but he makes various suggestions and hopes that these will give officers food for thought. As he points out we have advanced a long way from the situation in 1914, while in 1918 moves were generally slow. The problem as a whole lies in the probability of quicker movement by the troops and hence greater distance between them and railheads. At the same time the risk of attack on communications by the enemy, by land or air, will be much greater. The article is worth reading by those who are interested in this part of modern war.

In the sixth instalment of *Le Gouvernement de la Défense Nationale*, Lieut.-Colonel Guignes describes the eventual dissolution of the 2nd Army of the Loire and the defence of Paris during the Franco-German war of 1870–71. The interest is historical only, but many details are given of the various French soldiers and politicians after the formation of the Republic. General Chanzy, who commanded the 2nd Army, gives his final address before the army was disbanded. In Paris the various efforts to break through the German envelopment and the methods employed to get letters, etc., out of the town are described in considerable detail.

Général de Fonclare begins *Le Maréchal de Monluc* in this number. This is the first of three extracts from a book to be published shortly on this Marshal, who served about the middle of the sixteenth century. In this number two successful actions, in which he took part, are described: Cérisoles (near Turin), in 1544, and the capture of Thionville in 1558. Though only of historical importance the descriptions are interesting, as the Marshal was both anxious to fight and also to report what he had done. In both these actions he was successful and his reports are quite amusing.

H.A.J.P.

WEHR UND WAFFEN.

(*July*, 1932.)—*Practical Proposals from Practical Experience.* Captain von Graffen deals with laying out a datum, tests, wind, weather, registration and observation, in an article chiefly interesting to gunners.

Considerations About the Development of Modern Artillery. Captain Gallwitz, of the 4th Artillery Regt., continues the mathematical investigations prompted by his thoughts on the trend of modern field artillery, which were provoked by the news that the French Artillery had without change of calibre increased the range of their 7·7-cm. field-gun to 14 kilometres. He starts with a dictum that the tactical value of a gun depends upon its range, its mobility and its effect on the target. In other words, it varies directly as the first and last of these and inversely as the weight of the gun. From this starting point he arrives at the conclusion that the increase of range of a field-gun of 7·7-mm. calibre to 14 kilometres is a mistake, having been achieved by an undue increase of weight.

He next investigates a duel between the artillery of two divisions, the one normally equipped with 6 batteries of 7·7-cm. guns and 3 batteries of 10·5-cm. howitzers, while the other has his proposed equipment of 3 batteries of 9-cm. guns, 3 batteries of 7·7-cm. guns, and 3 batteries of 13-cm. guns for use as light mortars with a maximum range of 6 kilometres. The latter would be horse-drawn like the ordinary field batteries, but the 9-cm. gun batteries would have tractors. The only case in which he finds that the normally equipped D.A. would be superior to the D.A. having his proposed composition is the possibly rare one of an enemy offering many suitable targets at 14 kilometres, which can be taken under observed fire.

Captain Gallwitz's thoughts about the future of field artillery, ably assisted by mathematics, gain in interest when he intersperses them with battle reminiscences. Thus, to illustrate the difficulties of moving divisional artillery about the battlefield, he tells us that at the great break-through at Caporetto, in 1917, it took the combined efforts of artillery, infantry and engineers three hours to get one single howitzer of his battery over the Italian trenches. Similarly, when a generous Fate had provided him with the experience of another break-through, this time against the British in 1918, no battery in the author's brigade, during the great German attack on Arras, on 30th March, had more than one howitzer forward for several hours, all the rest being stuck in shell holes.

This evidence furnishes a sidelight on the situation at that time. The spearhead of the German thrust had been pushed towards Amiens as far as it would go without a further increase of the width of the break-through. Since the French were preventing an extension to the south the capture of Arras to the north became a necessary

condition of further progress, and when this German attack failed the push got no farther, furnishing us incidentally with an example of strategic victory of the greatest importance being gained by a side acting purely on the defensive.

The justification for his article which the author offers is that since the Treaty of Versailles prohibits all practical trials in Germany a critical examination of armament development in other countries is the only alternative to slavish imitation.

Tanks and Artillery. Lieut. Bolckheim writes of co-operation between these arms. As Germany has no tanks he bases his remarks on the British tank regulations. The key to successful co-operation between artillery and tanks he sees in clear orders and faultless communication. As both of these, however desirable, are not always possible of attainment, a third desideratum may be mentioned, viz., a thorough understanding by each arm of the work of the other, obtained by careful peace training.

Tailless Aeroplanes as Fighters. Starting with short descriptions of the aeroplanes of this type—Arnoux's Simplex, 1911, the Alula wing of 1920 used in a Bristol monoplane, the Hill Pterodactyl, the Hill-Westland Tailless Bomber, Couzinet's Arc-en-Ciel, Tscheranowski's Parabola, 1922—the article goes into the question aero-dynamically and constructively, before making out the author's case. This appears to run: against day-bombers the two-seater fighter is far superior to the single-seater for many reasons, while for local protection it is as good. Any considerable improvement in the heavy two-seater as regards its rising power and aerobatics can only be gained by ruthless cutting down. Here come in the incontestable advantages of the tailless aeroplane with its greatly reduced wind resistance. Is not the tailless aeroplane the answer to Blériot's well-known saying that the present-day fighters would not be able to attack the modern heavily-armed air cruiser?

Pneumatic Brakes for Vehicles of All Kinds. The object of Major Suren's article is to show to what extent the use of penumatic brakes is advantageous from the military standpoint. He deals only with brakes in which the moving body is checked by a stationary body, brake-block or checks, being pressed against it by means of compressed air. Owing to their great advantages pneumatic brakes have been used for decades in Europe for passenger trains, but for goods trains they have only been introduced since the Great War. For modern means of locomotion, the automobile and the aeroplane, they are being used in increasing measure. As regards railways, the author starts with the Westinghouse system, invented 1872 and improved later, the principle of which has been used for all later pneumatic brakes, including the Knorr system, in use on the German railways. The advantages of the pneumatic brake were so great that its application to goods trains (which includes troop trains) was decided upon in 1917, and started about the end of the war. By the end of 1926 one-third of a million goods trucks had been fitted with the brakes, and nearly as many more with the pipes only. The advantages have been: longer trains, greater speed, saving in rolling-stock, simpler and quicker marshalling of trains, greater safety, and on the financial side 30,000 hand-brake personnel saved and 500 less locomotives, with their staffs.—(*To be concluded.*)

Explosive Bullets for Infantry for A.A. Defence. A Swiss engineer, O. Matter, after long years of experiment, is said to have produced a rifle bullet, in the first instance for 6·5-mm. and 7·9-mm. calibres, which explodes within one-thousandth of a second after impact. It is said to tear sufficiently large holes in light metal surfaces and to be effective up to 1,100 metres. Although the use of such bullets by a machine-gun may be considered permissible, on the grounds that it is a gun and not a rifle, the St. Petersburg Convention of 1868 would still appear to forbid the use of such bullets to the single rifleman.

