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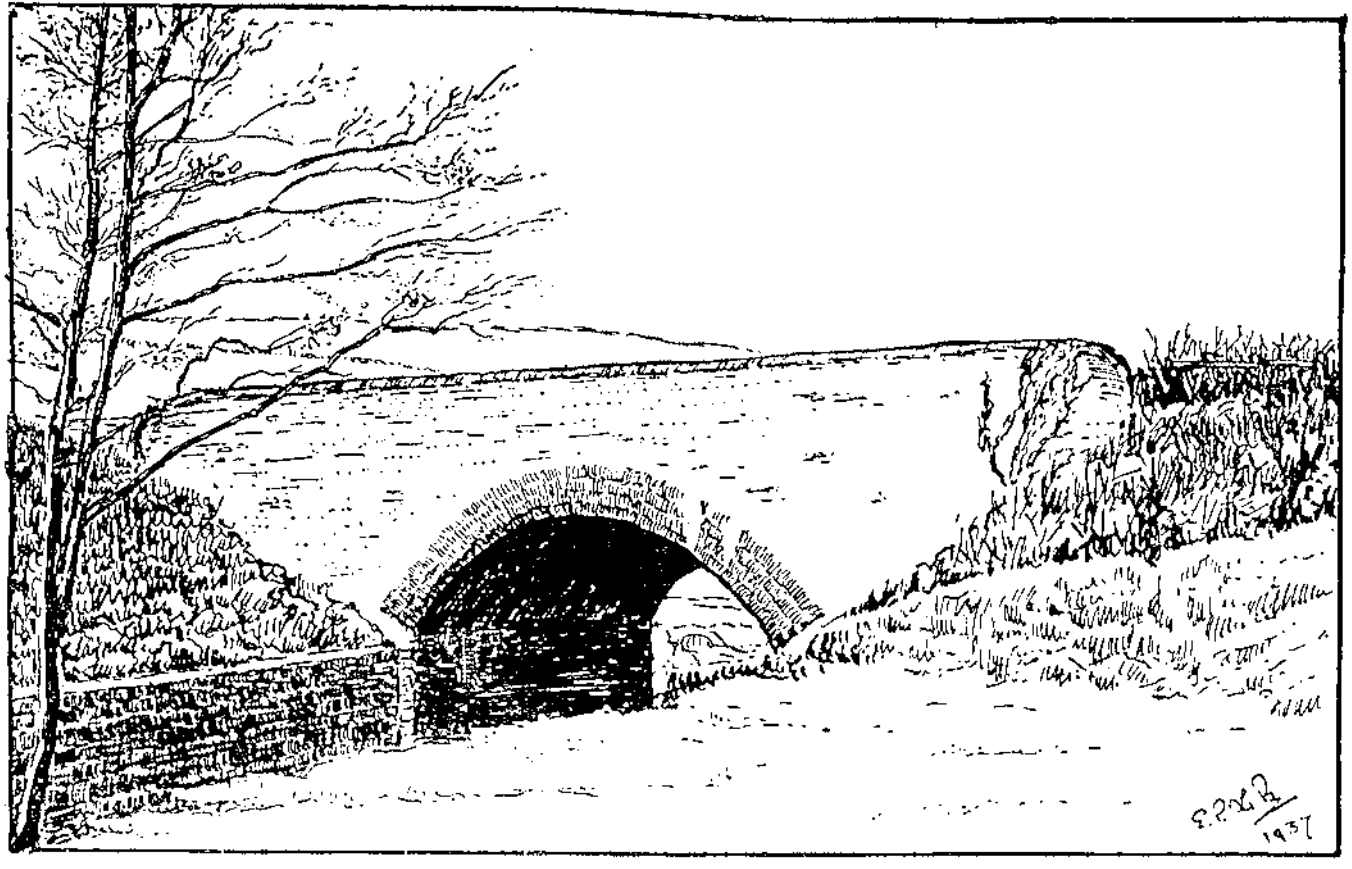
THE SALKELD BRIDGE.



From a drawing by Colonel E. P. Le Breton.

THE SALKELD BRIDGE.

EXTRACT from *London Gazette*, dated 18th June, 1858, awarding the Victoria Cross to Lieutenant Philip Salkeld, Bengal Engineers:

"For conspicuous bravery in the performance of the desperate duty of blowing in the Cashmere Gate of the Fortress of Delhi, in broad daylight, under a heavy fire of musketry, on the morning of the 14th September, 1857, preparatory to the assault."

Extract from a dispatch by General Campbell:—" . . . *officers to whom I am more particularly indebted, Lieut. Salkeld of the Engineers who personally fastened the powder bag to the gates, fixed the hose, and although fearfully wounded continued to hand to a non-commissioned officer of the Sappers and Miners the light to fire the train.* . . ."

MOST R.E's are probably aware that one of the earliest V.C's in history was that won by Lieut. Philip Salkeld of the Bengal Engineers for gallantry displayed at the blowing in of the Kashmir Gate at the siege of Delhi in 1857, a feat which cost him his life.

It is probably much less widely known that a memorial to Salkeld's gallantry exists in the shape of a bridge built in 1864 by his friends and neighbours to commemorate his action. The bridge spans the river Divelish, a tributary of the Stour, on the Sturminster-Dorchester road (in Dorsetshire), and is 1½ miles distant from the former village, and some 8 miles distant from Fontmell Magna, of which place Philip's father was Rector at that time. The bridge is built of stone with a four-ringed brick arch. Each of its parapets contains, on its inner face, a stone slab with the inscription in bold plain lettering—

SALKELD
1857
DELHI

Truly a fitting memorial to a brave Sapper.

W.H.B.

GUL KACH BRIDGE.

By LIEUTENANT A. S. BARTON, R.E.

INTRODUCTORY.

To provide uninterrupted communication by road between Waziristan and Baluchistan a reinforced-concrete bridge spanning the Gomal River at Gul Kach was constructed by the Military Engineer Services in 1936.

The work was carried out by contract and was in the charge of the Garrison Engineer, Wana.

The River Gomal forms the boundary between Waziristan and Baluchistan (see sketch map). Both these areas lie along the North-West Frontier of India, but whereas Baluchistan was brought under British administration before 1890 and is now a peaceful area, Waziristan has only in the last ten years been brought under an efficient control and a partial administration, while it still remains neither peaceful nor wholly safe to live in.

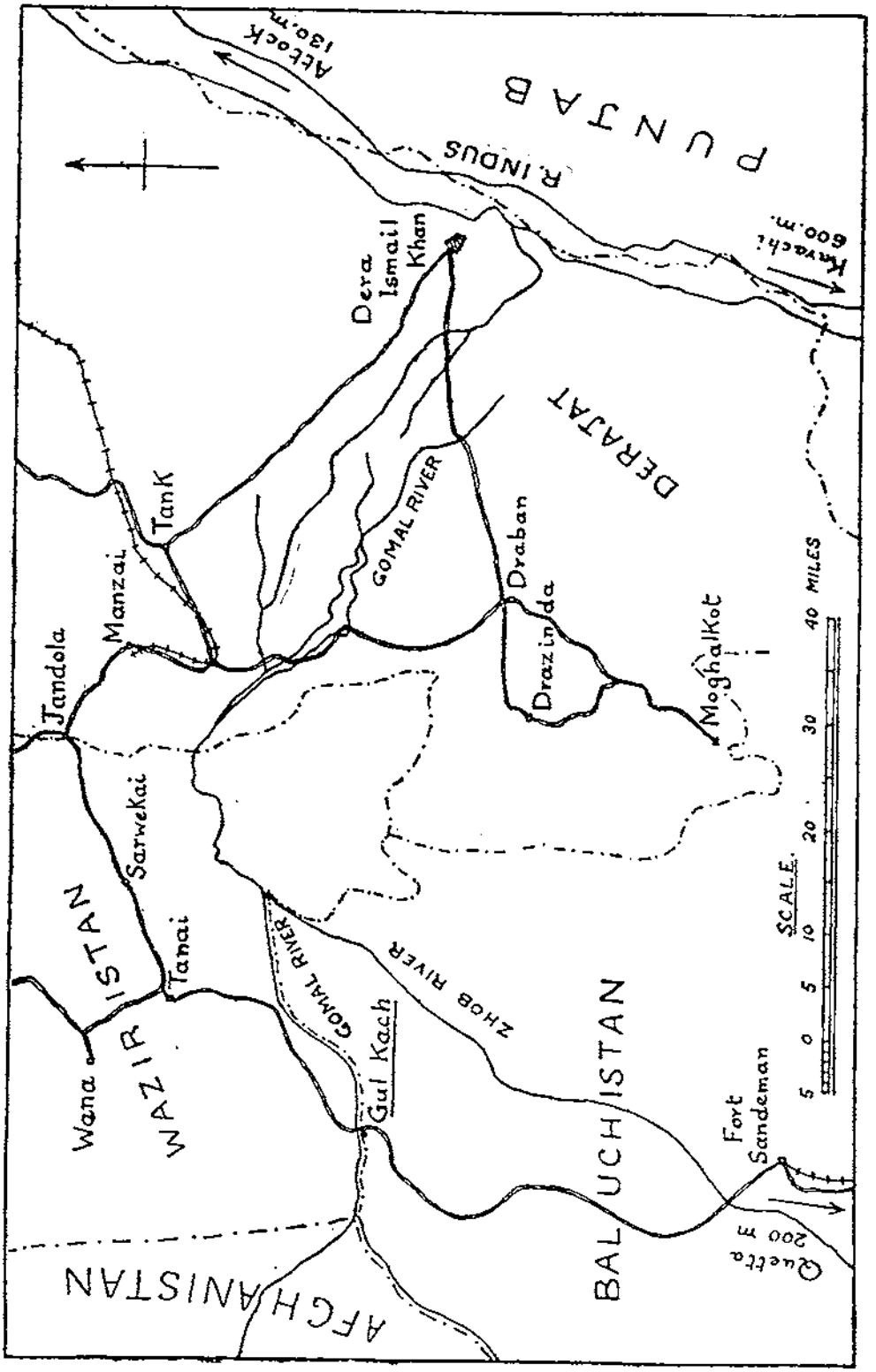
However, the policy in Waziristan has been in recent years, and is to-day, a forward policy of occupation and, as far as possible, administration. In pursuance of this policy a demand for roads and bridges arose, of which Gul Kach Bridge is one.

It may not then, perhaps, be too fanciful to regard the new bridge at Gul Kach as a symbolic link between the but recent forward policy of Waziristan and that more ancient and time-honoured of Baluchistan.

BRIDGE SITE.

In 1930–31 and 1931–32 an unmetalled road was constructed from Tanai, 14 miles from Wana on the main road to Dera Ismail Khan, to Fort Sandeman, thus connecting by road Waziristan and Baluchistan. Twenty-five miles from Tanai, this road crosses the Gomal River at Gul Kach. Prior to 1936 the crossing was a forded one, approximately 800 yards across.

The road on the Baluchistan side is open to traffic on two days a week only, between certain hours, owing to the necessity for special arrangements for protection over a stretch of the road, south of Gul Kach, which runs very close to the Afghan frontier. Hence it is particularly essential that traffic on these days should not be held up by floods in the Gomal River, as delay of a few hours may necessitate a wait of three days till the next road-open day.


PUNJAB
R. INDUS
Attock
130 m.
Kohat
600 m.
Dera Ismail Khan
DERAJAT
GOMAL RIVER
Draban
Draz Inda
Mogha Kot
Tank
Manzai
Jandola
Sarwekai
Tanai
Wana
WAZIRISTAN
GOMAL RIVER
ZHOB RIVER
Gul Kach
Fort Sandeman
BALUCHISTAN
Quetta
200 m
AFGHANISTAN
SCALE.
5 0 5 10 20 30 40 MILES

Traffic consists chiefly of local lorries and private cars. The Gul Kach road is the through route by road from Baluchistan to the North-West Frontier Province, the northern Punjab and Kashmir. It may also be considered the direct route from these provinces *via* Baluchistan to London (see Photo No. 2), though through-traffic is not considerable! In the event of tribal trouble it affords a strategic link with Waziristan.

Torrential floods occur in the Gomal River in the spring and also in July and August, and the forded crossing at Gul Kach becomes impassable by motor-cars.

The catchment area of the Gomal River above Gal Kach extends into Afghanistan and is very considerable. From the figure for the maximum possible discharge from this catchment area was calculated the maximum possible high-flood level, which at the bridge site, which is immediately below the forded crossing, was found to be 19 feet above lowest bed-level.

The bed of the Gomal River is a torrential river bed covered with detritus and boulders; the bed falls at a slope of about 1 in 100.

The possibility of providing a causeway across the river was considered, but rejected owing to the size of the floods, the considerable scour in the river bed and the width of the crossing, over which the normal water flow is distributed in several channels.

A high-level bridge was decided on and work on this was commenced in October, 1935, and completed, except for the surfacing of the approach roads, in August, 1936.

The site is about a mile downstream of the forded crossing, at a point where the river enters a gorge in the hills. The bridge is sited at the mouth of this gorge (see Photo No. 1). The view in this photo is one looking up the Gomal, the Waziristan bank being on the right of the photo, the Baluchistan on the left. The forded crossing is just visible as a faint white line which meets the shoulder of rock on the Baluchistan bank round which the bridge approach road disappears.

Both banks are of shale rock and in the stream between is a small rock island which rises well above maximum calculated high flood level and which forms a natural pier on which to seat a bridge. The channel between the Waziristan bank and the island rock carries the bulk of the flood water, as its bed is lower than that of the channel between the rock and the Baluchistan bank.

BRIDGES AND APPROACHES.

The former channel has been spanned by a 174-ft. span reinforced-concrete arch bridge, with a suspended roadway, and with abutments on the rock of the Waziristan bank and the island. The second channel is spanned by five 47-ft. spans of reinforced-concrete beam and slab bridge on stone masonry piers. (See Figs. 1 and 2.) The

roadway has a clear width of 12 ft. between kerbs in both bridges. Both bridges have been designed to carry a live load consisting of a 12-ton road-roller in working trim with an impact allowance of 25 per cent.

The roadway of the beam and slab bridge has been given a downward slope of 1 in 34 towards the Baluchistan bank, to reduce the amount of fill which would otherwise have been necessary in the approach road.

The approach road on the Baluchistan bank was straightforward, involving a slight amount of cutting only and the construction of one 10-ft. span culvert in stone masonry.

The approach road on the Waziristan bank was not so simple. The hillside on this bank rose to 67 ft. above the road level of the arch bridge, on the line of the bridge, and through this formidable obstacle the approach road had to be cut, a cutting which proved to be a task of a very considerable magnitude. A longitudinal section of the cutting is shown in Fig. 3. (See also Photos. Nos. 1 and 3.) The length of the cut at road level is 140 yards.

Beyond the through-cut, the approach road continues on fairly easy side-cut and embankment to join the existing Tanai road 500 yards from the bridge. In this length a short causeway and two 5-ft. span culverts have been provided.

The total length of the approaches on both banks is 860 yards. Over the major part of this length, soling where required, metalling and two-coat surface-dressing with Colas were specified. The work of laying the soling and metalling was left over till February, 1937, so as to allow the embankment filling six months in which to consolidate under traffic.

The cost of the arch bridge and the beam and slab bridge together was Rs. 92,200, the cost of the approaches Rs. 130,800, making a total of Rs. 223,000 (approx. £16,725) for the whole work.

Contractors.

The work was carried out under two contracts:—(i) the two bridges, (ii) all work in approaches, including culverts and causeway.

The contractors for the bridges were Messrs. J. C. Gammon, Ltd., of Bombay, who were also responsible for the design of both bridges. It is through their courtesy that the drawings accompanying this article are published.

A local contractor nominated by the Political Agent carried out the entire work in the approaches.

The bridge contract was a lump sum contract, that of the approaches was by measurement, at fixed prices as laid down in the special Waziristan schedule of rates, to which all tribal contractors are obliged to work.

LABOUR.

The work on the approaches commenced in mid-October, 1935, and for three months local Suleman Khel labour from the neighbourhood of Gul Kach was employed.

This labour, however, under the delusion that it had an inalienable right to any Government work within its territory and that it need fear no rivals, produced a very low output of work. Finally, in mid-January, permission was obtained from the Political authorities to remove the Suleman Khel labour, and the contractor imported in its place labour from Peshawar and Kohat districts, and even from Kashmir. These men worked very well indeed, under most trying conditions of heat and cold. In the winter months Gul Kach, which is about 3,500 feet above sea-level, is visited by bitter winds, with frosts by night, while in the summer the Gomal River valley which at Gul Kach is enclosed, of a rocky and barren nature, and utterly devoid of vegetation, trees or shade of any sort, becomes excessively and overpoweringly hot. The nature of the country is evident from Photo No. 1. A tribute is certainly due to the men who were working continuously day after day at Gul Kach throughout the hot weather.

The average daily strength of the labour working on the approaches between October, 1935, and August, 1936, when the work was completed, was 350. Numbers reached 700 in December, 1935.

The bridge contractor employed local labour for labourer's work and imported labour for bar-bending and other skilled work.

A labour camp was established near the bridge site, and protection for this was afforded by a number of *khassadars*—local inhabitants paid for the purpose and armed with their own rifles.

Twenty-five miles of new telephone line, from Tanai to Gul Kach, were erected, to enable touch to be maintained with Gul Kach in case of trouble developing with the local people at Gul Kach or with the numerous nomad folk who use the Gomal River as a caravan route from Afghanistan to India in the autumn and from India back to Afghanistan in the spring.

MATERIALS.

Railhead for Gul Kach is at Manzai, 75 miles distant (see sketch map). From there all materials not locally available had to be brought by road, of which 50 miles, to Tanai, are metalled, the remainder, to Gul Kach, shingled.

Sand and shingle for concrete and mortar were both available in the river bed at the bridge site. The specification for sand for concrete work required that the sand should pass a $\frac{3}{16}$-in. square mesh and should contain not more than 10 per cent. passing a 70-mesh sieve unless the proportion of cement be increased. The aggregate was required to be hard stone or gravel free from sand, dust or

GUL KACH BRIDGE.

1.—The completed bridge.

Gul Kach bridge 1

2.—Signpost at Tanai.

3.—The through-cut on the Waziristan bank approach.

4.—The arch bridge from the Waziristan bank.

Gul Kach bridge 2 - 4

powder, and to pass a 1-in. square mesh, no stone to be less than ¼-in. in diameter. In much of the work the aggregate used was a mix of shingle and broken limestone in the proportion of either 1 : 1 or 3 : 2, the gauge of the broken stone being sometimes up to 1¼-in.

Water for the work was always available in the river bed, but, when a flood occurred, the water became excessively muddy and water for concrete-making had to be brought from a clear-water spring not far from the bridge.

The presence of a white salt lying on the surface of the sand and shingle in many places in the river bed near the bridge site led to arrangements being made for a chemical analysis of the water to determine its purity. The analysis was carried out by Lahore University, who reported only very slight traces of nitrate salts in the water, the white deposit being mostly common salt and sulphate salts. The latter being readily soluble in water could be eliminated from the sand and aggregate by thorough washing, while pure water was obtainable from the clear-water spring.

Cement was supplied by the M.E.S. to the contractor, its cost being deducted from his bills.

All steel for the work was supplied by the contractor himself and was required to conform to B.S.S. No. 15 for structural steel, *i.e.*, to have a tensile breaking strength between the limits of 28 and 33 tons per square inch of section for plates, sections and round and square bars.

Timber for shuttering and falsework was obtained locally.

Limestone for stone masonry and for breaking for concrete aggregate was quarried 3½ miles from the bridge site and was conveyed by lorry.

Approaches.

Work on the approaches began in October, 1935, and, except for the laying of the soling and metalling, was completed by August, 1936.

Work on the Baluchistan approach was about two-thirds in sand or soft soil and one-third in soft conglomerate or soft rock in which very little blasting was required.

Work on the Waziristan bank was almost entirely in rock, which varied from a soft, highly-laminated shale to, in occasional outcrops, a very hard quartz.

Apart from the through-cut (whose section is shown in Fig. 3), the approach work was straightforward and requires no comment. The through-cut, owing to its great depth, was the dominating feature of the whole of the approach work ; it took ten months' continuous work to complete it.

The total quantity of material excavated in the approaches was 46,600 yards cube. Sixty-two per cent. of this was excavated from

the through-cut; and 90 per cent. of the through-cut required blasting.

Blasting.

Blasting was carried out almost entirely with gunpowder, both English and country powder being used.

Nearly 3½ tons of powder were used for the whole of the approach work, and on calculation an average figure is obtained of ¼-lb. of powder per yard cube of rock blasted. This is very low compared to the *M.E.S. Handbook* figure of ¾-lb. per yard cube of solid rock, but the low figure is undoubtedly partly due to the fact that 50 per cent. of the rock blasted was of a very soft nature.

Bore-holes for the blasting work were drilled by two ordinary jack-hammer drills operated off a Consolidated Pneumatic Tool Co. single-stage air compressor, driven by a four-cylinder petrol engine, and capable of compressing 220 cubic feet of free air per minute to a pressure of 100 lb. per square inch. Only one air compressor was in use as, owing to the restricted space in the cutting, the removal of soil could not keep pace with the drilling, even with the one compressor only.

The compressor was hired by the M.E.S. to the tribal contractor who was carrying out the approach works.

From the records kept on the site, the number of bore-holes drilled, of approximately 1½-in. diameter and of lengths varying from 3 to 6 ft., works out to an average of just under 10 holes per hour, over a period of 487 hours of actual drilling by the compressor. The average petrol consumption was four gallons an hour.

Nature of Rock.

Work in the through-cut was made particularly difficult by the fact that the shale rock of the through-cut was of a highly-laminated structure and its laminated strata stood at a slope of about 2/1 (64°) to the vertical. In addition, the rock was interspersed in places with thin layers of pure earth between the laminations of the rock.

In consequence, on the upstream side of the cutting, slips frequently occurred during the progress of the work and great care had to be taken not to undercut the face on that side. The lie of the strata is shown in the sketch on page 9 and is also apparent in Photos Nos. 1 and 3.

The recurrence of slips from the upstream face necessitated, in the interests of safety and the avoidance of future road blocks, cutting the whole of this face to approximately the same slope, *i.e.*, 2/1, as that of the rock strata. In view of the depth of the cutting, this involved a very considerable quantity of extra work, as this difficulty had not been foreseen or allowed for in the original estimate of the work.

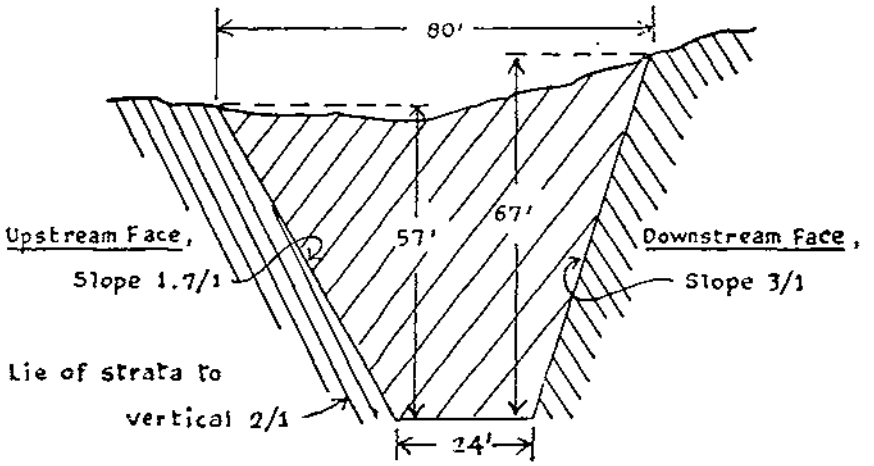


FIG. 3.

The clear width specified at the bottom of the cutting, *i.e.*, at road level, was 20 feet.

Excavation of the cutting proceeded from both ends at once, spoil being carried away by donkey, and being thrown, on the landward side of the cut, just clear of the roadway, and, on the river side, into the river bed just below the bridge.

ARCH BRIDGE.

Description of Bridge.

The reinforced-concrete arch bridge consists of a single 174-ft. span arch of 30-ft. rise. The arch has two ribs at 14 ft. 3 in. centres, supporting the reinforced-concrete deck 181 ft. long by means of columns and hangers (see Figs. 4 and 5). The deck is 15 ft. wide overall, having a roadway 12 ft. wide between kerbs; it has a 3 in. thick reinforced-concrete wearing surface, specially reinforced with hoop reinforcement to prevent cracking. The railings consist of two lines of galvanized iron piping fixed between the hangers.

The arch ribs spring from solid reinforced-concrete abutments founded on rock. These ribs were built on the Melan system. Steel arch ribs, of box section, with main angles of 4 in. × 4 in. × $\frac{3}{8}$ in. angle iron, hinged at either abutment, were erected first. They were then concreted in to form part of the reinforcement of the reinforced-concrete arch ribs (see Photos Nos. 7, 8 and 9). The width of the concreted rib is constant at 27 in. throughout; the depth varies from 54 in. at the springings to 27 in. at the crown.

The steel arch ribs were made sufficiently strong to take the weight of the shuttering and wet concrete of the arch rib. The shuttering was entirely fixed to and supported by the steel rib. This can be seen in Photo No. 8. Timber falsework was erected below the arch

ribs merely for convenience in erection of the steelwork and in concrete pouring.

Six temporary transverse steel bracings were provided between the steel arch ribs; they are clearly seen in Photo No. 9. After completion of the bridge, and not before, these temporary bracings were cut out and the concrete of the rib made good at those points. Permanent bracing against lateral forces is provided firstly by two 30-in. by 18-in. reinforced-concrete beams between the arch ribs, at just below road level, and secondly, by the general rigidity of the hangers, columns and roadway.

The roadway is suspended in the centre portion of the span from either arch rib by means of ten steel hangers of 3 in. × 3 in. × $\frac{3}{8}$ in. angle iron, encased in concrete, and spaced at 9 ft. 8 in. centres; each hanger has two angle irons, the concrete section of the hanger being 21 in. by 7 in.

Where the roadway runs above the level of the arch it is carried by reinforced-concrete columns, also of 21 in. by 7 in. section, resting on the arch ribs.

The 7 in. thick reinforced-concrete deck slab is supported by reinforced-concrete beams which run both transversely, from one hanger to its opposite number below the other arch rib, and also longitudinally from hanger to hanger along the length of the bridge. These beams are shown in Fig. 5.

A similar arrangement of transverse and longitudinal beams occurs over the columns.

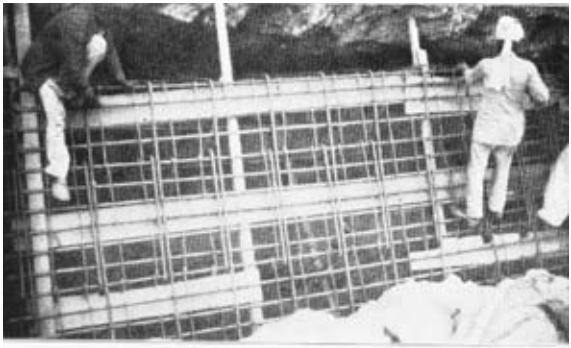
On completion of the whole bridge, the hinges of the steel ribs, which were left unconcreted to the last, were braced rigidly by angle irons fixed along either side of the hinge and were concreted in. The arch thus functions as a fixed arch.

Design and Specifications.

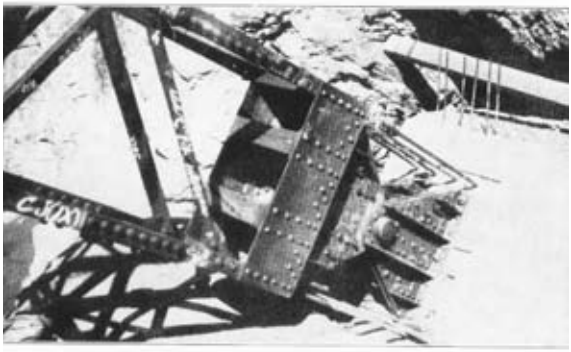
The design of the arch bridge was based on an allowable compressive stress in the concrete of 600 lb. per square inch and tensile stress in the steel of 16,000 lb. per square inch. The pressure under the arch abutments was taken as two tons per square foot under the maximum direct thrust, increasing to a maximum of three tons per square foot at the toe, for the condition of loading giving the maximum bending moment at the springings. The deck slab was designed for a bending moment in both directions.

The reinforced-concrete work was all of 1 : 2 : 4 proportions. It was specified that all concrete work should be kept wet after setting for two weeks. In the event of night frost, the concrete had to be in position at least five hours before the temperature fell to freezing point. All newly-placed concrete had to be protected the first two nights by a layer of gunny bags, two inches of sand (in the case of upper surfaces of slabs), and a further layer of gunny bags.

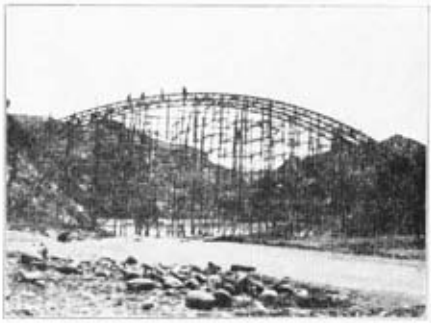
Removal of the centering of reinforced slabs was permitted after



5.—Reinforcement in arch abutment.

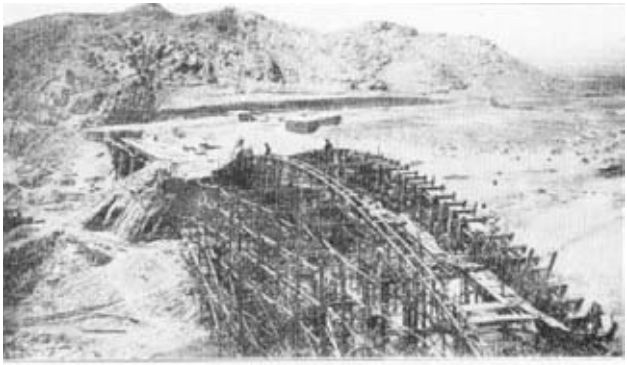


6.—Steel rib hinge at arch abutment prior to concreting.

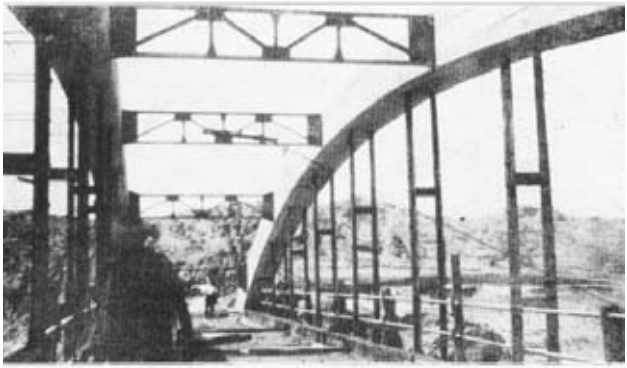


7.—The steelwork of the arch ribs completed.

Gul Kach bridge 5 -7



8.—Centering in position on one arch rib.



9.—View showing hangers and temporary cross-bracing.

10.—General view of bridge—mid-June.

Gul Kach bridge 8 - 10

seven days from concreting and of the underside of beams and of the arch ribs after 28 days; the centering was removed from the sides and top of the arch ribs after eight days. The surface of the concrete was rubbed smooth, as necessary, with carborundum stone after removal of the centering.

Test cubes were invariably made up during the course of concreting, and the results of crushing tests on a certain number of these are given later.

Arch Bridge Construction.

All concrete was mechanically mixed, a single Millar mixer being used. It was of the cone type, capacity 6 cubic feet, driven by a Bamford single-cylinder petrol engine, which used about 2¼ gallons of petrol a day.

The concrete was mixed wet for from two to five minutes. The amount of water in a mix, including the moisture in the sand and aggregate, was restricted to a maximum of 7 gallons per cwt. bag of cement. In many cases a workable mix was obtained with less.

Concreting on the arch bridge commenced with the concreting of the right bank abutment on the 4th February, 1936, and the bridge was completed by the 10th July, 1936.

Work on the beam and slab bridge was in progress alternately with this and the same labour was employed on either bridge.

The arch abutment, which is an interesting feature of the bridge, is 18 ft. in length and takes the thrust of either arch rib near the end of the abutment. As these thrusts act near the ends only, while the soil pressure opposing these thrusts is continuous along the length of the abutment, reinforcement has been provided in the upper face of the abutment against bending between the arch ribs (see Fig. 6 and Photo No. 5).

Each abutment was poured in two halves, the dividing line between halves being a vertical plane midway between arch ribs. The mix was of 1 : 2 : 4 proportions, the aggregate being 50 per cent. ¼-in. to 1-in. river shingle and 50 per cent. ¼-in. to 1¼-in. broken stone.

Holes were left in the abutment for the holding-down bolts of the steel hinges, and these bolts were grouted in after the hinges had been accurately positioned. One hinge in position is shown in Photo No. 6.

After the grouting-in of the hinges the erection of the steel arch ribs proceeded. The ribs were made up in sections, which were supported during erection on the timber falsework previously prepared, each section being bolted to the next (see Photo No. 7).

The temporary steel cross-bracing was then fixed between the steel ribs, and additional 1¼-in. reinforcing bars were laid along the steel rib (shown in Fig. 5).

The centering was next placed on three sides round the rib, the top being left open for concreting. The centering boards were held

in position by pieces of scantling bolted together to form a rectangular frame all round the outside of the boards. These frames are apparent on one rib in Photo No. 8. The top horizontal member of the frame, prior to concreting, rests in every case on two small pre-cast concrete blocks which in their turn rest on the two main 4 in. × 4 in. × $\frac{5}{8}$ in. angles of the steel rib. Thus, the steel rib, through the concrete blocks, carries the whole weight of the centering and of the wet concrete which is placed inside it. The depth of the small concrete block is made equal to the "cover" of the concrete above the angle of the steel rib, so that the pre-cast block, when concreted in, lies flush with the surface of the concreted arch rib.

The concreting of the upstream arch rib, except the hinge, was completed in mid-April, that of the downstream rib in the first week in May. The arch rib was poured in sections and the concreting of each rib was carried out and completed on four successive days as under (for numbers of sections see Fig. 4) :—

1st day—Sections No. 1 (both sides of arch rib).
2nd ,, ,, ,, 2.
3rd ,, ,, ,, 3, 4 and 5.
4th ,, ,, ,, 6, 7 and 8.

A fairly wet mix was used—about 7 gallons of water per cwt. of cement, giving a slump of from 5 to 6 in. During pouring, one man remained sitting inside the steel rib to assist in rodding the concrete, and this materially helped to produce a very fair face on the underside of the finished arch rib. This stage of the work is illustrated by Photo No. 10.

During May and June, after completion of the arch ribs, concreting was completed on the columns at either end of the bridge, the two 30 in. × 18 in. transverse bracing beams, the longitudinal and transverse roadway beams between hangers, the decking slab, and the 3-in. road surfacing, all in that order.

The road surfacing consists of 1 : 2 : 4 cement concrete, reinforced against cracking by means of flat iron hoops laid in the concrete just below the surface.

On completion of the above work, the arch hinges were concreted in and the arch thus fixed.

Finally, at the end of June, the arch hangers were concreted. By the 10th July the temporary steel bracing pieces between the arch ribs had been cut out, the concrete face made good, and the bridge was complete (Photo No. 4).

BEAM AND SLAB BRIDGE.

The beam and slab bridge, giving access from the island to the Baluchistan bank, consists of five reinforced-concrete beam and slab spans of 47 ft. centres of piers, the overall length of roadway being 240 ft.

The deck consists of a 6½-in. reinforced-concrete slab, 13 ft. wide, carried by two reinforced-concrete beams 8 ft. apart, centre to centre. The beams are haunched near the piers and are designed as continuous over three and two spans respectively. The continuity of the beams is broken by an expansion joint over Pier No. 3 (see Figs. 1 and 2). A 6-in. kerb has been provided, so that the clear width between kerbs is, as in the case of the arch bridge, 12 ft. As with the arch bridge, the roadway is provided with a wearing surface of 3-in. thick concrete with hoop reinforcement.

The piers are of solid coursed rubble stone masonry in Portland cement mortar 1 : 6, and are 3 ft. 6 in. wide at the top, except at the expansion joint where the pier (No. 3) is 4 ft. wide. The sides and cut-water have a batter of 1 in 24 and ease-water of 1 in 6. To allow for expansion and contraction of the beams, two layers of Callender's sheeting were placed between the beams and pier caps (see Fig. 2).

There is an abutment on the Baluchistan bank faced with stone masonry similar to that of the piers, but with hearting of 1 : 2½ : 5 Portland cement plum concrete.

At the island end of the bridge there is a bank-seat only, on the island.

The foundations of piers and abutment are open foundations carried down to hard rock, which was reached at depths below bed level varying between 1½ ft. and 12 ft. The foundations consist of 2-ft. thickness of 1 : 2½ : 5 cement concrete, on which the masonry piers are built.

A curved, galvanized iron pipe handrail is provided either side of the roadway.

The design of this bridge was based on the same values of allowable stresses in concrete and steel as in the case of the arch bridge, except that at the point of theoretical maximum negative bending moment the allowable stress in the concrete was taken as 700 lb. per square inch, as against the figure of 600 lb. per square inch used elsewhere. The deck slab was designed for a bending moment in both directions. A cross-section of the slab, showing reinforcement, is given in Fig. 7.

The specifications for this bridge were the same as those already given for the arch bridge.

Excavation for the pier foundations commenced on the 14th November, 1935, and the bridge was completed, except for roadway wearing surface, in April, 1936. As work on the arch bridge was in progress at this time, the road surfacing on the beam and slab bridge was laid later, in May.

The concrete mix in both the beams and slab was 1 : 2 : 4. The aggregate consisted of river shingle, ¼ in. to 1 in., and broken stone, ¼ in. to 1¼ in., mixed in the proportions of 3 to 2 in the case of the beams, and 1 to 1 in the case of the slab. The greatest quantity of concrete placed in a day, using the single mixer, was when the deck

slab over two bays was laid in one day—approximately 650 cu. ft. of concrete.

From April onwards Gul Kach was excessively hot, but the contractor's men carried on with the work on the bridges and worked particularly well under arduous conditions.

The bridges and approaches were open to traffic near the end of August, 1936, ten and half months from the date the work was first put in hand. The metalling of the approaches was carried out in March, 1937.

TESTS FOR COMPRESSIVE STRENGTH.

The compressive strength expected of the 1 : 2 : 4 concrete under the contract specification was a minimum of 2,400 lb. per square inch.

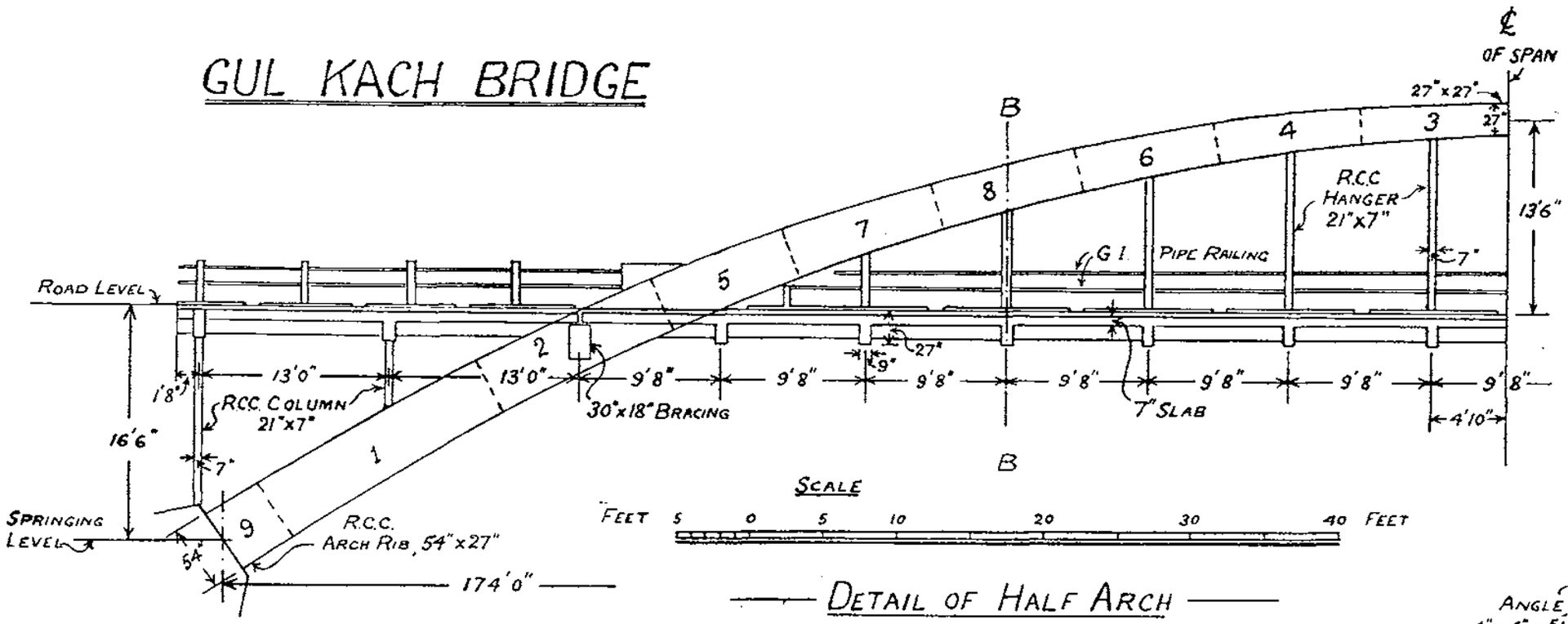
During the progress of work test cubes of 4-in. sides were made up of concrete taken at random from the concrete at the mixer. These were cured on site, and sent after 28 days for a test of their compressive strength. The concrete proportions were 1 : 2 : 4—river sand and aggregate being measured by volume. The aggregate consisted of river shingle, $\frac{1}{4}$ in. to 1 in., and broken stone, $\frac{1}{4}$ in. to 1$\frac{1}{4}$-in. (1 in. in the case of the arch ribs), in the proportions given below. The sand and aggregate were not artificially graded. The results of the tests are as under :—

Date on which test cube made up (1936).		Proportion of shingle, $\frac{1}{4}$" to 1" to broken stone, $\frac{1}{4}$" to 1$\frac{1}{4}$".	Water in gallons per cwt. bag of cement.	Slump in inches.	Compressive Strength in lb./sq. in.
4 Feb.	Right Arch Abutment	1 : 1	5 to 6	2	5,600
8 ,,	Left Arch Abutment	1 : 1	No record.		4,620
12 March	Beams of Beam and Slab Bridge ...	3 : 2	4 to 5	No record.	5,114
13 ,,	Beams of Beam and Slab Bridge ...	3 : 2	4$\frac{1}{2}$	$\frac{1}{2}$	6,020
18 ,,	Slab of Beam and Slab Bridge	1 : 1	5$\frac{1}{2}$	2$\frac{1}{2}$	5,040
12 April	Arch Ribs	3 : 2*	6$\frac{1}{2}$	6	4,396
13 ,,	Arch Ribs	3 : 2*	6$\frac{1}{2}$	6	4,900
14 ,,	Arch Ribs	3 : 2*	6	5	4,340
15 ,,	Arch Ribs	3 : 2*	6$\frac{1}{2}$	4$\frac{1}{2}$	4,900

* $\frac{1}{4}$" to 1" broken stone.

The increase in strength obtained by reduction of the water-cement ratio is well brought out by these figures.