Increase of Armaments Abroad. In March, 1932, the Danish Volksting passed a new Defence Law increasing the infantry and air force and remodelling the artillery as follows:—9 horsed field artillery batteries are to be replaced by 6 batteries with tractors; 18 horsed heavy artillery batteries with obsolete equipment, and partly only on paper, are to be replaced by 3 batteries of 10·5-cm. guns, and 6 batteries of

15-cm. howitzers, the whole of modern French manufacture and tractor-drawn; 8 batteries of A.A. artillery are to be raised and armed with 7·5-cm. Vickers-Armstrong guns by 1935-36; the whole of the coast artillery is to be put under the navy.

In January, 1932, draft proposals for altering the Law of 1928 fixing the composition of the army were made by the French Government. Besides increases in the infantry, cavalry and tanks troops, mountain artillery brigades are added to certain divisions, while field and heavy artillery by a redistribution of brigades both increase one regiment. The introduction of a varying number of brigades to the regiment makes for elasticity and strengthens the hand of the General Staff.

Pneumatic Tyres for Horse-drawn Vehicles. These appear to have been first used by one Carlton Groat, of Portland, Oregon, in 1927, for a farm wagon. The idea was next tried in Europe for wagons crossing sandy country on shooting expeditions. Finally, a wheelwright, called Graupmann, in Mecklenburg, brought out the *Graguva*, a wagon with pneumatic tyres for forestry work and rural transport, suitable both as a trailer and for horse draught.

Lieut.-Colonel Reiner, director of the German Agricultural Motor-drivers' School, near Königswusterhausen, has now given the system, applied to specially-built heavy wagons, a two years' trial, and finds with horse transport pneumatic tyres have all the advantages that they have with motor transport.

For army purposes they would have the additional advantages of saving horses and personnel and shortening march columns, owing to the wagons' higher useful load. As the *Graguvas* are made in three sizes, 3·75 tons, 5 tons and 7·5 tons, their utility would be found outside regimental transport.

The New Carden Loyd Amphibian. Following the introduction of swimming tanks in the United States and in France, Great Britain has now a swimming tank, the 2-tonner Carden Loyd, while the Christie and the Schneider-Laurent are both in the neighbourhood of 7 tons. At trials the Carden Loyd amphibian crossed the Thames at the rate of 6 knots, maintained its direction against wind and stream, and kept the opposite bank under heavy fire while crossing.

The New Hadfield Armour-piercing Projectiles. The firm of Hadfield Bros., Sheffield, is said to have produced 12″ and 15″ A.P. shells, capable of piercing over 12″ of the best hardened steel armour-plate at a range of 8½ miles, and even at an inclination of 30°. This achievement would appear to be due to improvements in both the composition of the material of the projectile, forged Hadfield chromium steel, and the process of hardening the point. Hadfield's also use the old method of a soft cap.

Civil Air Protection. With a former Minister of Transport, Dr. Krohne, as President, the German Air Protection Union has been formed, upon non-party lines and without respect to occupation, for the purpose of organizing the protection of the civil population from the air, and especially for the protection of women and children. The fundamental principle of this Union is that the protection of the civil population against attack from the air is the duty of the non-military authorities, who relieve the army of this burden. There must, however, be close co-operation, and the military authorities must be kept informed of the work and intentions of the civil authorities. The first general meeting of the Union took place in Berlin in June, when papers were read on "Air Protection Measures to be taken by Civil Authorities," "The Work of the German A.P. Union in Stimulating Individuals and in Organizing their Efforts so as to Assist the Civil Authorities," "Dilettantism in the Air Protection Movement," "Incendiary Bombs," "The Expert Preparation of Collecting Places," and "The Work of the Air Protection Branch of the Technical High School at Dresden."

Individual Camouflage. The *Echo de Paris* says that a camouflage net, weighing less than 1 lb., has been invented by a French officer, and is being tried out for adoption as part of the soldier's equipment.

Practical Sailing Flight. E. Bachem's book, with 54 illustrations, is published by

Volkmann's, Charlottenburg, and costs only 2 marks 80 pf. It deals with starts, downhill, catapult and towing; with the technique of utilizing upward currents, whether thermal in origin or due to slope or caused by storm; and gives all information necessary for those who are training for a pilot's certificate.

Now that Kronfeld has looped the loop many times consecutively in engineless flight before thousands of spectators, the publication of this book should be in no danger of being considered premature.

The Artillery Duel. Lieut. Field-Marshal Bernatsky's argument runs as follows: Owing to the extensive adoption by the artillery of concealed positions since about the time of the Russo-Japanese War, the artillery duel, that characteristic and unavoidable overture to earlier battles, disappeared. Also, in the Great War, the artillery on both sides were able at first to have but little effect upon each other. Later, however, sound-ranging began to establish itself everywhere. The more sound-ranging is perfected the more will artillery lose its special tactical position and comparative safety, the best camouflage against sight losing its value when the first shots fired betray the battery's position to the ear. Hence, in future, as formerly, it is to be accepted that the artillery on both sides enters upon a duel and will have to fight it out. There can be no doubt about the issue. Either one side has prematurely to quit the battlefield or to be smashed to pieces on the spot. In the first case, a freer opening is given to mobile warfare; in the second, we return to the decisive battles of Napoleon and of Moltke.

The moral appears to be that we must arm for the artillery duel since the decision will be gained thereby.

The Military Possibilities of Helicopters, by Capt. Thelen. Because of its starting and landing powers, the helicopter is almost independent of the nature of the country, thus possessing an advantage over other aeroplanes which assumes its full significance in war-time in foreign countries where landing grounds are scarce. Although its performance is limited by the strength of its wings and their maximum permissible speed of revolution—Rohrbach placed this performance at 250 km. an hour and 2 tons dead weight—the helicopter has a large field of military utility within these limits.

The uses for which it appears eminently suitable are:—(1) as an obvious connecting link between sectors of the front, or, since it can be carried in a column, between troops marching on parallel lines; and also from front to rear in the same column. These are all tasks for which the ordinary aeroplane is not specially suitable. (2) For tactical reconnaissance with independent motorized formations, especially in order to warn them of flank attacks. This low-flying reconnaissance is specially suitable for helicopters, which also have the advantage of being able to reduce speed down to 30 km. an hour.

A screen of such machines carrying light H.E. bombs would be excellent for fighting hostile tanks.

As regards armament, the reconnaissance machine, in distinction from the communication machine, must carry one, better two, machine-guns. They will either be arranged to fire through the wings, or in the case of larger machines an m.g. platform will have to be built above the wings.

As trials in England showed, the helicopter when attacked by fighters, by reason of its extreme handiness, is able to out-manœuvre the latter, so that they do not even get a chance to fire at it.

Pneumatic Brakes for Vehicles of All Kinds (continued). Diagrams are given of the Kunze-Knorr brake in the "off" position, and full on, also of the complete installation for locomotive and tender.

Major Suren then turns to road vehicles. The latter with increasing speed and weight nowadays demand strong and reliable brakes, and hand- or foot-actuated lever-brakes no longer suffice. Brakes must be driven by engine-suction, compressed air, compressed oil, etc., and of these, as railway practice has shown, compressed

air is the best. A diagram is given of a pneumatic brake fitted to a lorry, and also to a trailer. When one or more trailers are so fitted the system, like that of a train, causes all brakes to be applied when a coupling breaks. With a tractor which cannot itself be heavily braked, owing to skidding, the braking of each truck in two is essential. That this braking should all be done by one man is most necessary in the case of cross-country vehicles.

Finally, the pneumatic brake has been applied with success to the wheels of the larger Junker aeroplanes.

The Engineers in Various Armies. This article belongs to the series of monthly compilations from foreign military periodicals. It starts appropriately enough with the value of field engineering and the value of the field engineer. Of the former Napoleon wrote: "*Il est cinq choses qu'il ne faut jamais séparer du soldat, son fusil, ses cartouches, son sac, ses vivres, et son outil de pionnier.*" Of the last, Lieut.-Col. Regele, of the Austrian Army, said to an audience of Swiss officers in a lecture, "A lack in the organization of the field engineers, or in their equipment, or in their training, may react most disadvantageously upon the course of whole operations."

The rise in importance of the engineers is then shown very clearly by a table showing the composition of armies by percentages of the various arms at different periods from 1800 to the present day. Between these dates the engineers have risen steadily from forming 1% of the armies investigated to 7·5%, an increase which has taken place parallel with the rise in the numbers of the artillery, and apparently quite unaffected by the rise in importance of the new arms, air force and tanks.

Another table contains the peace strengths in units of pioneers, railway troops, and signals, of nine European powers, with notes in the column of remarks, as to the other engineer units possessed, *e.g.*, for pontoons, mining, electricity, searchlights, telegraphs, wireless, camouflage, fortress, and other services. From this list are missing Germany, Austria, Hungary and Bulgaria, since the number and nature of their engineer units having been determined by treaty, details of these powers would be misleading in a table intended to show modern ideas and tendencies. Turkey alone of the defeated powers was able to free itself from restrictions, and has now 9 battalions of field engineers, and signals to correspond. Other absentees from the list are Russia and England, the reasons for such omissions being left to the imagination.

Permanent Fortification. For twenty years no great work on this subject appeared. We have now had in quick succession General Culman's treatise (*v. R.E. Journal*, June, 1932, p. 382) and Lieut.-Colonel Lobligeois' *Reflexions sur la Fortification Permanente* (Berger-Levrault, Paris). The author of the latter takes precautions against being considered doctrinarian. He regards his method as pragmatic, being logically built up on war experiences. He takes as a basis the principles of field fortification, as laid down in the *Instructions provisoires sur l'organisation du terrain*, 1924 and 1926, and transfers them to permanent fortification. Armament, cover and obstacles are means to permanent fortification's one end, viz., with the least possible expenditure of personnel to offer the greatest resistance, and delay the enemy as long as possible. The author will not hear of rifles being used in the defence. They would to a certain extent be a contradiction of the principle he has laid down about saving personnel: he demands instead heavy machine-guns and light quick-firers. All works are to be fitted so closely to the ground that the word "fortress" never occurs in the book. Such works to be in plan isosceles triangles, with a base 130 metres long facing the enemy, and two sides, each 110 metres long, serrated in plan so as to afford a maximum of flanking fire, converging to the rear: the entrance being at the apex. These two sides contain in small concrete casemates m.g's, 7·5-cm. guns, searchlights and observation posts, so situated that they are covered from the front, and flank the ground right and left of the work. The defence of the front is a 7-metre broad ditch, with a concrete counterscarp and an iron fence on the escarp, raked by fire from both ends. Further, there are in the centre of the work

three armoured guns, viz., in the centre a 7·5-cm. gun, and right and left echeloned behind it, a mortar or trench-mortar, and an A.A. gun. Also in the work are various armoured O.P's and two m.g. posts. All three sides of the work are without parapets. Underground are three storeys of casemates and galleries, the floor of the top storey being on a level with the bottom of the ditch.

It is not known to what extent the author's ideas coincide with French official views.

Ninth Great Wireless Exhibition, Berlin. At the forthcoming exhibition an extraordinarily high development and improvement in apparatus generally since last year is promised. Amongst novelties are: a special increase in selectivity, necessitated by the recent vast increases of power in many European broadcasting senders, and obtained by band-filters, especially with superheterodyne receivers; by means of improved internal construction a striking simplification in action through one-knob control; automatic regulation of fading owing to the introduction of exponential valves; and a completely new type of receiver.

(*September*, 1932.)—*An American Division on the Railway.* The State of Texas furnishes to the National Guard a force of 7,200 of all arms, who live in 66 towns, scattered over an area of 220,000 square miles. Once a year these troops assemble for a fortnight's training at Palacios, at the end of 70 miles of a single line of railway. When the question of their assembly was raised for the first time the representatives of the twelve different railways concerned met and decided that the task was theoretically impossible. Since then it has been performed with increasing efficiency year by year, all requirements being met, down to Pullman cars for the train staffs to rest in, and a supply of ice to every carriage.