GUL KACH BRIDGE

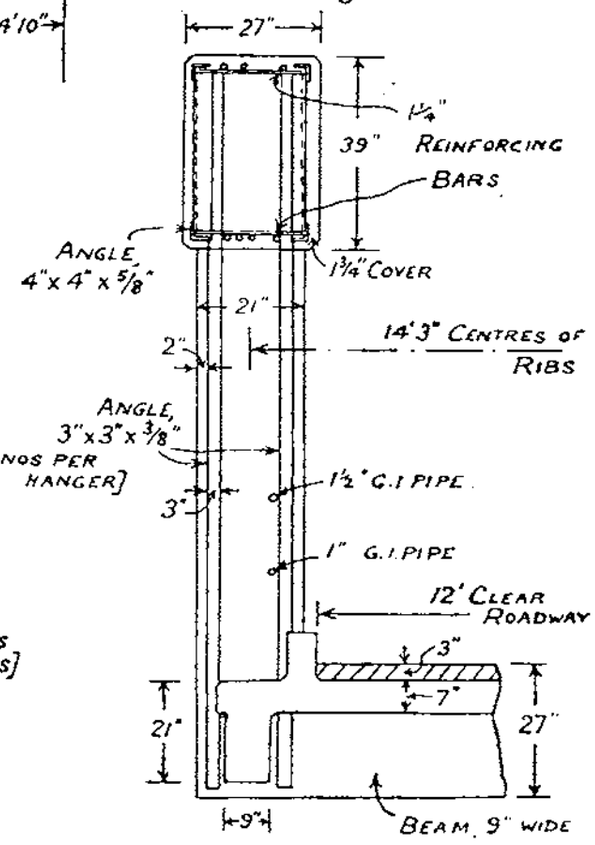


DETAIL OF HALF ARCH

Fig.4.

The figures on the Arch Rib indicate order of concreting.

Fig.5.

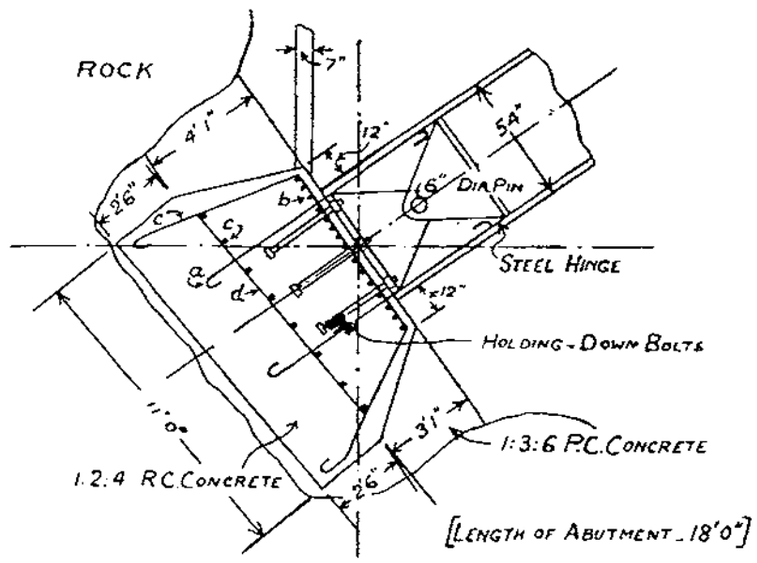


CROSS SECTION BB

Fig.6.

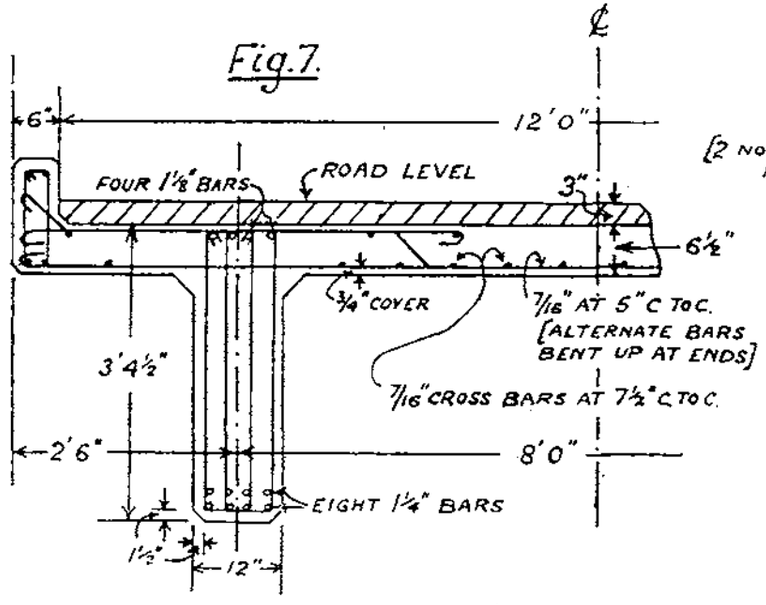
Sizes of Bars:

a - 1¼"
b - 1⅛"
c - ⅞"
d - ⅜"



DETAIL OF ARCH ABUTMENT

Fig.7.

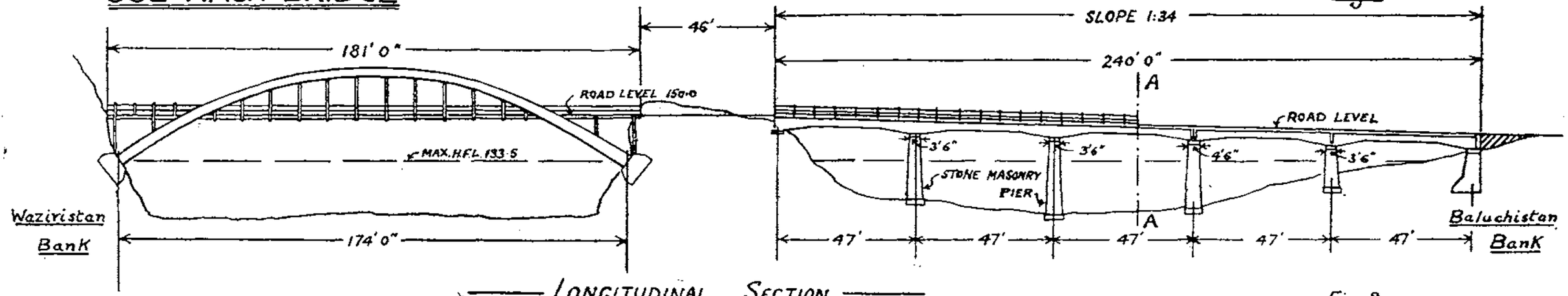


CROSS SECTION AT AA (See Fig.1.)

7/37 A

GUL KACH BRIDGE

Fig.1.



LONGITUDINAL SECTION

SCALE

FEET 10 0 10 50 100 160 FEET

Fig.2.

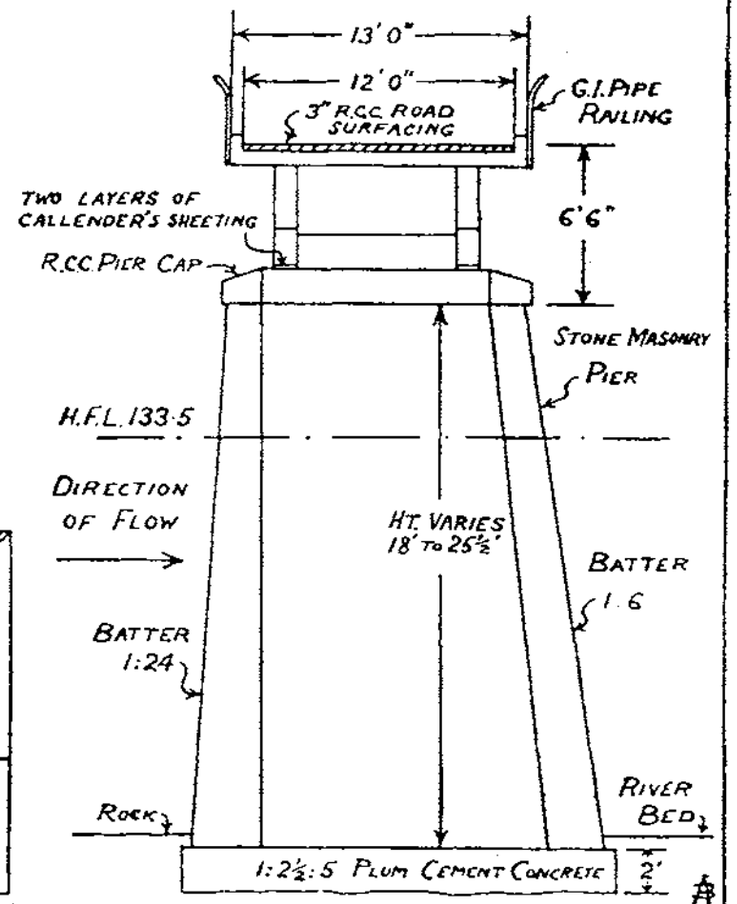
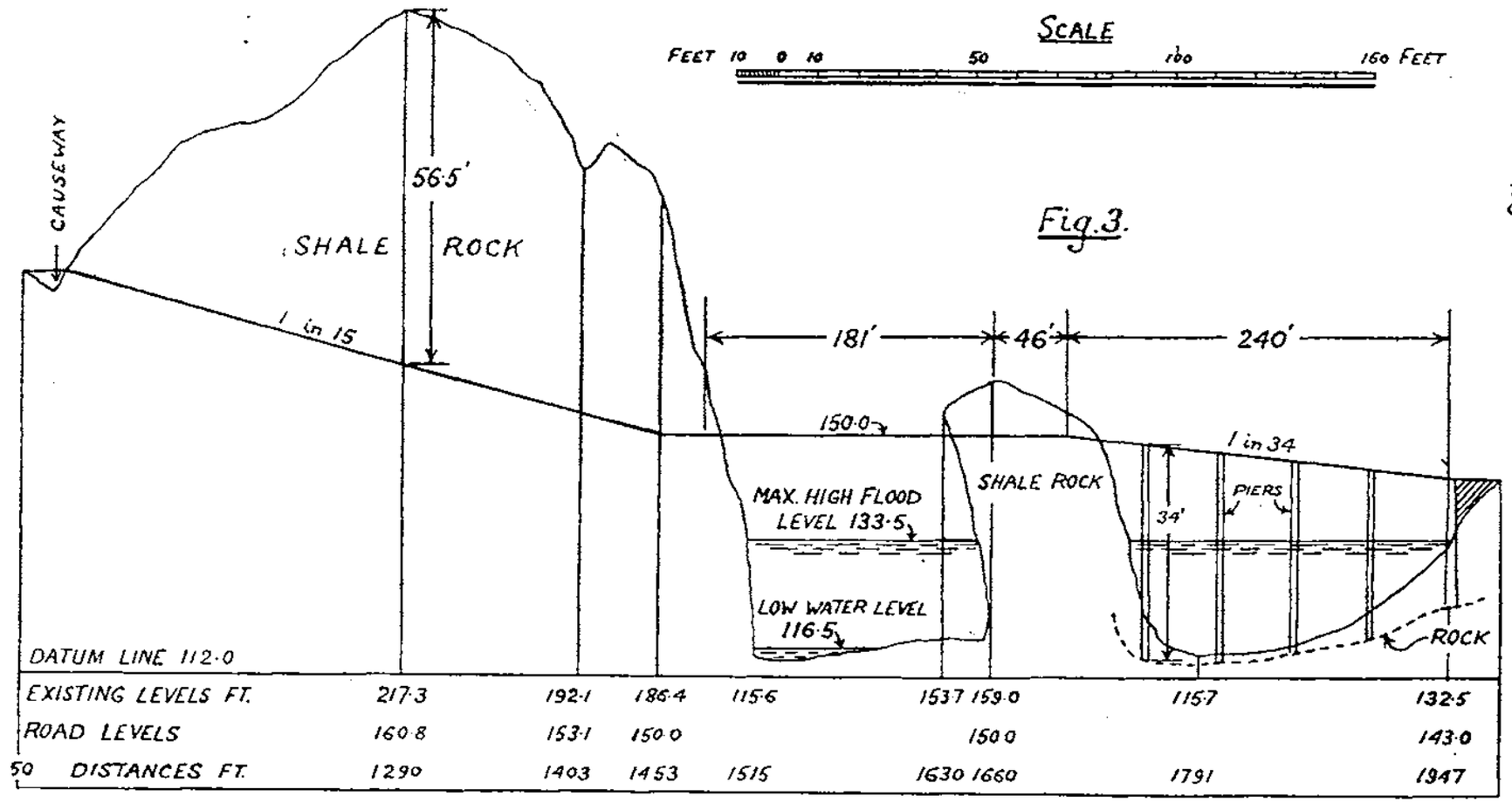


Fig.3.



LONGITUDINAL SECTION OF BRIDGE ALIGNMENT AND PART OF LEFT BANK APPROACH

CROSS SECTION A-A

7/37

FIELD DEFENCES.

By COLONEL G. R. PRIDHAM, C.B.E., D.S.O.

VARIOUS efforts have been made since the war to have the work of the Royal Engineers on Field Defences written up, so as to add to the valuable series of volumes already published upon various other activities of the Corps. These efforts have never materialized, owing chiefly to the immense difficulty of collecting the information required and editing it, and there are other reasons why this has been looked upon as a thankless and perhaps useless task. From the very start of hostilities, all nations viewed with disgust and horror the idea of stagnant warfare; every army had been trained to believe that success could only come from "Attack," and the doctrine of "Attack" (at all costs, perhaps) was firmly implanted in the minds of all soldiers. Defence was looked upon as a necessary evil, but was relegated to the status of a "side-show," which would more or less run itself; it had not engaged the brains of Generals and Staffs particularly before the war and it never appeared to be a very serious subject with them during its progress. When the war had ended in a triumphal phase of movement, the natural tendency of the re-formed army was to devote its energies to perfecting this form of action, and again "Defence" relapsed into its neglected state. Under such conditions, the compilation of a volume of somewhat tedious and detailed information did not arouse much enthusiasm.

It is, however, a matter for regret that the volume on *Field Defences in the War* has not been written, for the principal energies of a very large proportion of the Corps was put into them: they were the chief and constant work of all Field Companies, and a glance at the "states" of the period will show what a large percentage of the total number of R.E. officers and men were serving in such units. From this point of view alone, a record is surely worth while, and there are other good reasons for thinking that the story should not be forgotten: it is becoming evident that the subject of "Defence" is being taken more seriously by the army: improvements in weapons have strengthened the side on the defensive to an extent which is calculated at an almost fantastic figure compared with the state of affairs at the end of the war, and recent events in Spain seem to substantiate the contention. Although we aim at a War of Movement, and have mechanized ourselves, it is the opinion of many soldiers that this only puts a phase of "stalemate" into a different

position on the map, and possibly brings it about at an even earlier date. It is certain that, as a Corps, we shall be called upon to fulfil what has always been our primary role, "Fortification."

It is probably too late to hope that the missing volume will be written now, but the memories and traditions of a body of officers who were responsible for the trenches will not be available for much longer unless something is recorded. With a view to inciting authorship and to helping the rising generation of R.E. officers, chiefly by pointing out errors and difficulties, the following impressions are given.

It is difficult to realize at this date how very ignorant we were of what modern war was to be. Very few of the Corps had ever seen a real permanent trench dug, and the accepted meaning of an entrenchment was that it was merely a temporary halting-place: the idea of long periods of trench warfare hardly existed, although the fairly recent Russo-Japanese War should have enlightened us; the reason why it did not do so was probably because the best-known operation was the siege of Port Arthur, and the word "Siege" seemed to put the operations into a different category. Heavy and medium artillery were almost non-existent for the Field Army and consequently few officers outside the Royal Artillery had seen shooting from anything larger than field artillery: the effect of heavier gunfire on trenches was naturally not sufficiently realized. It was laid down that head-cover and overhead cover were essential in trenches as a protection from shrapnel and great efforts were made during Fieldworks Courses to provide it in the form of flimsy erections on top of the parapets: naturally such work was very soon found to be impracticable and useless. Hand-grenades were not articles of store, and this proved to be a great handicap for a long time. The units were well trained according to the ideas then existing and so N.C.O's and men had little difficulty in adapting themselves to the changed conditions of work, but the officers were much exercised over questions of layout and design. The whole work had to be considered on so much greater a scale than in peace, and enormous positions had to be designed for permanent occupation, instead of for serving the needs of a phase in a battle, which was all that had been envisaged before the war. Traverses were rather neglected at first and were built with rectangular corners instead of being rounded. The provision of good drainage, communications, kitchens, latrines, etc., was certainly laid down in text-books, but very few officers had seen a position completely dug and finished. Wiring for obstacles was looked upon as the business of the R.E. and it took some time to convince the infantry that the condition of their trenches was their own responsibility, with the assistance and direction of the R.E. Needless to say, there were only two Field Companies to a Division

and no Field Park Company, and in 1916 an official translation of a new word, "Camouflage," had, at any rate in one Corps, to be promulgated.

The conditions and mental outlook under which R.E. officers embarked upon four years of trench warfare have been briefly indicated. The first positions held were those in which the troops found themselves when movement had ceased and stabilization had set in. These positions were naturally not sited with any science and, generally speaking, were less advantageous to us than to the enemy, who had checked our advance on defined rear-guard terrain. A strong feeling existed against giving up ground, however useless, chiefly on grounds of "Morale." Thus began the ceaseless task of making trench lines defensible and habitable: this task was shared by the Staff, the troops in occupation and the R.E., but depended principally upon the last.

The original trenches, into which our worn-out troops subsided, were taken in hand according to the nature of the ground and according to the individual and particular ideas held upon the subject by Divisions: there was no attempt at strict uniformity and each formation worked out its own salvation, but on one subject everyone was unanimous: R.E. stores of every kind were wanted urgently and the demand from higher quarters was, considering the difficulties of provision and forwarding, met in a wonderful manner. Revetting materials were the chief desideratum and this led to every sort of expedient: besides the ubiquitous sandbag, expanded metal, gabions, wire netting, timber sheeting, etc., were all put into use. The Germans relied chiefly upon brushwood, but, on our side of the line, the French authorities apparently disapproved of a policy of stripping the woods and we never got it in large quantities. The inventions of the U-frame and the duckboard marked epochs in construction and their originators deserve some form of commemoration. Although against instructions, most units managed to evolve some sort of workshop containing, at any rate, a saw, and some weird pieces of machinery used to travel over a good deal of France. Needless to say, a great deal of the work had to be done at night and here the question of working parties became most difficult. Until a late period of the war, the infantry parties would be detailed in Brigade orders and a tired gang would (or would perhaps not) turn up to collect stores and tools at the dump. The difficulties in getting the men up the communications to the job and in then getting them to work satisfactorily were immense and daylight would come to show a miserable output for all the stress involved. The practice, evolved later on in some Divisions, of attaching an infantry party more or less permanently to a Field Company was a great advance. Much more and better work was done by a smaller party which

looked upon the job as its proper and definite work and which could see results. Pioneer battalions did not exist, but their necessity soon became apparent.

A few notes have been given above on the actual construction of the trench-line, and now the layout and design will be touched upon. Speaking under (perhaps severe) correction, the contention is put forward that the Higher Command, including both Command and R.E., failed to give necessary information and definite orders on the subjects of how best to design and execute the Defence Works required. The subject was not ignored: a stream of very helpful pamphlets flowed from Headquarters showing, for instance, how a certain division revetted, how another division designed a dug-out, how the Germans did this or that from captured documents, but never, until late in 1917, did there issue a definite and reasoned system embodying collated experience and opinion, of how to hold and defend the line. This system, showing what was accepted until the end of the war as a normal scheme of Defence, was evolved by a school for Field Company Commanders and was a Godsend to the Divisional R.E. Up to that time various fashions had prevailed in different parts of the line, generally set by a masterful Divisional Commander or C.R.E. For example, at one period the "strong-point" or "island" idea was in great favour until it was found that if overdone, the "strong-points" were crushed by concentrated artillery fire and the whole defence collapsed. Probably one of the principal reasons for the lack of control by high authority was that it was laid down as a principle that the Corps should not interfere with the Division in the fighting zone as far as defences were considered. Since Divisions moved constantly, while Corps were, generally speaking, stationary, a lack of continuity naturally resulted. A Division would move into a new sector, and probably, after a hasty look at the trenches, would decide upon a complete revision of the scheme and embark on a heavy programme: before this was half-completed, the Division would move off and the process would be repeated. All work took longer than anticipated owing to weather, damage by fire and many other reasons. A further weakness in the system was that, owing to commendable *esprit de corps*, no Division trusted the ones on its flank to hold their line and a multiplicity of switch lines and flanking defences grew up in place of a properly thought-out scheme of mutual support between Divisions. If the Corps had retained control of the layout and design of the works, a great deal of unnecessary work would have been avoided and a better system would have resulted: also more thought would have been given to Defence by the Staffs of higher formations, and definite instructions would probably have come down to the troops responsible for their execution.

For the reasons given above and for others, it can hardly be contended that our Field Defences were as good as those of the Germans. The details of work in ours were probably better executed, and a lavish supply of materials made our trenches appear almost luxurious compared with those of the enemy, but in layout and design they were probably inferior. Most particularly did the Germans surpass us in large and far-reaching conceptions, and two examples show this. The elaborate deep dug-out was almost unknown on our side of the line until the Somme battle showed what a valuable addition it made to the Defence. From that time we adopted the idea wholeheartedly and the release of a number of tunnelling units from mining, which was possible at the time, made it more easy to hasten the construction of really deep dug-out accommodation. The second example is the concrete machine-gun "pill-box," which was a complete and very unpleasant surprise for us and which may be said to have almost dominated the battlefields of the later periods of the war. No far-reaching departure or invention can be claimed by us which had important bearings on actual Defence, and it may be stated in general terms that we followed German methods and designs and evolved few new ones even in details of work. Such a confession, if true, is a serious reflection upon us as a Corps and it can partly be accounted for by the lack of an organized chain of direction, commencing at the very top of the army hierarchy.

A further reason is that insufficient thought, imagination and experiment had been brought to bear upon the subject of Defence: again, owing to the many duties imposed upon officers of the Corps, the majority of them had had little reason or opportunity to study defence questions since their service below field rank in units. Many officers who found themselves in positions as C.R.E's or Chief Engineers, although they could deal adequately with the many other, perhaps more important, questions of engineering for which they were responsible, came to defence work without any recent training or experience.

These notes are written to arouse interest in what sometimes becomes a neglected subject: to induce other officers to record their experiences and perhaps to assist the rising generation. By this it is not intended to convey that the methods of the last war should be followed, but rather that consideration should be given to newer and better ones: conditions to-day are quite different and training probably much better, but, by giving a few examples and instances, perhaps lessons can be learnt and particularly from the fact that we entered the war unprepared and ignorant in many ways. The chief energies of the Corps are now rightly given to more scientific subjects than "Field Defences," which are in the main "Pioneering" rather than "Engineering," but as long as the army gives the Royal

Engineers the responsibility for their design and construction, the subject is worth thought and research.

At the present time, two wars are in progress and in both "stalemate" and consequent trench warfare has, at times, set in on portions of the area: it does not seem likely that any war in which we may be involved and for which we train will be exempt from such a phase.

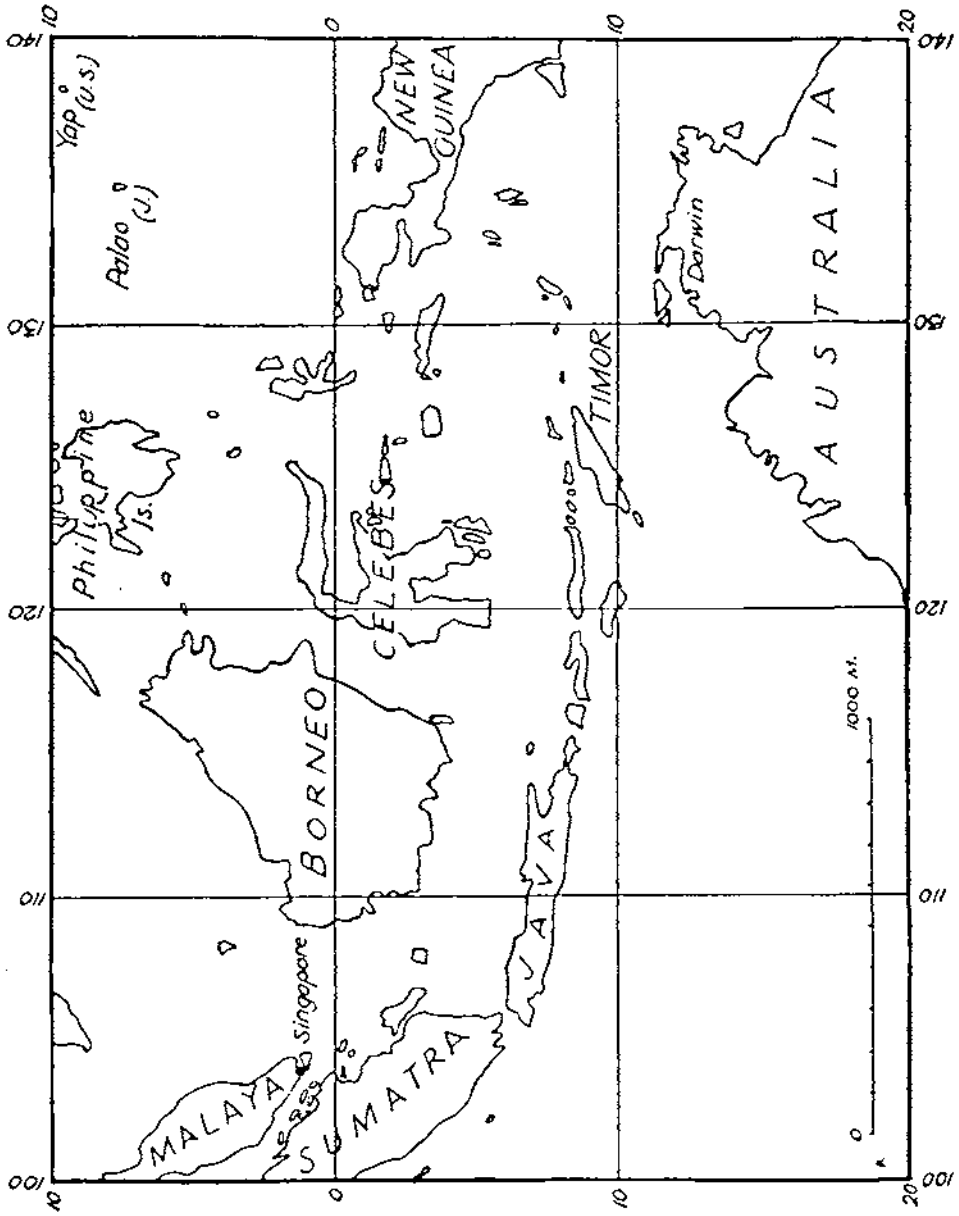
DEFENCE WORKS AT DARWIN.

By CAPTAIN R. R. MCNICOLL, *Australian Staff Corps.*

UNTIL comparatively recently the Northern Territory of Australia was not "news," and many Australians even would have been unable to name a settlement there, unless indeed they faintly remembered "Palmerston or Port Darwin" which they had heard mentioned at school. Now, however, Darwin is known beyond the Commonwealth; the name has appeared on the cable page of *The Times;* and it deserves (if it has not already received) the ultimate *cachet* of being the subject of questions in army examinations in Imperial Geography. The news value of the place is due to its having been the point of entry to Australia of many adventurous aviators, and, since 1934, of the regular air service. The harbour is good, so that the introduction of flying-boats will not cause the route to be diverted. The strategic significance of Darwin in the Eastern Archipelago need not be emphasized.

The immediate hinterland is poor. A railway runs for some 300 miles to the south into moderately good cattle country, but with the exception of beef the Northern Territory has to import all foodstuffs by sea. Building materials come mostly from Brisbane, Sydney and Melbourne by the monthly shipping service. The population of Darwin consists of 1,300 Europeans, 600 Asiatics—mainly Chinese—300 half-breeds and a fluctuating number of aboriginals. A large proportion of the town's activities depend directly or indirectly on expenditure by the Federal Government.

The climate is monsoonal, with a rainy season from November to April and a dry season from May to October. During the six wet months an average of 50 inches of rain falls, and conditions are unpleasantly humid. The dry season, however, is really dry, temperatures are lower, and humidity negligible; in fact, for some months the climate is ideal. Health generally is good. Malaria is not often found north of Lat. 14° S., dengue is limited and other tropical diseases are rare. On first sight from the sea or air the town makes a good impression, but this is dispelled on closer examination, for the commercial buildings are mean, the streets dusty and the gardens poor. In fact the recent stigmatizing of Darwin as the chief of "Australia's backyards" was not far from the truth. Much of the appearance of squalor is due to an insufficient water-supply during the dry season. This is now being remedied, and Darwin's looks will improve as the place grows in importance.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Palau (J.)
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Darwin
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BORNEO
JAVA
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Singapore
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SUMATRA
100
100
10
0
10
20

On the surface Darwin is a tropical town. It has, however, one striking difference from tropical settlements in other continents; there is no cheap labour. The aboriginal population does not take kindly to civilization. Only a small proportion can be trained in domestic work. It would be impossible to use natives on hard manual labour, even if political conditions permitted, because they would immediately desert. Unlike the Malays and Melanesians they could not be indentured satisfactorily. There are exceptions to this seeming incompetence, notably in the interior where the cattle stations would be unworkable without native stockmen, but in general the aboriginals cannot be considered as a source of labour.

Indentured labour is restricted to the pearling industry. The Chinese are engaged mainly in commerce. The half-breeds are competent workers but are paid, in common with all other workers, not less than the basic wage of the Northern Territory which is fixed to provide an adequate living for a white family. It will be obvious that the high cost of labour influences every side of life in Darwin and makes it virtually a southern settlement transplanted to the tropics. There is thus an interesting compromise between temperate and tropical conditions.

II

The question of defending the Territory had been considered from time to time, and in 1925 the Inspector-General had reported on the matter, but it was not until 1932 that defensive works were commenced.

By 1932 Australia was at the lowest point of the economic depression. All votes were reduced, and there was little money for new works. As there were no funds for paying civilians, military labour was indicated. Recruiting had by that time been suspended, so a small party drawn from existing permanent units (Royal Australian Artillery and Royal Australian Engineers) was chosen, embarked with its stores in ships of H.M.A. Squadron and arrived at Darwin in September, 1932.

At the outset the Darwin Detachment was quartered in the meat-works erected by the Vestey interests during the war, but disused in the main since 1919. These quarters were occupied until February, 1935. They leaked in the wet season and were draughty in the dry, but the alternative was to live under canvas. In spite of discomfort and inadequate strength the Detachment in twelve months completed the major armament and most of the defence lights and ancillary buildings.

The first permanent garrison arrived in September, 1933, whereupon most of the Detachment returned to Sydney. The garrison was still quartered at Vestey's. The barracks were started in April,

1934; the first two barrack blocks were occupied in the following February, and the move from Vestey's complete by September, 1935. Regular drafts now arrive each August. The policy of using soldiers for construction has proved so successful that it has been adhered to in spite of an improvement in finances. For this reason the station is unique in Australia.

III

Although almost exclusively engaged in constructional work the garrison is the nucleus of the war manning detail, and the consequent preponderance of gunners over sappers has remained fairly steady at five to one. The difficulty of finding enough tradesmen was solved at the outset by enlisting tradesmen into the R.A.A. for service (initially) at Darwin, giving them their recruit training at southern depots and drafting them in due course to the garrison. This procedure was facilitated by the depression. In 1932 and 1933 numbers of civilian tradesmen were unable to find employment, and thus three successive drafts contained a high proportion of recruits who had been competent carpenters, plumbers and mechanics. With the industrial recovery tradesmen are now at a premium. The most recent draft consisted entirely of unskilled men.

By simplifying the administration of the original Darwin Detachment the proportion of " employed " men was kept remarkably low. Of the total of 45 all ranks an average of 32 were available for constructional work, and as the greater part of this was concrete not many carpenters and plumbers were needed. The establishment of the garrison on a permanent basis has meant a steady increase in administrative personnel.

Another source of labour has been a party of long-term aboriginal convicts borrowed from the local gaol. The numbers vary from six to twelve. These men are given an extra ration by the Department and often improve visibly in physique, but at the best they cannot be employed on strenuous work for more than a few hours a day. In their own line they are most useful because of the patience with which they set about clearing and roadmaking, and other tasks that would soon prove too boring for the troops. Most of these convicts are serving sentences for either tribal or ordinary murder, but even the latter belie their villainous looks and turn out very docile. There has been only one escape from this gang in four years in spite of increased opportunities. The escapee was recaptured in his tribal country.

It is found that the efficiency of *unskilled* labour does not decline appreciably during a three-year term at Darwin. There is no doubt, however, that in their third year men start to lose initiative and the output of *skilled* labour is correspondingly reduced; this deterioration, of course, is not confined to the army. The output of a soldier

employed on construction, considering his short working hours (30 a week) and all other factors, cannot be reckoned at much over half that of his civilian counterpart in a temperate climate.

The works originally projected would have been completed long ago had the programme not been continually expanded. It seems likely that construction at the present rate will go on for several years more. Unless there is another industrial depression the shortage of tradesmen will thus become more and more acute. It is at present being countered by attaching selected unskilled men to the best tradesmen as learners, an unsatisfactory arrangement really; and by simplifying practice to the greatest possible extent.

Arrangements have now been made for future drafts to receive six months' trade training before their departure for the Territory.

IV

The influence of local conditions on defence works proper cannot be dealt with here, but a note on the design and construction of living and store accommodation may be of interest. Many of the problems encountered are common to all tropical stations. There are, however, some peculiar to Darwin.

Factors Influencing Design.

1. *Cost.*—Freights and charges on materials shipped from southern ports amount to 67s. per ton or 16s. 6d. per hundred super feet of timber. Local timber is even more expensive than imported. There is no local supply of bricks or building stone.

2. *Climate.*—The relative humidity in the wet season is commonly 80 per cent., coupled with a dry bulb temperature of over 90°F. The discomfort caused by high humidity exercises a preponderating influence on design. Also important is the very heavy intensity of rainfall during some parts of the year. Much of the rain falls in storms, when strong winds drive it horizontally with considerable force. A further factor is the high minimum temperature, which makes it unnecessary to heat buildings or to design them with a view to warmth.

3. *Pests.*—White ants abound, and all timber structures are vulnerable. Mosquitoes and sandflies are generally bad and have to be countered in some way or other.

4. *Acts of God.*—During the wet season gales are frequent, and there is an appreciable risk of cyclones. There is also a liability to slight earth tremors.

Effect of High Cost of Materials.

Labour costs are perhaps 25 per cent. over the equivalent in New South Wales or Victoria, but the Army, which does all its own building, feels the full effect of the 50 per cent. surcharge on materials.

Even if we had not been short of money for new works the high local costs would have forced us to build as cheaply as possible.

There are few stone buildings in the town, and those there are mostly date from the 'eighties and 'nineties when Asiatic labour was available. No quarries are worked in the Territory. No bricks are made, though there are traces of an ancient kiln near Darwin and the Royal Australian Air Force contemplate reopening the brick-works when they start on the construction of their new station next year. The materials available for building are concrete, steel and timber, and some combination of these is always used.

Effect of Climate.

Air-conditioning is obviously the best method of dealing with high humidity combined with high temperatures, but the cost of the plant for an average married officer's or W.O.'s quarters (given that power is available) would be about £250, and in addition special insulating arrangements would have to be made which would add perhaps a further £500 to the cost. Air-conditioning is sure to be adopted at some time in the future, more especially for bigger structures such as messes and institutes. It will be used extensively in the new R.A.A.F. station where the buildings, largely of brick, will lend themselves to this treatment.

Short of air-conditioning the best that can be done is to promote maximum air movement. All living quarters are thus as open to the outside air as possible. It is usual to eat, sleep and live on verandahs. Interior rooms—dressing rooms, stores, and so on—are of lesser importance and are kept small so that the verandah can be made wide. The requirement of having a verandah on three or four sides leads to the hip-roofed bungalow type of house so typical of northern Australia. In Darwin verandahs generally have bamboo-lined shutters hung from the verandah plate all round, and below the shutter sill movable horizontal louvres: the whole can be closed up when it rains. A score of times a year, of course, thunderstorms are apt to blow rain right through the shutters and the cracks in the louvres, and then the inhabitants vacate that side of the verandah and move to the other side of the house, whither as often as not the storm follows them round. Everything on the verandah is then liable to be wet, and for this reason as much as any other furniture and floor coverings are of the lightest and simplest.

It is possible to make the verandah walls weatherproof, but this is always at the expense of light, vision and air-circulation. A recent development has been the adoption of asbestos-cement adjustable louvres, which reduce to a minimum the disadvantages of weather-proofing and confer on the architect the very positive advantage of eliminating the verandah with its attendant waste of space and cramping effect on planning.

The insides of houses are left as open as the demands of privacy

DEFENCE WORKS AT DARWIN.

1.—Starting excavation for a gun emplacement.

2.—Completing emplacements for an anti-aircraft battery.

3.—Officers' Mess nearing completion.

Defence works at Darwin 1-3

4.—Barrack blocks under construction.

5.—Standard steel building; erecting roof trusses.

6.—Standard steel building completed as a store.

Defence works at Darwin 4- 6

allow. Partition walls are generally carried up to within a foot or so of the ceiling, and sometimes finish some inches short of the floor. Vents are provided on a liberal scale. Eaves are left unobstructed so that upward currents of air can pass between roofs and ceilings. Eaves are wide so that outer walls are shaded during the hottest hours. Swinging half-doors are used between rooms. Houses are generally built about six feet off the ground, to take advantage of the increased air movement at that height: provided a house has a wooden floor, it costs comparatively little to build it a few feet higher.

Until a few years ago galvanized steel sheeting was the only material used for roofs in Darwin. Now asbestos-cement has been widely adopted, and roofs, ceilings, partition walls, gutters, vents and, finally, louvres, are of this material. In the case of roofs, the initial cost is only 20 per cent. more (since the freight is much the same) and the insulation and durability are very much greater than that of steel.

Barracks and stores are built on the ground with concrete floors. In a hot climate the usual objections to concrete floors lose most of their point. Such floors are more durable, more easily cleaned and less vulnerable to white ants than wood floors, and, most important of all at the time the barracks were designed, much cheaper. Above the floor, barrack blocks are treated similarly to other living quarters, an all-round verandah being imposed by the conflicting requirements of ventilation and weatherproofing. The question of fitting the new asbestos-cement louvres and revising the plans of barrack blocks, so as to provide for separate cubicles, is now for consideration. In the meantime men sleep on the verandahs and a central locker-room is provided. Sanitary accommodation is in separate blocks.

Stores are steel-framed buildings with iron walls and roofs. One solid shutter is provided in each ten feet of wall. Large ridge ventilator cowls are used, but these have given much trouble owing to driven rain entering in the form of a fine spray.

The aspect of buildings is determined mainly by the prevailing wind during the worst season—the north-west monsoon—and efforts are made to site the sleeping and the living quarters so that each will catch a part of what breeze there may be. A lesser factor governing aspect is the hot afternoon sun.

Effect of Pests.

All timber buildings have to be designed to resist termites. The usual method in civil practice is to use cypress pine, a local timber which is expensive but a strong deterent. However, mostly from motives of economy, but also to gain structural strength, and in view of the certainty of regular inspection, non-resistant timbers have been used in army buildings in all ordinary cases, and reliance placed on precautions in design. Thus all concrete piers are capped, flights

of steps terminate on concrete slabs that can be easily inspected, and if concrete floors are used the lower wall plates are supported some inches clear, so that traces of white ants can be seen if they enter through the construction joints.

Mosquitoes and sandflies are a nuisance mainly at night, and for this reason buildings are not completely covered with wire gauze, which would seriously impede ventilation. It is customary to include in houses a gauze-lined room to which the occupants can retire between nightfall and bed-time. In some cases it is possible to make the gauze enclosure big enough to accommodate beds as well.

It is interesting to note that flies are exceedingly rare in the vicinity of Darwin. Two reasons are adduced—first, that there is hardly any livestock, and second, that there are so many ants of all kinds that it is hard for the larvæ of flies to survive.

Effect of Cyclones.

There have been only two really severe cyclones since the first settlement in the 'seventies, so that the extent to which building practice should be modified to meet the menace is problematical. The more recent cyclone (March, 1937) is the only one since the establishment of the defences, and the minor nature of the damage (about £200, in a total of £60,000 for the town) suggests that the designs are sound, even allowing for the comparative newness of the buildings. It has to be remembered that many modifications to resist cyclones are at the expense of ventilation—for instance, closing in the underside of eaves—and the risk of losing a roof or two every thirty, or even twenty, years is hardly worth covering at the expense of continuous discomfort to personnel. One result of the March cyclone may be to increase the proportion of married quarters built at ground-level instead of on concrete piers. Another may be to further the use of steel-framed buildings with roofs held on by hook bolts instead of nails.

V

The term of service in Darwin is three years. Soldiers who wish it are generally allowed to extend their tropical service for a year at a time. Leave can be accumulated for three years, or taken while in the Territory in some cases: flying visits to civilization will no doubt become a commonplace when air travel is cheapened, but otherwise it is not easy to get away from Darwin without spending an undue time travelling. The Territory offers only moderate amenities for spending leave. Buffalo-shooting is, however, to be had by the enterprising, and there is excellent rough bird shooting from July to October within easy reach of Darwin. The tracks in the interior are mostly bad, except towards central Australia, and motoring is strenuous work, the overland traveller to Queensland, South or Western Australia carrying spare springs and axles as a matter of course.

Although the cost of living is high in the town, in the garrison special victualling arrangements reduce it considerably. All ranks draw £80 a year (single) or £100 (married) as tropical allowance. For the officers stationed at Darwin there is golf of a kind in the dry season, and cricket also in the dry, and tennis (hard courts) all the year; and while the cultural amenities of the town are limited, the work, particularly for the Sapper, is interesting enough to make up for this. For the soldier there is cricket and football (played respectively in winter and summer) and a chance of getting away to camp out, to shoot and to fish at week-ends. He also has an unusual freedom from parades, dresses simply and comfortably, has few fatigues to do, spends his working time on interesting and useful, if laborious, tasks and at 1 p.m., as a rule, has finished his day's work. These advantages, coupled with a rising standard of comfort, should make service in Darwin not unpopular in the future.

APPENDIX.

TYPICAL UNIT COSTS OF BUILDING CONSTRUCTION AT DARWIN. OCTOBER, 1937.

	Volume, cu. ft.	Cost per cubic foot (pence). Materials.	*Labour.	Total.
Barrack block for an N.C.O. and 20 men (concrete floor, timber frame, softwood linings, asbestos-cement roof and ceiling, shutters all round, built-in lockers; not including washing and sanitary arrangements which are housed in separate buildings)	32,200	4·5	3·5	8·0
Store building, 87 ft. × 37 ft. (concrete floor, steel frame and trusses, galvanized iron walls and roof, no ceiling, wall shutters at intervals, racks and shelves built-in). Fabrication of steel members is included in materials cost ...	48,300	6·0	2·1	8·1
Quarters for a married warrant officer (reinforced concrete piers, timber frame; asbestos-cement roof, ceilings and linings; shutters and louvres all round, built-in lockers, and including out-buildings)	26,500	7·3	6·2	13·5
Underground water tank, 100,000 gallons (reinforced concrete, excavated in rock)	18,400	4·1	8·0	12·1

* These figures are the cost of equivalent man-hours of local civilian labour.

THE FUTURE OF SEARCHLIGHTS—II.

By "ENDYMION."

IN *The R.E. Journal* of December, 1936*, Major Cameron stated the case for the retention of Anti-Aircraft Searchlight units in the Corps of Royal Engineers. It must be admitted that his "pros" appears convincing, but, at the same time, there are certain "cons" which should not be overlooked.