F.A.I.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*July–August*, 1932.)—*The Development of the Strategic Idea before the Outbreak of the Great War.* Colonel Kiszling treats his subject by first running over very shortly the changes in the ideas of leadership on the grand scale in the most important wars of the last 150 years, and by then showing what principles of army leadership predominated in each of the four great military powers of Europe which, in 1914, entered the lists. As regards the former, in most periods of war the movements of armies which have brought about a decision have borne the stamp impressed upon them by a great leader. Such was the case with the wars of the middle of the eighteenth century, when, in spite of the hindrance of the Five March System, Frederick the Great's masterly operating on interior lines was most noticeable. In the battle itself, until nearly the end of the Seven Years' War, he was able to obtain victory by means of his celebrated oblique battle order. On the other hand, Napoleon, in distinction from Frederick, always conducted destructive strategy, and thus brought the war of movement to its fullest development. Without tying himself down to a fixed plan, he strove preferably to gain the enemy's line of retreat, even by the advance from the theatre of assembly. Again, in the battle, before which Napoleon united all his forces, he sought to gain a decision by powerful mass blows, without respect to losses. From 1813 on, surrounded by a superior number of foes, he also showed himself a master of operating on interior lines, until in the end the allied army leaders found effective counter-measures. Their victory at Leipzig was the first fruit of this new elastic method of leading armies.

Of the campaigns of the middle of the nineteenth century the outstanding operations are those of Radetzky, 1848–49, and of Archduke Albrecht, 1866. Their characteristics in common were concentration of strength for the battle, rapid deceptive flank marches, and the tying down of strong portions of the enemy's forces by quite weak detachments away from the spot chosen for the deciding fight.

Moltke, like Napoleon, free from every sealed pattern, brought in Bohemia in

1866, and especially in France in 1870–71, strategic envelopment to its fullest exploitation.

The next change in the conduct of war was that due to the introduction of Q.F. weapons and other technical achievements. It expressed itself principally in a great increase of the area of battlefields, a much extended use of field fortification, and a consequent increased duration of operations. The author says that all this started in the Russo-Japanese War of 1904–05, which is an obvious slip, since the South African War, 1899–1900, had taught the British Army the effects of smokeless powder, flat trajectories and magazine-fire. Having traced what might be considered our common heritage, he now turns to the individual great military nations. In Germany naturally those axioms of leadership retained their predominance which had been drawn from the teachings of the successful wars in Bohemia and in France.

In 1893, a Franco–Russian alliance was made, and henceforward Germany had to reckon with a war on two fronts. The principal factors of success, viz., in 1866 superior weapons, and in 1870–71 superior numbers, were no longer to be hoped for. Hence Count Schlieffen devised a plan the essential feature of which was immediate advance and a crushing defeat of one adversary, who must be eliminated from the war before turning to face the second adversary. Accordingly, German army leaders must be educated to look upon as necessary no mere driving back of the enemy, or ordinary victory, but a victory of annihilation, of which the prototype was Cannae. As the younger Moltke, who was von Schlieffen's successor, struck out no new line, it may be said that the Germans entered the Great War principally under the latter's operative teachings. Schlieffen's plan for the Western Front, employed as it was in a somewhat altered form, and short of the number of corps laid down as requisite, did not stand the acid test. The spiritual legacy bequeathed by Count Schlieffen to his successors in the Cannae idea imposed a task upon them to which they were not equal.

As regards the second of the four great military powers, already before the war Austro-Hungary's outstanding soldier was Conrad von Hötzendorf. As his writings show, Conrad's tastes inclined towards tactical questions, and he carried over into strategy ideas of leadership drawn from tactics. As a pronounced advocate of the offensive he had the Austro-Hungarian leaders trained on these lines and imbued them with his ideas. Like the Germans, they were also convinced that, having war on two or more fronts in view, decisive victory over one of their foes must be gained at the very outset. Colonel Kiszling examines Field-Marshal Conrad's strategic plans against Russia, against Serbia, and against Italy, and shows how clearly they conformed in each case to the principles of the conduct of war which he had striven for in peace.

Turning to the third great power, France, there is a very different tale to tell. After the disasters of 1871 Germany was keenly studied. At first, and up to the middle of the '80's, the French cherished distinctly defensive inclinations. Then, however, with growing strength offensive movements against Germany came to be planned, and after a military convention with Russia had been concluded in 1892 this form of preparation for war became intensified. In 1895, however, there was a return to the idea of the strategic defensive; and, in 1898, there appeared a G.S. Plan (No. XIV) for bringing all five armies and several groups of reserve divisions in three echelons on a front only 90 miles broad between the lines Metz–Troyes and Belfort–Vésoul. The French General Staff called this plan no more than *un dispositif d'attente*. Each formation consisted of advance guard, body of manœuvre, and reserve. There was no plan based upon the gaining of a distant object, but the advance guard had cautiously to introduce the fight, while according to the situation the body of manœuvre was put in to fight for the decision. The French thus, in making their actions dependent upon those of the enemy, assumed a passive role. Their leaders looked to the counterstroke for victory. These were the ideas not only of those responsible for the French war plans of 30 years ago, but also of Generals Bonnal, Lacroix, and of Foch. A school of younger G.S. officers arose, led by Colonel

Grandmaison, Chief of Operations, and afterwards by his successor, General Michel, who were against these waiting measures and all for a distinctly offensive plan of action. In 1913, Joffre, who had taken Michel's place, produced a new French doctrine, viz., powerful, determined and very swift attack in depth on a relatively narrow front against a discovered weak spot of the enemy. Joffre's general directions permeated by the spirit of the offensive had in the short time up to the outbreak of war not been able to take firm root among the higher commanders. Nevertheless the movements of the French 4th and 5th armies would have conformed to these ideas had not the Germans advaced on the N. bank of the Meuse instead of only on the S. bank, as the French expected. The system, re-invented by the Germans, was used by them for the overrunning of the British 5th Army in March, 1918, but without bringing a decision; the latter being reserved for an application by the French in August, 1918, of the earlier French method of the counterstroke.