As Major Cameron rightly stated, the matter must be approached from the point of view of the Defence Forces as a whole, and not from the more parochial outlook of the Corps alone.

In considering the question, the essential points seem therefore to be the following.

(1) Can the work of Anti-Aircraft Searchlight units be carried out more efficiently if their personnel are members of the Corps of Royal Engineers, than if they are members of some other Corps or service? If the answer is in the affirmative, there can be no argument for any change in the existing organization.

(2) Can the work of Anti-Aircraft Searchlight units be equally well carried out if their personnel are members of some other Corps or service, and, if so, will the efficiency of the Corps of Royal Engineers be increased by the loss of its commitments under this head?

MUST THE PERSONNEL OF ANTI-AIRCRAFT SEARCHLIGHT UNITS BE MEMBERS OF THE CORPS OF ROYAL ENGINEERS?

The functions of Anti-Aircraft Searchlight units are† :—

(1) The direct illumination of aircraft.

(2) The indication to friendly patrolling aircraft of the approximate position of the enemy by "pointers."

(3) The collection and rapid transmission of information about the height and course of aircraft which may be required for tactical purposes, and for air raid warning of the civil population.

* "The Future of Searchlights," by Major A. M. Cameron, M.C., R.E.

† *Manual of A.A. Defence.* Vol. I, Part II, Sec. 1, para. 6.

The question of the efficient execution of these functions must be considered from what will be called, for want of better terms, the " technical " and the " tactical " points of view.

By the " technical " point of view is meant the actual operation and maintenance of the searchlights, sound locators, and visual plotting stations, and the handling of the detachment, section, company, or battalion as such in a lay-out. By the " tactical " point of view is meant the co-operation of the Anti-Aircraft Searchlight units with Anti-Aircraft Artillery and Fighter aircraft.

It has never been suggested that personnel of some Corps other than the Royal Engineers will be able to carry out these " technical " functions better than at present. At the same time, it must be remembered that there is no " black magic " about searchlights, and the progress made by recently converted infantry units of the Territorial Army must convince any unprejudiced observer that keen men of average intelligence can learn the " technical " side of the business rapidly and thoroughly. The work does not come into the same category as that of " Railway Instructor to Little Tin Gods on Wheels."* It appears therefore, that, from the " technical point of view," it is immaterial whether the personnel are Royal Engineers, or belong to some other Corps or service.

Anti-Aircraft Searchlight units have, however, to co-operate intimately with Anti-Aircraft Artillery and Fighter aircraft. The importance of close liaison between the Anti-Aircraft gunner and the lights is likely to increase owing to the fact that, at present, the weak link in the chain of collection of gunnery data is the accurate and timely determination of the height of aircraft. In this, Anti-Aircraft Searchlight units may prove of enormous assistance to the gunners by means of visual plotting,† whilst the use of predicted fire directed by sound locators is likely to increase.

Sappers and Gunners have always got on very well together, but the fact remains that military co-operation is made much easier when the co-operating parties belong to the same Corps, and " talk the same language." The present writer cannot help feeling that our Anti-Aircraft Defence would be strengthened if both the searchlights and the guns were manned by personnel of the same Corps. It is not a practical proposition for the Sappers to take over the guns, but there do not appear to be any insuperable difficulties to the Gunners taking over the duties of the Anti-Aircraft Searchlight units, or, alternatively, for both to be merged into a new Anti-Aircraft Corps.

Whether, in order to attain the ideal of complete understanding and co-operation, this merging of Anti-Aircraft units should not be

* " By the laws of the Family Circle 'tis written in letters of brass,
That only a Colonel from Chatham can manage the railways of State."
" Public Waste," by Rudyard Kipling.

† See " Recent Developments in Visual Plotting," by Major R. P. A. D. Lithgow, *The R.E Journal*, December, 1936.

carried a stage farther, and the Royal Air Force assume the responsibility for the manning of all air defence, as it is already responsible for its direction in Great Britain during war, is, however, open to question. The subject is too extended to go into in the present article, but two factors are mentioned for consideration.

(1) With its present programme of expansion, will the Royal Air Force, for some time to come, be in a position to undertake added responsibilities ?

(2) Will not there be a danger of a " ground " branch of an Air Force suffering from an inferiority complex, and attracting the less capable and less ambitious only ?

This has certainly not been the case with the Royal Marines *vis à vis* the Royal Navy, nor with the present Armoured Car units of the Royal Air Force, but these cases are hardly analogous as this new branch would start without the traditions of the Royal Marines, and in a much more specialized form than the Armoured Car units.

In addition to their own training, regular units should in peace time render as much assistance as possible to corresponding units of the Territorial Army. The present writer would like to see a Regular Searchlight Company present throughout the summer at all Territorial Anti-Aircraft Searchlight Camps (just as a Regular " Depot " Battery is present at every Anti-Aircraft Practice Camp), in order, not only to relieve the Territorial Army of many of the " housemaid " duties in connection with the running of the camp, but also to provide instruction and assistance.

Owing to the necessities of their own training, no regular Company can, under the present organization, find the time for this, but it is suggested that, were these units to train for an Anti-Aircraft role, pure and simple, with no commitments in the way of engineer training, then time could be found to the mutual benefit of both Regular and Territorial.

From the above considerations it is submitted that, though, from the "technical" point of view, there will be no gain by removing the Anti-Aircraft Searchlight units from the Corps of Royal Engineers, from the " tactical " point of view, there is, to put it mildly, a strong case for such a course.

DOES THE EFFICIENCY OF THE CORPS OF ROYAL ENGINEERS SUFFER OWING TO THE FACT THAT IT CONTAINS ANTI-AIRCRAFT UNITS ?

Let us at once disabuse ourselves of the idea that the work of the Military Engineer on service will be a continual sequence of hasty demolitions and pontoon bridging. A glance through the pages of *The R.E. Journal* since the Great War, and a little thought, will

show us what his work will really be. It may be the erection of hangars in Iraq, or road and permanent bridge construction on the North West Frontier of India ; it may be the provision of temporary accommodation for reinforcements in the Far East, or the installation of cold storage plant for extra supplies required in the Mediterranean ; it may be the repairing and running of a power station or water-supply system after an earthquake or bombardment, or the organization of quarries in Palestine. Even in a major war, the majority of the Corps will be employed on works of this description.

The qualifications required for this class of work are—in the officer, sound practical engineering knowledge ; the knack of improvisation (which really means the possession of such complete knowledge as to be able to know what will " do instead ") ; a temperament undisturbed by difficulties ; and the capacity for getting work out of his subordinates. In the N.C.O. similar qualities in a lesser degree, substituting an all-round knowledge of trades for an all-round knowledge of engineering. In the man, the knowledge of a trade, supplemented by a general handiness, and skill in watermanship.

Service in an Anti-Aircraft Searchlight unit will undoubtedly, (as Major Cameron states), give the officer and N.C.O. " training in the maintenance of M.T., elementary electrical experience, and command of men " ; it will undoubtedly make the men hardy and self-reliant. But it will not produce Military Engineers. To produce these, we require, for the officer, continuous experience in Field Companies and the Works Services ; for the N.C.O. and man, continuous training in trades and their application, with an annual " brushing up " in field engineering and watermanship.

With at least two regular A.A. Battalions likely to be maintained at a high peace establishment ; with over twenty Territorial A.A. Battalions to be provided with adjutants and permanent staff instructors ; with numerous appointments, such as Instructors to the Territorial A.A. Divisions and at the School of Anti-Aircraft Defence, to be filled ; and with the personnel required for purely A.A. duties in Fortress Companies abroad, a large proportion of the captains, subalterns, N.C.O's and men of the Corps are getting no chance of learning one fifth part of their job as Military Engineers.

It is becoming increasingly likely that not until he attains the rank of Lieutenant-Colonel will an officer of the Royal Engineers get any experience in the Works Services. If this affected his training for war only, it would be bad enough, but it also reacts on the Corps in another way. The Corps must retain the Works Services in peace, not only in order to train its officers for service, but also to employ its senior officers (for whom there are insufficient appointments in Field units). And by the efficiency of the Works Services is the Corps judged. Everybody knows the old saying that officers are

either clever and idle, clever and industrious, stupid and idle, or stupid and industrious—and the uses to which each category should be placed. C.R.E's may equally well be classified as knowing their job and being helpful, knowing their job and being unhelpful, ignorant of their job and being helpful, or ignorant of their job and being unhelpful. Helpfulness is a characteristic which is fostered by service in Field units, but helpfulness without a knowledge of his job will not get a C.R.E. very far. Besides possessing practical engineering knowledge, a C.R.E. must be something of a financial strip-tease artist, and to become this he must have had experience in every grade of the Works Services. The responsibilities of the Corps in connection with Anti-Aircraft Defence are preventing this.

CONCLUSION.

The writer's conclusion is that the efficiency of the Corps—as a Corps of Military Engineers—is suffering from the presence of Anti-Aircraft Searchlight units, and as it appears that this work can be equally well, if not more efficiently, carried out by some other Corps, he puts forward the suggestion that it is now time that this promising infant should be sent out into the world on its own, or rather that it should join forces with the Anti-Aircraft units of the Royal Artillery, to form an Anti-Aircraft Corps.

THE HISTORY AND DEVELOPMENT OF MODERN MILITARY BUILDINGS.

By A. LLOYD SPENCER, *A.R.I.B.A.*

(*A member of the Q.M.G.*10, *War Office Staff.*)

PART II.

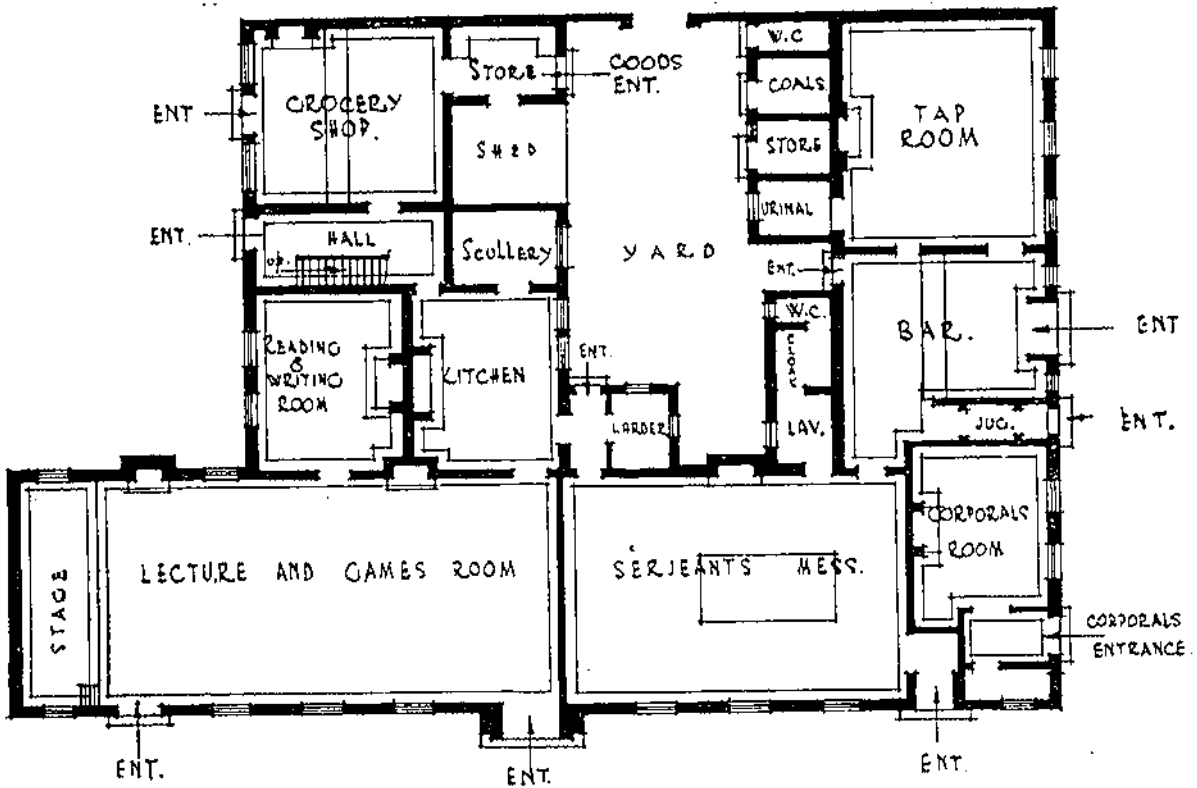
REGIMENTAL INSTITUTES.

THE origin of the present day regimental institutes is to be found in the private canteen which was run by an independent civilian shopkeeper seventy years ago. During the inquiry of the Royal Commission into the methods employed in the running of these canteens, it transpired that the practice had been to lease a house and canteen to a private individual who paid the Government a fixed rental plus a fluctuating sum depending upon the number of soldiers occupying the barracks. This arrangement compared unfavourably with commercial conditions in the civilian world and, in order to recoup himself, it followed that the lessee would do so at the expense of the soldiers.

The Committee suggested that this system should be discontinued, and that the following mode of management should be given a fair trial. The purchasing and pricing of the stocks for the canteen was to be taken over by a committee of officers, and a non-commissioned officer was to be appointed who would be responsible for its efficient running and organization. To ensure the success of these canteens, it was recommended that their construction should be a Governmental responsibility, and that large comfortable rooms well lit and warmed should be provided. The original accommodation consisted of a shop and bar eighteen feet square, a tap room eight hundred square feet in area and a reading room of about the same size. A canteen man's quarter was erected over the canteen.

By 1900 the canteen, serjeants' mess, and recreation establishment, had become incorporated under one roof and an early building of this nature is shown on page 36. The plan, as will be seen, is shaped like an " E " laid on its back with the top member missing. At the end of the bottom member the bar and tap room were situated; this planning was occasioned by the necessity of keeping the entrances of the various ranks as far apart as possible. The bottom half of the horizontal leg is occupied by the serjeants' mess and the corporals' room, the entrances in this case being placed round the corner to

COMBINED CANTEEN RECREATION ESTABLISHMENT AND SERJEANTS' MESS FOR APPROXIMATELY 200 MEN.



GROUND PLAN.

each other, whilst the kitchen, grocery shop and stores form the middle portion. The serjeants' mess is so placed that service can easily be obtained from the kitchen and bar without interference or crossing of passages to the men's rooms. The top projecting portion of the " E " shape consisted of a lecture, supper and games room, a platform being erected at one end to stage plays, and for similar uses.

The elevations show little architectural merit, no uniformity being observed; skylights break the roof line, the windows were long and out of proportion, and there were too many porches, occasioned by the number of entrances required, to give the design unity. A similar type of elevational treatment can be seen, however, in many Council Schools erected about this period.

An addition to the plan occurred about 1904, when a reading and writing room was added to the accommodation provided in the serjeants' mess. This necessitated the corporals' room being moved to the position of the bar entrance; the bar itself was then enclosed except for a service counter to the tap room, and the name of the tap room changed to soldiers' room. This alteration reduced the floor space available for the soldier and inconvenienced him further by making the entrance to the soldiers' room, which was through the bar, on one of the side walls. This alteration, if anything, tended to increase the irregularities of the plan which, naturally, had a further detrimental effect on the elevations.

In 1907 the regimental institute replaced the building formerly known as the canteen and recreation establishment. In 1908 it was decided that separate regimental institutes should be provided for every corps, regiment or battalion, except in the case of small units when two institutes might be combined in one building.

The accommodation to be provided under the new heading was greater than the canteen in that a billiards room, reading and writing room and library were to be provided. This order eventually came into force about 1911 and constituted a great improvement on the old canteen. The close proximity of the serjeants' mess to the men's rooms had caused dissatisfaction, and the addition of the writing room to the serjeants' mess, at the expense of the soldiers' room, had been severely criticized. It was, therefore, recommended that the serjeants' mess should become a separate building, except, again, in the case of very small units. The new regulations hardly had time to prove their value before the outbreak of war, when, as has been said before, all work of a permanent nature was stopped.

It is now considered that one of the necessities of a modern barrack is an efficient regimental institute, where the men can congregate and enjoy recreation after a strenuous day, and for this reason the shortage of labour and high price of materials were not allowed to hamper their development as was the case with other buildings. In 1923–24 a

regimental institute was erected at Smallshot for over one thousand men, the improved accommodation as laid down by the authorities before the war being fully observed and in some instances increased.

The plan of this institute is illustrated on page 39, and it will be seen that the problem has been tackled from an entirely different angle from that prevailing in pre-war days. The block plan is roughly "E" shaped, the restaurant forming the vertical member with the kitchen, scullery, coffee bar, etc., directly behind it forming the middle member. The reading, writing room and library forms the front part of the top member with the billiards room behind it. A porch is situated to give independent entrance to these two rooms, which are connected to a corridor giving access to the back of the restaurant. Another porch provides a separate entrance to the centre of the restaurant, whilst a door is placed at one end, presumably to meet the emergency exit regulations when the restaurant is being used for the production of concerts, etc. The stage and dressing-rooms for this purpose extend across one end of the restaurant thereby diminishing its effective length.

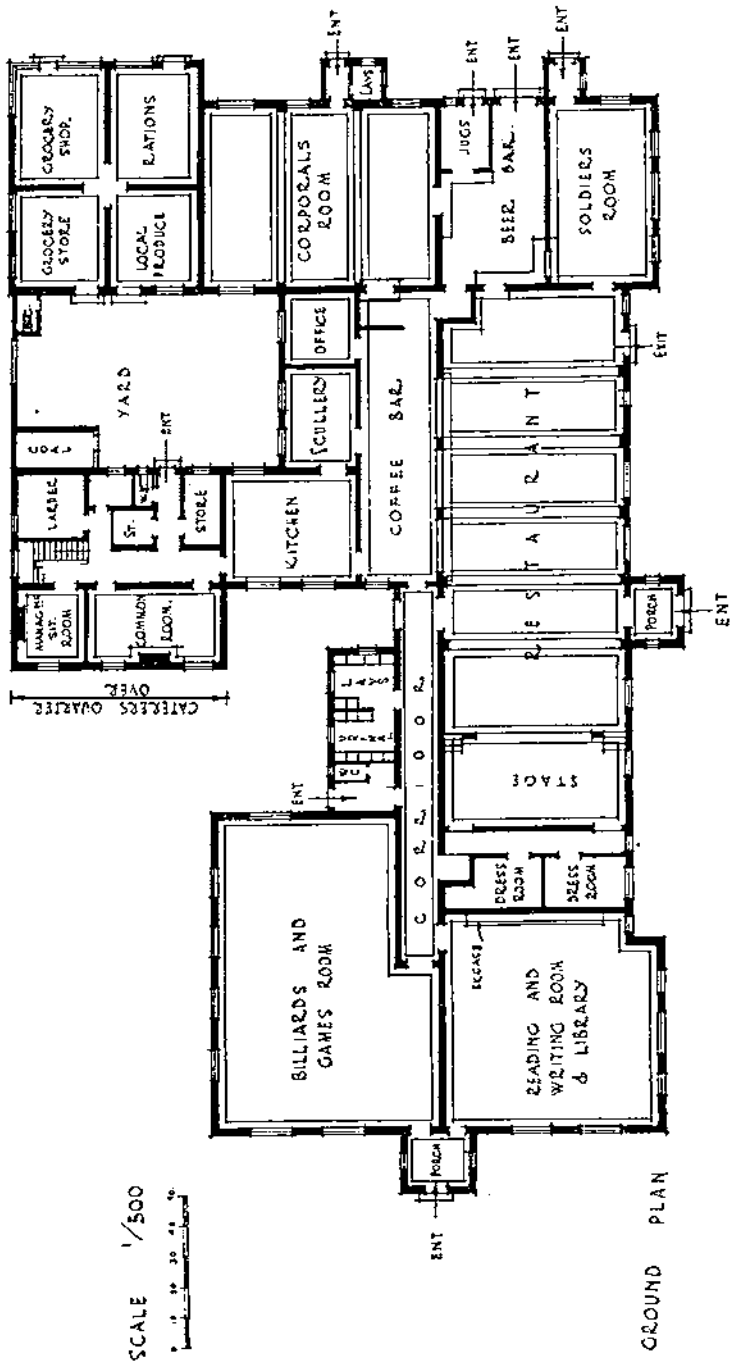
The soldiers' room, beer bar, corporals' room and grocery provision store form the bottom member of the "E". Each has its separate porch and entrance and the beer bar is planned to enable service hatches to open into the restaurant, corporals' room and soldiers' room.

The elevations of this plan show a decided advance upon its predecessors, the excessive number of porch entrances give trouble but are more skilfully treated as main features of the design, rather than additions to a block. The windows are more proportionate to the size of the building and a symmetrical treatment where possible has been attempted. The design as a whole shows a marked improvement in this type of building.

The institute at Shorncliffe, erected in 1928, is based on the plan just described. An attempt has been made by the architect to square up the plan and give it a feeling of unity. To further this end the soldiers' room, restaurant, stage and reading and writing room have been placed on the front in a line in that order. This enables the porch entrance to the restaurant to be balanced by an entrance to the back of the stage and reading room. The billiards and games room is approached from the connecting corridor, as is the restaurant from the reading room. At the opposite end of the plan the soldiers' room, beer bar and corporals' room run at right angles to the restaurant. Internal porches form the entrances to the soldiers' room and corporals' room and this method of planning, although it is an advantage when elevating, detracts from the value of the room. The kitchen, scullery and coffee bar occupy the same position as previously, directly behind the restaurant.

Owing to these improvements in planning, the elevations are

SMALLSHOT REGIMENTAL INSTITUTE FOR 1,280 MEN



superior to those of the institute at Smallshot. The balancing of the porches and the position and symmetrical placing of the windows improve the main elevation considerably, whilst the other elevations, although not necessarily symmetrical, show a balanced relation between solid and void.

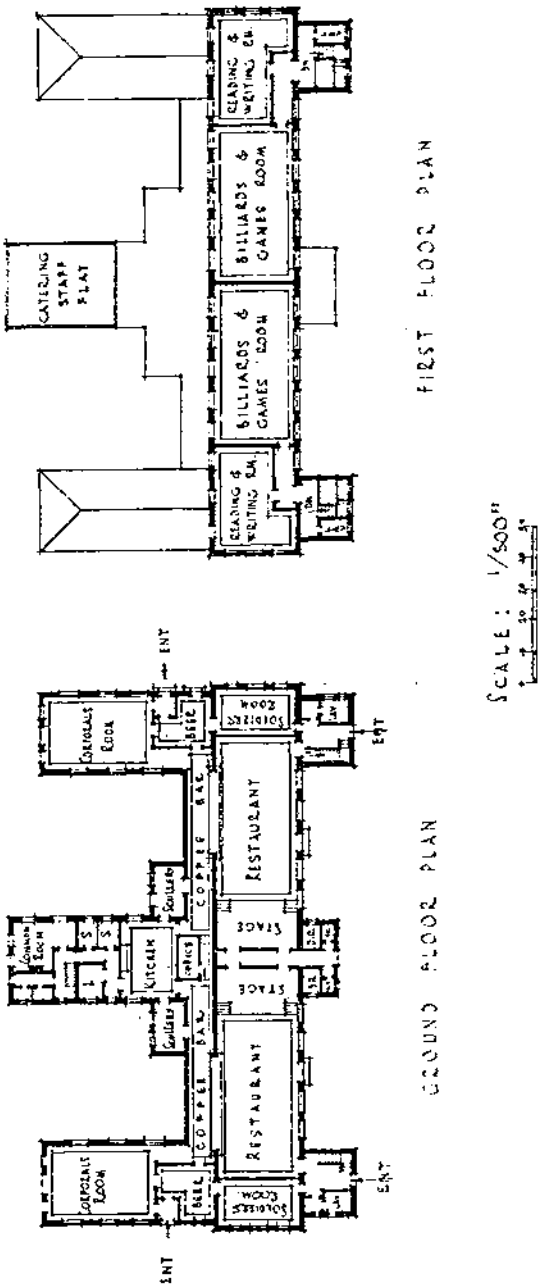
In the same year it was decided to erect institutes, where possible, for two battalions instead of as previously for one. The regimental institute at Aldershot for the Alma and Dettingen Barracks is one of the first of the modern combined institutes for two battalions. It was not proposed to make the institutes common for all the men but to build two institutes, each with the same accommodation, as one building. The primary object was the reduction of cost occasioned by the combined building and the necessity of providing only one kitchen and catering block.

The plan of the institute referred to above is reproduced on page 41. The "E" type of plan is still favoured owing to the central position of the kitchen. The restaurants are placed in line with the stages backing on to each other; a separate projection forms the stage entrance and dressing-room. This part of the plan forming the back of the "E" is two stories in height. At the extreme end of the restaurants two other projections mark entrances to the soldiers' rooms. They also contain stairs to the first floor and sanitary annexe. The beer bar, which has slowly diminished in area owing to a smaller demand, and the corporals' rooms form the top and bottom members of the "E" with the kitchen and accommodation essential thereto between them. The billiards rooms and reading and writing rooms constitute the first floor.

This plan almost eliminates waste space without cramping or hindering means of communication. The three similar entrances on the restaurant elevation are liable to cause a certain amount of confusion, but this tendency has been skilfully avoided by making the central entrance only one story in height. Circular-headed windows to the restaurants give the ground floor the necessary relative importance to the first floor. This combination of institutes is justified by the more dignified composition arising from the greater total accommodation, and by the greater economy in construction.

Where it was not found suitable to erect a combined institute, *i.e.*, in small detached units, the economy in siting and construction in erecting two-storied buildings as opposed to a single story, caused the authorities to redesign the institute for one battalion on two floors. A plan completed in 1931 is shown on page 43, and illustrates this scheme. The restaurant and soldiers' room extend the length of the plan; the stage, which unfortunately has no adjacent dressing-rooms, is placed at the opposite end of the soldiers' room. A fireplace and chimney stack in the centre of the front wall of the restaurant forms the central feature of the design, and its somewhat unfortunate

REGIMENTAL INSTITUTE, ALMA AND DETTINGEN BARRACKS, FOR TWO BATTALIONS.



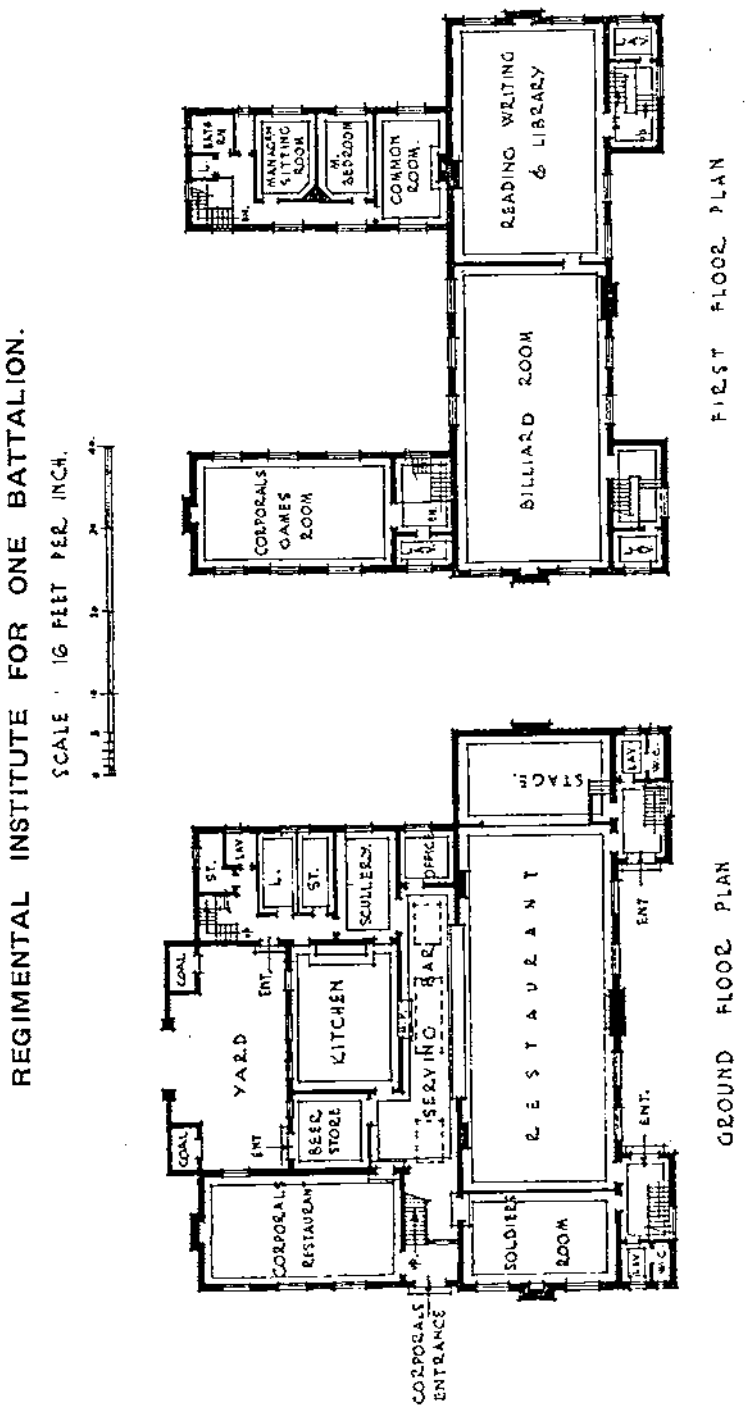
central position is further accentuated by the two entrances required to give access to the upper floor at either end of the restaurant. The corporals' restaurant is placed behind the soldiers' room and is approached by a door on the side elevation ; a corporals' games room is directly above. The billiards room and reading and writing room form the first floor over the restaurant.

In an endeavour to make the institutes more homely, central heating, which previously had been used exclusively in these buildings, was replaced by open fireplaces ; this tends to give a cheery atmosphere to the institute, but there is some doubt whether the large rooms will be effectively heated. The separate entrances to the billiards room and reading and writing room will ensure a greater measure of quiet for the latter. It is interesting to note that in this plan the beer bar has now entirely disappeared, a small beer store taking its place. The division of the corporals' room into a restaurant and games room is another improvement in the endeavour to provide the soldier with satisfactory accommodation.

The latest design in the combined regimental institute, illustrated on page 45, differs in many respects from its predecessors. The restaurants form the front of the plan but the soldiers' rooms are now back to back instead of at the extremities. These rooms are recessed six feet from the general frontage for an entrance to both restaurants ; this allows the soldiers of either unit to intercommunicate at this point and might occasionally cause trouble, but the main entrance to the restaurant is situated at the side of the stages. This recessing of the soldiers' room decreases the amount of daylight it enjoyed in previous plans, but when it is considered that this room is chiefly used at night, the point is not so serious as it would at first appear.

The corporals' rooms have been placed at the back of the side entrances, together with their entrance and stairs leading to the games rooms above ; this eliminates any trouble that might occur if one entrance did duty for both ranks. The kitchen block extends from the centre of the restaurant parallel to and past the ends of the corporals' room ; the kitchen is centrally placed between two sculleries, one for each restaurant. The serving bar runs behind the restaurant and soldiers' rooms, and returns to communicate with the corporals' restaurant. This method of planning facilitates the easy organization of the kitchen premises, and is made more effective by the provision of two sculleries and hot plates on either side of the kitchen.

As before, the reading and writing room, and billiards room are placed over the main restaurants, and the corporals' games room over their restaurant. The staff of the catering branch are housed in a dormitory over the kitchen, while the manageress is provided with a bedroom and sitting room on the same floor.


REGIMENTAL INSTITUTE FOR ONE BATTALION.
SCALE · 16 FEET PER INCH.
0
16
32
48
GROUND FLOOR PLAN
FIRST FLOOR PLAN
YARD
KITCHEN
SERVING
BAR
RESTAURANT
STAGE
SCULLERY
L.
ST.
LAV.
W.C.
ENT.
COAL
BEER STORE
OFFICE
CORPORALS RESTAURANT
SOLDIERS ROOM
CORPORALS ENTRANCE
CORPORALS GAMES ROOM
BILLIARD ROOM
READING WRITING & LIBRARY
COMMON ROOM
M. BEDROOM
MANAGERS SITTING ROOM
BATH
LIFT
CUPB.

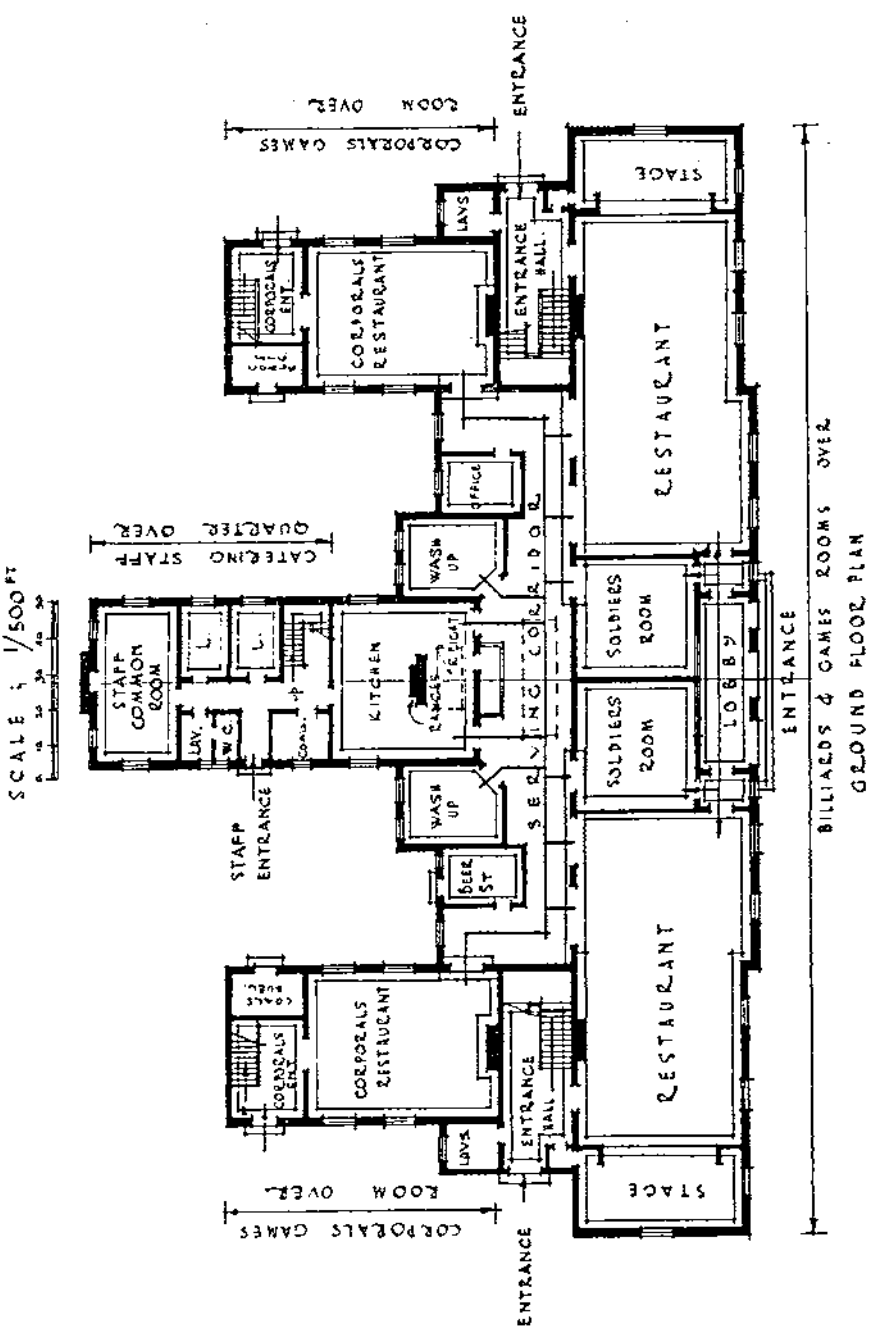
The elevations of this institute are similar to those of the institute at Aldershot except that the porch entrances have been eliminated to the betterment of the design. By the recessing of the soldiers' rooms and the provision of a central entrance the main portion of the elevation has been considerably improved, the semi-circular-headed windows have been retained as they give the air of an institute and give the building a more inviting appearance. An institute based on this design is at present in course of erection at Warminster.

The planning and designing of institutes has of late years become an important feature in the provision of military buildings, as army camps are not now by any means confined to the towns. The provision of some type of cinematograph projecting apparatus is an innovation that seems lacking in Regimental Institutes, especially those far from towns. No doubt some provision of this nature will soon receive official consideration. When soldiers are quartered in the heart of the country or among the hills, these institutes provide the only means of relaxation and discussion available to the soldiers and, therefore, in the interests of good discipline and the general efficiency of the troops, they now receive special consideration. It is agreeable to note the close collaboration which has taken place between the War Office and the N.A.A.F.I. in arriving at designs providing the high standard of comfort, and convenience of service, which has now been attained.

OFFICERS' QUARTERS.

Prior to Lord Monck's committee in 1855, officers' quarters, although by no means so unsatisfactory as the men's quarters, were rather inadequate as regards size and finish, for the number or rank of the occupants. The quarters were often built outside the barracks and a married field officer was allowed only two rooms and a kitchen, no provision for a servant being made. The mess accommodation, which comprised a mess room and reception room, was also insufficient; the reception room very often being taken over by the mess man or given to the orderly officers living out of the barracks.

Again drastic recommendations were made by the aforesaid committee and it was agreed that the field officers, the battalion staff and a proportion of captains and subalterns should be provided with such accommodation as would enable them to live within the barracks. The commanding officers were to be allowed two sitting-rooms, two bedrooms, dressing-rooms, kitchen and two servants' rooms; the majors and those of equal rank the same as the commanding officer, less one sitting-room; the captains, quartermaster, adjutant, etc., less a sitting-room, a bedroom and the servants' rooms. The subalterns were to be quartered together, and each provided with a


WARMINSTER COMBINED REGIMENTAL INSTITUTE FOR TWO BATTALIONS
(1,440 MEN).
SCALE 1/500 FT
GROUND FLOOR PLAN
BILLIARDS & GAMES ROOMS OVER
ENTRANCE
RESTAURANT
STAGE
SOLDIERS ROOM
LOBBY
SOLDIERS ROOM
SERVING COUNTER
WASH UP
BEER ST
KITCHEN
RANGES
WASH UP
OFFICE
CORPORALS RESTAURANT
ENTRANCE HALL
LAVS
CORPORALS ENT.
CORPORALS RESTAURANT
ENTRANCE HALL
LAVS
CORPORALS ENT.
STAFF ENTRANCE
STAFF COMMON ROOM
LAV.
W.C.
CATERING STAFF QUARTER OVER
CORPORALS GAMES ROOM OVER
CORPORALS GAMES ROOM OVER
ENTRANCE
ENTRANCE

bed-sitting-room and dressing closet, a kitchen between two, and a sufficient number of w.c.'s to serve the whole.

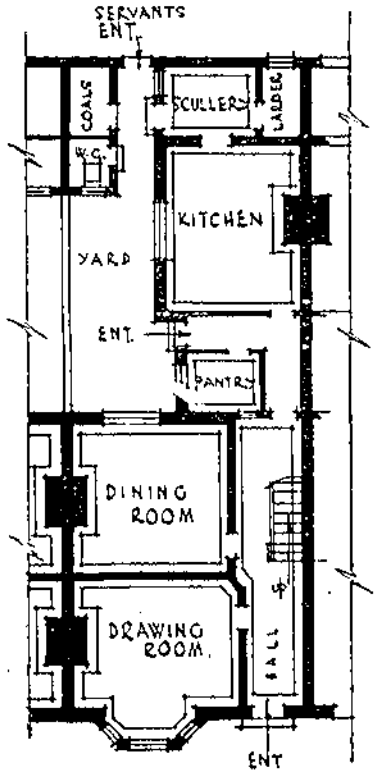
The committee also suggested that in addition to the usual mess room and ante-room, a reading room should be provided in connection with the officers' messes. There should also be provided in new messes, a mess waiters' day-room and bedroom, a pantry and plate closet; two rooms for a mess man, and a kitchen, scullery, larder, beer and wine cellar.

The foregoing recommendations revolutionized the planning and the provision of officers' quarters, but quite a number of years elapsed before all the suggestions could be incorporated in a design, owing to the extra expense involved and the difficulty of modernizing the existing premises. A sudden departure from precedent in erecting new barracks would have caused considerable agitation, and it was not until about 1890 that the plans contained most of the recommendations.

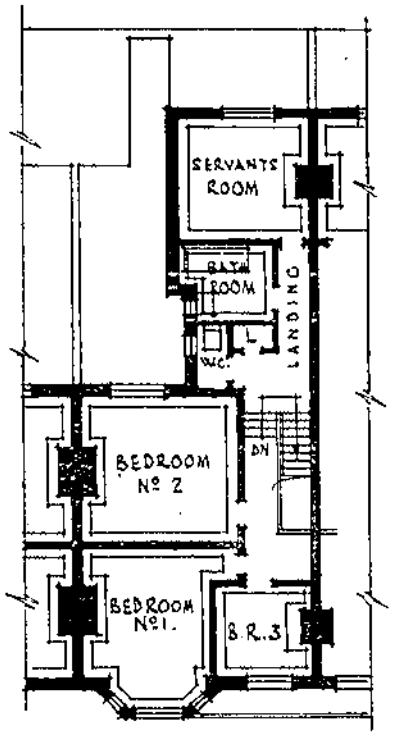
The married officers' quarters came to be incorporated under five headings, Group I, II, III, IV, V, to prevent duplication of design, and for ease in working. Group I and II quarters were for officers of rank classification 1 to 5 (generals and full colonels); Group III, officers of rank classification 6 (lieut.-colonels); Group IV, officers of rank classification 7 (majors); and Group V, for officers of rank classification 8 and 9 (captains and subalterns). In 1900 the usual practice in the provision of these quarters was the terrace design, and Group IV quarters erected in 1903, as a terrace, were similar to many houses erected by private owners about that time. In a single house a semi-basement provided accommodation for a servant's room, a kitchen and scullery and a coal house (under the steps up to the front door). The ground floor consisted of a drawing-room at the front and a dining-room at the back; access to the upper rooms built over this floor being by means of the usual staircase built against the party wall. Very soon after this design had made its appearance it was superseded by a quarter designed to eliminate the semi-basement. The basements, which entailed a large excavation, were always unhealthy and never properly lit and appear to have been a false economy; it was no wonder, then, that few were completed before a better plan was introduced. The displaced rooms were erected behind the dining-room; the coal house and servants' w.c. being built in the yard. The servants' room was built over the kitchen and cut off from the rest of the house by a bathroom; see illustration on page 47. The external treatment consisted of red pressed bricks with three-sided bay windows, stone parapets, and slated roofs, these materials making the designs almost identical to the usual terrace houses erected at the same period.

A Group I quarter built about the same time had a study, drawing-

MARRIED OFFICERS QUARTERS, GROUP V. TERRACE TYPE WITHOUT BASEMENT.



GROUND FLOOR PLAN



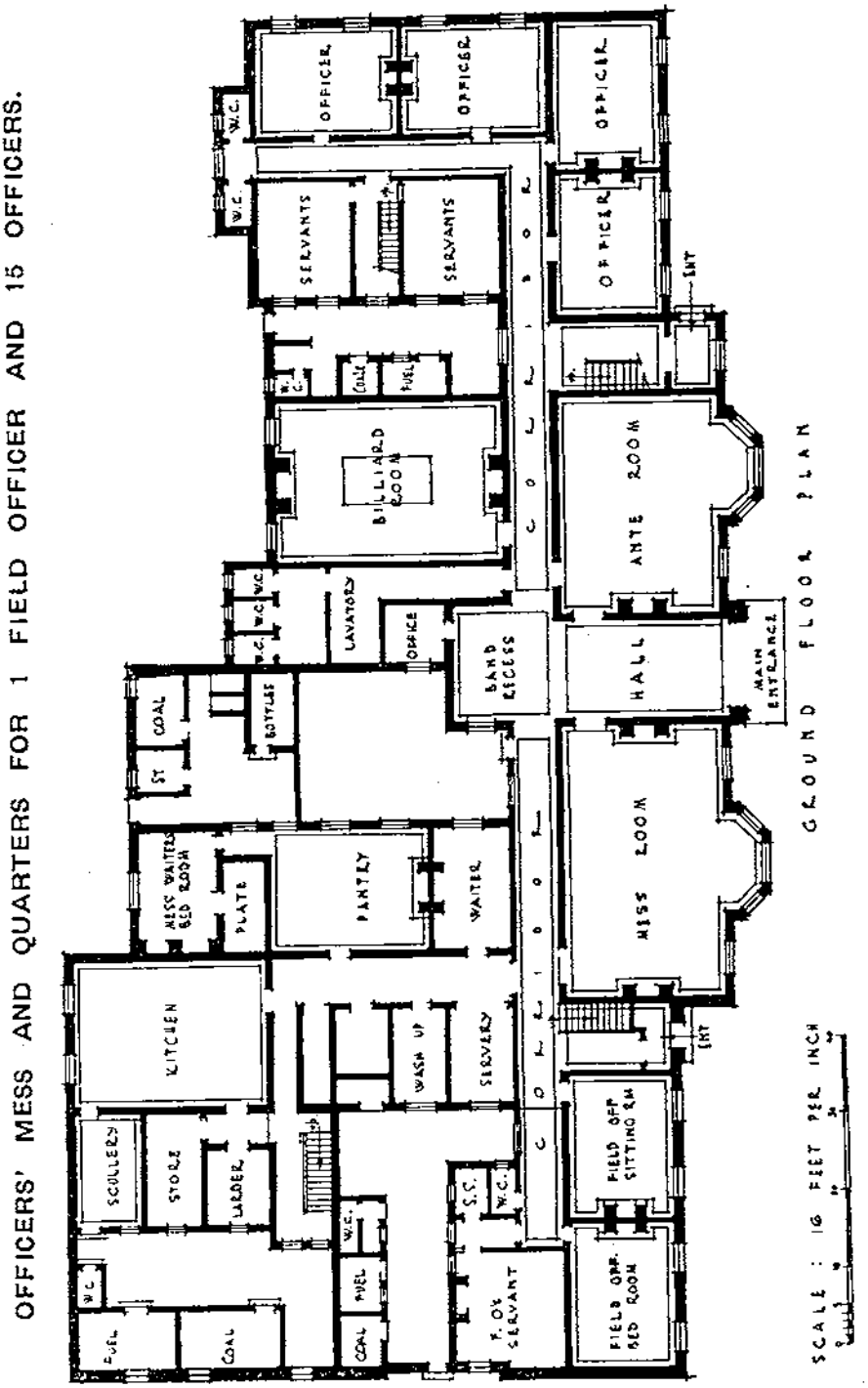
FIRST FLOOR PLAN

room, servants' hall and more accommodation on the ground floor than the Group IV. In these quarters the drawing-room was centrally placed on the front of an "L" shaped plan, the entrance being on the right-hand side, the study and hall lavatories were placed to the right of the entrance and formed the end of the plan. The top part of the plan contained all the servants' and kitchen rooms. The study apparently performed the function of an interview room, as it was cut off from the rest of the house so that visitors could call and leave without entering the main portion of the house. The whole plan was compact and worked well but showed little imagination. The elevations were reminiscent of the Georgian period.

The following description illustrates a typical officers' mess built about 1906 for six to twelve officers. A mess room was placed on one side of a large entrance hall and an ante-room on the other side. A corridor along the back of these two rooms separated them from the kitchen stores and cloakroom, both facing out on to a yard. The kitchen, which was behind the stores, was too far from the mess room for efficient service, and the mess man's quarters and service block appear to monopolize the plan. No reading room was provided and the cloakroom would have been more convenient nearer the entrance hall.

The quarters for the officers using this type of mess were erected in a different part of the barracks, entailing some distance to walk to get meals and hold meetings, etc. One or two years later the quarters and mess were combined as a unit, and an early mess after this description is illustrated in plan on page 49. The mess room and the ante-room were allowed four feet more height than the quarters to be erected alongside them and, therefore, formed the centre of the plan; at the end of the entrance hall a bandstand was provided, and to the right of the bandstand a billiards room was situated. These rooms were two new additions to the normal accommodation, the billiards room would tend to create a more communal atmosphere and the bandstand provided the mess with facilities to hold dances, concerts, etc. The kitchen was situated a long way from the mess room and, although a servery was placed conveniently beside the mess room, food would probably get cold before being served. This arrangement of the kitchen was apparently due to an endeavour to minimize the unpleasantness of cooking odours pervading the rest of the building.

Quarters for officers formed wings on either side of the central block. The field officer was allowed a sitting-room and bedroom, each of 300 square feet, and a servant's room. The junior officers were allowed one bed-sitting-room, 300 square feet in area, and two junior officers' servants had a room between them. The first floor was allotted to junior officers and their servants, and owing to the


OFFICERS' MESS AND QUARTERS FOR 1 FIELD OFFICER AND 15 OFFICERS.
GROUND FLOOR PLAN
SCALE : 16 FEET PER INCH
OFFICER
OFFICER
OFFICER
OFFICER
SERVANTS
SERVANTS
W.C.
W.C.
W.C.
W.C.
W.C.
W.C.
W.C.
W.C.
COLONNADE
BILLIARD ROOM
COAL
FUEL
ANTE ROOM
HALL
MAIN ENTRANCE
INT
INT
LAVATORY
OFFICE
BAND RECESS
BOTTLES
COAL
ST
MESS WAITER'S BED ROOM
PLATE
PANTRY
WAITER
MESS ROOM
KITCHEN
SCULLERY
STORE
LARDER
WASH UP
SERVERY
S.S.
F. O's SERVANT
FIELD OFF. SITTING RM
FIELD OFF. BED ROOM
FUEL
COAL
FUEL
COAL

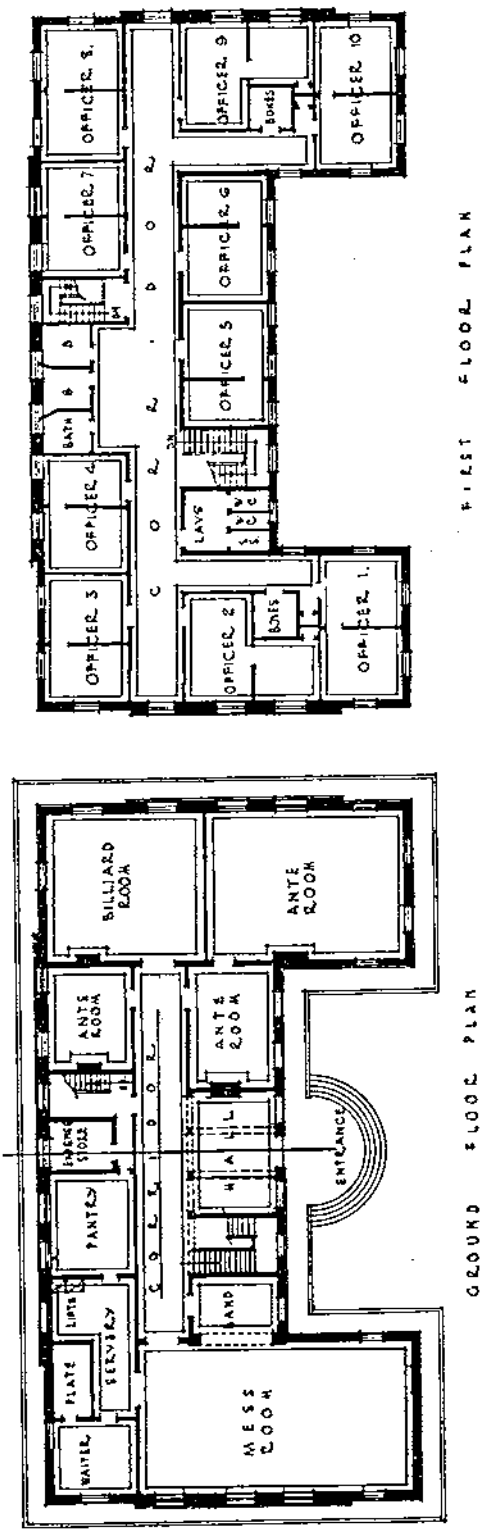
planning of the ground floor several of the rooms to be used for identical purposes varied in area. It is interesting to note that the field officer was without a bath on the ground floor, and that there were only four baths, provided in the centre of the first floor plan, for the use of the whole establishment.

The plan as a whole is confused and contains several courtyards and areas, a considerable amount of space thus being wasted; combined officers' messes and quarters were a new type of building and little or no experience had been gained in the planning and working in this means of housing. The completed mess is more reminiscent of a large country house than a military building. Plans up to the time of the Great War were based on this type of design.

Wellington Barracks officers' mess and quarters was one of the earliest to be erected after the war and shows a distinct advance in planning to the pre-war type. The illustration on page 51 shows a compact square " C " shaped plan, with a central entrance. The left wing contains the mess room and servery and the right wing the ante-room and the billiards room; a reading room is placed to balance the staircase and band recess about the centre of the hall. The kitchen, scullery, cloakrooms, lavatories and stores are all contained in a semi-basement. The kitchen is directly below the servery and connected thereto by a service lift; this arrangement improves the service considerably. The placing of the cloakroom and its conveniences in the basement follows the modern trend of hotel planning, and is more preferable than the yard system used previously. The first and second floors were devoted to junior officers' rooms, each 300 square feet in area, suitably divided, by a bookcase and wardrobe fitting, to form a sitting-room and bedroom. Three centrally placed bathrooms serve each floor, which accommodates ten quarters. The provision of lavatory basins seems to be negligible, two per floor being provided in a small lavatory adjacent to the staircase; in comparison to the numbers two w.c.'s also seem to be insufficient.

The general plan is better in many respects than its predecessors, its shape is cleaner, waste space being reduced to a minimum and more thought has been given to the disposition of the various rooms to produce an efficient working arrangement. The elevation is classical in design, to be in keeping with the surrounding buildings.

A further advance in the planning of this type of building occurs near London at Biggin Hill, see illustration on page 53. This building, erected in 1930, is the first of the suntrap type of plan used for officers' messes; the wings are splayed at 45 degrees to enable the rooms to receive the maximum amount of sunlight. The placing of the mess and ante-room on either side of the hall is again reverted to, these rooms being permitted four feet more height than the quarters. The ante-room is divided by a sliding screen, to form a


WELLINGTON BARRACKS, OFFICERS' MESS AND QUARTERS.
FIRST FLOOR PLAN
OFFICER 1.
OFFICER 2.
OFFICER 3.
OFFICER 4.
OFFICER 5.
OFFICER 6.
OFFICER 7.
OFFICER 8.
OFFICER 9.
OFFICER 10.
BOXES
BATH
LAVS.
CORRIDOR
GROUND FLOOR PLAN
BILLIARD ROOM
ANTE ROOM
ANTE ROOM
ANTE ROOM
HALL
ENTRANCE
PANTRY
LIFTS
SERVERY
PLATE
WAITER
SAND
MESS ROOM

general room and a reading room when the occasion demands and the two rooms can be incorporated to form a dance floor. The kitchen forms the right back projection and is separated from the mess room by a servery, containing a hot plate serving counter. The billiards room occupies a position on the opposite side of the plan to the kitchen, with the mess man's quarter behind it. The field officers' rooms are situated on the left front wing, and show a reduction in area to that provided in pre-war days. Field officers are, however, provided with a private bathroom and lavatory.

The first floor extends only over the wings and central block, and contains junior officers' quarters, which still consist of a room 300 square feet in area, divided by a wardrobe and bookcase fitting. Two bathrooms were provided and placed at the junction of the wings with the main block, a better sanitary arrangement than the plans previously mentioned. The composition of the elevation in rustic bricks and hand-made tiles, with the centre block raised several feet, is very happy; the large windows to the ante-room and mess room make a very pleasing feature and the angular side wings give the building a feeling of originality.

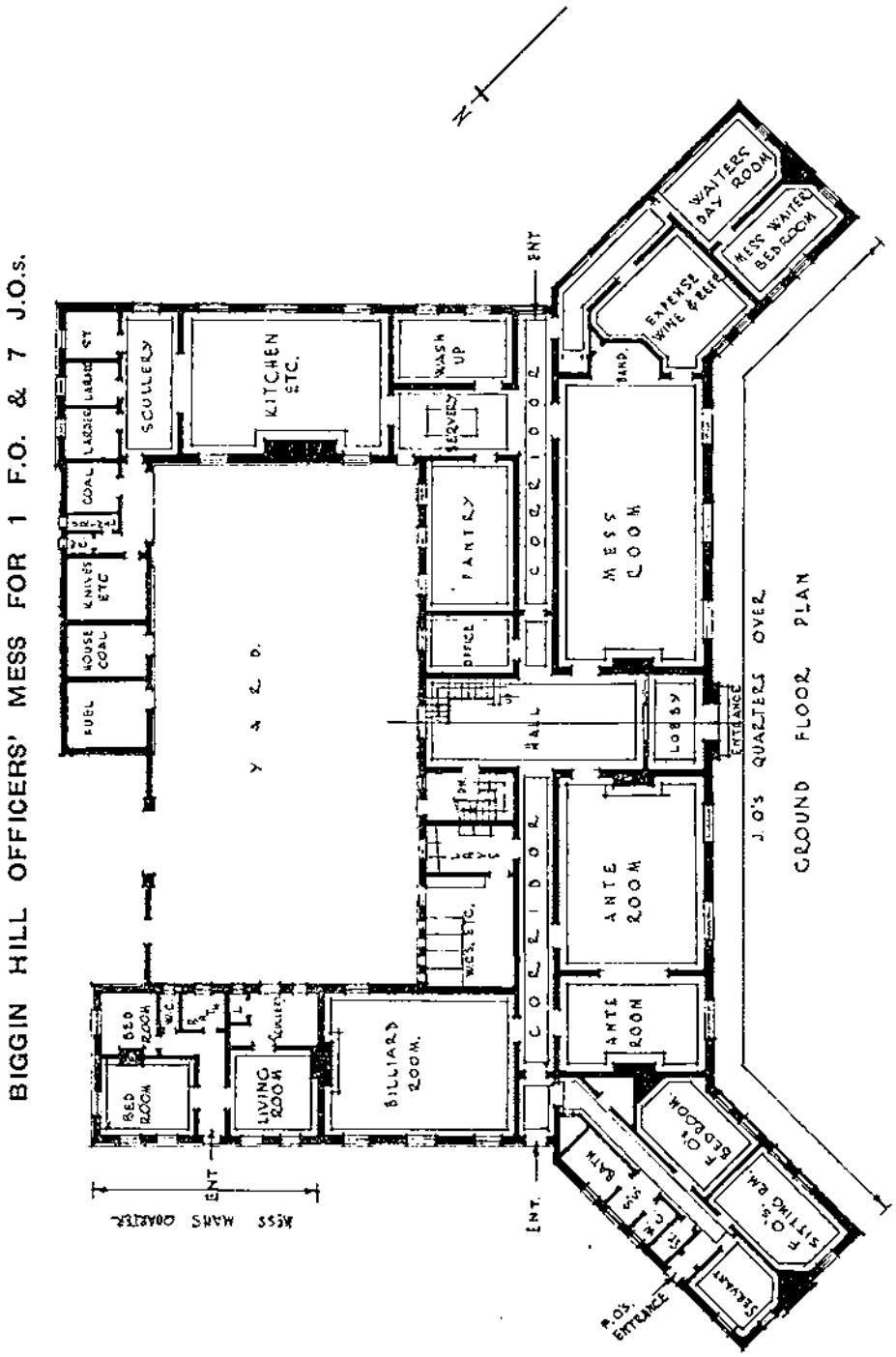
Married officers' quarters were affected by conditions to the same extent as almost all military buildings immediately after the war. After 1927 these quarters, which were not required to such an extent as the soldiers' quarters, were considered in many cases as special designs and therefore conformed with the latest civil ideas on the subject of housing.

A Group IV quarter erected, for a married officer of rank classification 7, in 1930, is shown on page 55; it is designed as a north aspect house. The drawing-room and study are to the left of a central hall, with the dining-room and kitchen to the right, the staircase and the cloakroom are situated at the north end of the hall. Four bedrooms are provided on the first floor, a dressing-room being placed between the main bedrooms on the south front. The bathroom, situated over the ground floor cloakroom enables external plumbing to be reduced to a minimum.

The elevations are dignified and satisfying. The walls, generally, are finished in rough cast, except for the chimneys, plinth and columns which are of rustic brick. The roof is executed in hand-made tiles with bonnet hips. The design is very fitting for an officer of the rank of its intended occupant.

The latest design for Group V quarters contains a garage, the provision of which has now been confirmed. The occupants of these quarters can now be assured of possessing houses equal to those built by the civil population.

A further development of the combined officers' mess and quarters on the Biggin Hill suntrap principle is sketched on page 57; it is at present in course of erection at Warminster. The wing blocks have


BIGGIN HILL OFFICERS' MESS FOR 1 F.O. & 7 J.O.s.
GROUND FLOOR PLAN
J.O's QUARTERS OVER
N
WAITERS DAY ROOM
MESS WAITER BEDROOM
EXPENSE WINE & BEER
ENT
KITCHEN ETC.
SCULLERY
WASH UP
SERVERY
PANTRY
COLLIDOR
MESS ROOM
BAND.
OFFICE
HALL
LOBBY
ENTRANCE
Y A R D.
FUEL
HOUSE COAL
KNIVES ETC
COAL
LARDER
LARDER
ANTE ROOM
ANTE ROOM
BILLIARD ROOM.
W.C.
BED ROOM
BED ROOM
LIVING ROOM
ENT
MESS MAIDS QUARTER
F.O's BEDROOM
F.O's SITTING RM
BATH
SERVANT
R.O.S. ENTRANCE
ENT.

been extended to accommodate more officers, and the two back projections are built two stories in height instead of one. The billiards room instead of forming the back projection now forms a continuation of the main entrance hall. In this position it is more convenient and confines the higher rooms to one block. The band recess is not now provided for the mess room, but the ante-room is still divided into two rooms for the benefit of writers. The kitchen premises remain in more or less the same position as in the previous messes as this position has been proved to work efficiently.

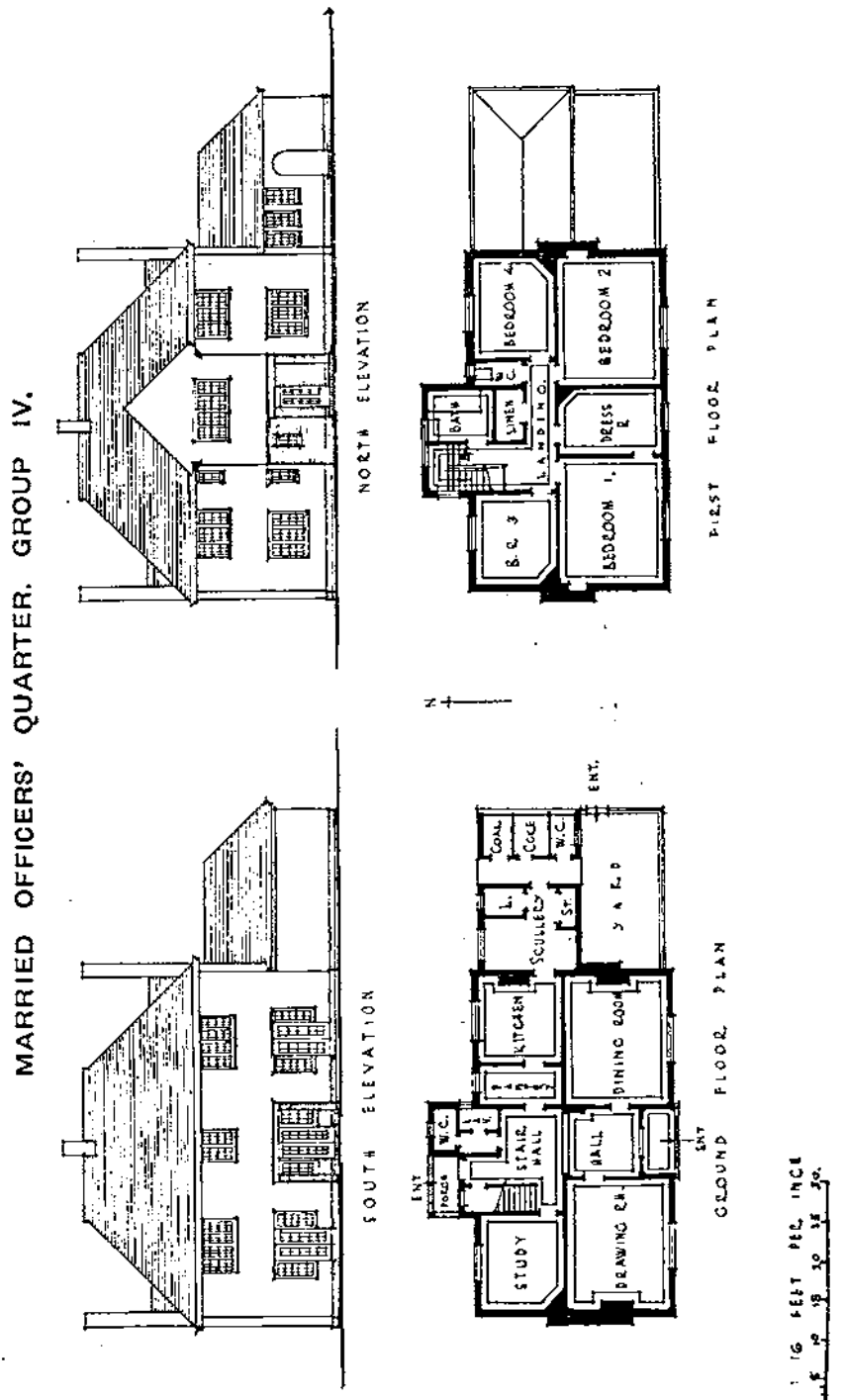
The first floor is devoted entirely to junior officers' quarters and their servants. The allowance of 300 square feet for the junior officers' rooms remains unaltered; and a specially designed combined fitting, seven feet six inches high, divides the rooms as at the Biggin Hill mess. This arrangement has been found preferable to one large room, and in addition the fitting contains all the cupboards, etc., necessary in a bedroom and sitting-room. Lavatory accommodation is considerably improved, the number of baths per officer now being in the proportion of one to every four junior officers and one to every two field officers. A lavatory basin is also provided in each bedroom.

The design of the elevation is more balanced than that at Biggin Hill, the division and spacing of the first floor windows in relation to the mess and ante-room windows is a considerable improvement, and the proportion of the first floor windows, in the main block, is preferable in a design of this nature. The mess is being built in brick, with an Italian type tile roof, and there is a simplicity of outline which should give dignity to the design.

CONCLUSION.

In the preceding pages a brief survey has been made showing the gradual development of the four main types of military buildings, viz., Barracks, Married Soldiers' Quarters, Regimental Institutes and Officers' Quarters. The buildings described and illustrated in this article are the specialized designs, prepared by the various military establishments created from time to time for that purpose, but by no means cover the complete programme of works carried out for military requirements. Buildings such as guard houses, stores, stables, tank garages, ranges, etc., are also provided for units; improvements to them, both in planning and in the installation of fittings, take place more in accordance with civil design than the buildings specially referred to.

Churches, hospitals and headquarter offices are all considered as special designs; and the locality, siting and local practice are fully explored before the preparation of drawings for the buildings are commenced. This latter class of building also follows more closely the general civil practice, with minor exceptions required for military


MARRIED OFFICERS' QUARTER. GROUP IV.
NORTH ELEVATION
SOUTH ELEVATION
FIRST FLOOR PLAN
GROUND FLOOR PLAN
BEDROOM 4
BEDROOM 2
BEDROOM 1
B. R. 3
DRESS R
LANDING
BATH
LINEN
W.C.
ENT.
COAL
COKE
W.C.
SCULLERY
L.
ST.
KITCHEN
DINING ROOM
HALL
STAIR WALL
STUDY
DRAWING RM
ENT
PORCH
N
SCALE 1 16 FEET PER INCH

purposes, than the buildings to which special reference has been made, and a résumé of their development would be superfluous.

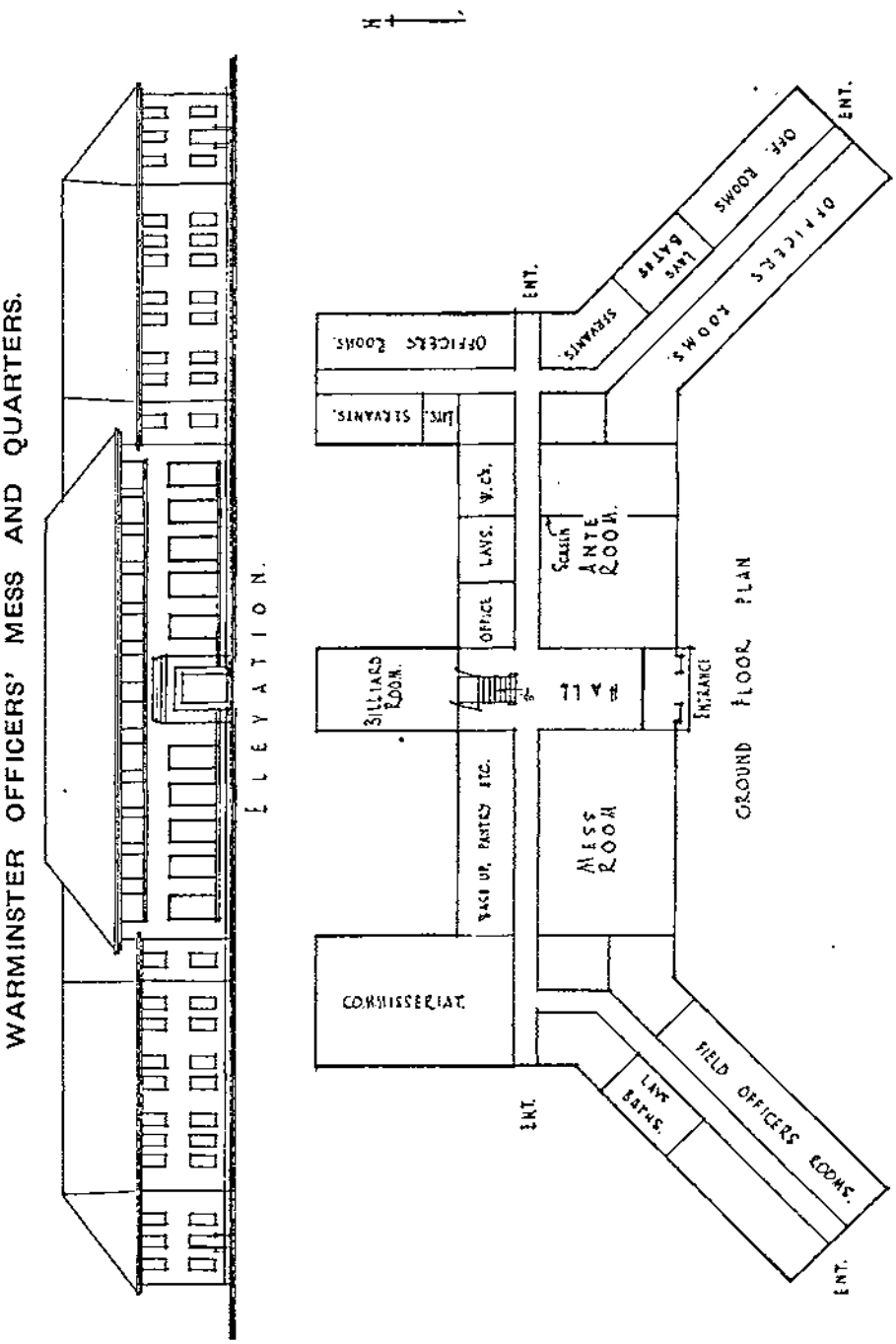
From about 1700 to 1855 the provision of barrack accommodation was seriously neglected; this was due, primarily, to the lack of consideration for the troops by the military authorities, occasioned by the class of man enrolled as a private in those days. Criminals, if given the necessary licence, would join the army in preference to going to prison, and it is little wonder that the civilians raised no comment about the disgraceful state of affairs.

As the methods of waging war were becoming more scientific and complicated, men with more character and higher educational standards, than had previously been enlisted, were required in the lower ranks. In all probability it was the absence of this type of recruit that culminated in the inquiries and commissions instigated between the years of 1850 and 1860. The facts disclosed by these committees caused the authorities to amend and enforce hygienic regulations, and by 1865 the first laws relating to the cubic space per man in barrack rooms were established by Parliament. One or two committees were constituted, whose duty it was to report upon the general sanitary and medical condition of the men of the army.

After initial improvements made between 1860 and 1895, little progress was made up to the outbreak of the Great War. This was probably occasioned by the great strides, made between the dates just mentioned, which would normally have taken a century to materialize.

The military authorities were, and are still, bound by tradition to an extent that hindered experiment in new development. Progress can only be maintained by constant experiments, many of which may be doomed to failure before they mature. The cancellation of a traditional plan may have led to severe public criticism if it had been a failure. To avoid this criticism the military authorities were inclined to sacrifice progress until a new idea is commonplace to the general public.

The setback in permanent military housing during the Great War and repercussions immediately afterwards, due to economic reasons, were cases of necessity. When the nation had recovered from the effects of the war, great progress was made in all buildings coming under military jurisdiction. This sudden acceleration could be accounted for in different ways, the most manifest being the general recognition for the welfare of the rank and file of H.M. Forces. The recruitment of civilians to the army during the war had made the nation "military conscious," and caused the public to change its views on the housing and treatment of troops. From 1930 to the present day, improvements in military buildings continue to be made, and increases in areas of rooms, etc., confirmed by the authorities. The international situation and the recruiting problem


WARMINSTER OFFICERS' MESS AND QUARTERS.
ELEVATION.
GROUND FLOOR PLAN
ENT.
OFFICERS ROOMS
SERVANTS
LAVS
BATHS
OFF. ROOMS
OFFICERS ROOMS
SERVANTS
LAVS.
W.C.
OFFICE
LAVS.
SMOKE ANTE ROOM.
BILLIARD ROOM.
ENTRANCE
MESS ROOM
WAIT UP. PANTRY ETC.
COMMISSERIAT
FIELD OFFICERS ROOMS.
LAVS BATHS.
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account largely for these allowances, but it is very agreeable to record that the public is becoming aware of the conditions under which soldiers live. It is to be hoped that the improvements that have recently taken place, in the living conditions of the soldier, will continue until military housing is, in every respect, equal to modern civil practice.

The aim of Army service is now not merely to give as complete a military training as possible, but is designed to produce a healthy man of steady character, or in other words a fine citizen. With the soldier's realization that Army service is now of more than individual interest, and that he is fulfilling a duty of national importance to the country, his environment acquires a new significance. The fact of living in a building with well planned rooms of harmonious proportions, and clean and pleasant decorations, and with light, well-ventilated sitting- and dining-rooms, will tend to show that military service is a duty, owed not to an unappreciative and irresponsible aristocratic class, but to the nation fully conscious of the soldier's responsibilities.

The placing of the barrack designs branch (Q.M.G.10) of the Directorate of Fortifications and Works, under the supervision of a fully qualified architect, at present Mr. W. A. Ross, F.R.I.B.A., whose staff, before they can be appointed to a permanent post are obliged to become students of the R.I.B.A., naturally tends to improve planning and design, and to the use of the latest building material available. These factors combine to the betterment of military buildings, and so assist in creating the high standard of efficiency required for the British Army.

HUTTING IN A HURRY.

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

The account by Major Bush of the emergency measures adopted at Alexandria gives a good example of the successful execution of a rush job.

It must be emphasized, however, that the ignoring or breaking of regulations in the execution of a works service is only justifiable in such an emergency and that, even then, a due regard must be paid to an avoidance of waste of public money.

In such circumstances it is a golden rule always to keep the powers-that-be informed of what is being done. It is far better to carry them with one than to have to try to justify the regulation-breaking afterwards.—[Editor.]

DURING the recent emergencies in Egypt and Palestine it fell to the lot of the writer on more than one occasion to produce in the minimum amount of time, hutted camps of various sizes. In all cases Active Service conditions prevailed, for time and materials were short and the R.E. Staff was inadequate and consequently overworked.

The work had to be put out to contract and the only persons available for preparing the contracts were the local D.C.R.E.'s staffs. It was very much a case of having to do the job oneself, and it is felt that, as this might happen to others at some future date, the methods used and the experience gained should be of some interest.

The following is a description of one of the smaller jobs we had to do, in this case in Alexandria :—

We were informed that hutted accommodation was required for part of the 5th Division which was arriving from the United Kingdom in about three weeks' time.

Headquarters laid down that the scale of hutting was to be :—

(i) Dining huts, institutes, messes, bath-houses, ablution huts, latrines, stores and so on—sleeping accommodation only being in tents.

Officers were to have long baths and the men shower baths. (Both with h. and c.)

(ii) Water and electric light were required, but latrines were to be on the bucket system.

Drainage to be to sumps.

(iii) Cooking—at first by "dixie" in the open, but later on by ranges in the cookhouses.

(iv) Fly-proofing of cookhouses only.

No jalousies or verandahs to be fitted (we had to fit these later and a tricky job it was !).

Heating stoves to be provided.

Three single battalion camps, adjacent to one another, were required, and the only available site was on loose sand. This area having been used for camps before, there were sufficient roads, but we should have to provide hard standings for the motor transport, all units being mechanized.

Having ascertained exactly what was required, we studied the text book—*Military Engineering*, Vol. VII (Accommodation and Installations), 1934—and (being old at the game) added a bit to every one of the authorized scales in that book. This was to allow for tropical conditions, changes of policy, etc., and for units other than Infantry Battalions occupying the camps.

Thus we got an idea of the sizes and types of the various huts we had to build, and adding up the requirements we found that forty-five huts were needed.

Next we decided how the job was to be done :—

(i) The huts were to be built by contract.

(ii) Wooden fittings, such as grease traps, ablution benches, latrine seats, draining boards, etc., were to be made in the D.C.R.E.'s workshops, where we had previously turned out this sort of stuff for the Navy.

(iii) M.T. standings were to be given to the Term Contractor as he was prepared to start at once. Later, Audit caught us out on this, as roadwork over £10 was outside the scope of his contract. Our explanation of dire necessity was, however, accepted without question.

(iv) Water-supply and electric-lighting mains needed bringing into the Camp and we would have to ask the corporation concerned to do this. We would have to do all the distribution work from these mains by direct labour, having the necessary supervisory staff available.

(v) Large fittings such as stoves and boilers were to be obtained from stocks in R.E. stores, or otherwise, and fitted by direct labour.

(vi) Early in the emergency, power of local purchase had been given us and this helped a lot.

One large firm does the bulk of the importing in Alexandria and an arrangement had previously been made with them that, as far as they were able, they would supply us with anything we wanted. If they had the

article in stock we were to buy it in the normal way. If they had not got it in stock they were to buy it from another firm and we were to pay the invoice price.

The above system was to be used when R.E. Stores had not what we wanted in stock. At this stage of the emergency there was hardly ever time for tenders to be put out.

Actually this system worked very well and we were saved the trouble of going from shop to shop looking for what we wanted (a procedure, of course, for which we had not got the time or staff).

The next step was getting out the contract for the building of the huts and this will be dealt with in detail.

It is not proposed to deal with the direct labour side, which, of course, was carried out concurrently with the provision of the huts.

The preparation of the Hutting Contract.

This had to be as short as possible, consistent with clarity and foolproofness.

On a job of this nature there are sure to be alterations due to change of policy and so on, and after due thought we decided upon a Measurement Contract, and one that was based on cube rates (see details later); thus subsequent alterations would be easy and the measuring up of work done would be minimized.

Actually the metric system is in use in this part of the world, but as all our drawings were in feet and inches we stuck to English measurements for the purpose of this contract. But we expected (and got) timber supplied which was cut to the nearest metric measure.

We decided that the minimum features the contract could contain were :—

(i) A Works Contract Form (A.F. K. 1275).
(ii) A Site Plan and Working Drawings.
(iii) A Schedule of Quotations.
(iv) A Bill of Quantities.
(v) Specifications and General Conditions for Specification.
(vi) A list of work which would be carried out by the W.D.
(vii) The order of priority of work.
(viii) A summary of hutting, showing location by camps.
(ix) A description of the special methods of tendering.
(x) List of drawings, etc.

Quite a formidable-looking list ! The points which came to light in the preparation of these contract documents are as follows :—

Site Plan.—This was small-scale and was only intended to give contractors a general idea as to the lay-out and site. In actual practice we pegged the huts out for them.

The siting of individual huts was largely decided by the following factors :—(*a*) the foul areas that would be caused by the sumps ;

(*b*) the desirability of reducing roadwork, electrical work and water-supply work, as much as possible.

Working Drawings and Hut Design.

We had available (i) Drawings (assembly sheets) of the War Office Standard Hutting (Wood) of 28-foot and 24-foot spans. These are the same huts as are detailed in *M.E.*, Vol. VII, but the drawings are to a much larger scale. (ii) Our own design of a 20-foot span hut and an ablution hut (12-foot span) from a previous job.

We realized that the designs given in *M.E.*, Vol. VII, are very wasteful of timber, but, as we had no time to start designing huts, we made use of them as they were.

Our designs included :—

(i) Corrugated iron roofs, as we had no choice.

(ii) Corrugated iron walls. Weather-boarding we turned down as it meant more wood cutting and so might slow up the job.

(iii) Matchboarding for roof and wall linings and partitions. Pulpboarding we turned down as being expensive, not available locally in sufficient quantity and requiring careful cutting and thus slow erection.

Asbestos sheeting had the same drawbacks as pulp-boarding and in addition was considered too brittle a wall covering.

For simplicity's sake—roof and wall linings had to be of the same material.

(iv) Wood floors raised off the ground on short piles, except in cookhouses, bath-houses and similar huts which had concrete floors at ground-level, drained to sumps.

(v) Two sizes of window—(*a*) " casement " ; (*b*) " store " (which had bars fitted).

(vi) Two types of door—double and single.

(vii) No huts to be T- or L-shaped—all to be straight.

Everything we specified was readily obtainable locally in the sizes we demanded, and we did not insist on British manufactured articles. (We had to take what we could get.)

We found that five different spans of hut were inevitable, viz :—

(i) 28 feet for dining huts and institutes.

(ii) 24 feet for serjeants' messes.

(iii) 20 feet for officers' messes, cookhouses, bath-houses, wash-ups, etc.

(iv) 12 feet for ablution huts and troops' latrines (which were double-sided).

(v) 9 feet for officers' latrines.

We put our draughtsmen (borrowed from the C.R.E.) on to producing tracings from the War Office drawings of their 28-foot and

24-foot span standard hutting and we modified these designs to our requirements. We already had our own designs for 20-foot and 12-foot span hutting.

For each span we produced on a single sheet of paper :—

(i) A section.

(ii) A side elevation of sufficient length to show the detail of bays containing a double door, a single door, a casement window, a store window, and no opening.

(iii) An end elevation showing the details when a double door was fitted.

All construction details from roof ridges to the footplates of the foundations were shown on these drawings, which were fully dimensioned. We added notes, too, where we thought them necessary.

This gave us full details of the " shells " of the huts only.

But as there were many different uses to which the huts were to be put, we also made single-line plans for every different size and type of hut. These were approximately to scale and were drawn in pencil on sheets of foolscap, the requisite number of carbon copies being taken at the same time. Two examples of these drawings are shown in the plate to this article. We also had to produce detailed scale drawings for doors and windows.

For small huts like latrines we just drew quite rough sketches of our requirements.

Method of Tendering.

We decided that the simplest method would be for contractors to tender :—

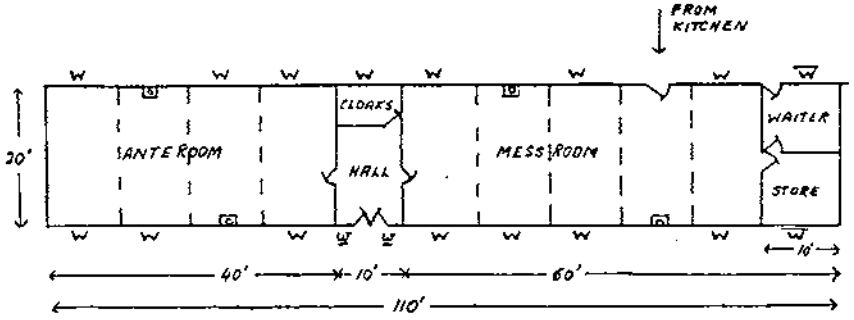
(i) By the foot cube for shells of huts.

Separate quotations were necessary for each width of hut and these quotations included roofs, floors, walls, linings, founds, windows and their furniture, etc.—in fact the complete hut shell. No difference was to be made for the number of doors, windows, etc., in the various huts. We wanted a flat rate for a hut shell of any particular width, and we laid down the " official " height for each width too, so as to avoid arguments later.

(ii) By the foot super for partitions.

Here again we specified a flat rate regardless of whether partitions had doors or not, or counters and so on, and in practice we often designed an unusual partition as the work progressed (giving pencil sketches). This method of tendering allowed complete flexibility and also reduced the measuring up of the completed work to a minimum. We had all the hut heights and widths, so we were only concerned with measuring lengths of huts and the superficial area of the few partitions.

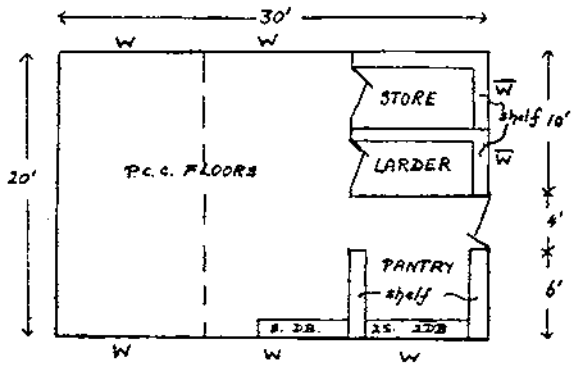
OFFICERS' MESS.



3 MESSES REQUIRED THIS SIZE.

COOKHOUSE.

INSTITUTES AND OFFICERS' MESSES.



6 COOKHOUSES REQUIRED THIS SIZE.

W = Casement window.
$\overline{W}$ = Store window.
w = Half a casement window.
$\overline{\sqcap}$ = Stove (supplied and fitted by W.D.).
S = Sink.
D.B. = Draining board. (W.D. to supply and fit above.)
– – – – – = Truss over.

For further details see specifications. Line drawings are only approximately to scale.

Had we made the contract an ordinary measurement one, very many hours of work would have been necessary in measuring up and abstracting at the end of the job.

A lump sum contract would not have given us the required flexibility.

A Bill of Quantities and an approximate estimate were, of course, both necessary in order to give the contractors an idea of the scale of the job before tendering. As we were dealing in cubes and squares only, these items were quite simple.

The Specifications took a long time to prepare at first, but we got quite expert at them after we had made out one or two contracts. Being technical, a description of them is beyond the scope of this article.