The author points out great difficulties in the way of tracing the development of the operative idea in the fourth of the great military powers, Russia. Before the Great War strict secrecy was observed in these matters, few military publications were allowed to find their way out of the country, and no foreign *attachés* except the French were invited to Russian manœuvres. After the war it is true that many publications appeared, but they were either written by ex-officers of the old Imperial Army, who, not being allowed access to official documents, had only their memories to rely upon, or they consisted of studies compiled under the orders of the Staff of the Red Army, and were consequently unreliable on account of bias. It appears, however, from Zajontschkoffski's *The Preparation of Russia for the World War* (Moscow, 1926), that, from 1880 onwards, offensives were planned against Austria, and against Germany from the date of the military convention with France. The depression felt in Russian leading military circles after the defeat by Japan caused the offensive ideas to be abandoned until, in 1911, French stimulus was applied, plans for a Russian offensive being called for in return for armament credits. That these offensive ideas were not better executed when the time came is attributed by General Martinoff in his book *The Czar's Army in the February Revolution* to ignorance on the part of the Russian higher leaders, through lack of a common and thorough education. A strategic staff tour actually took place in the spring of 1914, but too late for its lessons to spread widely. It is noteworthy that this staff tour was conducted by the War Minister to the exclusion of the C.G.S., and that the latter was changed six times between 1905 and 1914, while the Grand Duke Nicholas, who might have done great things, having incurred the Czar's displeasure, was unhappily excluded from 1908 onwards.

An appreciation by the German G.S. in 1913 runs: "The movements of Russian armies are very slow. The rapid utilization of a favourable strategic position is as little to be expected from Russian leaders as the rapid and exact execution by the troops of a movement ordered." Thus warned, Ludendorf was able to gauge his enemy before Tannenberg as Wellington did the French in the Peninsula.

Nevertheless the Russian plans for 1914 remind one of Schlieffen's plan leading to a Cannae, since they envisaged both the encirclement of the German 8th Army in East Prussia, and of the whole Austro-Hungarian Army in Eastern Galicia. Both efforts having been defeated the Russian leadership turned to the simpler idea of the steamroller.

Hence it seems that of the four great powers, Germany and Austria alone were trained for and aimed at early and crushing victories; Russia aimed at the same, but without adequate training or the tradition of the offensive; while France alone played a waiting game.

The Defence of the Isonzo, from the Fall of Gorizia to the Capture of Caporetto, by the late Colonel Veith. This article completes a trilogy, "The First Battles Against the Italians" (*v. R.E. Journal*, December, 1931, p. 758), and "The Defence of the Isonzo to the Fall of Gorizia" (*v. R.E. Journal*, March, 1932, p. 190), having already

appeared. As Gorizia was taken by the Italians in August, 1916, in the sixth battle of the Isonzo, the present article has to cover the six remaining battles and a period of fourteen months. The account is a popular one, but makes very good reading. If a little journalese creeps in now and then, as when the sixth battle is called " the mighty sixth symphony of the Isonzo Battle-god," the author can generally get his effects without apparent effort, and the enthusiasm his articles awaken in his Austrian readers is easy to understand.

The Events Leading Up to the Brussilow Offensive in the Summer of 1916, by Lieut.-Colonel Diakow. In the spring of 1916 the Russian front ran in almost a straight line from the Gulf of Riga to the frontier of Rumania, which country had not yet entered the war. Both sides had strongly fortified themselves by months of work, and had got themselves well wired in. The Russians made two offensives from this position, the first of which was against the northern or German part of the line. It took place in March and was intended to relieve the pressure on Verdun. Some initial success was gained, in fact the Russians broke through towards Vilna, but the offensive petered out in mud and blood, and by the end of April the Germans had counter-attacked and regained their old positions. The second Russian offensive was directed against the southern or Austrian portion of the line. It took place in the direction of Luck, and met with considerable success: in fact, it nearly settled the fate of the Austro-Hungarian Army. This is the attack known to the Austrians as the Brussilow Offensive, from the name of the commander of the Russian S.W. front or southern sector (four armies on 800 km.), who carried it out. This second offensive was made by the Russians also, generally, to relieve the French, but especially at the urgent request of the Italians, against whom the Austrians had started an offensive from the Tyrol in the middle of May. Such are the bare outlines; and Colonel Diakow, who is employed in the Viennese War Archives, gives an intimate picture of the Conference of Russian Commanders, held in April, by Alexeieff, " the finest character and most capable among Russia's leaders," in the presence of the Czar, in order to determine how best to help the Allies in the west, and especially to relieve the pressure on Verdun. Alexeieff's own plan was to strike against the Germans towards Vilna, and this was eventually decided upon, although it had been opposed by two out of the three commanders, viz., Kuropatkin (Northern Sector) and Ewerth (Centre Sector). The third commander, Brussilow, put in so urgent a plea for the offensive to be undertaken on his own front, making no demands and countering all objections, that Alexeieff gave way and the Conference included in their programme Brussilow's offensive as a subsidiary operation to the main effort from the Centre Sector towards Vilna. The whole was intended roughly to synchronize with the British effort, now known as the Battle of the Somme, but Italy's anxiety regarding her Tyrolese front induced the Russians to release the eager Brussilow on June 10th.

The author's sketches of Alexeieff and of Brussilow supply just those personal details which help materially to the understanding of war history.

French, Belgian and Dutch Fortifications, by Major-General Schäfer. The chief points dealt with are:—Fortresses classified as valuable or of no value according to the experience of the Great War (Note, the former greatly preponderate); General result of the post-war controversy as to value of fortresses in future wars, viz., favourable, provided that in organization, equipment, armament and method of fighting they answer to modern requirements; Post-war permanent fortification, owing to treaty or financial restrictions, confined to France and Belgium; Historical development in France—Vauban, effect of Napoleon's campaigns, value in 1870–71, Séré de Rivière's plan, plan against Italy, 1914–18 experiences and value; Historical development in Belgium—the Holy Alliance, two rows of fortresses against France, 1859 change from line system, Brialmont, 1914 experiences and value; Lessons of the Great War, the great value of the right kind of fortress in the right place, and the great disadvantage of not having fortresses where needed, *e.g.*, in the north of France;

Post-war fortification, pre-war system *versus* continuous system controversy, combination of the two systems finally adopted by both France and Belgium, viz., near the frontier fairly continuous chain of fortified posts, farther back fortresses with girdle forts; A complete scheme of permanent fortification for Holland as published in the *Deutsche Wehr*, 4th December, 1931.

The author summarizes, "Thus against disarmed Germany there are partly arising, partly in process of extension, permanent fortifications from the Mediterranean to Holland, or even to the North Sea, which present an absolutely impassable barrier. Only a rich country like France can equip itself militarily in so ideal a manner, having both a fortification system strong beyond precedent, and an army and air force entirely for the purpose of the offensive, and accordingly equipped."

The Plan of the Attack. This is the third article of Lieut.-Colonel Rendulic's series dealing with the attack, "the approach to the enemy" and "preliminary skirmishing" having already appeared. To the encounter battle and the attack of a position is now added a third case demanding essentially different treatment, viz., the attack of a position when the defender has completed his preparations for the defence.