The following books, etc., are of assistance in making out such specifications :—

(i) The *Schedule of Prices for Works and Repairs to Buildings, etc., of the War Department* for the district.
(ii) *Design and Construction of Military Buildings*, 1933.
(iii) A.F. K.1303 *General Specification of Clauses used in Contracts for Buildings and Works for the War Department.*

The Schedule of Quotations is considered of interest and is detailed in the Appendix.

Issue of Tenders.

The method we used was somewhat unusual.

We selected firms who (from our local knowledge) had connections with the kind of work we wanted and so were likely to do the job themselves (without unofficial sub-letting).

We telephoned these firms one morning and told them to have an accredited representative at our office at 2 p.m. the same day.

We handed these representatives their copies of the tenders and explained briefly what was required. We made it clear that we really meant the jobs to be done in the times specified (17 days for most of the huts), but that we were not in such a hurry that we were prepared to pay fabulous prices. We gave the impression that, if prices were unreasonable, we would do the work by direct labour or troop labour.

On another occasion we also took the tendering contractors out to the site in a lorry.

Tenders had to be in by noon two days later and we arranged that all firms should have English-speaking representatives at hand in their offices at 1 p.m. on that day, as we proposed informing them at that hour as to whether they had got the contract or not. These telephone messages would be confirmed in writing the same day. The "winner" was to start transporting materials to the site immediately.

All this worked extraordinarily well and, as we had already started pegging out the huts, the chosen contractor made a flying start.

In a rush job it pays every time to explain the situation. Our contractors' various nationalities covered most of Europe and the Levant and most were not versed in the English of Contract documents—anyway, there was a lot for them to read. It is quite a common occurrence for so called "native" contractors to tender almost entirely on information readily visible on drawings, with merely a glance at the specification (which probably contains the essence of the technical requirements). Time also means little or nothing to them.

The progress of the work.

The selected contractor was an Egyptian and an owner of wood-working shops. He cut most of the timber required from baulk and a visit to his crowded workshops proved a most unnerving experience, for any form of machinery protection was apparently looked on as unnecessary and a waste of valuable space.

Everything went well until shortly after the contractor had started lining the huts, when he produced some decidedly inferior match-boarding. We marked the many bad pieces and told his agent to remove them, but we found the next day that our pencil marks had been planed off and the bad lengths were still there. This called for drastic measures, so, borrowing a hand-axe of one of the workmen, we split every piece of matchboarding not up to standard. We then went our way and, of course, received a visit from the contractor in person a few hours later. However, we told him firmly that we had specified good timber and we wanted it, and after a bit of grumbling, he went off quite happily and we had no further trouble of this nature.

After a few days, we found that we really wanted a W.D. representative on the job the whole time. The contractor's agent was young and inexperienced (the usual English-speaking (?) ex-university student) and there were many points to keep an eye on. The Clerk of Works had an area covering over 20 miles and so could only make one visit daily. So we borrowed a sapper (a carpenter) from the field company in Cairo and put him full time on the job, and he proved invaluable, as he had a working knowledge of Arabic as well as his trade qualifications.

There is little more to say. We got the huts up in the times specified and the occupants seemed to like them. Unfortunately such items as hot-water boilers were not available in Egypt (where heating is largely done by multiple primus burners), so we could only supply cold baths at first.

The supply of stores always seems to be the deciding factor in R.E. work, and it is extraordinary what small stocks are held by civilian firms, even in quite large towns. As the Government cannot obviously lock up capital maintaining large stocks of R.E. stores

against possible "emergencies," it seems that the supply of stores will always remain a problem.

To the expert eye our contracts must have appeared inadequate and crude, but the fact remains that they worked, and this and similar jobs were done at a reasonable cost and in the time allowed.

Had we attempted to turn out the mass of paper required in peace-time contracts, we should have failed in our tasks. We realized this and so we stretched the regulations to our own requirements, trusting that the "powers that be" would back us up, which they did. They nearly always do if you go the right way about it.

APPENDIX.

Schedule of Quotations.

The contractor is to fill in his prices on the following Schedule :—

This tender is indivisible.

Item.	Description of Work.	Quotation.	
1.	Hutting 28-foot span, includes founds, floors, lining, doors and windows	10¼	Milliemes per foot cube.
2.	Ditto—24-foot span	10¼	do.
3.	Ditto—20-foot span	10¼	do.
4.	Ditto—20-foot span, as above but with concrete floors	15¾	do.
5.	Ablution shelters 12-foot span, includes concrete floors, windows and doors ...	15¾	do.
6.	Latrine shelters 12-foot span, includes partition and hinged flaps. No floor, doors or windows required	15¾	do.
7.	Latrine shelters 9-foot span, includes partitions, internal doors, and hinged flaps. No floor, external doors, or windows required	15¾	do.
8.	Partitions of ½-inch matchboarding on 3 × 2 inch studding	20	Milliemes per foot super
9.	Sumps—Excavation, lining, filling and wooden covers	450	Milliemes per metre cube.

Witness *Hassan Sherif.* Signature of Contractor *Soliman Ali.*

Date 28/12/35.

Note.—(i) Prices, date and names are fictitious.

(ii) 1,000 milliemes = £1 Egyptian = £1 0s. 6d. sterling.

CONVERSION OF AN INFANTRY BATTALION INTO AN A.A. BATTALION, R.E.

By "TERRITORIAL."

DURING the past two years the establishment of the Corps has been increased by the addition of a number of anti-aircraft battalions. These have been formed, with one or two exceptions, by the conversion of Territorial Infantry Battalions to Royal Engineers. Such a change of category could not, of course, be carried out by a mere change of title and it may be of interest, consequently, to summarize the triumphs and disasters which have accompanied these conversions. The writer is, unfortunately, only qualified to speak for his particular unit but, from personal contact with members of similar battalions, he is of the opinion that much the same obstacles have been encountered by all and, although the methods have varied, these obstacles are gradually being overcome. As will be seen, the back of the job has been broken and only time is now required to allow the accumulation of men, equipment and accommodation, and to heal the soreness which was caused inevitably by the conversion.

Let us, as a start, consider the situation which confronted the R.E. Permanent Staff on their arrival at the Battalion Headquarters. They found an old, rambling drill hall situated in a back street, lined with tall warehouses and odoriferous eating-houses. This was the only drill hall of the regiment and was obviously completely unsuitable for searchlight work. A large railway yard nearby rendered listening practice in the open air out of the question—in any case there was not a square inch of ground beyond the four walls of the building! The regiment itself proved to be a very small (about one-sixth of the establishment of an A.A. Battalion), very old, very proud unit with a most distinguished war record. It consisted of four skeleton companies and a large H.Q. wing, containing N.C.O's and men of long service who had earned their places among the "specially employed."

The attitude of the personnel was at first difficult to assess, as the Permanent Staff were received with unfailing but very guarded courtesy. A few weeks, however, made it plain that the man in the ranks was, on the whole, very satisfied with the conversion. His drills were much more interesting, foot-drill was kept down to a minimum and annual training did not hold out the prospect of many hours of marching as it did in the infantry days. The older

N.C.O's and men were very much perturbed that the knowledge they had gained by years of service and many part-time and full-time courses would be practically useless. Moreover, they were almost without exception of the opinion that good soldiering meant good ceremonial drill and that a soldier dressed in overalls was an impossibility. The attitude of the officers was, however, quite definite. Only their regard for the regiment prevented them from resigning their commissions. There was a very obvious feeling that, by becoming Royal Engineers, they were losing caste. This was caused by the fact that they were almost entirely ignorant of the nature of the Corps, its history, capabilities and prestige. Quite frankly, the Corps was classed as a collection of scruffy, non-combatant, uniformed civilians with no knowledge of "real" soldiering.

With very few exceptions, all ranks now accept whole-heartedly the conversion and are proud to call themselves "Sappers" and to sing the "C.R.E." This change of mind was brought about slowly but surely by greater knowledge of the Corps. In the first place, the Permanent Staff (a very good lot) produced week after week real "T.B." turn-outs, incredible thirsts, and equally incredible stories of the past, present and future glories of the Royal Engineers. Also the Divisional and Group Staffs, the instructors of the School of Anti-Aircraft Defence and the School of Electric Lighting and various members of the 1st A.A. Battalion did an enormous amount of good by the whole-hearted and understanding way in which they co-operated.

The reorganization of the Battalion into A.A. Companies was naturally the first step to be undertaken. It was laid down that two companies were to be formed immediately at the existing Headquarters and the two remaining companies at outlying stations as soon as suitable sites for them could be obtained. The former step was carried out by amalgamating two infantry companies to form one A.A. company. Unfortunately, one of the conditions under which the unit accepted conversion was that no officer, warrant officer, N.C.O., or man should be reduced in rank. Hence the two new A.A. companies were saddled with four Company Serjeant-Majors and five Company Quartermaster Serjeants. In addition there were a hundred and one people who could not readily be absorbed such as the Bandmaster, the Regimental Quartermaster Serjeant, the Drum-Major, the Pioneer Serjeant, the Officers' Mess Serjeant, the Transport Serjeant, the Medical Corporal, etc. Altogether, the position bordered on the fantastic. Imagine the position, however, when we were instructed to amalgamate the two new companies and to form an extra outlying company!

Another radical change which had to be made was the decentralization of control from Battalion Headquarters to Company Head-

quarters. In the infantry days, with four small companies using one drill hall, practically everything was under the direct control of the Battalion Orderly Room. Company offices and stores did not exist; clothing and equipment was centralized under the Quartermaster; all records were kept by the R.S.M., in fact, the battalion functioned on similar lines to an R.E. company. The continuance of this was obviously impossible if three outlying companies were to be formed and so, very gradually, responsibility was passed over to the companies. At first this was not popular but, having once tasted freedom, companies are becoming more and more jealous of their individuality.

The retention or otherwise of the Colours was a problem which for the first month or so created great bitterness. Naturally, in such an old-established regiment, a good deal of sentiment was attached to them both by the unit and among the old comrades. In the end, the War Office laid down that the Colours should be carried only when the Battalion was on parade alone. At first this ruling caused some dissatisfaction but its wisdom has now been more generally recognized. It is a matter of doubt, however, as to how long this state of affairs will continue as it is already becoming difficult to find subalterns who know the drill!

The next point of friction was the problem of the new title and uniform. After much discussion the former was more or less amicably settled but the latter was a long time in reaching the final answer. At first, a much begrudged partial change was made, *i.e.*, breeches and leggings adopted by all officers, the cap badge and buttons retained and R.E. shoulder titles substituted. The result became more and more unpopular and finally a complete change-over to R.E. uniform was made.

One more difficulty must be mentioned. The Quartermaster—an ex-regular soldier with Boer War and Great War experience—was naturally completely mystified by the stores which were showered upon him. With characteristic energy, he applied for and obtained a fortnight's attachment to the Regular Army and returned full of the necessary knowledge or, as he himself put it, knowing what "H.C.D." meant.

The first essay at a week-end camp was a most unfortunate experience. To begin with the weather was atrocious. Then the aircraft co-operation was cancelled. Finally, the equipment which was issued was as old as most of the men who were manning it, would not work, and was incomplete. Such a situation, however, brings out the best from the Territorial and, despite every handicap, every set of equipment was made to function before work was abandoned.

By the time these teething troubles had been overcome, permission was given to make a start with the formation of the outlying

companies. This proved to be a most enjoyable but very strenuous task. Having found and purchased sites suitable for the erection of the new headquarters, a heart-breaking search for suitable temporary premises was started. In one case, which will serve as an example, it was found possible to rent a large house conveniently near to the permanent site and one morning the Adjutant proudly unlocked the front door and admitted a P.S.I. labouring under a load consisting of a typewriter and a varied collection of army forms. The former was deposited on a convenient mantelpiece and the latter on the only table possible, *i.e.*, the floor, and a start was made. The first few weeks were very trying but extremely comic in retrospect. The searchlight, office and canteen equipment arrived bit by bit, as also did the clothing but the apparently limitless enthusiasm of the recruits overcame such trifles. The expedients employed to promote recruiting were varied and often unorthodox but gradually the men filtered in so that, by the time of annual training, at least a skeleton company was able to parade. Actually, clothing was arriving up to the last few days before camp and it was with only two days to spare that the last man received his full issue. Despite the short period of their training and the enormous difficulties they encountered, the new companies managed between them to win every regimental cup. A truly wonderful performance.

For the converted infantryman, annual training was very different from his camps of former years. Instead of a long morning's work and a free afternoon and evening, he found that he was expected to work for about three and a half hours in the morning, to rest in the afternoon, and then to operate his light from dusk till the small hours of the following day. Such discomforts were, however, more than counterbalanced by the fact that they were living their own life away from guards, duties, orderly serjeants and hard-hearted cook-serjeants. In fact, the men definitely enjoyed annual training, to the confusion of the more pessimistic of us who anticipated a mass exodus from the unit after a taste of detachment camp life.

At the present moment, the battalion has one—the original—company well over establishment and the three new companies flourishing in the outskirts of the town. The full-strength company is still badly overloaded with warrant and senior non-commissioned officers but various improvements in the distribution of the old infantry personnel have been made. For instance, the Drums have been disbanded as the amount of marching carried out by an anti-aircraft battalion is small, to say the least of it! Then again, certain warrant and senior non-commissioned officers have, at great personal inconvenience, transferred to one or other of the newly-formed companies, thereby helping considerably in their formation and training, in addition to easing the congestion in the senior non-commissioned ranks of the old company.

The training difficulties of the old company, with its drill hall situated amid a wide expanse of warehouses and railway sidings are still, of course, enormous. However, difficulties are meat and drink—one is tempted to say the birthright—of the Territorial Army and, after many failures, a fairly suitable outdoor training site has now been found within a mile or so of the headquarters and rumour has it that the drill hall is shortly to be given a flat roof on which a searchlight could be operated.

The new companies, being outside the industrial area, are far more favourably situated, as fields can be found within easy lorry journey, in which searchlight stations can be erected and in which the silence, which is so essential for the training of listeners, can be obtained.

Thus a new and it is hoped worthy unit has been added to the Corps of Royal Engineers. Many difficulties have been encountered; some already overcome, some yet to be surmounted. Nevertheless, we feel that the worst is over and we look forward to the time when our ambition is attained—a full strength and efficient anti-aircraft battalion.

DEMOLITION OF REINFORCED-CONCRETE BRIDGES.

By MAJOR J. SPOTTISWOODE, M.C., R.E.

I HAVE been encouraged to write this article by the thought that I probably have as much practical experience of the subject as any officer of the Corps. That is, of course, as near *nil* as makes no difference. Like many others, though, I have been considering the matter for some time and have visited the offices of sundry County Surveyors with a view to enlarging my ideas on it. I have a hope, therefore, that my conclusions may have some interest, even if it is only to produce contradiction.

Before I begin, let me apologize to those who object to a too liberal sprinkling of " I's." Since the whole thing is an expression of personal opinion and I refuse to try and hide behind the plate-glass window of " the writer," it has been unavoidable.

From the point of view of arriving at some general principles of demolition of R.C. bridges, the following would appear to be the main considerations.

(i) Being a plastic material, R.C. lends itself to such individual treatment that it is impossible to produce any concise classification of types.

(ii) Even if this were done, the outward appearance of a bridge may often indicate the wrong type or even fail to disclose the fact that it is R.C. at all.

(iii) Concrete strengths and amount or placing of reinforcement differ greatly according to the age and locality of the bridge. This is owing to the recent advances in cement qualities and to the individual ideas of designers. Even in the few surveyors' offices that I visited, it was quite easy to pick out local peculiarities. Since we do not hope to use our knowledge of this subject in this country, we are likely to meet still larger differences abroad. For instance, I understand that in France it is the practice to use a drier, and therefore stronger, mixture with more punning, necessitating a less close spacing of the steel.

(iv) In the case of bridges of more than one span, the construction is monolithic over the piers and the spans are usually capable of taking reversed stresses. From this it follows that, even if not calculated to do so, a span will often stand up as

a cantilever over much more than half its length when completely cut.

(v) It is normal to work in design to a factor of safety of 4, and it is quite ordinary, for reasons of symmetry and ease of construction, for appreciably more steel to be incorporated than is called for by the calculations. Therefore, when reckoning on making the bridge's own weight complete the destruction, it is necessary to induce stresses well in excess of this factor of the designed strength.

(vi) The steel is proof against the drill. The top and bottom of a beam is completely armoured in most cases and, even in a slab, allowing 1-inch bars at 6-inch centres, there is a 50 per cent. chance of hitting one.

(vii) No appreciable amount of steel will be cut by the first blow.

The favourable factors do not make such a long list.

(i) A span once dropped cannot, like a girder, be raised and used again. It is not, therefore, necessary to shorten it by cutting.

(ii) R.C. is heavy and it may often be possible to use its own weight for its own destruction. Large spans are designed with great attention to economy of dead weight and material. This, except in the case of solid spandrilled arches, normally leaves some vulnerable point or relatively small member, the destruction of which will bring the necessary excessive stresses on the remainder.

(iii) Borehole charges have a great effect on concrete though none on the steel. Since R.C. bridges are still comparatively rare, there is always likely to be a compressor available.

Also, though it does not help one to decide on the method of destruction, it may be noted that the debris of a dropped bridge will be the devil's own job to move and should be a most unpromising foundation for new piers. That is on the assumption that a span has not been dropped flat.

From these considerations and my examination of the anatomy of various bridges, I have come to the following conclusions.

(i) Large-span bridges are going to present relatively much easier problems than the smaller ones, but will need individual treatment.

(ii) Small spans will, in the majority of cases, be best attacked at the abutments or piers. If the concrete is knocked away, the steel will fail as a column and be torn out. This is not, of course, confined to small bridges.

(iii) Unless a decent drop, say 5 feet, can be obtained, it will

not often be worth while attacking the bridge, even if no easy deviation exists. In these cases, it will be necessary to seek some other means of creating the maximum traffic obstacle, such as a crater in the nearest defile, possibly at some considerable distance from the bridge.

Before proceeding to particular cases, I will give a few general hints I picked up in the surveyor's offices that may be of interest or use.

Plain slabs are nowadays often built on abutments that are not designed as retaining walls. In such cases, the latter are held apart by the slabs themselves into which they are keyed. But there is no guarantee that they will not still continue to act as retaining walls if the slab is dropped. These are used up to about 30 feet.

Portal frames, in which the abutments and slab are monolithic and reinforced throughout, go up to some 40 feet span. Beams may be found up to about 70 feet. Road bridges over railways will frequently have thick un-reinforced abutments of mass concrete.

Jack arches and troughing will also have thick retaining wall abutments.

As I am going to be bold enough to suggest some actual figures of time, weight of explosives and parties that might be needed for the various examples I am taking, it will be necessary to give the data on which I have worked, where these are not generally available.

The first is the speed of the drill, of which few officers have much practical experience and which does not yet appear in any book. The following answers are based on my enquiries and are given with all reserve.

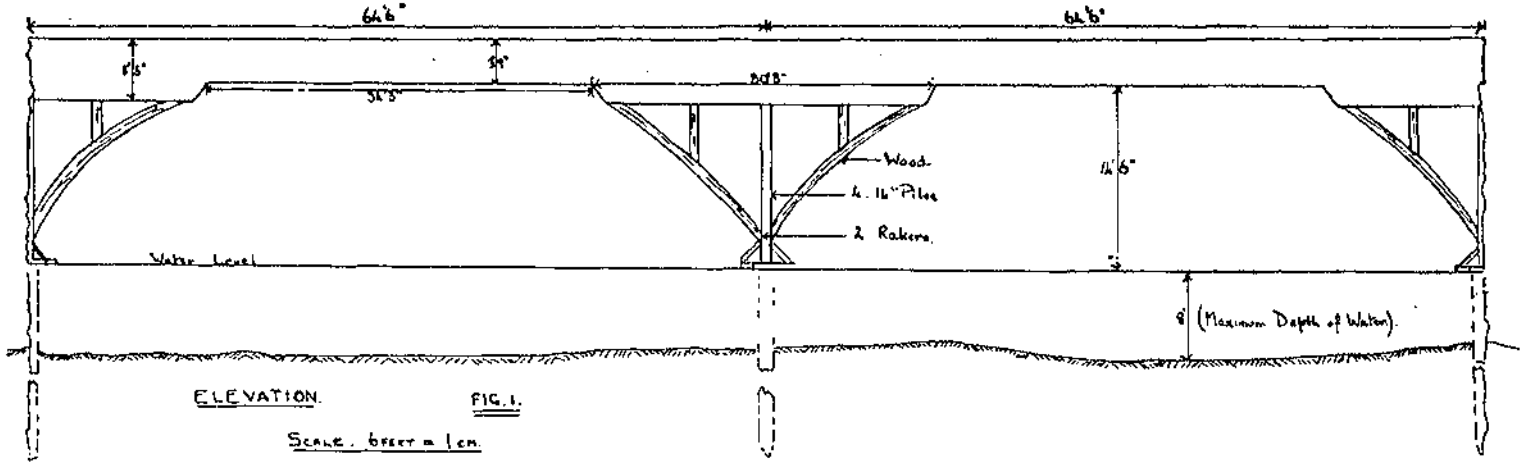
In good structural concrete, a $1\frac{3}{4}$-inch drill will penetrate one foot in from one minute in short holes to nearly $1\frac{1}{2}$ minutes for long ones vertically and it is necessary to double this for horizontal work. To arrive at a round figure we must allow for :—

(i) Changing drills in long holes.
(ii) Changing bits. This is necessary after 22 minutes' drilling, *i.e.*, about 14 feet vertically or 7 feet horizontally. By this time the $1\frac{3}{4}$-inch drill has worn down to $1\frac{1}{2}$ inches.
(iii) Shifting from hole to hole. This may be the work of a moment but may take some time in awkward situations.
(iv) False starts due to hitting steel.

I have therefore used figures of $2\frac{1}{2}$ minutes per foot vertically and 5 horizontally unless there appears to be some unusually unfavourable factor. I have also allowed for a compressor to operate two drills simultaneously.

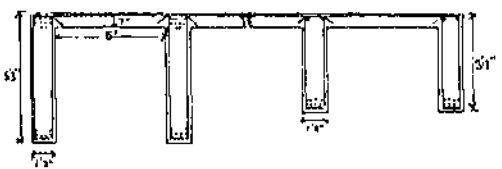
Owing to the liability to jamming on loose material, hitting " plums " etc., no reliable figure can be given at all for mass concrete.

BRIDGE No. 1. Plate 1.



ELEVATION. FIG. 1.

Scale. 6 feet = 1 cm.



SECTIONS OF BEAMS. FIG. 2.

Scale: 3 feet = 1 cm.

Dem^n 1.

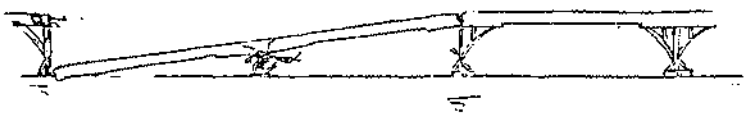
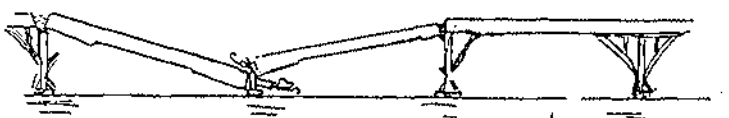


FIG. 3.

Dem^n 2.



4. 63.

I have throughout used plastic, of which just over 1 pound goes into each foot of borehole.

There are some bridges, *e.g.*, Bridges No. 1 and No. 2, in which the vulnerable members are so thin and unsupported that it is probable that time might be saved, without an extravagant use of explosive, by applying surface charges. As, however, I know of no reliable formula for the charge that will shatter the concrete of a given thickness of R.C., I have neglected this method.

Nor do I know the radius of effect of a borehole charge but hope I am not unduly optimistic in assuming a radius of about half the depth with a maximum of 18 inches and a minimum of 12 inches of shattered concrete.

For my first example, I am taking Bridge No. 1 (Plate 1). This is a simple beam bridge of varying spans up to about 65 feet. Each span is borne by four beams 3 feet 9 inches deep in the centre and 5 feet 3 inches over the piers. The piers are composed of four 14-inch vertical piles and two rakers rising some 14 feet out of the water, which is about 8 feet deep. The things that look like longitudinal bracing are merely wooden pretty-pretty. There is a convenient platform between the piers at about water-level. As R.C. bridges go, this is a fairly venerable one, some twenty summers old.

Like most large bridges, this is, or anyway looks, pretty easy. The piles are thin and accessible. A borehole charge let off through the middle of one should shatter the concrete over a length of about 18 inches, I hope. To ensure that there should be no chance of the ends jamming and being held by the steel, I should prefer to put two into each at as great a distance apart as it was convenient to drill, say 1 foot and 4 feet above the bottom. Each pair could be connected by F.I.D. or a trail of plastic, necessitating six detonators, for a pier, with 12 feet of boring and 12 pounds of explosive.

Now for the time. If only one pier is to be attacked, start off with half an hour to scratch your head and get going, half an hour's drilling, charging up as you go and another hour to finish and clear up. A total of two hours with another hour, say, for each further pier that is to be attacked. The cautious officer might like to add another allowance before he passed it on to the General, but I do not think it should take any longer than that. As for the party, one N.C.O., one man on the compressor, two drilling and four charging, should be ample for quick work.

Now if we consider for a moment that the bridge is of only two spans and that the faces of the abutments are difficult to attack, I think one point of interest may arise. That is how the roadway is actually going to break. I think we are safe in assuming a clean break somewhere, as the only alternatives are a stretch of some 6 feet in 130 feet or a hold-up over the double span, neither of which looks possible.

BRIDGE No. 2. Plate 2.

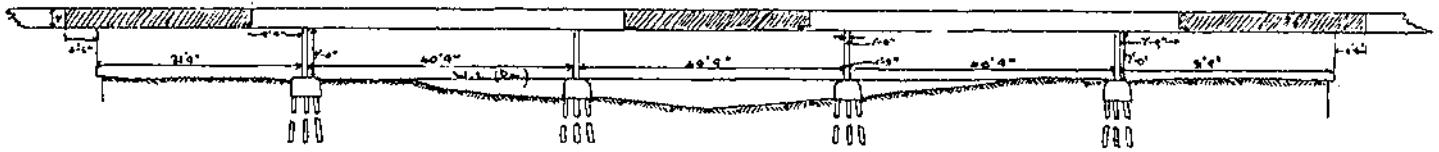
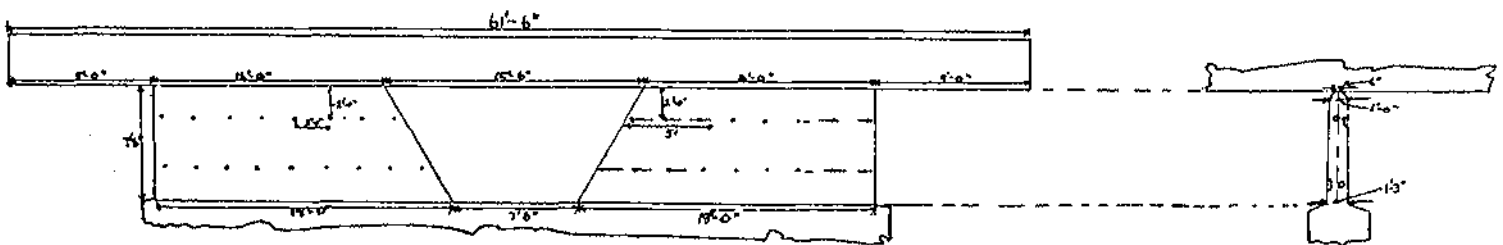


FIG. 1.

ELEVATION.

SCALE: 10 feet = 1 cm.



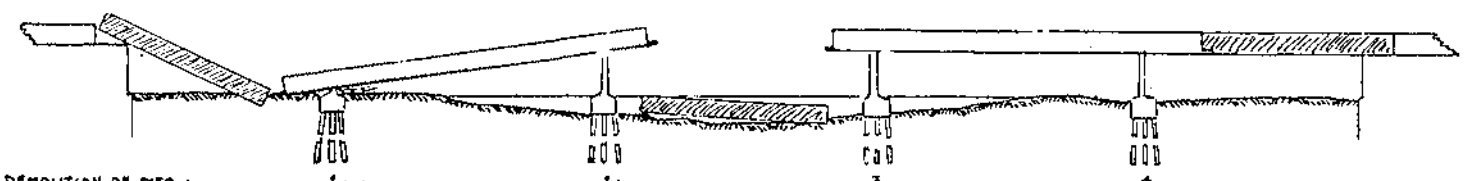
FRONT ELEVATION OF PIERS. (Showing Proposed Changes, Method 1 & 2)

Scale: 10 feet = 1 inch.

FIG. 2.

SIDE ELEVATION OF PIERS. (Showing Alterations as Method 1 and Changes as Method 2)

FIG. 3



DEMOLITION OF PIER 1.

SCALE: 10 feet = 1 cm.

FIG. 4.

S.R.

It might do it either as in Figure 3 or 4. Is there any choice between them? I think there is. In Figure 4 there will be much less clearing to be done before a new pier can be made on the same site. In Figure 3 the sloping span will not be sufficiently well supported at the top to bear a new pier in the middle, nor, besides that, is it going to be too easy to produce a good horizontal bearing for it. I should like to put some small charges into the shear areas near the chosen abutment to ensure fracture there. These might have to be sloping sideways to avoid the steel. If this is agreed, it follows that it will be best to attack alternate piers rather than adjacent ones in the actual bridge.

The next bridge is No. 2 (Plate 2). It is of unusual design, but then modern R.C. bridges of decent size are very apt to display intense individuality.

I think the elevation in Fig. 1 shows fairly plainly the general principle of design while the drawings of the piers show how easy they should be to blow. Each has an average length of 32 feet and a thickness not exceeding 15 inches.

Though not, I think, actually useful for destruction, it is interesting to notice the extremely small bearing surface, 6 inches by 26 feet, on top of the piers. This is designed to act as a hinge and a heavy vehicle actually causes the bridge to go in waves, so that you can pinch your fingers in the expansion gaps in the parapet.

To return to our muttons. Two rows of holes at 2-foot intervals near the top and bottom, as indicated on the left-hand half of the pier in Fig. 2, should do the trick. That is, 30 holes of about 1 foot each. Or else, as indicated on the right-hand half, the outer holes might be replaced by 5-foot holes drilled in from the edge, making a total of 38 feet of hole. These long charges would make a more certain job but would be more difficult to drill and charge. They could not go in dead central because that site is occupied by the steel. In Fig. 3 I have indicated these holes as well as suggested chases for surface charges if used.

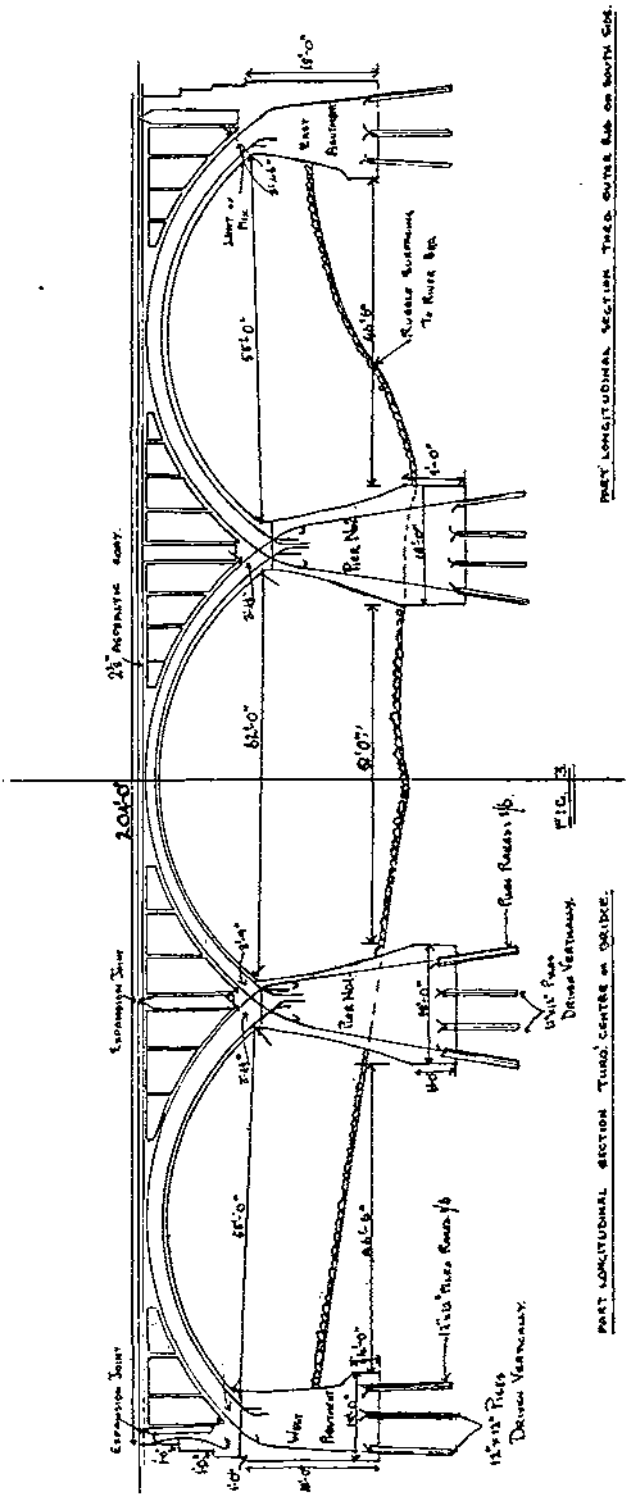
The time here per pier will be half an hour to start, 1½ hours for drilling and charging, one hour to complete. Three hours, plus General's allowance to taste. Party as before, 8. Charge: 30–40 pounds P.E.

But the really interesting part is, I think, to consider what happens on the collapse of one pier. The loose span supported on its cantilever naturally would be dropped off and, on the other side, I should expect the connected pier to be pulled over and cracked somewhere. That cantilever end will rise and be pulled away from the next loose span which should also be dropped, leaving the profile as indicated in Fig. 4. The blowing of the two outside piers, which are dry, would therefore do the whole bridge.

A possible alternative would be to leave one outside edge of

Plate 3.

BRIDGE No. 3.



say 3 feet of the pier untouched. This would make the span fall sideways, remaining cocked up on that side. This should make an awkward repair.

It is regretted that I could not get hold of the full reinforcement plans of these piers but, from what I could glean, I do not think this would be any serious difficulty. It might also be noted that the design is by no means easy to spot by an ordinary inspection and this brings out one difficulty in R.C. destruction. In this case misreading would probably only result in attacking an unnecessary number of piers with consequent extravagance in time and explosive, but in other cases it might be more serious.

Next an arch.—Bridge No. 3. This is an open-spandrelled arch of three spans, 55 feet, 62 feet and 55 feet, with piers of a height in the order of 20 feet. The arches are plain slabs and the width is 45 feet. Plate 3 shows enough of the construction for our purpose.

The arch slabs are accessible and can be perforated quite easily but it would need a large number of holes to join up the perforations. Nor will the collapse of one arch bring down the next, as sometimes happens in brick or masonry arches. The faces of the piers are rather inaccessible but their tops are not. This then is my chosen point of attack. The steel here, though pretty close, is all lapped or jointed and none of it goes through to hold up the wreckage. The removal of the concrete round that area must cause the two arches to drop.

To effect this, I should put down holes at 4-foot intervals on each side of the central support, staggered, of course, at a convenient angle for drilling to my maximum depth. Owing to the sharpness of the angle, this might not be more than 4 feet 6 inches. That is 20 holes with a total length of 90 feet. 45 feet per drill takes just under two hours on my assumptions, say four hours for the job and 100 pounds of P.E.

Bridge No. 4 is more difficult since, having arches of smaller span, the spandrels are filled. The arches themselves, except in the centres, are well covered and a cut at that point will not cause any collapse. To attack the faces of the abutments or piers needs a staging or fairly solid boat, which must be moored firmly to provide a suitable base for drilling operations.

Given a boat or boats, the pier is the obvious place to attack so as to affect both arches. It can be assumed, and is a fact, that all the steel again is lapped over it. The thickness of the pier is, however, nearly twice the longest drill and it is necessary to attack both sides. Say, then, nine 5-foot holes (3 feet apart) on each face of the pier. 45 feet at 5 minutes a foot equals 4 hours, assuming a boat and drill each side. With only one boat it will take longer. One hour to get going and one hour to complete makes 6 hours a fair computation and 100 pounds of explosives will be required. The required line for

Plate 4.

BRIDGE No. 4.

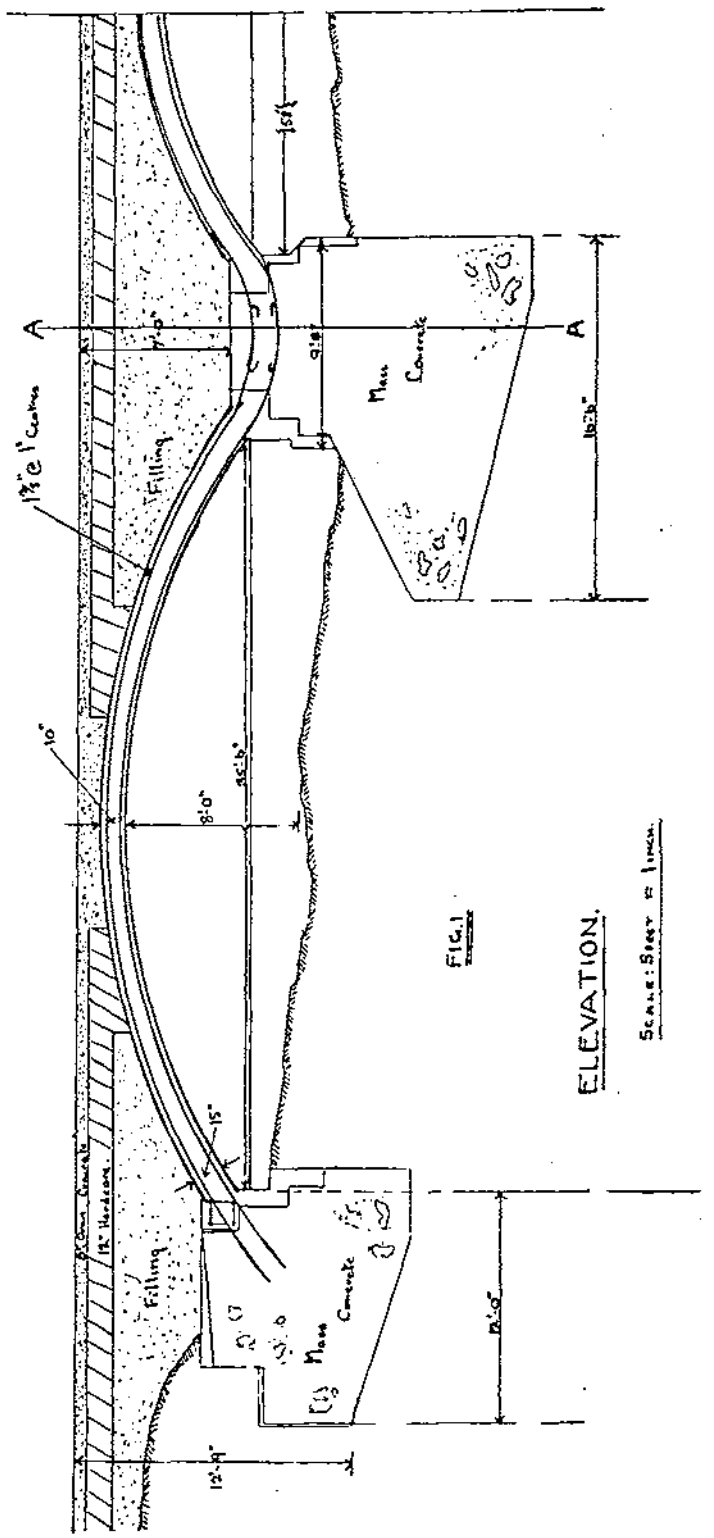
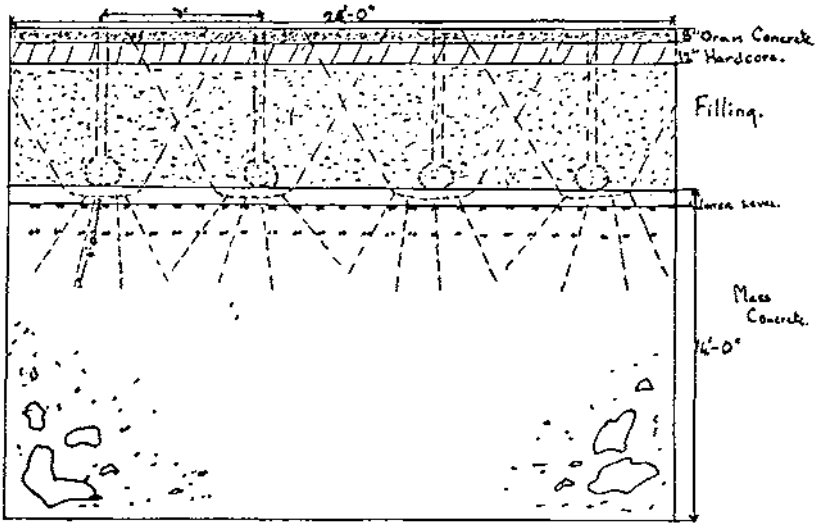


FIG. 1

the holes will, however, be very near water level and drilling may be awkward.

But I think there is another less obvious and quicker way. Assuming we have been issued with cratering equipment, blow four craters over the pier, at 7-foot intervals. 1½ hours, with 2 pipes, and 160 pounds should see this done and we already have a fair obstacle. Then clear out the bottom of each crater to unshattered concrete (1½ hours) and drill four 4-foot holes in each, sloping outwards at the best angle possible. 32 feet per drill at 2½ minutes equals 1½ hours and 70 pounds of explosive in all. One hour to complete. (See Plate 4, Figure 2.) A total of, say, 5 hours and 230 pounds P.E. If the roadway does not have to be kept open till the last moment, this method might have considerable advantages, especially if no boats were immediately available.



Section through Pier to illustrate 2nd method.

Plate 4.—Fig. 2.

I have taken structural concrete figures for drilling into what will, at least partly, be mass concrete. Any loss of time due to this will favour the second method, which has less drilling to do and that nearly vertical instead of horizontal.

Next, we have a small bridge, No. 5, a portal frame. It is not quite a normal one as, firstly, the steel does not go right through in the top member and, secondly, the abutment foundations go very deep on account of poor bearing. The first helps us but little and the second is a distinct drawback.

In this type, I have found no one really fatal point to attack. A blow at an abutment only causes a tendency to rotate about the

inner toe of the further abutment and a consequent mere digging by the roadway into the filling above the blow. At the centre of the span, a slight sag might be produced, which could easily be repaired. In this case particularly, owing to the depth of the abutment walls, craters behind them would also be necessary to cause any considerable movement and this, I think, is the best solution.

One row of 18 holes at 2-foot intervals across the centre of the bridge and two camouflets sunk 6 feet deep, 4 feet behind one or both abutments, holding 40 pounds each is suggested. One party of 6 could place these charges in $1\frac{1}{2}$ hours for the borehole and 1 for each pair of craters. An increase in the party in this case would more or less proportionally reduce the time by allowing two or more jobs to proceed concurrently.

Failing camouflet equipment, I favour one series of boreholes half-way up an abutment, or two series well spaced in height at A, and another lot across the opposite angle at B to enable the bridge to hinge on that line. The weight of the bridge not being great, however, I should not expect the steel to be torn out to any great extent and the drop might be disappointing until some, at least, of the steel was cut by a subsequent attack. As a variation, the effect might be tried of having fewer holes in the abutment, driving them farther through into the filling and blowing small camouflets behind, say three or four 20-pounders.

Bridge No. 6 is more or less of the type indicated in the *R.E. Pocket Book* and the method recommended there would be suitable. The actual positioning of the holes requires, however, a little thought. One hole down through the centre of each would be the ideal, but unfortunately it is too probable that, over the abutment, there will not be enough space between the steel to get the drill down through the top layer. To make a good job of it, it will be necessary also to get below the bottom layers in order to deal with the corner strap and no drill will get through both layers.

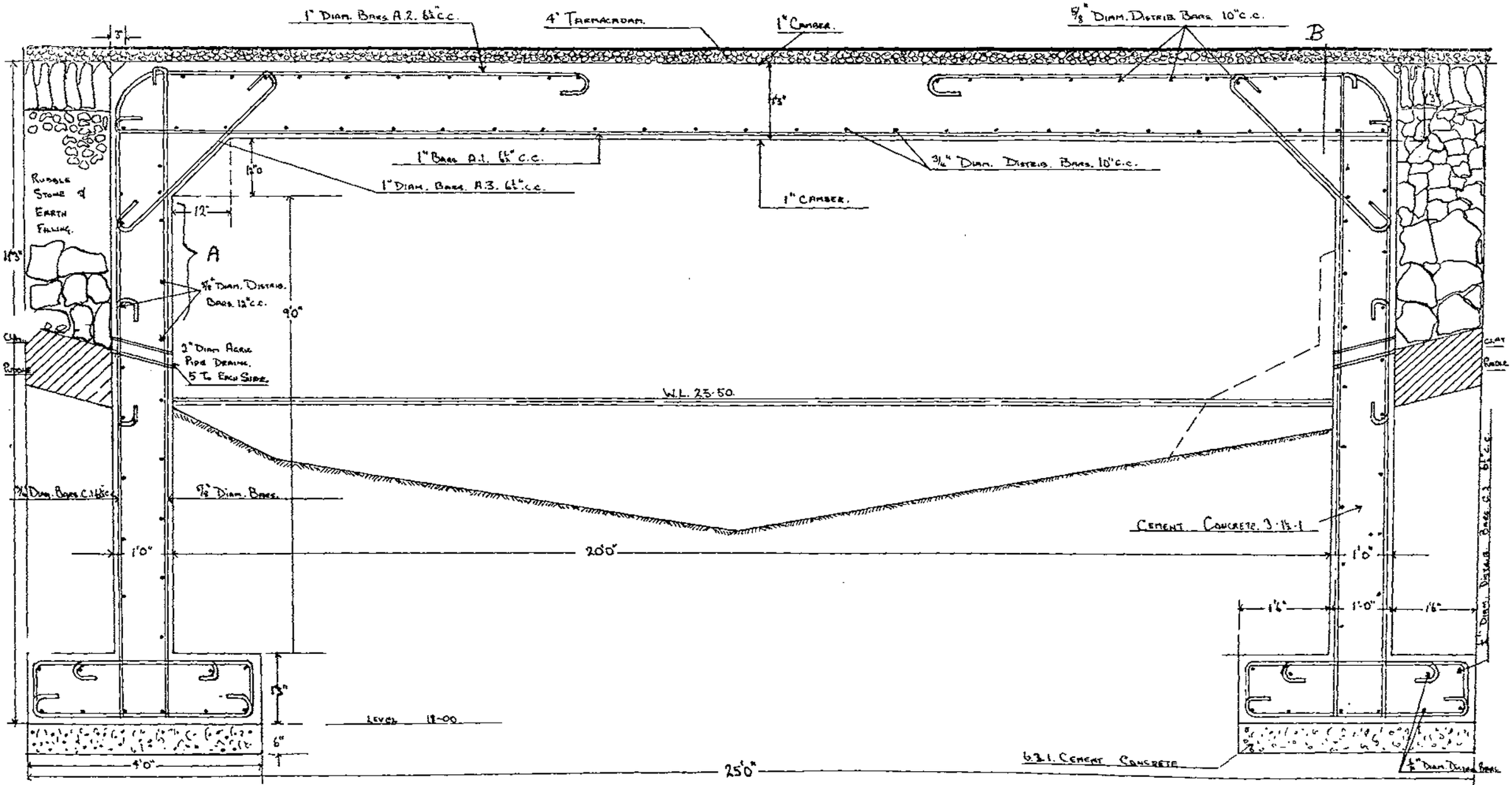
My recommendation, therefore, is to put a hole down close on each side of each beam about 2 feet back from the front face of the abutment. The outside beams beside the sand-filled channel will need special treatment in the form of sloping holes.

The total of 10 beams will therefore need 100 feet of vertical drilling, *i.e.*, 2 hours, say 4 hours for the whole demolition and 100 pounds of explosive.

Bridge No. 7 is of little interest as a demolition, but is put in as an example of the vertical beam type, in which the abutments are supposedly held up by the slab. In this case, there would appear to be little doubt that they are fully capable of acting as retaining walls.

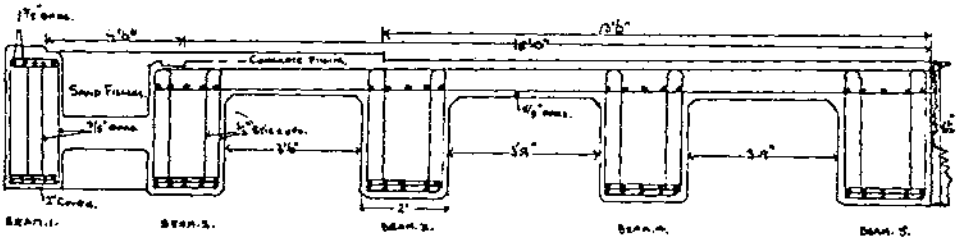
The abutments are easily attacked from the top or face. The weep holes, of 3-inch agricultural drain, would quite likely obviate the necessity for drilling, though I regret that my plans did not show

BRIDGE No. 5.

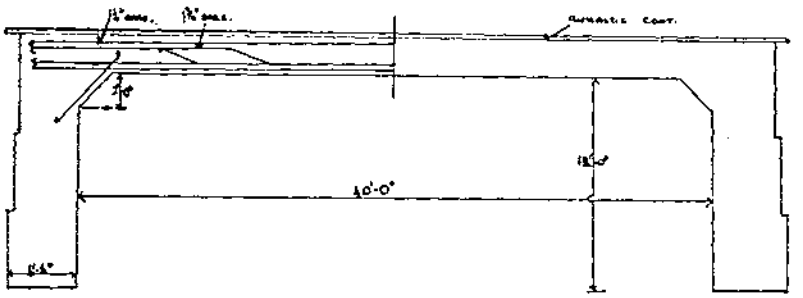


Cross Section.

BRIDGE No. 6. Plate 6.

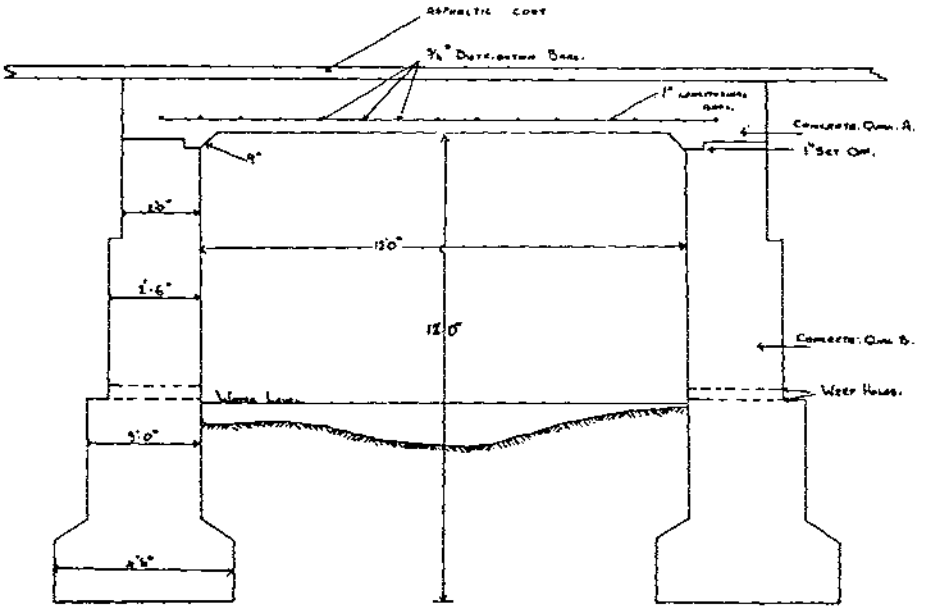


SCALE: 4 feet = 1 inch.



SCALE: 10 feet = 1 inch.

BRIDGE No. 7.



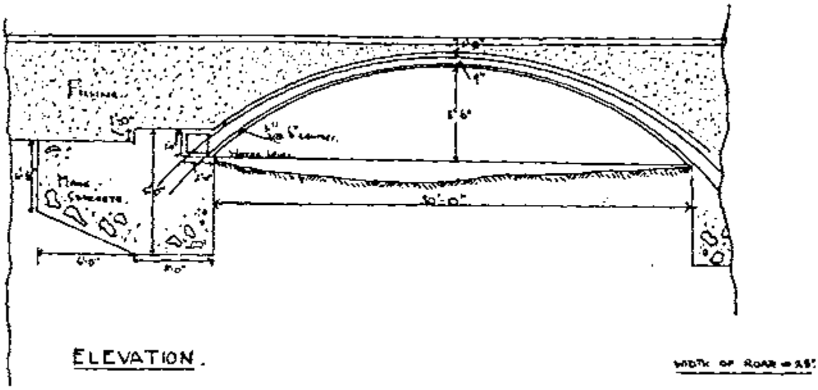
Width of Weir 28'.

ELEVATION.

SCALE: 4 feet = 1 inch.

BRIDGE No. 8.

Plate 7.

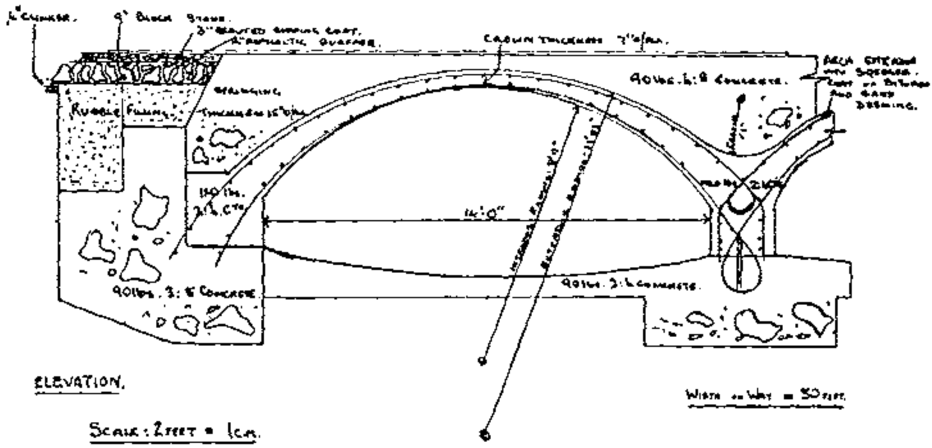


ELEVATION.

WIDTH OF ROAD = 25'

SCALE: 10 feet = 1 inch.

BRIDGE No. 9.



ELEVATION.

Width of Way = 30 feet.

Scale: 2 feet = 1 cm.

their distance apart, nor have we figures for the radius of action of a 3-pound charge. I think, however, a line of charges higher up would give less chance of the bridge holding up by jamming.

It should be noted, however, that there may be no external indication differentiating this type from the portal frame, except possibly the span.

Bridge No. 8 is, I consider, a hard nut that is probably well worth leaving alone. Damage at the abutments would produce, by itself, negligible sinkage, at the crown it would produce a reduction in the weight-carrying capacity easily repaired. Successful attacks at all three would drop the bridge, but the debris would, in all probability, still leave an easy passage for most military traffic. Craters over the abutments cannot be deep and will, almost certainly, be better placed elsewhere.

Bridge No. 9 is even worse, the arches are half the size and much stronger, the filling, even, is of mass concrete and a deviation is too simple.

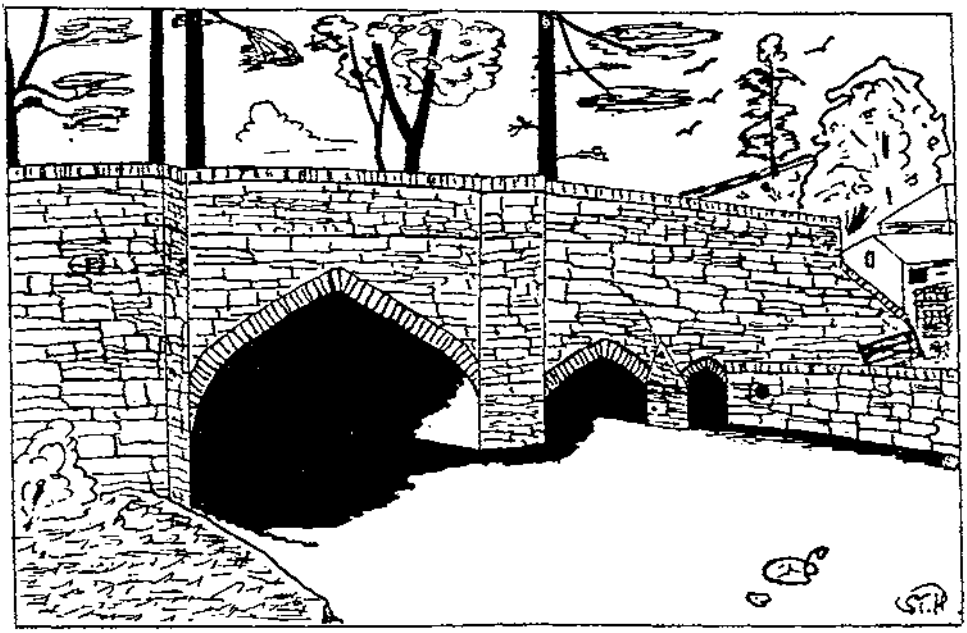
It also, as a matter of fact, camouflages itself as masonry with a stone facing. I should strongly advise anyone to leave it alone.

The remaining drawings relate to bridges of which, except in one case, I know no further details, and are added so that readers may, if they like, while the subject is, I hope, still hot in their minds, decide what would be the best way to attack them.

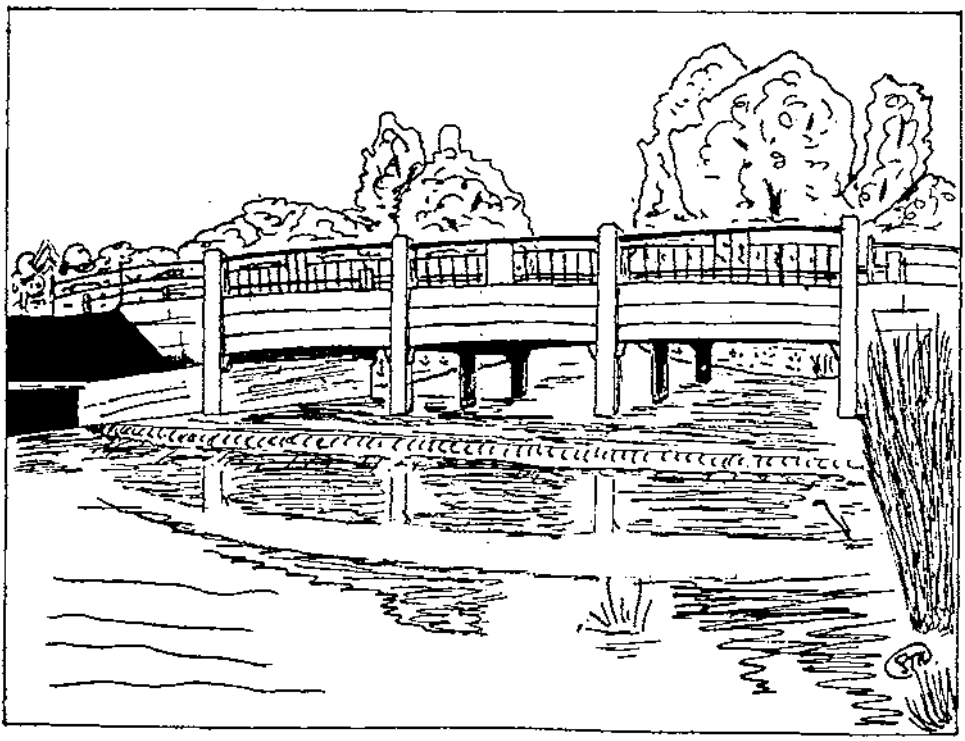
The one case is that of Bridge No. 10, which is put in as an example of an arch-deceiver (the pun, I assure you, was not intended, at the first draft) having been strengthened and widened in R.C. while retaining its ancient appearance, and it is, I fear, one of many.

In conclusion, I wish to record my very sincere appreciation of the manner in which the bridge engineers, whom I consulted, placed their time and trouble, apparently unlimited, at my disposal, allowed me to copy or carry off plans and displayed the keenest interest in proposals to destroy, however academically, their own treasured masterpieces.

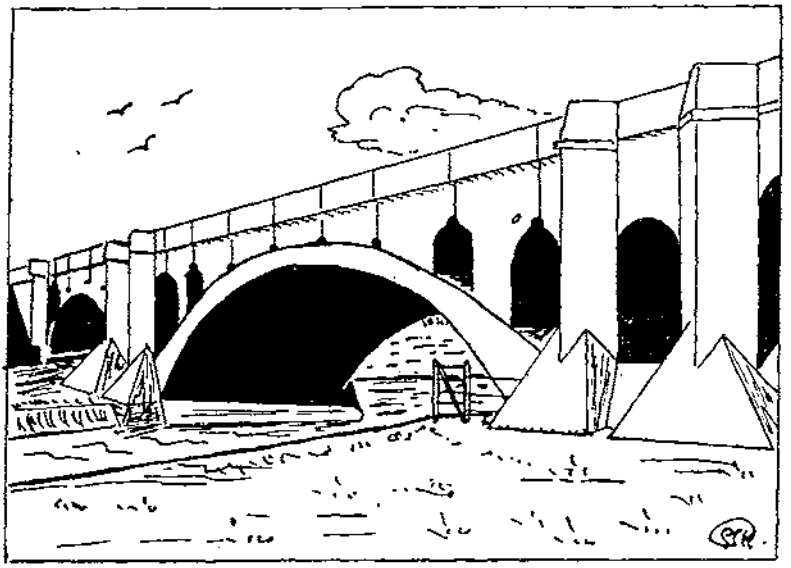
BRIDGE No. 10. Plate 8.



BRIDGE No. 11.



BRIDGE No. 12. Plate 9.



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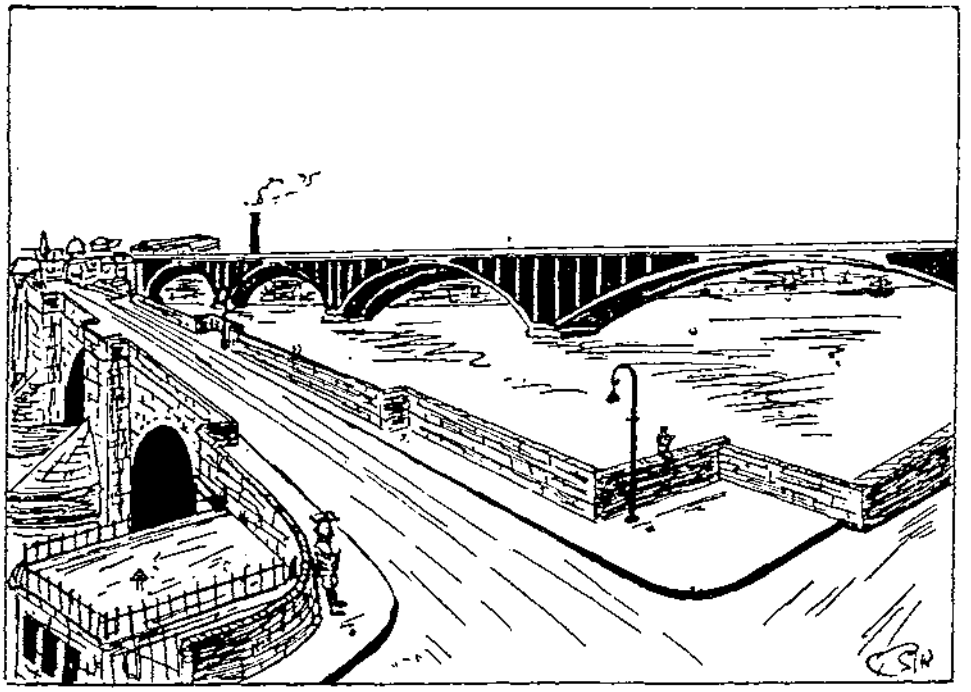
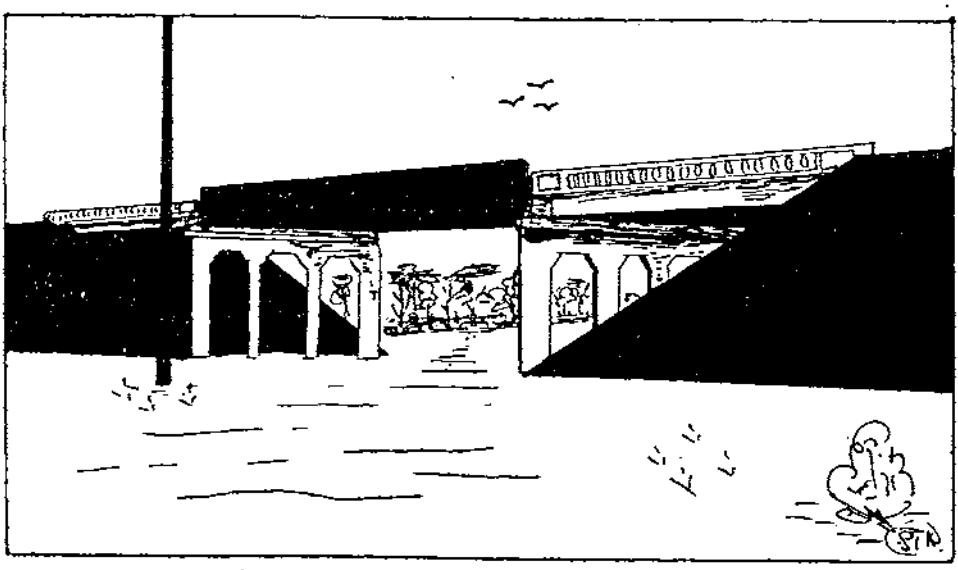


BRIDGE No. 14. Plate 10.

Open Abutment.

BRIDGE No. 15.



Skeleton Piers.

SKELETON OR OPEN ABUTMENTS.

A MINOR EXPEDITION.

By CAPTAIN M. T. L. WILKINSON, R.E.

AT the beginning of December, 1935, the 9th (Field) Company, Royal Engineers, had settled down comfortably for the usual winter training; the O.C. had disappeared to the Senior Officers' School, and the Sappers were employed in building a new bath house for their own use and winning the local football cups.

Suddenly, to the delight of a few, the surprise of all, and the mortification of many, came orders that the company would embark for Egypt on New Year's Eve. A special establishment of Headquarters and two sections had been devised by the War Office, and special equipment tables for this "mock up" had also been drawn up. The necessary personnel was made up from other units, and the stores partly from mobilization store and partly from Ordnance. As it is not the purpose of this article to describe the difficulties of getting away from Shorncliffe, it is merely pointed out that the unit found itself in S.S. *California* on the right date, and that the transport, tools, etc., were also loaded in time but into another freight ship.

After a very comfortable sea trip to Alexandria, and a not so comfortable train journey to Cairo, the unit was installed in the barracks at Abbassia, usually occupied by the 2nd (Field) Company, R.E. Three weeks in all were spent there, while the C.Q.M.S. made up the stores lost in transit, the M.T. section painted the transport in futuristic camouflage designs (now called disruptive painting), and the Sappers route-marched in the neighbouring desert.

No one was really sorry (until they got there), when at the end of January, 1936, the company was moved to Mersa Matruh, a small town about 200 miles west of Alexandria, on the Mediterranean. The journey was made by train, even in the case of the transport, as far as railhead at Fuka, and the last forty odd miles by the so-called road, which in reality was a dust track.

At first the whole of the force at Mersa Matruh, except for a few high officials who lived in bug-ridden native houses, was under canvas; it was the duty of the Sappers to provide water at these various camps, connect them up by roads, and later to provide a certain amount of hutted accommodation. Also a section had to be maintained at the smaller camp of Sidi Barrani (90 miles west of Matruh), and the track kept in order between these two places.

Thus, there was plenty of Sapper work available, and any tradesman could be certain of a variety of tasks.

A list of a number of jobs carried out in Egypt by the 9th (Field) Company is given; some have probably been left out but it gives a good idea of the sort of use that may be made of a Field Company on a minor expedition of this type.

Blacksmiths.—Oxy-acetylene welding; sharpening picks and other tools; cutting rails for splinter-proof roofs.

Carpenters.—Making goals for hockey, soccer and water polo; making diving rafts; building a cricket pavilion; laying floors and making doors; building boats, both rowing and sailing; making bridges into camps and M.T. parks; making setts for mine shafts; hut building, including officers' and serjeants' messes, engine sheds, barrack huts, institutes, garages, litter sheds, workshops, telephone exchange, mortuary and disinfestor shed; erection of ablution benches, latrines, cook-houses and other camp structures.

Painters.—Sign writing; disruptive painting.

Concreters.—Foundations for huts; facing walls; pre-cast concrete blocks; mortuary slab; making concrete cricket pitches; concrete strips for wheel tracks; rendering insides of stone water-tanks.

Plumbers.—Maintenance of water-supply systems; erection of water points; fitting 3-ton lorries with tanks and sprinklers for road watering use; erection of showers and ablutions in camps; installation of hot-water systems.

Electricians.—Installing electric bells; installation of E.L. plant, fittings and line.

Surveyors.—Survey of water-pipe system; chain survey of camp; survey of rifle range.

Bricklayers.—Building brick walls.

Fitters.—Running concrete mixers; running ice-making plant; running water-supply pumps—Aster-Gwynne, Tangye, Pelopone and Blackstone; running compressors for:

(i) Assisting infantry with defences.
(ii) Levelling off rocky roads.
(iii) Digging foundations for huts.

General.—Digging wells; division and issue daily of native rations up to a maximum of 1,600 camped up to 100 miles away; paying natives as above; providing medical orderly; erecting burglar-proof fences round depots; providing garrison librarian; making a rifle range out of local material; running a military post office; carrying out the duties of Field Cashier; erecting and dismantling Piggott pressed steel tanks; loading and unloading trains; road-making of mud, stone, sand and clay with extemporized tools and equipment to stand up to tracked vehicles; making football and

hockey grounds, tennis and deck tennis courts; erecting and dismantling steel-framed huts.

The majority of the smaller tasks were straightforward once the tools and stores were available, and it is not necessary to enlarge on the methods of carrying them out. Some of the larger projects, however, presented interesting features.

Before giving fuller details of these projects, it would be better, perhaps, to explain the method whereby the company obtained the necessary tools and stores, and any extra labour required. The mainspring of all this supply was the Adjutant R.E., whose official title was Officer i/c R.E. Dump; he was assisted by the R.S.M., and a number of Sapper storemen and clerks, drawn from all the companies.

How he kept his dump stocked was a mystery, but it always seemed possible at a moment's notice to obtain from him anything from a tintack to a concrete mixer, or from an unskilled Bedouin labourer to a highly-skilled Egyptian carpenter. There was usually plenty of R.A.S.C. transport available for moving the stores, except when the G. staff insisted on a " mobile " exercise.

Apart from water-supply the two main tasks that the company had to tackle were, in order of importance:

(*a*) Roads.
(*b*) Hutting.

(*a*) *Roads.*

To understand the road-making difficulties that arose in the Western Desert, it is essential to know what is meant by this word " Desert." Films give one an idea of a desert as a place of rolling dunes of glorious golden sand, and evidently this is the impression gained by some of the authorities, as vehicles ordered from home to be painted in a " desert " colour, appeared a vivid yellow. In actual fact the Western Desert is very drab; the surface is composed of a crust of dried earth, which very easily disintegrates when traffic passes over it; the ground is liberally dotted with patches of low scrub, which have the effect of binding the earth together. Unfortunately the first action of any troops camped on this type of ground is to uproot all the scrub to give the place a tidier appearance, and this encourages dust storms.

The roads that had to be made or maintained over this ground were two types:

(i) Local roads in Mersa Matruh.
(ii) Mersa Matruh—Sidi Barrani road.

Considering first the matter of local roads. Originally there were no defined roads or tracks, and traffic found its own way. In a short time the passage of hundreds of lorries and even tracked vehicles,

for no one walked who could travel in M.T., had reduced the desert crust to a fine dust. This dust blew over, under and into everything; it acted adversely on the insides of men and vehicles, and the slightest wind made the atmosphere worse than any London fog. The first step taken to eradicate this trouble was to mark out tracks with "kerbs" of small stones, and then to water these tracks with sea water, the method of doing which will be described later. The effect of the water was to harden up the crust and make quite a good surface, provided that vehicles travelled at a moderate speed; in cases where the track was too bad for the water to be effective, the bad piece was cut out and relaid with a special green clay, collected from a site about four miles away (Photograph 2). This clay, having been watered, was rammed into place by a party of Bedouins, slowly chanting as they raised and lowered the home-made rammers, and the result was a fine hard surface.

At least ten miles of road had to be watered daily, and for once the Dump was unable to produce the ready-made article in the shape of a road sprinkler. However, a number of "mock up" sprinklers were soon made up; these consisted of R.A.S.C. 3-ton vehicles fitted with 400-gallon tanks and locally-made sprinklers. Naturally the R.A.S.C. did not provide its best lorries for this purpose, and the combined effect of sea water and running the lorries very slowly, led to a lot of mechanical trouble; the tanks also were a source of trouble, and their repair gave plenty of employment to the welders.

To fill these tanks, two water points were erected; these consisted of standard 1,500-gallon tanks (as then carried in the Field Company), fitted into a wooden frame on a staging (Photograph 3); the tank-fitted lorries could be backed up alongside the staging and filled with sea water by gravity. The water points themselves were supplied with sea water by Blackstone pumps or, on the days that these proved recalcitrant, by Rees Roturbo pumps.

This method of keeping the roads or tracks in order proved very successful, and later each unit had one of its trucks fitted as a road-sprinkler, and by this means kept down the dust in its own lines.

Turning now to the Mersa Matruh-Sidi Barrani road, this presented quite a different problem. The distance between these two camps is about ninety miles, and it runs at five or six miles from the sea, which precluded any water being used in its maintenance. It will be found marked on the map and labelled "Grand Khedival Road." In actual practice it was difficult to distinguish the road from the surrounding desert, except in a few places where a little bottoming had been put in by the Egyptians; when the Army first arrived in the desert, the road was in fair condition as it was so little used, but a few months of military transport wrecked it in no uncertain degree.

The only facilities for road-making were unskilled labour, picks, shovels, stone, sand and a few lorries. Even the lorries were a

A MINOR EXPEDITION.

1.—R.E. Mess, Mersa Matruh.

2.—Green clay on-loading point.

3.—Sea-water point and 3-ton lorry fitted for spraying.

A minor expedition 1-3

difficulty, as when twenty were required for a fortnight, the best offer was one hundred and forty of them for two days. Camps of half a dozen Sappers and three or four hundred natives were established at four points on the roads, and these parties had to maintain their lengths of road by any means they could. It was like milking a he-goat into a sieve, and it was a marvel that the road was always kept open. Various experiments were tried; clearing the desert of scrub as a diversion from the road; laying stone and hoping that the traffic would roll it in; laying wheel tracks of stone with Colas binding; and when near a water-supply, laying wheel tracks of concrete. However, one always felt that the traffic would win in the end, unless better equipment was provided, and it was a genuine relief when the work was abandoned on the evacuation of Sidi Barrani. (The road was later taken over by the Egyptian Government, to be completely rebuilt.)

(*b*) *Hutting.*

Hutting came as rather an afterthought, but when it was started the work overshadowed all other Sapper enterprises, since here was a thing that the non-technical arms could easily understand, and where they were on safer ground with their criticism. The main hutting to be erected was men's, serjeants' and officers' messes and canteens in that order, with priority of units decided by the G.O.C. The first huts were all of wooden construction, but later the standard steel hutting was used.

(1) *Wooden Hutting.*—The wooden huts erected were designed in the Dump and were all of 18- or 28-foot span; the length, of course, varied with the unit and the purpose for which intended and the longest hut erected by this company was 130 feet, although later in Palestine a similar hut 330 feet long was erected. The wooden framing was covered outwardly with corrugated iron sheets, and inwardly with any lining available, such as Insulite, Tentest or three-ply. The huts had wooden floors laid on joists which were, in their own turn, supported on wooden piles, and for the windows, Window-lite was used instead of glass.

The trusses and sections were made up in the R.E. Dump by native carpenters on templates, and the stores were taken to the site in R.A.S.C. lorries towing pontoon trailers, on which the large trusses could be carried. At the site, mixed Sapper and native labour erected the hut, each gang doing the same task on each hut, *e.g.*, piling, flooring or lining, etc. Later, these huts had to be dismantled and packed into trains, so that they could be re-erected in Palestine by the same men; after dismantling, trusses, sections, piles and flooring could be and were used again, but the corrugated iron had too many nail holes in it to be really useful in a wet climate. The floors were cut into sections for transport to Haifa and carefully

marked, but unfortunately the movement control staff delighted in playing with the trains, and no two pieces of the same floor ever reached Palestine on the same day.

(2) *Steel Hutting.*—Standard huts of various spans were erected, but this type of hutting was not popular, as it took longer to erect than wooden hutting; this was mainly due to the necessity of a wooden framing to carry the lining of the hut. Also, during erection, there was a very real danger of the whole hut coming down before partitions were put in to act as bracing; two large huts collapsed (not erected by this company), just when the steel framework was completed. Dismantling also took longer, and greater care was necessary than with wooden hutting.

There is no doubt, however, that it was the snags and not the straightforward work that was good training. Every Sapper had a responsible job, and it was up to him to devise some means of overcoming any difficulties, which had probably never been foreseen in any textbook. The writer himself had a lot of worried moments, but the worst did not occur until the company got to Palestine, but is worth including in this article as an example of what is not to be picked up by any amount of "studying the manuals."

A camp was to be got ready for the 1st Division in Haifa, and the water-supply was to be tapped off the town main. Four miles of 4-inch victaulic pipe were to be used, leading from sea-level to a tank on the 30-metre contour; so many cubic metres per hour could be delivered by the contractor at so much a ton, and the staff wanted so many gallons a day. The subaltern latest from Cambridge, complete with his Molesworth, was called in to figure all this out, and he insisted on knowing the head of water in the town main; when the contractor told him "seven atmospheres," he was obviously puzzled. He decided, however, that the water would reach the tank, and a nervous time ensued when the water was turned on and stopped half-way up the hill, with the 1st Division already disembarking. However, an inspection of the line cleared up the trouble, when some packing notes were found jamming the water meter. Certainly the paper should not have been there, but then there would have been no moral to the story either.

MEMORIES OF AFGHANISTAN IN 1879.

By MAJOR-GENERAL SIR LOUIS JACKSON, K.B.E., C.B., C.M.G.

Ali Musjid was the first dish cooked which made the Ameer look down
His nose at the daring way in which 'twas captured by Sir Sam Browne,
But the advance of the Murree Brewery caused him to break teetotal,
Especially when he heard of the licking he got at the Peiwar Kotal
From Roberts's Force.
He got drunk on bilati pani to drown his remorse.
(Air " Bow Wow Wow.")

From a Camp Fire Song. Jellalabad. April, 1879.

READING the other day a letter from my son (who was then D.C.E. with the Wazir force), his mention of a day's reconnaissance from Razmak by motor-car, aeroplane and armoured-car made me smile as I recalled my own experiences in those parts 58 years ago. After such a long time one's memories are rather patchy, but fortunately some letters of mine to my family have just turned up and serve to fill the gaps.

I went out to India in the winter of 1878–9, in the old troopship *Euphrates*, landing in Bombay early in January. There were three other Sappers on board, Reggie Hart, C. B. Mayne, and another whose name I have forgotten. Hart was then a subaltern of ten years' service returning from Indian leave, Mayne was a contemporary of mine. Hart, of whom I was to see a great deal in the next few months and who became a great friend, was a man of uncommon type whose very quiet, courteous manner and gentle voice masked a regular fire-eater, a Bayard in his thirst for adventure. He was the best of comrades, kindly and cheerful, but had one peculiarity; he was entirely without a sense of humour. It was not safe for a stranger to chaff him, however good-humouredly, for he might think he was being insulted and want to call the man out. This actually happened once when I was with him, and it took me two hours to calm him down.

At Bombay, to our great joy, we got orders for the front. The Afghan war had been going on for two months and Sir Sam Browne with the Khyber force had reached Jellalabad. Colonel Maunsell (afterwards General Sir Frederick), a Mutiny veteran, who commanded the Bengal Sappers and Miners, had moved the headquarters *en bloc* from Roorkee to the front, and we were all to go up at once. I found myself posted to the 6th (Field Telegraph) Company, B.S. and M.

There was also an invitation from the Chief Justice of Bombay to stay with him in passing through and a letter from my father, who was then a Judge of the High Court at Calcutta, saying that he had got me a month's leave and I was to join him at Calcutta. This might have been the sensible course, as my father, who liked to do things on a large scale, would have given me a first-rate camp kit and seen to it that I had some good servants. But it did not at all sort with my ideas, and meeting Hart at the station next morning, we decided to go on at once, collecting some kit *en route*. We were both of us boiling with impatience, Hart because it was his nature to, and I, because it was my first chance of seeing active service. In truth I was very young, and Verdant was my middle name.

I think Pindi was then the rail-head, anyhow, we halted there. We had no money and for some red-tape reason neither the pay-master at Bombay or Pindi would make the necessary advances. So we walked into the bank and made our request. The manager asked if we had anyone in India to whom we could refer. I mentioned my father and he promptly drew a bill on him for Rs. 500. The result was that, a few days later, Honourable Judge was considerably annoyed when, as he was sitting in Court hearing a case, a bailiff walked in and demanded Rs. 500 on the spot. However, we being now in funds bought some more kit. Khaki was, as we were told, the only wear, so I got from a tailor a suit of mud-coloured broadcloth of more or less military cut.

We went on by *dak* to Peshawar where we got ponies and servants at war prices. Hart wanted me to grow a beard. I thought not, but he settled the matter in his own way, for as he had undertaken to trim our ponies' ragged tails, I found next morning that he was doing it with my razor. Then we rode on to Jamrud, getting there in record time from Bombay.

There we had some luck, because a so-called punitive expedition was about to visit the Bazar valley and Hart, having a friend on the staff, managed to get us attached to the 24th N.I. who were going. It happened that Lieut.-Colonel Norman, who commanded them (afterwards Major-General Sir F. Norman), was a connection of my family. Before we started a minor misfortune occurred. I had bought a camp-bed, a miracle of lightness, which, however, was so fragile that it had to be treated with great consideration. C. B. Mayne, who had just arrived, came to see me and sat on the edge of the bed. As he weighed 16 stone that was "done finish" for the bed. I mention this because it had results later.

We trekked off up the valley, at first a narrow gorge with a stream which we had to ford every 100 yards as the path went from side to side, but which soon opened out. There were, as well as I remember, some of the 60th Rifles, Gurkhas and 24th N.I. On the second morning I was sent off with a Jemadar and a few of the 24th, to

picket a hill while the force went by. I knew no Hindustani and the Jemadar no English, but we got on very well with signs. We sat on the hill all day, saw the last of the camels pass and then came down. Then we were fired on for the first time and a sepoy showed me proudly a jezail bullet that had hit his ammunition pouch; but we saw no one, and so followed on to camp. There was a good deal of sniping in the camp at night, but no particular damage done. So after three or four days we reached the main Bazar valley and camped, sending out parties on the following days to blow up towers. We were joined in Bazar by the 45th Sikhs and some other troops from Dakka.

The Pathans were now gathering very thickly round us in all the hills, and sniping at night made some casualties. The 24th went out one morning to climb a ridge behind the camp. When we reached the top we could see far over the country, but, of course, the snipers had all gone home to breakfast and so did we. The Gurkhas begged to be allowed to go out at night with only their *kukris* and stalk the snipers, which seemed an excellent idea, but the General refused. He was an old man with Crimean memories, and I suppose he thought it unorthodox. Also there was a nervous horror at headquarters of having to report casualties.

One morning Captain Chapman's company of the 24th went back to meet a convoy that was coming across the hills from Lundi Kotal, and escort it in, so Hart and I went with it. We marched a few miles and met the convoy just where they had come out of the hills into the Bazar valley, which here was more of a wide *nullah*. About three-quarters of a mile from this point on our homeward route was a small hillock in the middle of the *nullah*. Here I halted with Hart and Chapman and waited for the convoy to pass. The tribesmen, who had been very keen to loot the convoy, were out in strength in the hills on either side. Just as the last of the convoy passed us, there was a commotion at the point of junction. A post had just come through from Lundi Kotal, carried by "Catch 'em alive oh's," escorted by two *sowars*. As they came into the valley, they were fired on, both *sowars* were wounded; one came galloping towards us, the other one went down with his horse in a bed of rushes, in the middle of the *nullah*. The tribesmen came running down from either side to finish them off. I saw Hart talking hurriedly in Hindustani to Chapman and a native officer, then he turned and ran down the hill. I wondered what he had gone for, and presently saw him running down the valley, and Chapman followed more slowly, collecting his men. It was too late to join Hart, and knowing no Hindustani I was rather in the dark as to what was going on, but with field-glasses I could see some Pathans running towards the fallen man. I gathered half a dozen men and fired some long-range volleys at them, and then went down the other side of the *nullah*,

to protect that flank. Hart reached the man, and then some Gurkha skirmishers came down from the flanks and joined him. They were under fire from a low cliff close by, so they picked up the man and carried him to shelter under the cliff, Hart stopping to save the saddle. It was extraordinary that he was not hit, at such short range.

While they waited there for more help, Hart wondered whether the Pathans would try to rush them. A Gurkha said: "Rush! I should like to know who's going to rush ME!"

Then Chapman came up with some more men, and they brought the *sowar* in, but he died on the way. Thus Hart got his V.C.

It was curious that, long before I knew him, I saw him twice in leading rôles. As a small boy at Woolwich I saw him win the steeplechase at the Shop, and about a year later I was on the pier at Boulogne one evening when he saved the life of a fisherman. The man had fallen overboard from a boat entering the harbour. Hart saw it and dived straight in after him, not knowing that the wooden pier was built on a sloping stone embankment, against which he cut his head severely. He got his man, but, half-stunned as he was, could not support the weight, and went to the bottom with him, holding on. His younger brother Horatio (another Sapper) went in after him, and between them they brought the man out.

I do not believe that this is known by anyone now, and am glad to put it on record about my old friend.

We stayed several more days in the Bazar valley, having a fair-sized brush with the tribesmen one day, which led to nothing. Then there was a great *jirga* and a sort of truce. Some of the column went back to Jamrud, and the rest across the hills to Dakka. Camp rumour had it that the punitive expedition ended in our buying our way out with rupees and rifles, but that can hardly have been the case. Hart and I went to Dakka with the 45th Sikhs.

In the old fort at Dakka there was great talk of an expected attack. A padre was there who was correspondent for the *Pioneer*, and a few days later that journal had a letter: "There are 40,000 Mohmands in the hills assembling to attack us. Let them come—they will find a warm welcome." Some weeks later on, at Jellalabad, there was an alarm one night, to get the troops practised at their posts. Most of us Sappers had nothing to do, but we turned out and were sitting in the mess tent, smoking, when this same stout-hearted correspondent came in, much troubled in mind. He sat down among us and looked from one to the other. No one said anything, for we were all sleepy. Presently he burst out: "We have been lulled into a false security, but this is indeed a rude awakening!"