Practical Results of Psychotechnics in the Austrian Army, by Major Fechner. The military significance of practical or applied psychology, under the name of psychotechnics, was pointed out by the same author in an article reviewed in *The R.E. Journal*, September, 1930, p. 561. Since then much experience has been gained. The principal activity of the Army Psychotechnic Centre provisionally set up in Vienna nearly three years ago is testing soldiers as to their suitability before training as specialists in the army, *e.g.*, motor-drivers, telegraphists, wireless operators and artillery technicians. At first the A.P. Centre had to be tested itself. Classes which had completed instruction were handed over to the A.P. Centre to test. The results were often surprisingly accurate, thus, with three classes of motor-drivers and three classifications, "very suitable," "suitable" and "not suitable," the A.P. Centre in 90·5% gave the same classification as the Chief Instructor. It is doubtful whether it is quite fair to call upon the testing Centre to do more than place the candidates in order of suitability, since the exact placing of the line between classifications lends itself to disagreement about standards with the instructors. Even with this handicap results are very good indeed, *e.g.*, with wireless operators and telegraphists, 36 in class, classified as "suitable" 30, "unsuitable" 6. The A.P. Centre gave 29 and 7 respectively, and there was agreement regarding 28 and 5.

In the case of an artillery class the respective figures were 9 very suitable, 48 suitable, 6 not suitable, as placed by the A.P. Centre, while the instructor's classification (which, of course, was accepted) was 18, 45 and 0. This appears to be clearly a case of differing standards, and the whole of the six men reported by the A.P. Centre as "not suitable" were to be found in the instructor's list between 49th and 63rd.

The worth of the A.P. Centre tests having thus been established, the Austrian War Department decided to change the order and to let the A.P. Centre test first. This new system started in the autumn of 1931, and has the manifest advantage that men are rejected as unsuitable after tests lasting about six hours instead of on completion of a course lasting as many months.

The Centre has also been used for testing the candidates for admission to the Officers' Academy, when it achieved 85% of agreement with the Educational Staff; and for testing men about to leave the colours so as to assist in choice before vocational training.

The motto of the Army Psychotechnic Centre might be taken as "The right man in the right place," but there is also another important aspect of its work. Hitherto, in the widespread effort towards increased output of work, attention has been paid chiefly to improved work methods and to improved distribution of work. It is now becoming generally recognized that an important factor of increase of performance

is the increase of human working power to its highest possible capability, or in other words, of the value of psychological rationalization.

Joffre and the Marne. Major-General Schäfer writes a review highly praising the book with this title, written by Joffre's orderly officer, Major Mullen, and published by G. Cres et Cie, Paris. The reviewer finds nothing in the book throwing fresh light upon the vexed and much written about questions, in Germany, "Who lost the battle of the Marne?" and in France, "Who was responsible for the victory of the Marne?" and quotes Joffre's own remarks upon the subject: "People can write what they like about the Marne battle; they can neither alter the orders given, nor the events. I don't know who won the battle, but I know very well who would have been held responsible if we had lost it."

The picture of Joffre would have been incomplete if it had omitted mention of points upon which his ideas clashed with those of the dress regulations, how he resolutely wore his old blue peace uniform in war instead of service dress, how it took his staff six months to induce him to discard a cap which had lost its shape, and how, having most reluctantly given in and put on gloves for the first time for the King of England's visit, he absolutely drew the line at spurs.

The highest praise General Schäfer awards to Joffre during the great retreat in 1914. At the worst time, between 26th August and 5th September, he visited those Army Headquarters, where he thought his presence necessary, no less than seven times. He displayed then his best qualities as a leader, "utter imperturbability, ruthless power of action and self-confidence." During the first two months of war he removed two army commanders, ten corps commanders and forty-two divisional generals from their commands.

Literature of the Great War. Professor von Frauenholz deals in this first article with publications containing general accounts of the course of events, political and military. He recommends for a study of events leading up to the war Friedjung's *The Age of Imperialism*, 1884–1914, published by Neufeld and Henius, Berlin, which investigates the reasons which almost compelled the Great Powers to transfer their interests farther abroad and thus to create fresh points of contact and friction. The American, Barnes, is praised for his book which declines to put the whole responsibility for the war upon Germany. From the British official documents about the origin of the war, 1898–1914, the author says that two things stand out clearly, the far-seeing nature of British politics, which is accustomed to work far ahead and in wide circles, and the fact that the growth of Germany's overseas' trade was far less the cause of strained relations between England and Germany than the growth of the German Navy.

Of the Belgian pre-war diplomatic documents, published by the Germans after they had occupied Brussels in 1914, Dr. Frauenholz considers the most important those which show that the French and Russian General Staffs reckoned with the march-through, so that Belgium's neutrality would be impossible of maintenance. This being so the Belgian Embassy reports sought with special anxiety to establish a correct state of relative strengths in the event of war; and it was a grave sign for Germany when, in spite of its offers and in spite of the situation being distinctly in Germany's favour at the outbreak of war, Belgium, without reservation, placed itself on the side of the Entente.

On the military side, the author recommends for clearness and reality and as coming between the short reviews (Reclam's of Leipzig have produced one of only 78 pages) and the Official Histories, General von Kuhl's *The World War*, 1914–18, two volumes, published by Wilhelm Kolk, Berlin. This is now appearing in 17 parts at 2 marks 50 pf. each.

The Contrasts of 1931—Mobility or Rigidity? This is a review by Lieut.-Colonel Rendulic of an article on the 1931 manœuvres by Captain Liddell-Hart, which appeared in the January-February, 1932, *Infantry Journal*. The mobilization and march of the 1st Division from Aldershot are described. This is the rigidity with,

amongst other things, "what appeared most out of date, the R.E. Field Coys. marching on foot with every prospect of arriving where required too late and tired." Mobility is exemplified by the 1st Bde. R.T.C., the positive lessons to be drawn from the experiences of which are in sharpest contrast with the negative lessons to be drawn from the 1st Division's mobilization march.

After discussing three of the five exercises of the Tank Bde., and having already clearly shown his admiration for the author, Colonel Rendulic winds up: "We are bound to agree that all the exercises described, in the way they were drawn up and in the tasks laid down, fully conform to the demands of modern warfare, and that they may be regarded as text examples for the employment of mechanized formations. What seems to us too modern is the author's attitude towards what has been up to now the organization of the troops and higher formations in all armies. If organization and equipment are doubtless in many ways out of date, we are bound nevertheless to hold fast to this, that mechanized formations even in the more distant future can only form a fraction of the army, and that in any case the decision does not lie with them."

There follows the review of a Hungarian article, "The Infantry of the Future," which says the same, only more so.

Convertible Bridges. An article by Colonel Perroni, in the *Rivista di artigleria e genio*, describes how that officer has invented a standardized bridging equipment which, used in the first place for making a light infantry bridge, permits of that bridge being later converted into a lattice-girder bridge to take artillery. The length in each case is 24 metres, the breadth 2·3 metres; weight per bay of the simple bridge, 180 kilos, of the converted bridge, 750 kilos; the former takes up to infantry guns, the latter up to 6½ and 9 tons. All components can be carried by hand, but a portable derrick is required for launching built-up members.

(*September–October*, 1932.)—With this number the editorship passes out of the hands of Major-General Schubert. During his nine years of office the *M. Mitteilungen* has not only improved, but increased in size, until it is now the most imposing military magazine published in the German language. General Schubert's activities have not been confined to the paper itself, as in addition to publications like *The Most Important Campaigns of the World's History* and *The Care of Tradition in Austria's Army of To-day*, he stepped in, when no private publisher had the courage to do so, and undertook the production of the Austrian Official History of the War.

The Assembly and Activity of the American Army in the World War. Compiled by Major-General Adler from the accounts of the U.S. Official Pictures of the World War, Pictorial Bureau, Washington, 1920. This first instalment makes breathless reading, owing partly to the interest of the subject, and partly because it manages to cram into 13 pages all that happened between America's declaration of war on February 4th, 1917, and the capture of the St. Mihiel Salient on September 12th, 1918.

Espionage and How to Defeat It. An account of the experiences of a former Head of the Intelligence Service and the lessons for the future which he draws therefrom. The chief of these lessons appears to be that espionage like many other things has to be paid for, results being generally in proportion to the amount of money spent; and that an intelligence service belongs to the essential peace-time war preparations, since the information which it gathers about the enemy, his strength, disposition, and above all about his resources, is required even before war breaks out. Also because such information can be gained without undue difficulty in peace-time, and because an intelligence service, with its multifarious sources of information and its wide ramifications, cannot be suddenly improvised.

Another important point upon which the author insists is that a knowledge of what the intelligence service has to find out and of its means for so doing should be as widespread as possible. There are not many real secrets, when one knows how to put two and two together. This is where the general public can help, by furnishing news

items of the right sort. In any case, the nations have " accredited spies " in their military and naval *attachés*, to whom have recently been added trade *attachés* and in some instances engineer *attachés*.

As regards propaganda, tribute is paid to England's success in this department, and the claim is made that Austrian propaganda caused desertions and mutinies in the Italian Army, and also contributed to Russia's final breakdown.

A minor tip is that we should all endeavour to avoid Spionitis, or the fear of spies to the *n*th degree, amounting to a disease and highly infectious. Examples of Spionitis occurred in all countries, ludicrous enough if they had not been so dangerous. Here, too, it is knowledge that is chiefly required, being the best prophylactic against a phenomenon of mass psychology, which has deep roots in the psychology of the individual.

Another minor tip, addressed to the General Staff, Intelligence Branch, is that when the larger enemy press fails as a source of information, owing to censorship, much may be gleaned from less important publications. Thus, the German Intelligence Service in the war is said to have revelled in the information about French units and their postal sectors, furnished them by the addresses of amorous warriors advertising for *marraines* in *La Vie Parisienne*.

The Conduct of the Attach. This article in Lieut.-Colonel Rendulic's series deals with the encounter battle, which it treats up to that point where similarity begins with the attack upon a position.

The Preparatory Training and Higher Education of Officers of the Regular Army in Germany, Italy and Czecho-Slovakia. Major-General Schäfer makes a comparative study of officers' education in the armies of Austria's three most important neighbours. The chief difference is that, in the first-named and in the last-named countries all officers enter the military academies solely from the ranks, while in Italy the chief mode of entry is from civil schools *via* Modena and Turin, the Italian counterparts of Sandhurst and Woolwich. About one-quarter of the cadets at these colleges consists of ex-N.C.O's and of officers of the reserve, *i.e.*, those who have, owing to possessing certain qualifications, performed their compulsory service in the ranks as a shortened period of special training.

In Germany and in Italy the training of the young officer then becomes a regimental matter, the Italian *Regolamento di istruzione*, 1930, being especially clear and emphatic on this point, while Czecho-Slovakia goes in heavily for young officers' courses.

For the higher education of the regimental officer all three countries provide schools and courses. There is also complete unanimity in insistence upon officers of the General Staff returning to do duty with troops. In this respect Germany is specially strong, requiring G.S. officers to serve in succession as company, battalion and brigade commanders.

A New Substitute for Textiles in War. This article goes into the origin and gradual improvements in the process of making artificial silk. This material, which in the last war proved but an inefficient substitute for silk, in the only form in which the latter was required, viz., as a wrapping for explosives, has lately so greatly improved that it may well be of military value in future wars, not only as a substitute for silk, but principally as a substitute for textiles. This will especially be the case in countries which are short of textile fibres, and rich in the raw materials of artificial silk, above all, pine forests.

F.A.I.

CORRESPONDENCE.

MOSQUITO NETS.

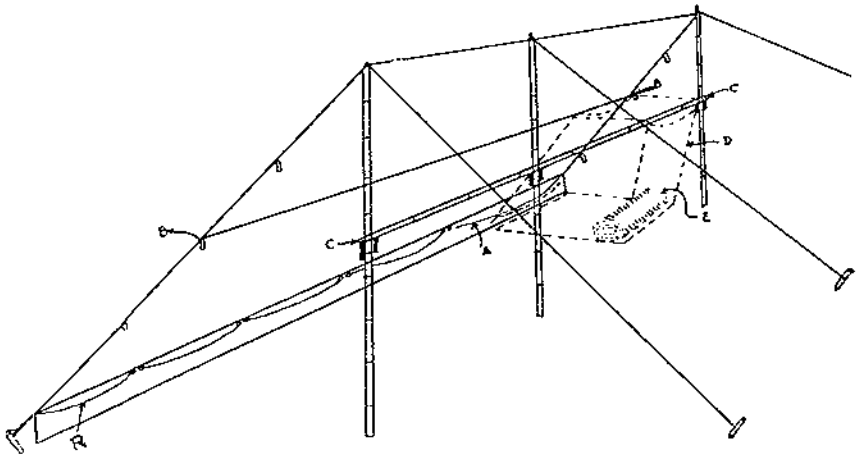
Maymyo, Upper Burma.
24th June, 1932.