From Dakka I went on into the Jellalabad plain, and just out of the hills found my C.O., Stafford, of the 6th Company, with Ancrum, the other subaltern, both of whom I had known at Chatham. They were carrying on the field-telegraph line to Jellalabad, so I joined

them in the work and a few days later we got to headquarters. There, as our own work was finished, I was at once put on to roadmaking, and preparing a ford.

And so for nearly two months the whole force waited, inactive, while Cavagnari was negotiating with Yakoob. Then the rains came on. In one of my letters, dated March 14th, I find: "There was some talk of an advance to be made shortly; but at present it is impossible. The camp is such a swamp that the camels can't even walk across it without subsiding into ditches at the side of the road —there they stay all day. The horses are very miserable, and we are not too comfortable."

At this time I got a sharp attack of dysentery. In my inexperience I had dug out the inside of my Swiss cottage tent, two or three feet, to get more head-room, and as I had no bed, was sleeping on a ground sheet laid on straw. With the camp latrine, which was simply a canvas screen, fifty yards away across the mud, and incessant rain, the conditions for a dysenteric patient, especially at night, were such as the British public to-day would not approve. However, presently our Quartermaster came up from Roorkee, bringing with him some Roorkee-made camp equipment, out of which he spared me a bed, and I soon began to mend. My father heard that I was ill, and wrote to the General, but by that time I was sound again.

Another extract: "Two days ago, Sir Sam Browne sent for me —said that you had written to him—that he had heard of my being unwell, but that I must take care of myself, and so forth, and that he would write to you. He was very kind—and the next day I had practical proof of his interest, in being taken off the road which has been my sole charge for about six weeks. Since then the situation has been most amusing. If I attempt to go out to any work, some distinguished official throws himself into my path, and implores me to lay aside my rash purpose. If I meet Colonel Maunsell, he inquires with tender solicitude whether I took *chotahazri* before venturing into the morning air; and thus all day I am environed by delicate attentions. On the whole, this sort of thing is more annoying than gratifying."

Meanwhile, on the night of March 31st had occurred the affair of the Kabul ford. "The 10th Hussars started at midnight with an expedition for the Loghman Valley to try to intercept Azimullah Khan. Our bridge over the Kabul had been dismantled some days since, and they had to cross by a ford. Of the guides who had been provided, several failed to appear, and the 10th had to cross an intricate ford in the second branch of the river without direction. As far as we can gather in the multitude of reports, they seem to have crossed in double file and in close order. They missed the ford and got carried away by the current—and out of a total of 5 officers and 70 men, 1 officer and 46 men were lost. Our brigade major, Lovett,

was riding back from the river, after seeing them across the first branch, when he was passed by a stampede of riderless horses towards the camp. Suspecting an accident, he went back with help, and took a boat, that we recently built, down the river. They were able to bring back several men and officers who had been washed down the stream, including Napier, the adjutant. One horse was found this morning in a quicksand. They tried to get him out with the help of elephants, but failing had to shoot him. The men who have been found to-day have, almost all, hoof wounds in the head, showing that the confusion in the water must have been something terrible. We are all very cut up about this."

This was written the following morning. Later we learnt the real cause of the disaster. Some yards from the farther bank the ford bent sharp to the left, upstream, and below it was a deep pool. The squadron of native cavalry who went first followed the bend and got safely across. As there were not enough guides, the last half of the squadron of the 10th gradually lost direction and rode into the pool. The situation was made worse by the fact that, just before crossing, the men had been given the order to sling carbines by some staff officer. It must be added that the R.E. had some time since reported against this ford as being too dangerous, but the advice of the political officer was taken against theirs.

About this time occurred the fight at Futtehabad. "By the way, General Gough's brilliant victory over them at Futtehabad was not quite the tactical triumph of science over numbers that the newspapers will probably have described to you. He is a dashing cavalry general, and went out with the Guide cavalry, some of the 10th and the R.H.A., to make an example of the enemy. When he got there, he found that they were 6,000 strong, and very well posted; and so far from running away from the guns, the guns had to run away from them. The infantry had to double out three miles from camp to support, urged by frantic and un-Wellingtonian messages from dozens of gallopers. The guns, after retiring once, were only saved from ignominious flight by a really fine charge of the Guides, over very bad ground, which cost Major Battye's life. However, the result was eventually most decisive."

Stafford and Ancrum had gone on with half the telegraph company and the advance troops while I was on the sick list, and I followed with the rest of the company about the 12th of April.

"Sufed Sung, 19th April.

"We had two or three rather hard marches up here. The first, from Jellalabad to Bhaullee, was about 12 miles, partly along, or rather near, the Kabul River, and all of it through a deep, sandy plain, here and there very thickly strewn with stones. The second, from Bhaullee to a camp two miles short of Muila, was better, as

part of it was among fields and there was plenty of water about. There I joined Stafford, who had been laying the line from Futtehabad, and on the next day we got away early and completed the line over some rather difficult ground, opening it in camp here about 3 p.m. I think the General is pleased with the work of the Company. We have quite cut out the Army signallers, who find their post a sinecure.

"About two miles from Futtehabad is what may be called the head of the Jellalabad valley, as the ground is cut up by small, irregular groups of hills which soon shape themselves into one or two ranges of medium-sized hills running parallel with the Safed Koh. The Gandamak Valley, of which the Surchab is the most important stream, is formed by the Safed Koh and one of these ranges. This camp, which overlooks the valley as far as the old cantonment of Gandamak, about three miles off, is at the foot of the hills which block the eastern end of the valley. Behind us the country grows gradually more and more barren—in front, it smiles invitingly. Water is plentiful, some of the hills are almost clothed with turf, and the pines and snows of the Safed Koh are pleasantly close. Though not quite the land of milk and honey I have heard it described, Gandamak is a very pleasing contrast to all the country in our rear. This place takes its name from a white stone which the natives had in great regard. I say had, because Stafford and I had the pleasure of blowing it to fragments on Friday. It was very large, as hard as iron, and chiefly composed of pure white lime marble. A road has been made as far as this by the exertions of Major Blair (whose energy, however, was chiefly limited to telling a native contractor to 'go on') and the stone blocked the road. It took us a day and a half to blast it. My company is now employed in making the road to the front. Almost everyone knocked up as soon as we got here with diarrhœa, caused, I think, by the bad water we have had ever since leaving Jellalabad. We have since found two good springs here. The wind is the worst evil, as it blows almost incessantly, bringing a great deal of dust with it. The climate otherwise is cool and pleasant."

The business of waiting for Yakoob to come in now began again. No one in the camp had anything to do, and there was much disgust at our inaction. We all wanted to get on to Kabul, but Cavagnari continued his palavers. A little change came my way, however, as the next letter shows.

"Sufed Sung, 3rd May, 1879.

"Two or three days after writing, I went out with Stafford and the company to camp at Gandamak, for roadmaking purposes, with a company of the 27th N.I. as coverers. . . . We thus became the advanced guard, and were very proud of the position. On the second

evening, just before going to bed, a second company of the 27th turned up in a great hurry without tents, rations, or even blankets, and said they had been ordered out to support us at five minutes' notice. Thanks to the intelligence and forethought of the H.Q. staff, the Subadar in charge had brought no message or explanation of any sort.

"We thought their arrival meant war, and prepared accordingly, strengthening our shelter trenches and putting camel saddles round the camp, with double sentries and everything according to Cocker. The night passed off quietly, and we have not been able to get the slightest explanation of the affair from anyone. However, the next day we got a villager and questioned him—and he said that 1,000 men of the neighbouring villages had camped that night in a *nullah* about half a mile away, intending to attack us. They had gone on in the morning to join Yakoob. My own idea is that a Khan of a friendly village close by, whom we knew to have gone in to see Cavagnari the previous afternoon, had warned him of the rising, and that we were reinforced on that account—the *laissez-aller* system of the Staff quite accounts for the haphazard manner of their coming. Some men were seen prowling about the camp in the middle of the night, and we probably should have been attacked, but for our own preparations. We were 200 strong altogether, and I don't think many of that 1,000 would have seen Yakoob if they had paid us a visit. Our camp was not far from the Jagdalak hill, which Stafford and I went over but did not find any relics. We stayed out there a week and did a good deal of work, being joined after four days by three companies of the 17th. Then were we suddenly recalled, 'for political reasons,' much to everyone's disgust: and are now chiefly employed in making a bridge over the river just below the camp—which bridge will be carried down to Jellalabad by the first rising of the water. Our line is now replaced up to this point by the Government wire, and has been rolled up, but I don't think, even in case of an advance, that we shall lay it any farther.

"There is a very strong impression here that it is all over as far as the soldiers are concerned. Cavagnari keeps his secrets wonderfully; but a careful sifting and comparison of the camp *gup* generally gives a pretty good line. There seems to be no doubt that Yakoob is within very little of coming to terms; and I should be inclined to bet on a brigade going forward with Sir S. B. and Cavagnari to meet him at Tezeen and settle matters. The Ghilzais in front of us have not come in, and the Guide scouts report them as being very sulky and quite ready to fight—but even they seem to expect peace, as a powerful *jirga* is said to be expected, and I have noticed, when at work on the road yesterday and to-day, all their women and children and flocks going homeward in streams. So I suppose it will end in our spending a few months up here convoying

an inverted indemnity to Kabul, to fix Yakoob on his throne and returning in the cold weather, when some of us will turn off to thrash the Momunds and Zucca Kheyls.

"6 p.m. A lot of Wali Mahommed's people came in about two hours ago, who seem to be related to the expected *jirga*; in to-night's orders the pickets are doubled, and officers are not allowed to go more than two miles from camp. The rumour about Yakoob's coming gathers strength."

The rumours were well founded at last, as the next letter shows.

"Sufed Sung. Gandamak. 10th May, '79.

"I have not got a particularly cheerful letter to-day, as I am in a state of general disgust. Here we are camped in this confounded place with nothing but stones all round us, and a fair prospect of staying here for the next two months or more with nothing whatever to do—not even a bit of ground where you can get a gallop. Jacob came in on the 8th. He's an ugly hound—more like a Russian diplomat than a soldier: with a fat, sallow face and black beard. However he does as well for an Ameer as anyone I've seen in these parts, which isn't saying much. I was hard at work for three days before he came in, making roads to his camp and a small bridge over an irrigation cut. It poured all the time—and the day he came in we all tumbled out early to line the road for about three miles as at the approach of one whom the Government delighteth to honour: rained again—all wet through, cursed the Ameer freely. The 40-pdrs. fired away more than 100 pounds of power in salutes, and I hope he was pleased. Nothing has come of the consultation as yet, except a shave that he declines to treat with Cavagnari as being only a Major of low degree. But in that case, why did he come so far for nothing? The practice here is absolute mystery and silence on all subjects, so we shall do nothing and hear nothing for the next fortnight probably. I am the more disgusted with Jacob and things in general, that owing to the continued rain and sitting always under an open tent (the wind blows here incessantly) I have got such a dose of rheumatism that I can't move my head or left arm. Such a thing hasn't happened to me for five years and I am proportionately indignant. Another thing happened to upset my temper, a week ago and just before Jacob's coming was announced. Part of the Division was to hold itself in readiness for an advance without tents on Kabul—and while we were all congratulating ourselves on the chance of a little action, our doctor coolly told me that he had reported me unfit to proceed without baggage, on account of the attack of dysentery I had at Jellalabad. That would have been a pretty end to my travels; for if there had been such an advance, there would have been the squarest chance of a fight since Ali Musjid. The people about here are great fun. It is perfectly natural to them

to bring us in supplies, cheat us freely and fraternize all round, and then after a fortnight to come and gravely confide in one of the servants that after the next day they won't be able to bring any more eggs, as they have got the *hookum* to go off and fight us. The Khugianis, who are now just in rear of us, are very good sort of people. They say themselves—'We are not like the Khyberis: we have only one word. We've fought you and got a thrashing, and now will make friends and work for you and make as much money as we can out of you.' Such a speech shows that they possess the rudiments of civilization.

"The much-vaunted Gandamak is little less a desert than the rest of the country. It is all hills; and the hills are barren and stony to the last degree; but the valleys are well watered by mountain streams running through broad, stony beds: there is a good deal of cultivation round them, with here and there a tree. The wind is generally blowing half a gale and the dust storms are a great nuisance. The odd thing is that they are always most severe when it is raining, until the rain has thoroughly soaked the ground. We are between four and five thousand feet above sea-level. We were all knocked up when we first came here, I think by the water. I had a slight return of dysentery, but soon got over it.

"The latest is that Jacob is going to Simla. I think I shall volunteer to go as his A.D.C."

A few days later Yakoob left for Kabul with Cavagnari, the latter being escorted by Hamilton with his company of Guides. Again we lined the road to see them off, and many of us wondered if we should ever see Cavagnari and Hamilton again. The war was now over and the question was—what next? It was very hot in the Jellalabad valley and there was a good deal of cholera and typhoid about, but I suppose the Government at home were anxious to be able to tell the House of Commons that the troops were on the way back to India, so in a few days the return march began. A local company of pioneers had been raised and I was given charge of it and sent down to Fort Battye to work on the road. There I remained for a week and then took my pioneers back to Jellalabad and handed over the command. I reached Jellalabad on June 4th after a trying march. Very hot, dust storms, etc. Hart and I rode in together, both feeling pretty well done. We quartered ourselves in an old mill, and then went to look for refreshments; we found a store of medical comforts which the W.O. in charge refused to part with. However, we overruled him and commandeered a bottle of port, leaving a chit for it. Then in the shade of the mill we knocked off the top of the bottle and drank the contents out of tumblers—after which we felt much better.

Now there was a new job—there was a very large accumulation

of stores in Jellalabad, which had been prepared for a possible advance. The officer in charge of the commissariat told the General that the stores would have to be abandoned because of the great losses among the transport animals. Then the C.R.E. took a hand and said, "If you can't transport the stores, I will." He sent up and down the river to collect every available *mussuk* and suitable wood. Then the 6th Company set to work to make rafts. They were about 10 ft. square. As each one was completed, it was loaded up with stores and two sepoys put in charge. The raft was then pushed off to float down the stream. My special contribution to the rafts was one made of *ghee dubbas* and bamboo telegraph poles. This, rather to my surprise, reached Dakka safely.

While this work was going on, the rest of the force marched on down-country, leaving, when all the rest had gone, one company of N.I. as a guard for the remainder of the stores. These had all been parked in a large fort, built when the force first went up, a good, old Peninsular pattern, with earth parapet, V-shaped ditch and bastions. The good folk of Jellalabad, who had watched with disgust the removal of the stores, attacked the fort on the last night in the hope of saving at least some of them, but were easily beaten off. When all was done, my company marched down with the escort, but Colonel Maunsell embarked on the last raft, taking with him Lovett, the Brigade Major, Hart, Scott-Moncrieff and myself. We floated down very fast, doing the 40 miles to Dakka in, I think, eight hours. It was an experience not to be forgotten, which probably has fallen to no other European, for after the river left the Jellalabad plain and entered the hills, we passed through a gorge where the cliffs rise perpendicularly from the river to perhaps 1,000 feet, and far up near the top we could see little dots of black, which were the cells that Buddhist hermits had hollowed for themselves in the cliff-face. The only access to them was by ropes from above.

All our rafts had reached Dakka safely, except one, which sprung a leak. The two sepoys in charge grounded it on the Jellalabad side just before reaching the hills and made their way to Dakka on foot. There was, of course, some sniping as the rafts went down and I think two men were wounded.

That raft journey perhaps saved my life, for I had been in poor condition ever since the dysentery, and the troops who marched down suffered terribly. There had been cholera in each of the rest-camps on the way down and the medical authorities knew no better than to let each regiment use the same camp as their predecessors had occupied. In this way I believe the 10th Hussars lost ten per cent. of their strength. We had also lost our best native officer, Hyder Shah, from cholera, before leaving Jellalabad. But there was a loss which touched us more dearly. After I left Peshawar, Ancrum

went down with fever and died; a very promising officer and the best of comrades.

That was the end of my Afghan experience. I rejoined my company which was stationed at Peshawar; got a bad attack of Peshawar fever, and being convinced that the only chance for me was to get out of the place, I asked for leave, being strenuously opposed by the doctors, who said if I travelled in my then condition I should die. However, I got into a *dak* one evening with twelve bottles of soda-water, and reaching Attock the next morning, had drunk all the soda-water, and lost the fever. Then I went on to Simla and got a very severe attack of intermittent fever, after which a medical board invalided me home, with an enlarged liver. Later I exchanged back to Imperial Service. Thus it happens that I am, I suppose, the only Bengal Sapper who has never seen Roorkee.

THE FIRST R.E. MECHANICAL TOOL CART (1911).

By COLONEL F. WILSON, D.S.O., T.D.

late C.R.E. 54th East Anglian Division, T.A.

[The author was " attested " from Bedford Grammar School as a Sapper in the 1st Beds. R.E. Vols. in 1900 and served continuously with the unit, through the change to T.A., until 1934. He went to France in 1914 as O.C. 1st East Anglian Field Coy., which joined the 2nd Division. The article is of historical interest as an account of what is probably the first serious and practical initiative in mechanizing the R.E. Divisional Units.—EDITOR.]

ALTHOUGH all the officers of the 1st East Anglian Field Coy. R.E. were very fond of their horses and had each been thoroughly " put through it " by Major Griss at Aldershot in mounted duties, it was felt that too high a proportion of works time was wasted during the training season by untrained horses obtained from different contractors. It was no unusual event to have to unwrap a six-horse pontoon team from John Bunyan's statue on starting out of the town or disentangle a pair of leaders when the off-horse playfully leapt over his near mate in full harness. The O.C. Unit therefore determined to attempt something more useful for the job by means of the new (then) mechanical transport.

The C.R.E. (Lieut.-Colonel G. H. Wells) very generously helped in matters financial and the Unit eventually turned out a mechanical Tool Cart R.E. A description of the vehicle produced is perhaps not uninteresting in these days of mechanization.

A subaltern officer (Lieut. A. J. Berry) was a keen engineer and both he and the O.C. Unit (Major F. Wilson) were partners in the same motor works; Sapper F. C. Pales, the driver-mechanic, was also an employée of the firm. The idea followed was to produce a vehicle capable of carrying the section of 16 sappers and all the section tools complete. To put merely the tools and a few sappers into a lorry had no real appeal and ambition decided that the vehicle must be able to cross rough country and be capable of crossing a 15-foot ditch, and also negotiate water up to at least 2 ft. in depth. Finally it was required to tow the pontoon wagons.

With this idea to work to, a 40-h.p. 1907 Daimler chassis was

bought and was in course of time converted into a mechanical tool cart.

This vehicle was so re-designed that it could go through ponds, over ditches, cross rough and ploughed land and pull the pontoon wagons complete with normal equipment, and some of the messes it was able to get in and out of are shown in the accompanying illustrations.

To enable these feats to be accomplished considerable modifications were essential. First of all the frame was reinforced with flitch plates and struts, especially round the radiator. The diameter of all the bolts holding the main bearings of the crankshaft was increased and carried right through the cylinder block so that the extra loads put on the crankshaft did not cause the engine to split in half. Overheating whilst pulling slowly in column of route with the troops was guarded against by fitting a larger fan with a positive chain drive, into which was incorporated a free-wheel, so as to avoid the chain breaking on stopping the engine. The idea of proceeding by bounds had not then developed.

To increase the pulling power of the vehicle, a 3 to 1 reduction gear-box was fitted between the engine clutch and the front of the gear-box and controlled by a separate lever: thus it was possible practically to treble the pulling power of the vehicle especially on the lower speeds. It was, of course, necessary to bring the car to a complete standstill to engage this extra reduction gear.

Another major difficulty was to enable the front of the vehicle to surmount rough and uneven ground without twisting the frame and this was done by fitting a transverse spring for front suspension which was pivotedly mounted in the centre of the front cross-member of the frame. This action is clearly shown in Photo No. 3.

The tyres on the rear wheels were solid rubber twins, and spuds of a paddle type, shouldered and fitted with a quick detachable lynch pin, were pushed through holes between the tyres to enable the wheels to get tractive effort on very soft ground.

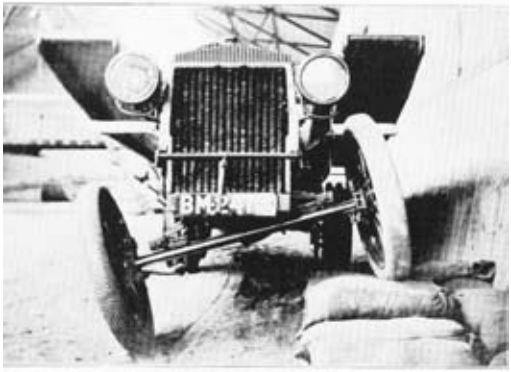
Another feature was an armoured undercarriage to prevent mud getting into the mechanism and to give the vehicle a certain amount of buoyancy on soft ground and pushing power when going through a hedge. The drive to the rear wheels was by means of chains, one to each wheel, the small sprocket having eight teeth, to the large one 60 teeth.

To enable the vehicle to cross gaps up to 15 feet, two box-girders made up in oak, were designed to take the load and were carried one on each side of the body on two solid and two tubular members jutting out from the chassis sides.

In this position the girders served both as mudguards and also as a

1.—At H.Q., Bedford

2.—Army Manœuvres, 1913.



3.—Pivoted axle.

The first RE mechanical tool cart (1911) 1- 3

4.—Crossing gap.

5.—Through pond.

6.—Rough stuff.

The first RE mechanical tool cart (1911) 4 - 6

platform or foot rest for the sappers who were seated on the tops of the tool chests.

On arrival at the gap the girders were dismounted and thrown across without any form of shore transom, and when roughly in alignment two steel rods were pushed through metal-bushed holes in the girder and then pinned with lynch pins through slotted holes at one end of each rod. In order to keep the roadway so formed in alignment with the wheel tracks, tubular distance pieces were used inside the roadway through which the rods were pushed and finally pinned. The roadway occasionally twisted owing to uneven heights of the shore banking, but the wheel tracks so formed could not splay or get out of alignment with the road wheels. When the vehicle was driven over, the driver had only to get his front wheels and tail square on to the bridge and shut his eyes for the rest.

To carry the section tools and equipment, three large chests were designed, in which these were carried in compartments and duly catalogued so that each lid when lifted showed a tally of the tools in that chest.

A further experiment was tried out in that the fastenings of the three chests to the chassis were of a quick-release type, the chests could be dismounted at a river bank, tools emptied and the three used as a raft for the rapid crossing of one or two men. In practice, however, it was found that owing to dry exposure the chests usually leaked badly and either sank or turned turtle with the sappers. The beginning of the war prevented final experiments with a catamaran being carried through.

In 1912 the vehicle was driven to Felixstowe and was used there on works during the Annual Training of the East Anglian Divisional R.E. and was also on the same duty throughout 1913 and Camp at Clacton.

The tool cart became an unofficial part of the Unit's equipment and was a matter of great interest to Inspecting Officers, so much so that the authorities arranged an official trial and inspection by the Royal Engineers Committee.

A letter was received from the Committee congratulating the Unit on the production of the cart, but pointing out that it would cost £60,000 at least to equip the Field Coys., and such a sum, although possible for the Navy, was unprecedented for the Army!

The outcome of the visit, however, was that the Unit gained permission to join Army Manœuvres in 1913 and was attached (with pay and allowances) for work under the C.R.E. 4th Division, commanded by the late General Snow. The tool cart plunging along was an object of much curiosity and some derision to the troops. The Gunners, for instance, cursed it freely when meeting it with their teams in narrow roads but changed their views considerably after it

had proved highly useful in doing a watering job for them in half record time.

On August 1st, 1914, the Special Service Section of the Unit left for its War Station on the coast and on the 4th Headquarters and 1st Field Coy. followed. Although several attempts were made to keep the cart with the Unit, this could not be allowed, and on leaving for France the old cart was left behind.

On the whole the pioneer attempt to harness the new power for Army purposes was fairly creditable and interesting now in the days of mechanization.

THE USE OF MODELS FOR FIELD WORKS TRAINING.

By LIEUT.-COLONEL R. E. KEELAN, M.C., R.E. (T.A.).

IN *The R.E. Journal* for March, 1937, Major Whitehead wrote an interesting article on "Field Works Training with Models." The following suggestions and notes on the use of similar methods for the instruction of subalterns and senior N.C.O's of a Supplementary Reserve unit may perhaps be of interest to S.R. and T.A. officers.

The relative dullness of winter evening lectures for subalterns and senior N.C.O's, with the aid of the blackboard, can be very materially reduced by the organization of a Field Works Course with the aid of Model Field Works Stores, and considerably more benefit derived therefrom. In organizing such a course one must consider the subjects and the model stores necessary. Practical experience has proved that the following subjects can be covered :—

(1) Blocks and tackles, sheers, gyns, derricks, holdfasts.
(2) Trench systems and R.E. work in connection with their repair or alteration.
(3) Bridging (improvised), framed and lashed trestles, crib piers.
(4) Pontoon bridging.
(5) Small box-girder.
(6) Large box-girder.
(7) Demolitions.
(8) Water supply, overhead storage, camp layouts, units' requirements.

MODEL STORES.

For items (4), (5) and (6) the models are already available and this may also be said of item (7) to some extent. For the remainder of the items the following stores are put forward as a suggestion and can usually be purchased by tender from local firms, the funds being available from the company's grants for training stores as authorized by *Equipment Regulations* for Army Troops and Workshops and Parks Companies. Where T.A. units are concerned, a raid on the company's expendable stores will meet many requirements and a small expenditure could no doubt also be met by a special appeal to higher authority in a suitable manner, although it will be found that the small amount of capital required is usually obtainable if efforts are made with sufficient determination.

		No.	Cost.
(*a*)	3-sheave pulley blocks for $\frac{3}{8}$"-diameter cordage ..	25 at 4s. 6d. ..	£5 12 6
(*b*)	Single-sheave do. do. ..	4 ,, 2s. 6d. ..	0 10 0
(*c*)	Timber spars, 12' × $\frac{3}{4}$" diameter	3 ,, 6s. 0d. ..	0 18 0
	10' × $\frac{3}{4}$"	6 ,, 5s. 0d. ..	1 10 0
(*d*)	Balks, 4" × 4"	100 lin. ft. at 4½d. ..	1 17 6
	,, 4" × 2"	50 ,, ,, ,, 1¾d. ..	0 7 3½
	,, 4" × ½"	150 ,, ,, ,, ⅞d. ..	0 10 11¼
	,, 2" × 1"	50 ,, ,, ,, ½d. ..	0 2 1
	,, 1" × ½"	50 ,, ,, ,, ⅜d. ..	0 1 6¾
		Total ..	£11 9 10½

(Also a tin of detonators, electric.)

All other stores required, such as nails, spikes, X.P.M., tin sheets, lashings, spun yarn, small spars for ledgers (poles used for elbow rests in musketry instruction), can be obtained from Company Stores.

The composition of the classes would naturally depend on the strength of the unit and the attendance, but as a practical example classes, consisting of 5 to 6 officers and 20 to 30 N.C.O's, have been held during the past winter. These were divided into four syndicates, and the subaltern officers lecturing had to organize the practical work so as to produce four separate tasks. This was found feasible in all cases, except when training with S.M.E. model bridges, namely, items 4, 5 and 6 in the syllabus. For these, syndicates were given separate responsibilities, such as holdfasts, reeving tackles, setting-out, etc., and two or three members of the syndicate carried out the work while others watched. As far as possible realism should be and was insisted upon, and box sections were moved by carrying bars held by two men and similarly with other heavy stores. Two old 6-foot tables formed each bank and holdfasts, etc., were nailed to the tables. Other practical works were organized and carried out as follows:—

(*a*) *Derricks, Sheers, Gyns.*—Using blocks and spars (purchased). The holdfasts consisted of ring-bolts let into wooden blocks which, in turn, were nailed to the floor. These gave the necessary strength without damaging the floor. It will, of course, be understood that the Drill Hall floor was made of wood.

(*b*) *Trench Systems.*—A-frames, duckboards and sandbags were all made to quarter-scale (the sandbags were produced by dividing one standard sandbag into four, and although not

quite to quarter-scale were nevertheless quite suitable). A length of trench was dug in wet sand (the miniature range with its sand is usually handy and makes an ideal site; furthermore, many drill halls have sand tables available) and revetted with A-frames, tin sheets, three-ply wood, wire netting and sandbags, or even thin brushwood, thus illustrating different types of revetment. After such a trench was completed the class was told to lead out or bring in a communication trench joining up the two revetments. For this latter part, of course, only two or three do the work while the remainder look on.

(c) *Improvised Bridging.*—Timber balks and spars as purchased were used for frame and lashed trestles; 4" × 4" representing 12" × 12" timber. 6" nails were used for spikes and drift bolts, but the trestles were constructed to the exact full-size details.

(d) *Demolitions.*—Model R.S.J's and rails were produced by members of the Unit and so also dummy slabs of guncotton and primers. Wiring circuits were made up and completed with the standard electric detonators, and instruction given in testing and connecting up. A large spar representing a tree-trunk or telegraph pole was also drilled for primers to demonstrate a method of rapid cutting. Attempts were made also to blow up a section of the trench referred to above and to demonstrate the difficulties in carrying out a repair to the revetment, etc. (It is suggested that a primer as a whole or part can quite safely be used in drill halls under certain circumstances and provided that all precautions are taken.)

(e) *Water Supply.*—A water tower was built from the timber balks bought for bridging, also a lashed tower from the spars. Canvas was used for the tanks, and instruction given in the use of pumping sets, with which units are now being equipped, and instruction was also given in the use of air-compressors and pneumatic tools.

General.

Such lectures delivered by the Subaltern officers serve two purposes, firstly, instruction and general brushing up of the subject by the subalterns, and secondly, instruction to N.C.O's. By this means the officers are compelled to revise their subjects very thoroughly to ensure that they can answer any questions put to them by the N.C.O's, who are usually very interested and have a fairly good general knowledge of the subject. It is very important that the

lectures should be of an essentially practical nature and that academic treatises should be avoided, and every encouragement should be given to discussions on the subjects in question; the object, apart from the theory, being to equip N.C.O's with a practical knowledge which will enable them to choose suitable dimensions of materials for work they may have to carry out, without having to work out calculations in every instance, such as the size of spar and tackle for a derrick for, say, a 2-ton load and similar simple, practical problems, but the N.C.O. must nevertheless know how to work out the formulæ without any doubt. This procedure should be pursued in each subject and it will be found that the classes derive considerable benefit from such lectures, with practical demonstrations made feasible with models.

As to the scale of model equipment required by a unit, that given herein was found to meet the requirements. The number of three-sheave blocks, however, might be reduced slightly.

In conclusion, it might be emphasized that the trouble taken in the arrangement of such lectures and the obtaining of the model equipments is amply repaid by the added attention and interest shown by the classes and the benefits accruing.

SOIL STABILIZATION AT LYDD.

By LIEUT.-COLONEL T. T. BEHRENS.

THE South Brooks road is a very old cart track, made passable by the fishermen, from Lydd village to the foreshore about a couple of miles to the south of it. This track, practicable as long as dry, runs alongside the drainage ditch and at the edge of a shingle bank, the top of which is some six feet above the marsh grazings through which the land drainage ditches run. In winter the ruts are deep and the track is in many places under water. The shingle banks, here generally devoid of any fine stuff between the pebbles and in practice impassable to fully-loaded two-wheeled carts, have been treated with clay, since time out of mind, wherever a practicable track was wanted by the farmers or fishermen of the district. They discovered that clay plus shingle or shingle plus clay made a better track than either of these alone.

The first, as long as it is dry, makes a good foundation, while the second, when not too wet, is firmer than the marsh clay alone. Could the clay but be kept dry no more would be required than enough clay to fill the interstices of this natural aggregate to a depth of 6 to 9 inches. The new ranges which were to be taken into use this autumn, lie on the top of the shingle waste and about a mile of South Brooks track was required as an all-weather approach road to them. Soil stabilization appeared to be the natural reply to the problem set—an all-weather road, at short notice, for light motor vehicle traffic: but no one had had practical experience in carrying out such work and we were to see how much in practice the absence of proper plant and trained labour increase costs.

The theory of soil stabilization is based on the observed fact that sun-dried clay is hard and strong and if not subject to wet conditions it makes a perfect road foundation. In talking of a clay, an earth is meant that contains a large proportion of very fine particles and it is the adsorbed water in it that binds the clay particles together when the clay is dry. Adsorbed water holds the very fine colloidal (clay) particles together with a force of the order of 1,000 to 1,500 atmospheres and after both the "gravitation" water has drained off and the "capillary" water has been dried off, it is therefore left behind in the material when clay mud is being brought to a sun-dried condition. Soil stabilization research is now making it possible to waterproof the mass by coating these individual colloidal particles

with a minutely thin film of bitumen, still using the adhesive strength provided by the adsorbed film of water. Once these colloids are coated with bitumen and dried out, they lose their affinity for adsorbing a detrimental amount of moisture and thus are waterproofed.

The present technique, which is daily improving, makes it possible to turn any soil into an all-weather waterproof foundation for roads, parades, etc. Some soils are more suitable than others and it is therefore necessary for a certain amount of laboratory work to be done to ascertain how soils, poor from a stabilization point of view, can be improved both as regards results and costs by admixture with other local materials.

It must be understood that the soil stabilized mix-in-place crust, when de-hydrated and rolled, is the road foundation or base, and that it must be sealed with a hot special cut-back bitumen and given a wearing surface, the thickness of which will depend on the traffic to be carried. For average traffic an armour coat consisting of $\frac{3}{4}$-in. material sprayed with quick breaking Colfix emulsions is generally sufficient.

SOIL CHARACTERISTICS.

It was decided to stabilize to a depth of 5 to 6 inches. Laboratory examination of the soil gave the following sieving analysis :—

Passing 1-in. mesh	93·1%
¼-in. mesh	26·9%
10 mesh	5·2%
200 mesh	1·3%

It is seen from this analysis that the job was less a purely soil stabilization one, than the preparation *in situ* of a cold bitumen macadam. The correct quantity of emulsion for this purpose was found to be 13 gallons per ton, *i.e.*, 2·5 gallons per square yard for a 6-in. depth. It was therefore decided to apply Lomix Stabilizer at 2·25 gallons per square yard, mix in thoroughly, and apply a top shot of 0·25 gallons per square yard. It was also considered desirable to dilute the emulsion, in the ratio of 650 gallons of emulsion to 250 gallons of water, before application. This mixes far more efficiently than straight emulsion.

PREPARATION OF AREA.

The road was marked out in three sections, two being 12 ft. wide and the other 21 ft. At one end was a 50-ft. square to enable vehicles to turn. A total area of approximately 8,800 square yards was treated, requiring 22,500 gallons of Lomix Stabilizer. It was decided

to give the road a slight one-way camber to drain off water towards the land drainage ditch. In one place, the road cut through a portion of gorse, which had, of course, to be removed completely.

An American type grader (Fig. 1) was loaned by C.R.E., Camps and Roads, Aldershot, but without the 40 h.p. tractor which is required to draw it. As no suitable tracked tractors could be hired at the time, two tractors were eventually found of 22 and 25 h.p. each with which the big grader and the spring-tined mixing harrow (Fig. 2) were worked: but this was not until a disc-harrow had been tried, found useless, and a spring-tined harrow had been purchased. The two tractors were of different makes and it was soon evident that the lower-powered tractor was better able to draw the big grader than its nominally more powerful competitor.

As the finished grading of the surface of any road is formed by the grader itself, it is evidently on the grader-driver's skill that this result depends. The work suffered in proportion as a complete set of equipment (tractors, light and heavy graders and spring-tined harrow) with skilled drivers were not available for the work. It was found impossible while training the personnel to ensure that the " highs " were cut off to grade and pushed into the " lows." As the practised skill of the grader-driver, both of hand and eye, is essential to any good result, it is evident that, if soil-stabilized road foundations are adopted, to be economical in varied types of soil for military roads in peace time, a complete plant and skilled personnel should be kept ready to proceed from one job to the next as long as there remain roads, etc., to be made.

The principal difficulty in dealing with the marsh and shingle conditions at Lydd is that, on the line of road lying along the junction of shingle bank and clay lands in the marsh, the proportion of clay to shingle varies much from one place to another. Very great care must be given during grading to ensure that (*a*) the scarifier is not used, if possible, until the grading is finished and (*b*) that a sufficient amount of clay is brought to every part of the road where there is a deficiency, until the proportion of clay to shingle is brought everywhere up to the average (*i.e.*, the average on which the laboratory tests were made). When the grading is finished, the whole of the surface should be scarified to the designed thickness and no more, six inches in this case. It will always be hard to prevent the mix of emulsion plus clay sinking below grade during mixing, when there is, as here, loose shingle below the crust to be stabilized. Indeed, where a foundation of stabilized soil has to be carried across a shingle bank, special precautions to avoid this will have to be taken when deciding the method to be adopted to get the stabilized soil to dry out in position.

The grading and scarifying lasted 10 days.

STABILIZATION.

This was begun on August 12th. The 50-ft. square was treated first. After loosening with the disc-cultivator to a 6-in. depth, water was applied by means of 200-gallon water carts to moisten the 6 ins. of loosened material before applying emulsion. The diluted emulsion (650 Lomix : 350 water) was applied by means of a 12-ft. spray-bar, mixing being performed with the cultivator. For the 12-ft. wide road, 1,000 gallons of diluted stabilizer were sufficient to treat a length of 75 yards at the rate of 2·25 gallons per yard. It was found necessary to spray this on in five separate applications.

It became apparent that the disc-cultivator was not efficient as a mixer for this type of aggregate, and it was therefore replaced by a set of spring-toothed harrows which proved far more effective. Heavy thunderstorms were found not to wash off appreciable quantities of even freshly applied emulsion. Water-carts, to carry the very large amount of water (required to damp the scarified soil and shingle before the emulsion was added), were with difficulty collected from surrounding municipal authorities, and horses had to be hired to draw them. Most local authorities have done no road watering for some years since the coming of water-proof road surfaces, and so these museum pieces required general repairs before use. The horses and drivers collected from different places made the water-carts expensive and rather inefficient, so water-tanks and spray-pipes were improvised and fitted into lorries as quickly as possible. The quantity of water to be put on to moisten the soil before mixing was estimated at about 100,000 to 200,000 gallons.

A very large quantity of loose shingle had to be bladed off the line of the roadway in many places before sufficient earth was found in the shingle to provide a mix. The scarified 6 ins., which in August was quite dry, was first watered until judged to be moist enough to take the emulsion. The emulsion as stated above was incorporated in five applications while the spring-tined harrow was doing the mixing.

In some places, where the shingle had not sufficient earth content below, the emulsified mix tended to sink too deep into the shingle and so get lost below the grade designed. It also prevented the tank-waggon and spray-bar driving itself because there was no hard foundation under the mix to drive upon. The tracked tractor had then to be used to haul it. These details are mentioned as points to be considered before undertaking work on similar ground in future.

DE-HYDRATION.

The mix should be left to dry out with the roughest surface possible. It appears to be most important to make certain of having plenty of drying weather to do this before the wet

1.—Big grader with blading knife.

2.—Spring-time harrow mixing.

3.—The surface after partial rolling.

Soil stabilisation at Lydd 1- 3

weather or winter sets in. Work should certainly be begun at the beginning of the summer.

It is a matter of judgment and therefore of experience when the mix has become plastic enough to start blading it (with a light grader) to the finished surface desired. It must then be rolled lightly with a 30-cwt. roller and finished off as it gets harder (again a matter of judgment) with a 6- to 8-ton roller. In both cases these rollers should be of the tandem type. They are not common and so are not easy to hire at short notice.

In the present case the road had to be opened for use by the 27th September, and a peculiarly inconvenient period of heavy rain set in just as the road was drying out nicely. This led to what proved to be a premature attempt to put on the sealing coat of hot cut-back bitumen and the armour coat of crushed shingle and quick breaking Colfix emulsion. In the event it proved that the mix-in-place had not hardened out enough to support traffic and the armour coat in many places cracked and broke up on the foundation.

Armour or Wearing Coat.

The sequence of operations is :—

1. After application of the hot bitumen sealing coat, spread $\frac{1}{2}$-in. to $\frac{3}{4}$-in. crushed shingle about 1 in. thick (1 y.c. to say 30 y.s.) and roll.
2. Water to moisten, spray with Colfix say 1 gallon to 3 yards super, spread $\frac{1}{8}$-in. to $\frac{3}{8}$-in. crushed shingle (1 y.c. to say 60 y.c.) and roll.

Plant.

This should all be collected beforehand but, if plant has to be hired, it will be both difficult to find the right machines and to avoid delays, during which the cost of hire goes on although machines are standing idle.

The necessary plant proved to be :—

1. One large American type grader (fully articulated with blade and scarifier) with 40 h.p. caterpillar tractor and an experienced driver for each.
2. One spring-tined harrow and 20 h.p. caterpillar tractor with experienced tractor driver.
3. One light grader with blade only.
4. Two 50-cwt. lorries fitted with 500-gallon tanks, the latter fitted with spray-pipes for moistening the surfaces.
5. One (at least) 30-cwt. and one 6- to 8-ton roller of the Tandem type. Suitable rollers and enough of them to cope with the

programme of work are necessary to ensure success in catchy weather.

6. Suitable flexible arrangements for the supply of the spray-bar tank-waggons for emulsion and hot bitumen, as and when required, must be made with the Company who undertake the supply and spreading of these liquids.

COSTS.

It seems probable that, if all the plant and experienced drivers were available without hiring, and if this trained crew under local supervision had such few D.E.L. as might be necessary added, the cost for this type of foundation should be about 2s. 3d. a yard super and the cost of the armour coat, using local gravel, about 1s. per y.s. in addition. The analysis of actual costs under the conditions of haste in which the work was done (*i.e.*, all the plant except the two graders had to be hired and collected as was found possible ; drivers had to be trained during progress of the work) can lead to no figures in themselves indicative, except in a general way, of what costs should be under favourable circumstances.

Col Sir Walter Coote Hedley KBE CB CMG

MEMOIRS.

COLONEL SIR WALTER COOTE HEDLEY, K.B.E., C.B., C.M.G.

DIED DECEMBER 27th, 1937, AGED 72.

WALTER COOTE HEDLEY was the son of Robert Hedley of St. George's Square, London, who married Miss Charlotte Coote, of Bellamont Forest, County Cavan, and was born on December 12th, 1865. He was commissioned in the Corps for the " Shop " in December, 1884. After his S.M.E. Courses, he remained at Chatham with the 38th (Field) Company, moving with it to Shorncliffe. In 1890, he went to Gibraltar, where he served in the 6th (Fortress) Company, as Adjutant R.E., and later as O.C., 20th (Fortress) Company. While at the Rock, Hedley married Miss Anna Fellowes, the daughter of Colonel James Fellowes, the Chief Engineer, himself a Corps and county cricketer of great distinction. On returning home in 1895, Captain Hedley (he had been promoted in 1894), joined the Ordnance Survey, working at York and Southampton, until in October, 1899, he went to South Africa with the 17th (Field) Company, with which he served two years, taking part in all the operations that led up to the Relief of Ladysmith, and later in the Transvaal, getting two mentions in dispatches, a Brevet Majority and six clasps to the Queen's Medal. On returning home at the end of 1901, he rejoined the Ordnance Survey, serving first at York and after, from 1903, at Southampton, where he remained till 1911, except for two years (October, 1906, to September, 1908), spent on special duty with the Survey of India at Calcutta.