To the Editor, *The Royal Engineers Journal.*

SIR,

In his interesting article (June, 1932) on "Road Construction in Baluchistan," Captain C. T. Edwards made a statement which, I

METHOD EMPLOYED FOR HANGING MOSQUITO NETS.



NOTES :—
Right fly not shown
A.—Log line to carry foot of mosquito nets fastened back of rope boles.
B.—Log line to carry centre of mosquito nets.
C.—Bamboo lashed to centre poles.
D.—Mosquito net in position.
E.—Bedding roll (man's head towards centre).

think, cannot remain unanswered. Had the troops in Burma last year adopted an axiom that "mosquito nets are useless in 160-lb. tents," their operations would have been brought to a speedy conclusion by the immobilization of the army through disease. The use of mosquito nets was insisted on throughout the rebellion. Various expedients for fixing the nets were adopted by different commanders, and I attach a sketch showing the method worked out

by Capt. G. A. I. Sanders, whose Company of the 1st (K.G.O.) Madras Pioneers was encamped for nearly five months in some of the most highly malarial districts of the Province. As a result of all precautions taken, the sickness ratio was very little (if at all) above normal. It is, of course, true that the number of men who can be accommodated in tents with nets is less than without.

Yours faithfully,
C. PREEDY, *Lieut.-Colonel, R.E.*

TORNADO IN ASSAM.

(Received through the Commandant, Royal Bombay Sappers and Miners.)

Dacca.
16*th June*, 1932.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

In case it may be of interest to you or any of your officers, I enclose herewith a few photos showing what a tornado can do.

This tornado attacked a district gaol in Mymensingh, a district in my circle in Eastern Bengal, about 40 miles south of the Garo Hills (Assam).

The tornado took place on May 9th, at about 4 p.m., and lasted 3 to 5 minutes.

The width of the track was some 600 feet, the direction being from north-west to south-east—the length of the track being some 30 miles.

The effects are unbelievable unless actually seen.

Thirty-two warders and convicts were killed and the number of casualties exceeded 100, many very severe. The total population of the gaol was about 1,400, 100 belonging to the staff.

The velocity of the wind is estimated to be 125 miles an hour, which would exert a pressure of over 35 lb. per square foot of area.

A few examples of actual incidents may be of interest.

One man had his head entirely severed by a sheet of corrugated iron. His body was found 300 to 400 feet away, but the head was found in the remains of a village half a mile distant.

An iron pestle, weighing 3 to 4 maunds, was blown 1,000 feet.

The concrete terraced roofs of some of the barracks were broken and lifted right off the building.

Many doors and windows entirely disappeared.

Two-thirds of the 14-foot perimeter wall collapsed, and one curious thing about this is that part of the north wall fell inwards and part out.

Of two temporary barracks constructed recently for 100 political prisoners each, the one running north and south collapsed, but the other adjacent, going east and west, was hardly damaged at all.

Within six days we had treble barbed wire fencing all round the perimeter and within ten days practically the site and debris were cleared. This meant a force of some 300 coolies each day—helped the first few days by 200 convicts—to excavate and clear the ruins in order to extract the dead and wounded.

Over 1 lakh of rupees' worth of damage was done in 3 to 5 minutes.

As I have previously said, I send you these photos, as I don't believe there are many Engineers in India who actually know what a tornado can do—before this I certainly did not, but I do now.

Yours faithfully,
C. W. TANDY GREEN,
Superintending Engineer, Eastern Circle.

CORRECTIONS.

IN the review of "Aviation and the Aerodrome," which appears on page 545 of the September number of *The R.E. Journal*, the first line should read:—"The author, Mr. H. A. Lewis-Dale, is the Assistant Director of Works and Buildings at the Air Ministry, etc.," and under "Correspondence" on page 583, line 28 should read "Major G. A. Cockburn," instead of "Major E. A. Cockburn."

1.—North-west wall, latrines, etc.

2.—Outside Main Gate, south end.

3.—West Wall. Barrack No. 1, Hospital cook-house. Barrack No. 2 (top storey to be dismantled on right).

4.—North Gaol Wall.

Tornado in Assam 1-4

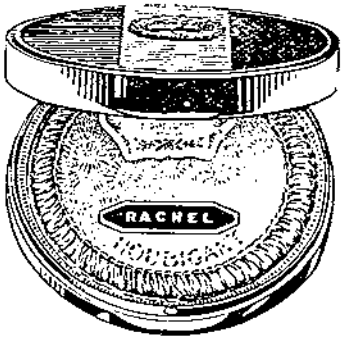
5.—A Departmental Godown inside the Gaol.

6.—North-West Wall.

7.—Departmental Buildings inside Gaol.

8.—Departmental Grain Godown.

Tornado in Assam 5-8



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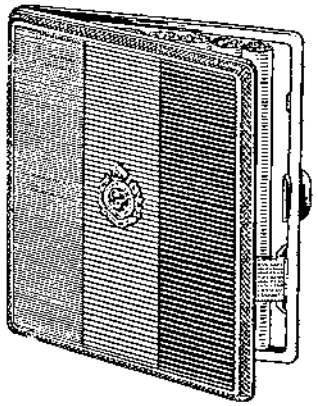

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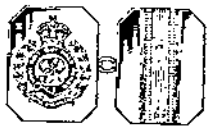

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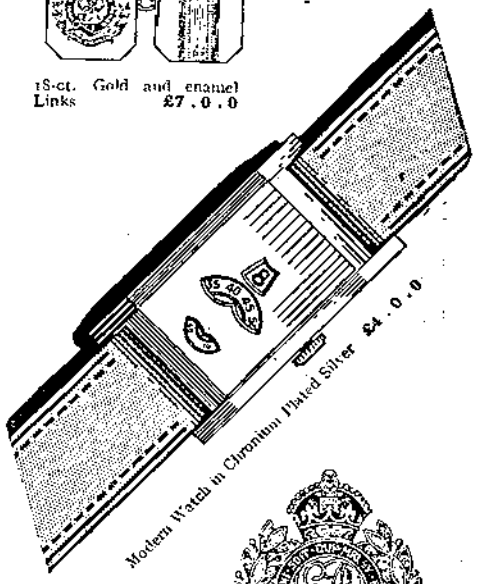

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