In September, 1911, he went to the War Office as G.S.O. 1 (M.I.4), retaining that appointment till he retired at the end of August, 1920. Thus in the Great War he did not go to the front (except for a few months early in 1915), but in accordance with the arrangements laid down for war remained at the War Office in the post of Chief of the Geographical Section of the General Staff, which he had occupied since 1911. The magnitude of the task which fell to his lot is difficult to appreciate, except by those who were in immediate contact with his work. The whole of his expert staff of officers went overseas, either on the outbreak of war or soon afterwards, and he was left to cope with the situation alone with an improvised staff. What that

situation was may be gauged by the fact the pre-war official policy envisaged a small Expeditionary Force operating in one area, and a short and mobile war. Hedley had to prepare maps of areas of war in all parts of the globe, and to find personnel, equipment and instruments for an unforeseen and rapidly expanding survey organization in France and in other theatres. Fortunately for the country, no officer could have been better equipped, by his previous experience and great knowledge, for this task, which he carried out with conspicuous ability.

One item in connection with map production may be mentioned. Before the war a scheme had been inaugurated for the production of a map, in a uniform series of sheets, of the whole of the civilized world, on the scale of 1/1,000,000. The work was distributed among the various nations, and was actually proceeding, but in some cases at a very slow rate. Hedley, foreseeing the need, put in hand the preparation of a provisional series (provisional because Great Britain was not responsible for the production of sheets in the Continental area) of these 1/M sheets covering practically the whole of Europe; and, with the aid of the Ordnance Survey and the Royal Geographical Society, was able to get them completed before the Armistice. The advantage of having this series of maps, uniform in size and style, available for the work of the Peace Conference, can hardly be overestimated.

For his services in the war, he was mentioned in despatches and received the C.B. (1915), C.M.G. (1917) and K.B.E. (1919). He was also made an officer of the Legion of Honour, of the Belgian Order of the Crown, and the Order of Leopold.

All who came in contact with him recognized his kindness, tact, and thorough grasp of his subject. He was quick to discern ability in his subordinates. It was he who found a post in his department for T. E. Lawrence, when the latter had failed to secure admittance to an Officers' Training Corps at Oxford, and who recommended him for service in Egypt when Turkey entered the war. Professor W. L. Bragg, O.B.E., M.C., F.R.S., the eminent physicist of Manchester University, who was another of Hedley's discoveries, writes of him as follows:

"My contact with Colonel Sir Cootc Hedley during the war was very slight, but it left an extraordinarily vivid impression on me. In the summer of 1915, when I was training with a Territorial Artillery Battery in England, I had orders to report to Colonel Hedley at the War Office.

"He told me that it had been decided to form an Experimental Sound Ranging Section, on the model of the sections which were on trial in the French Army, and that my name had been suggested to him as that of an officer with a knowledge of physics, who might

be put in charge of the work. After my interview with him I walked on air along Whitehall.

"As I realize it now, he was very clever at putting a raw youngster at his ease. He fired me with enthusiasm, and he put me on my mettle to ensure that an experiment, in which he had faith, should have every chance of proving successful. I subsequently saw him on several occasions to report the progress of the work. No one could fail to come under the spell of his courtesy and charm, and I shall always remember him as a very gallant and wise soldier, whom I am glad to have known.

Coote Hedley had thus a distinguished career in the Corps and the Army, but, apart from this, he will be long remembered as an athlete, especially as a great cricketer. He was probably the best all-round athlete that the Corps has ever had, or perhaps will ever have.

He played cricket for the Shop, and the Corps, and it was not long before his activities extended to first-class cricket. He played regularly for Somerset, and besides taking many wickets made many runs. But in spite of all such encroachments on the time at his disposal he always made himself available for our best Corps matches especially against the Royal Artillery.

In the *History of R.E. Cricket*, which was edited by Lt.-Col. R. S. Rait Kerr, D.S.O., M.C. (now Secretary M.C.C.), mention is made of him as follows:

W. C. HEDLEY,

1885 to 1909.

Taking him all round, probably the best cricketer the Corps has ever had. His records for Somerset show what class he was. He was a most dangerous bat, and the Gunners in particular must always have been glad to see his back. In this match he made 1,222 runs, the next highest aggregate to Renny Tailyour's, with an average of 27, and including three scores of over a hundred.

It was as a bowler, however, that he was really first class. He was quite capable of running through any side—he bowled medium to fast with a good ball coming off the pitch and breaking back.

In Corps cricket he took well over 600 wickets at an average cost of about 13 runs. In three seasons he took more than 100 wickets—his best season being 1888 when his 119 wickets only cost 9·2 runs apiece.

In the Gunner match he has taken 185 wickets—a larger number than any other player on either side. In 1892, he took 6 for 25 in the first innings, and 7 for 37 in the second.

In first-class cricket one of his best performances must have been in 1890, when playing for The Gentlemen of England *v.* Oxford University, he scored 43 and 70—this last effort in 50 minutes—and

took 6 wickets for 86, and 5 for 61, and in addition held 4 catches in the second innings.

W. C. Hedley's skill at cricket and indeed all games was only equalled by his modesty.

It is fitting that these records of Hedley as a cricketer should end by the insertion of a letter to *The Times*, from the pen of Sir Pelham Warner :

> May I be allowed to say something of Colonel Sir Coote Hedley, who was a big figure in the Somerset Eleven in the days when that county was wont to humble the great, as Yorkshire, Surrey, Nottinghamshire, and Middlesex have good cause to remember? He was a member of that Somerset team which numbered in its ranks such men as H. T. Hewett—a left-handed Jessop—S. M. J. Woods, L. C. H. and R. C. N. Palairet, V. T. Hill, W. N. Roe, J. B. Challen, A. E. Newton and the Rev. A. P. Wickham—fine wicket-keepers both of them—Tyler and Nichols—a team which was always a draw because of the manner and spirit in which they played, and because you never knew what they would do. They were no respecters of persons !
>
> Hedley represented at various times Kent, Hampshire, and Devonshire—the qualification rules were somewhat lax in those days—but his name is chiefly associated with that of Somerset. He was a useful batsman, his highest score in a first-class match being 102 for Somerset *v.* Yorkshire at Taunton in 1892, the innings in which H. T. Hewett (201) and L. C. H. Palairet (146) put on 346 for the first wicket, but he was a better bowler than batsman, and against Yorkshire at Leeds in 1895 obtained eight wickets for 18 runs in the first innings, and six for 52 runs in the second innings. He played for the Gentlemen *v.* Players at Lord's in 1890.
>
> The first time I met him was on the occasion of the Somerset *v.* Middlesex match at Taunton in 1894. It was my first match for Middlesex, and I was naturally very anxious to do well, but Hedley was my master, knocking my off-stump out of the ground in the second innings with a break-back which came like lightning off the ground when I had scored only four. I can remember every incident of that match as if it had taken place yesterday, and I fancy Mr. A. J. Webbe, our beloved captain, can do the same, for there was a desperate finish, Middlesex winning by 19 runs chiefly owing to a grand innings of 110 on a sticky wicket by Sir T. C. O'Brien. No fewer than 17 amateurs took part in the match—nine for Somerset and eight for Middlesex. Sir Coote Hedley was a very charming man, and his many friends regret deeply the passing of one whose gentle and delightful manner radiated happiness and ease wherever he went.

Such is the cricket record of a man, whom a youthful sapper once asked at the Gunner Match, to the great joy of Hedley and his neighbours, whether he had ever played for the Corps. *Sic transit gloria mundi.*

In addition to being a great cricketer, Hedley was absolutely first class at racquets and nearly so at golf and billiards. At these three he represented the Corps again and again against the R.A. in our annual matches. He was plenty good enough for any Sapper side at both Rugby and association football and no mean performer at lawn tennis.

At racquets, indeed, he was almost as celebrated as at cricket. He won the Amateur Doubles championship in 1890 in partnership with P. Ashworth.

While at Gibraltar he was an ardent follower of the Calpe Hunt, and used to lead the R.E. team in the Inter-Regimental Point-to-Points. It was largely due to him that the Corps won so many of these very sporting events, where sometimes there were over a hundred starters. He was a heavyweight, but his calm judgment and fearless riding inspired his team to follow him as best they could.

As may be imagined he was also a fine performer at polo.

Golf was another game at which he excelled, although he did not take it up till latish in life. He never played lower than in the first four in the Corps side.

On several occasions at Sandwich he beat opponents who (having devoted themselves to no other game since their youth) were on the scratch mark.

He had no finished style at golf, but as might have been expected he was very hard to beat, and at times deadly when approaching the hole.

With his marriage at Gibraltar commenced an ideal union, for he and Lady Hedley were devoted to each other until death has now, alas, divided them.

The last time I saw Coote was as their guest at a Corps golfing society meeting at Sunningdale.

He won the Veteran's Prize, and I remember when congratulating him, he replied, "Thank you, I *do* like taking a prize home to Anna, for it gives her such pleasure." Their happy marriage has been blessed with three daughters, the eldest of whom is married to Major H. F. Heywood (late R.A.).

The last letter I received from Coote Hedley was about three months ago. It must have been but a short time before he got the stroke which presaged the end. In it he informed me of the engagement of his youngest daughter to Mr. C. H. de Sausmarez (a master at Wellington College, Berks).

He was so pleased. It is sad that he will not be at the marriage.

Hedley's modesty was a distinguishing trait in his character. In talking to him one would never have imagined he was so outstanding in all branches of games and sport.

He had a great sense of humour and liked a good story, but, what was more, I cannot visualize anyone telling a doubtful one in his

presence, for he carried with him the inspiration of a clean-minded and God-fearing English gentleman, one, too, incapable of any mean-spirited thoughts, words, or actions.

He had as has been seen more than a good show of war medals and decorations. Such, however, was his retiring disposition that he was always averse to putting them up. It is significant that his family did not think he would have liked them to be displayed at his funeral.

The funeral was " private " with " no mourning," thereby showing consideration for many who otherwise would have wished to pay a last tribute to his memory.

But although, true to his character, he left this world with so little ostentation I like to imagine that as he " crossed the bar," the trumpets were sounding for him on the other side.

I cannot help thinking that if Rudyard Kipling had met Coote Hedley and others like him, he would have toned down those lines about " flannelled fools and muddied oafs." For the same qualities which are invariably needed for success in games and sports are also necessary for success in the greater game of Life. These qualities, both mental and physical, were possessed to the full by Coote Hedley. He was a living example of the old Latin tag :

Mens sana in corpore sano.

T.A.H.B.

Maj Gen H D Reginald Tompson CB CMG DSO

MAJOR-GENERAL R. H. D. TOMPSON, C.B., C.M.G., D.S.O.

IT is not usual to publish in *The R.E. Journal* obituary notices of officers who never served in the Corps, but an exception may well be made in the case of one who was known to so many R.E. officers. General Tompson was acquainted with hundreds of sappers, both Regular and Territorial, owing to the fact that he had been Assistant Commandant of the R.M.A., and later Commander of the 1st Anti-Aircraft Division, T.A., the appointment that he held at the time of his death on the 11th October, 1937.

Reginald Henry Dalrymple Tompson was born in 1879. He was educated at Winchester and Merton College, Oxford, and in 1900 was gazetted to the Royal Artillery. After barely two years' service he was awarded the D.S.O. for conspicuous gallantry while on active service in West Africa. He passed into the Staff College shortly before the outbreak of the war, and during the war held a series of staff and regimental appointments in France and in Italy. Shortly after the war ended came his four-year tenure as Assistant Commandant at the "Shop," followed by four years in India and by three years as Brigadier i/c Administration at Chester. At the end of 1934, he was promoted Major-General, and early in 1935 he was posted to command the Air Defence Formations, T.A., to take charge of the process of its development into the 1st Anti-Aircraft Division, T.A.

At the time that he assumed the command neither he nor anyone else realized the magnitude of the task before him. There had never before been such a thing as an Anti-Aircraft Division. The Air Defence Formations, which were to be the nucleus of the Division, consisted of a few scattered units, low in strength, and with little attempt at higher organization. To complete the number of units required it was decided by the Army Council to convert eight Battalions of Territorial Infantry to either A.A. Brigades, R.A., or A.A. Battalions, R.E. The process of conversion itself presented many and difficult problems, and when it was completed there remained the still more serious question of how to expand the converted units, as well as those units that had always been Anti-Aircraft, to approximately five times their existing strength. How many new Batteries and Companies were to be formed, and where, and in what order? By whom were they to be commanded, and by which County Associations were they to be administered? How were they to be housed, temporarily and permanently? And how were they to be equipped and trained?

Into this labour of Hercules the General threw himself heart and soul; attending War Office conferences and County Association

meetings; interviewing important employers of labour; addressing recruiting committees; discussing with Commanding Officers their various difficulties. Wherever things were going well, there he would be, to praise and to congratulate. Wherever things were going wrong, there also he would be, to set them right by his own personal persuasion and energy. Decentralization was no part of his creed. More and more he came to be looked upon as the one man to whom everyone in the Division, or connected with the Division, could bring their troubles, confident that he would find a solution. Day by day his private correspondence grew, until he was answering thirty or forty letters a day in his own clear and beautiful handwriting. By the spring of 1937 he was working over twelve hours a day for seven days a week, and he had had no leave whatever for two years.

Not the least onerous part of his duties was his attendance at regimental social functions. Realizing the gratification that his presence gave, he made a point of never refusing an invitation; and night after night through the winter he attended dinners, dances, and prize-givings, both in London and outside London. At dinners he almost always had to make a speech, which fortunately gave him little difficulty. He was an exceptionally good after-dinner speaker; forcible, witty, and clear. Nor could anyone hearing him fail to perceive the glowing sincerity that lay behind his words.

By the early summer of 1937, although he had broken the back of his task and the worst was over, it was obvious to those near him that the strain had become intolerable and that something was bound to snap. Urged to take a holiday, he replied that he would consider it, but it was too late. On the 25th of May he sat for half an hour in his office, his head in his hands, and then said that he was tired out and must go home. He was seen by his doctor, whose report was alarming, grew steadily worse, and died on the 11th of October.

General Tompson married in 1915. Mrs. Tompson survives him, and there are three children: one of them a boy at Winchester, intended for the Army.

A character sketch of him is not needed by those who have read *The Newcomes*, for in him was worthily incarnated Colonel Thomas Newcome, C.B., of the Bengal Cavalry. He had the same warm and generous temperament; the same unfailing kindness and courtesy; the same almost child-like simplicity; the same indifference to externals; the same deep and unobtrusive piety. Pictures of him come back to one's memory, pictures only a few months old. The tall, gaunt, slightly stooping figure, a battered attaché-case in his hand, walking from Uxbridge Station to his office; stopped by zealous R.A.F. sentries, anxious to arrest him as "a civilian of suspicious appearance," only to be waved aside with a cheerful: "No, no, I'm General Tompson, commanding what's-a-name."

Or at War Office conferences, where he spent the time, his opinion of War Office conferences being low, in writing letters, only pausing to look up and say "yes" or "no" when so prompted by his neighbour; and taking no other part in the meeting except at the end of it to collect and stuff into his bag all the pencils and paper that the War Office provides for such occasions. Or, during a visit to a Drill Hall, chancing to come across a difficult matter that called for immediate decision, and making the decision himself there and then, in the teeth of the opposition of those immediately concerned. Or, in a railway siding after dark, filling a sandbag with stones to take back to the rock garden that he was cherishing at his London house. Or, at Christmas time, summoning the clerks one by one to his office to receive his present of a bottle of wine and a box of cigarettes.

The following incident was typical of him. Last winter he was spending two days visiting some of his units in the country. His programme for the first day covered every half-hour from breakfast to dinner, and ended after dinner with a conference at the hotel where he was to spend the night. It was a wet day, and bitterly cold, but he followed the programme strictly until the afternoon, when he chanced at one Drill Hall to ask what had become of Serjeant X, who had formerly been P.S.I. there. It transpired that Serjeant X had been very ill, and though he was better he had been invalided out of the Army. What was he doing now? He was living hard by, and was out of work. Attempts had been made to find a job for him, but he was "difficult": thought he had a grievance against the War Office, was inclined to be aggressive, and so on; and, of course, it was hard to find a job for a man who wasn't really fit. The General said no more except to enquire the address, and as soon as he left the Drill Hall, there he went. It was a mean house in a mean street. He was fingering his note-case as he went in, and he stayed for half an hour.

He was buried at St. Alban's Abbey on the 14th of October.

"Blessed are the pure in heart, for they shall see God."

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

BOOKS.

Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE ROYAL ENGINEERS IN EGYPT AND THE SUDAN.

By LT.-COL. E. W. C. SANDES, D.S.O., M.C., R.E. (RET.).

(The Institution of Royal Engineers, Chatham. Price 18s.)

As the result of an immense amount of research in official documents and in the works of recognized authorities, supplemented by personal information from officers concerned in many of the situations described, and by his own visit to the countries, Col. Sandes has produced a most valuable book. It is much more than the Regimental History it purports to be, as it is an almost complete account of the principal British military operations in Egypt and the Sudan and of the engineering works which laid the foundation for the modern prosperity of the two regions. There is, of course, an immense literature connected with the military operations and with British rule in Egypt, but I know of no other book in which the ordinary reader will get such a complete picture.

General Sir Reginald Wingate, than whom there is no higher authority, testifies in a Foreword to the accuracy of the record, which will be found easy to read and full of human interest.

The problems of Egypt and the Sudan, though they have changed in character, are still with us and their background deserves study, not only by officers of the Corps, but also by the general public, whom it is to be hoped the book will reach.

Many of the names Col. Sandes introduces would, of course, mean nothing to those unconnected with the Corps, but Gordon and Kitchener are national figures. Possibly in these days when the Army comes in for so much criticism, the public will be interested and relieved to learn that so many of their subordinates were also capable of more than competent work and of devotion to duty.

Col. Sandes has arranged his book in two parts. The first, which is the larger, is military history. It begins with the British and Turkish operations undertaken in consequence of Napoleon's occupation of Egypt, and officers of the Corps were to be found with both Armies. Actually, Capt. Lacy with the Turkish force was the first Royal Engineer to serve in the country. This is an interesting chapter about events with which few can be familiar.

After that, there was a long interval, during which British troops were not called on to intervene in Egypt and the military story does not open again till Arabi Pasha's rebellion in 1882. In the second part of the book, which deals with civil activities, there is a record, however, of much that occurred in the interval. The construction of the Suez Canal, and the initiation of irrigation and other schemes to be brought ultimately to fruition, when R.E. Officers were called in to take a notable part in reducing chaos to order. In this part, too, is included an account of Gordon's earlier missions to the Sudan.

From 1882 onwards, there is no lack of material for military history in which the Corps played an outstanding part. In the Tel el Kebir campaign, Graham commanded Wolseley's leading Brigade and in spite of criticisms of the kind to which Sapper Officers, when placed in command of infantry, are apt to be exposed, retained the full confidence of his Chief. Watson, almost single-handed, secured the surrender of the Citadel of Cairo when accompanying the cavalry pursuit after the decisive battle. Taking into account what was to happen in the future, perhaps the most notable event of the campaign was the somewhat irregular appearance of Kitchener to start his Egyptian career at the bombardment of Alexandria.

The following year, the rise of the Mahdi, followed by Hicks' disaster in Kordofan, and the activities of the elusive Osman Digna on the Red Sea Coast, opened a new chapter in British military history. Early in 1884, Gordon started on his mission to evacuate the Egyptian Garrison in the Sudan and Graham led a force to Suakin to deal with Osman Digna. When the Dervishes began to close in on him, Gordon asked that Graham should send a small force from Suakin to stiffen the Garrison of Berber, and, after he had defeated Osman at Tamai, Graham was prepared to make the attempt. With wells far apart, the route was one which tried slow-moving transport camels to the utmost and it is certain that a line of communication with garrisons at the wells and escorts for convoys could not have been maintained.

It is possible, perhaps, that with Berber still holding out and Osman subdued by defeat, a small well-mounted Camel Corps might have been rushed through and have produced great moral effect. It is hardly surprising, however, that the Home Government refused to allow Graham to act on Gordon's appeal in view of the risks, and after the fall of Berber to do so was out of the question. Nor need we join those who cavil at Wolseley's choice of the Nile route, when the Government at length decided that Gordon must be rescued, for in spite of some miscalculation he nearly succeeded. The controversy as to the respective possibilities of the two routes can never be definitely settled, but it is interesting to speculate what Graham could have done if he had had a mechanized force at his disposal.

Reading Col. Sandes' narrative, one has the feeling that the use made of the Engineer arm by the higher command in these campaigns was somewhat amateurish. The Sappers were looked on as maids of all work, useful and energetic, ready to improvise to supplement the deficiencies of a meagre equipment, but there was no indication of far-reaching Engineering schemes being included in military plans.

Even the abortive project of the Suakin-Berber Railway was placed in the hands of contractors with apparently little military control, and, in spite of the efforts of the Sappers on the spot, it produced only some 18 miles of valueless track at a cost of over three-quarters of a million.

When, in the nineties, Kitchener was able to give effect to his dreams of the reconquest of the Sudan, the story is very different, for strategy then allied itself to Engineering.

Col. Sandes describes Kitchener's campaigns in considerable detail. The work done by Girouard with his band of subalterns and by Manifold on telegraph construction naturally takes pride of place. Kitchener was a sympathetic and understanding master, but his determination to economize and his contempt for factors of safety, must have sorely tried his hard-driven subordinates.

The military history of Egypt and the Sudan is carried through the events of the Great War up to recent times and it includes the precautionary measures taken on the Western Frontier of Egypt during the Abyssinian Crisis.

Then the Author turns to the civil side and arranging his chapters by subjects, shows us the part taken by Sappers in developing the resources of Egypt and the reconquered Sudan.

In Egypt, the task chiefly took the form of correcting and getting into shape ill-conceived or ill-executed projects and of establishing order in corrupt and chaotic administration. Irrigation, postal and telegraph services and railway administration

all owe much to the Corps, and the development of the Port of Alexandria by Girouard, when transferred from the Sudan to Egypt, is a monument to his foresight. At the time, many held that it was a mistake to spend money on machinery where labour was cheap, plentiful and efficient, but he has been proved to be right. Scott-Moncrieff rescued the first great barrage on the Nile from becoming a fiasco which might have delayed the development of irrigation schemes and the establishment of Egyptian prosperity by many years. By proving that the *corvée* system was inefficient as well as inhumane, and by insisting on its abolition to the point of resignation, he deserves especially to be remembered by the Fellahin. It adds to the interest of Col. Sandes' account that, while emphasizing the contribution made by officers of the Corps, he is able to sketch in the work done by their civilian colleagues and successors.

In the Sudan, the problem of establishing the administration of an immense depopulated country with few apparent resources fell on Sir Reginald Wingate when, within a few months of the final disappearance of the Khalifa, Kitchener was summoned to South Africa. Starting with a purely military administration, an immense amount of pioneer work was required from officers of the Corps.

Railways, telegraphs and buildings, to open up the country and make it habitable, had to be constructed at a minimum cost, for the country was desperately poor and few were optimistic about its future. Would it do till something better could be afforded, rather than would it last, or would it look nice, was the test of most of the work. Railway stations without platforms and the cheapest of tracks, telegraph poles which provided food for white ants and playthings for elephants, sufficed for immediate requirements. What was necessary, however, was an immense amount of hard work and initiative in a constant struggle with the forces of Nature; and as had been shown in the campaign of reconquest, Nature was an opponent ever ready to play dirty and unexpected tricks.

The construction of railway from the Red Sea to the Nile and the conversion of the little-known anchorage at Sheikh Barghut into a port which could be used freely by modern shipping was perhaps the greatest contribution made by the Corps.

Suakin, always an indifferent Port, and with little possibilities for expansion, was becoming increasingly dangerous to approach with the growth of coral reefs, which lined the long entrance channel. It could never have served the needs of the country, and after some doubts and controversy, Kennedy, an officer of outstanding ability, was given the task of laying out the new Port to which Lord Cromer gave the name of Port Sudan—Sheikh Barghut (the Sheikh of the fleas) was hardly dignified.

The Sudan prospered on the work of its military pioneers and with prosperity civil has replaced military administration and early engineering works have been brought into line with increasing demands. The Army and the Corps in particular may, however, look on the Sudan with pride as their child. In other regions, as the Empire expanded, it has been said that the flag followed trade, but in the Sudan the order was reversed.

Kitchener, of course, is the hero of Col. Sandes' book, and much light is thrown on his character, which shows how greatly mistaken was what Sir Ronald Storrs calls the "Stereotyped halfpenny Press image of the roaring nineties" which the public has so credulously accepted.

Those of us who belong to the older generation will be grateful to Col. Sandes for bringing our friends back to us. For the rising generation, the record of what the young accomplished may, one hopes, inspire ambition. Opportunities may not be so common as in the Victorian age, but they can still be found by those who seek them.

The book certainly deserves a place on the shelves of all R.E. officers and it can safely be recommended to their friends interested in Egyptian and Sudan affairs.

C.W.G.

FRONTIER PATROLS.

A History of the British South Africa Police and other Rhodesian Forces.

By Colonel COLIN HARDING, C.M.G., D.S.O., late Administrator, Barotseland, and Provincial Commissioner, Gold Coast Colony, 372. pp.

(London: G. Bell and Sons, Ltd., 1937. Price 8s. 6d.).

In a foreword to the volume the Governor of Southern Rhodesia, Sir Herbert Stanley, expresses the hope that by its means some knowledge of the British South Africa Police may reach much wider circles than are at present aware of the origin and activities of the magnificent body of men, who under various regimental titles have, during the last fifty years, been so closely connected with the development of the territories now known as Rhodesia.

The author set himself a difficult task when he undertook this labour of love on behalf of his old comrades. The history of the police forces of the border is to all intents and purposes the history of the creation and development of Rhodesia. The forbears of the British South Africa Police of to-day took part first in the bloodless expedition of 1884–5, led by Colonel (afterwards Sir Charles) Warren, R.E., to Fourteen Streams on the Vaal River, where that distinguished sapper had a conference with President Kruger and extracted a promise from him that the Government of the South African Republic of the Transvaal would cease to encourage the raids of the frontier Boers against the native tribes, whose land they hoped to annex to the Transvaal. Their next active service was the Matabele War of 1893, and the occupation of Mashonaland in the following year. Then came the Jameson Raid at the end of 1895, which was followed by the Matabele Rebellion and the Mashonaland Rebellion in 1896. The South African War followed in 1899–1902, and the Great War in 1914–18. In all these campaigns the Mounted Police forces took an honourable part.

Known originally as the Bechuanaland Border Police when the first contingent of Mounted Police was raised in Southern Bechuanaland in 1885; thereafter, subsequent to the grant of a Charter to the British South Africa Company, as the B.S.A. Company's Police. Then, after temporary disbandment, as the Mashonaland Horse, the Corps was in 1896 formed into the British South Africa Police out of an amalgamation of the Mashonaland Horse, the Matabele Mounted Police and the remnants of the British Bechuanaland Police. Colonel Harding has done his best to produce a connected story covering the 40 years to the end of the Great War, but it is a disjointed narrative, hard to follow. For material he has had to quote largely from various books, and he has been supplied with material from the police records and by survivors of the various units. It is to be regretted that the history was not put in hand before most of those who took part in the events he describes had passed to their rest. The account of the part taken by the Rhodesian Forces in the first year of the South African War is meagre and inaccurate. To those who think of trying their luck in South Africa, the volume should appeal, and it should certainly be read by the young men recruited in Great Britain, who are being trained for the B.S.A. Police at the Police College and with the Metropolitan Police. To the soldier the book is useful as a guide to some of the books already published dealing with the various expeditions and campaigns in South Africa enumerated above.

The appearance of the book at a moment when the absorption of the Protectorates is being urged by South African politicians is timely, for it will remind the present generation of the sacrifices made by the early pioneers on behalf of the Empire, and of the promises given to the native chiefs when they asked for and obtained protection by the Crown, personified in the "Great Queen"—Queen Victoria.

H.B.-W.

THE CIVIL WAR IN THE UNITED STATES.

By W. BIRKBECK WOOD, M.A., and Brig.-General Sir JAMES E. EDMONDS, C.B., C.M.G.

(Methuen and Co., Ltd. Price, 12s. 6d.)

This book is virtually a second edition of a volume which originally appeared in 1905. The authors have reprinted the book in order to amplify the first edition in the light of the information which has since become available. A series of biographies have been published in the last decade which have made a more complete history possible.

This volume contains only a summary of the outbreak and first three years of the American Civil War. It has special reference to the years 1864 and 1865. As such it tends to redress the balance of our knowledge of this war, which for many soldiers has been confined to the first years of the war owing to the wide influence of Henderson's *Stonewall Jackson.*

This new edition, like the old, must be regarded rather as a valuable book of reference than as an instructional military history in itself. Even though the main portion of the volume is restricted to the last two years of the war and embraces over 250 pages, there were so many theatres of fighting and so many actions in each, that the chapters cannot help being in the nature of a mere outline of events. Only rarely have the authors allowed themselves the luxury of an instructional comment. One could have wished this volume expanded into more, to give space for the reflections upon history which are so much more value than the history itself.

There are eight outline maps enclosed, sufficient to enable the text to be followed.

This is a book that should be held in all military libraries.

B.C.D.

THE TERRITORIAL ARMY.

By Colonel G. R. CODRINGTON, C.B., D.S.O., O.B.E., T.D.

(Sifton, Praed and Co., Ltd. Price 4s. 6d. Postage 4d.)

Colonel Codrington's book—of which this is the second edition, the first being entitled *What is the Territorial Army?*—is an interesting and very readable work, written with the aim of eradicating the suggested ignorance of the Regular soldier regarding his Territorial brothers in arms. It deals with the history, organization, finance, conditions of service, training and spirit of the T.A.

The problems confronting the Territorial, and the Regular serving with him, are clearly set out and discussed. The reasons why no two T.A. units are exactly alike are explained, as are the consequent effects on recruiting and the training necessary to bring each unit up to the common standard of efficiency which must be attained if the T.A. is to fulfil the role alloted to it.

These factors demand elasticity, and it is explained how this is provided by the County Association System. The methods of clothing and equipping units are outlined, together with some details of the pay, allowances and grants which can be earned by individuals.

This is an interesting and informative book which should be read by any Regular soldier who is about to encounter the T.A. for the first time.

KRUPP—THE LORDS OF ESSEN.

By BERNHARD MENKE.

(William Hodge & Co., Ltd. 406 pp. Price 12s. 6d.)

This is the sordid story of one of the more notorious members of the armament ring—a ring which, as the author demonstrates, was maintained by a very qualified code of morals.

From such a resounding title the reader is entitled to expect a dissertation on the evolution of modern armaments. The author, however, concentrates on the political and commercial aspects of the firm's activities. The absence of any serious treatment of the technical is possibly explained by his summing-up of Krupp's Great War effort for Germany. "Generations of unenterprising monopoly resulted in failure "at the critical moment." The military commanders had done all they could with the material available. Germany was at the cross-roads. All Krupp could offer was "Big Bertha." To intensify the irony, its designer was made a Doctor of Philosophy. The imagination to produce material surprise was lacking, and the tank was inspired by British brains.

But as a basis for consideration by a Commission on the Manufacture of Arms by Private Firms, the book is invaluable. For here we find all the subtleties for the seduction of Governments illustrated with compelling force, and, as far as can be checked, veracity.

The years 1857 to 1877 saw the opening of the era of competitive armaments. Alfred Krupp was a man of business, not a technician. He exhibited his wares all over the world, and at the Crystal Palace even the M.G.O. was impressed with his castings—43 cwt. of steel. But in spite of this publicity, and decoration from the French, Krupp could not sell his guns to Germany. He made an astute appraisal of the situation and decided to make influence and nepotism replace the "usual channels." From then onwards we see the firm gradually become the King's favourite. Having attained royal patronage, the next step was monopoly. This paved the way for profiteering, which in turn simplified the wholesale seduction of Government officials in all services. Ambassadors became the firm's representatives. Competitors found their secrets stolen or their firms bought out. Competitive gun trials in South America with Schneider are described as "Wild West Shows." And it is not an unfair generalization to say that the firm obtained more orders by corruption than by the technical superiority of their designs.

It is significant that Krupp has always favoured dealings with autocratic governments, since their structure simplified his methods of obtaining business. In spite of 60 years of royal patronage, the firm has had to face some awkward moments. In 1902, when the Navy was being built up, fear of a State armour-plate factory forced the price for such a commodity from 2,320 marks to 1,920 and still left 900 marks profit. In 1913 the "Kornwalzer" Scandal proved that Krupp had key-men in the Inspection, Test and Advice Departments of the Army in his pay.

In post-war years, secret attachments were formed in Sweden with the Bofors Arms Co. in Holland and in Spain. It was not until von Blomberg contrived a reconciliation between Hitler and the Reichswehr that the Swastika floated over Hügel—the family mansion; it had not been clear which way the cat would jump. Spring, 1933, saw the rebirth of the firm and imports of copper and iron ore increased 200% and 600% respectively. Thereafter tanks were openly built at Magdeburg, and Q.F. guns at Jüterborg, and an attempt was made to unload all the obsolete material manufactured in Sweden, Holland and Spain on to China. History was beginning to repeat itself. In these present times, there is much food for thought for the patriot in this volume.

HINTS TO TRAVELLERS.

ELEVENTH EDITION. VOL. II.

Organization and Equipment. Scientific Observation, Health, Sickness and Injury. R.G.S., 1938.

(Printed in Great Britain by William Clowes and Sons, Ltd. Price 14s. od.)

In this edition of *Hints to Travellers* Survey and Field Astronomy have been separated wisely into one volume: Volume II, which has been completely re-written

in the light of modern theory and practice, now incorporates the former *Hints on Outfit.*

It is divided conveniently into three parts. The first thirteen chapters deal fully with organization, equipment, food, clothing, transport and other allied subjects. They embody the experience of many travellers, mostly British, in many parts of the globe, but chiefly in the Polar Regions and Central Asia.

Invaluable hints on preliminary preparations at home, including estimates, newspaper rights, costs, permits and the passing of Customs, are followed by a very instructive, if rather specialized, section on food, balanced diets and cooking. A useful table showing the qualitative analysis of foodstuffs is included.

The vexed questions of clothing and equipment are dealt with in great detail. Accepted practice is set forth in very readable form supported by frequent extracts from the reports of expeditions, papers read to the Society and travel books; also handy references for those who wish to follow the subject farther. Different schools of thought are advanced impartially with comments, and such highly specialized matters as the design of tents and the weave of materials for clothing are investigated to enable the would-be traveller to compile his own specifications.

The section on photography merits attention by any amateur photographer, whether he intends to travel or not. A brief section gives advice on the selection and care of apparatus for different purposes and for different regions. Another a description of different types of cameras, supported by a handy classification table at the end of the chapter, giving approximate price, brief specification, and a reference to the makers of the better known examples. A section on photography for survey appears incomplete in that it does not mention the importance of records, *i.e.*, position, bearing, and inclination of the camera; height of photo station, L.M.T. of exposure, etc. Light intensity, exposure, aperture, and emulsion speed are given a novel and interesting treatment and there is a very able section on development under Field conditions. Colour photography rightly receives a lot of detailed attention, but the section on moving-picture cameras is disappointingly short and incomplete considering the tremendous value of this form of photography for record purposes.

The second part consists of six chapters which introduce the principal subjects of scientific enquiry which a serious traveller may and ought in the interests of science and his own edification to pursue. Separate sections cover vegetation, meteorology, geology, natural history, anthropology and antiquities. The would-be scientist is given an outline of each subject and ably advised on what to note, investigate, and collect and how to do it.

The last part, of two chapters, deals fully but simply with Health, Disease and Injury. This is perhaps the most useful and instructive part of the work and most of it, excepting the specialized tropical diseases, frost-bite, etc., is what everybody ought to know but does not. It is hard to think of anything more useful for a sapper officer on a boundary commission, who has to be doctor and dentist to all and sundry, than this last part.

The whole book, not only contains a mass of carefully compiled information but makes extremely interesting reading.

It is to the traveller what *F.S.P.B.* ought to be to the soldier and what a good pocket-book is to the engineer.

H.C.S.

"NOISE."

By A. H. DAVIS.

(Watts and Co., London.)

This book, written by an official of the physics department of the National Physical Laboratory, is excellent on the psychology of individual reaction to noise

and on the theory of transmission and measurement of intensity of sound. Noise, that is sound undesirable to the recipient, seriously impairs the capacity of the mental worker, and in fact a man's intellectual effort at any moment can to a great extent be judged by his intolerance of unnecessary noise.

The general theory of sound, its intensity, pitch, speed of propagation in various media, absorption, refraction and quality are well and concisely given. In particular an analogy with the wave theory of light over the effect of obstacles of different sizes on rectilinear propagation is interesting. The effective range of the human ear, the relation of apparent loudness and true intensity of sound, measurement of noise on an arbitrary scale of phons and the analysis of complex sounds into component pure tones are clearly explained.

The remainder of the book gives general details of modern practice developed from the foregoing theory, and covers methods of location by binaural sense, the theory of hydro-phones, the use of sound ranging and stethoscopes; it also deals with methods of suppression by balanced design in machinery, by insulating layers, by absorptive hangings to reduce reverberation, and by avoidance of resonance; the peculiar problems of air and water propeller noises are touched upon together with the general problems of silencing travel by air, rail and road.

Some understanding of the theory of sound and of the problem of noise is necessary in the design of all new accommodation, and for modifications of existing accommodation, where efficiency is likely to be affected by noise. This book is written in non-technical language which makes easy reading and will serve to give a general knowledge both of the modern theory of sound and the present practice of reduction of noise.

H.E.C. de C.

MILITARY ENGINEERING (VOL. II) DEFENCES, 1937.

(H.M. Stationery Office. Price 4s.)

The new volume is on much the same lines as the previous one. It is divided into two parts—Deliberate Land Defence and Coast Defence.

Part I refers essentially to the construction of fortresses similar to those along the frontiers of continental nations. The lessons of the Great War and subsequent developments stress the importance of depth for all types of defences and also the great strength of properly constructed and organized trench systems. The development of a trench system, either thrown up hurriedly or dug deliberately, to fill the gaps between permanent fortifications, is discussed briefly. More space is given to the consideration of the principles and details of permanent fortifications. After a general reference to these principles, separate sections deal first of all with the requirements of the various different works involved :—infantry positions, artillery positions, aerodromes, tanks, anti-gas defence, communications, accommodation, obstacles, concealment and maps. This is followed by a comprehensive chapter containing details of the design and construction of such works. Part I ends with a short chapter on the superintendance of work.

Part II, like most books on Coast Defence, starts with an historical record, presumably intended to support a subsequent conclusion that " to gain possession of a properly defended port by naval and air attack unaccompanied by land attack, is, under present conditions, not a practical proposition." Section 74 gives very clearly the relative merits of ships and shore batteries, and in Chapters X and XI the likely forms of attack and necessary measures to deal with them are fully set out.

The various fixed defence works are briefly considered in the last chapter of the book. First of all the requirements and styles of batteries and emplacements, together with the arrangements for ammunition supply, range-finding and control; then the siting, employment and control of defence electric lights; and lastly beachdefence are dealt with.

A short appendix "General instructions for the construction of a rear defensive position" at the end of the book would possibly have been more suitably inserted immediately after Part I.

There are some thirty plates mostly dealing with land defences.

The book is written in clear and concise language and contains no surprises, except that it seems to have inherited a nice red cover from its predecessor.

E.W.B.H.

A PRÉCIS OF THE KING'S REGULATIONS AND THE MANUAL OF MILITARY LAW FOR OFFICERS.

By Major W. J. PENDLEBURY, late R.F.A. (T.).

(Wilding and Son, Ltd., Shrewsbury. Price 1s. 6d.)

The title of this booklet is wrong. A précis of *King's Regulations* and the *Manual of Military Law* could not be produced in 50 pages. What the author has endeavoured to produce is a précis of part of Chapter VII of *King's Regulations* which deals with discipline in general and which he apparently intends should lead up to Courts Martial.

The arrangement of the book is not clear. Although there is an index at the back, there is no table of contents to show the general sequence of the subject matter.

The book is not strictly accurate. There are many minor inaccuracies which tend to show that the author has not got a clear grasp of the subject, *e.g.:*

Page 5 says "Military custody of an officer or W.O. is usually arrest." Military custody *is* arrest; this is clearly stated in *King's Regulations*, paragraph 546 (a).

Page 9 says "Every charge against a soldier will be heard by the C.O. in his presence." This is not so, as Company Commanders are authorized to dispose of certain offences. (*King's Regulations*, paragraph 556 (d).)

Page 25 says "Where a N.C.O. is convicted by the civil power, the case is reported to G.O.C., who, if he wishes to reduce the offender, will transmit his desire to the competent military authority." But the G.O.C. is a competent military authority!

There are many other points which are not correct but there is one on page 49 (Summary of Evidence) which is worth special note, viz., "The accused after being duly warned that any statement he may make may be used *against him by the prosecution*," etc.

The words underlined are most important. Rule of Procedure 4 (E), which is the reference to this point, does not say that any statement may only be used *against* an accused. A statement may assist the accused in certain circumstances and in The Judges' Rules—No. 5 on page 92 of *The Manual of Military Law*—it states that:

> Care should be taken to avoid any suggestion that his (the accused's) answers can only be used in evidence *against* him, as this may prevent an innocent person making a statement which might assist to clear him of the charge.

The book cannot be recommended as a reliable guide to knowledge of discipline and military law.

W.H.K.

MAGAZINES.

RIVISTA DI ARTIGLIERIA E GENIO.

(*October—November*, 1937.)—This number is devoted to artillery subjects.

La nostra artiglieria all'inizio della grande guerra.

General Ago, who held an appointment at the Italian War Office in 1914, under General Cadorna, describes the shortage of material and personnel in the artillery on the outbreak of war. The deficiencies had been aggravated by the war in Libya, and the economies that followed that war.

Germany and France had kept their artillery up to date; the Italian artillery had been neglected, and was greatly inferior to that of Austria-Hungary when the World War broke out. Even by the time that Italy joined the Allies, only a little of the leeway had been made up, and it was a long time before the Italian artillery became a match for that of the Austrians.

On mobilization there was a shortage of 13,000 officers in the Italian Army. It took a long time to make good the deficiency, and the new officers were only very inadequately trained for their job.

Esperienze di conservazione prolungata a 80° ed in ambiente secco di balistiti di varia età e provenienza.

Drs. Tonegutti and Brandimarte have conducted a series of experiments which go to show the preservative effect of calcium oxide on nitro-cellulose powder stored for a considerable time at a temperature of 80° C. The effect of calcium oxide makes itself mainly felt after the explosive has already lost a great part of its initial stability.

Influenza delle caratteristiche dello chassis di un autoveicolo sulla sua attitudine a percorrere le strade ordinarie.

An investigation, by Colonel de Braud, of the connection between the dimensions of the chassis of a motor vehicle (*i.e.*, wheel-base, width of track, radius of turning circle) and the minimum width of road necessary to take the vehicle round a hair-pin bend of given radius.

Rifornimento delle munizioni con particolare riguardo alla guerra di movimento.

Brig.-General Monti has made a study of the supply of ammunition in mobile warfare. The introduction of the present type of armament, in a division alone, has increased the weight of ammunition for a "unit of fire" from 61 tons to 105 tons The ammunition required for a single day's battle requires 3½ times the transport of a day's rations and fodder. The writer makes suggestions for speeding up the rate of supply and explains the advantage of using aeroplanes.

(*December*, 1937.)—This number is devoted to engineering subjects.

L'arma del Genio negli anni XIII e XIV dell'era fascista e durante la campagna in Africa Orientale.

This instalment gives details of some of the works on which engineers were employed in the East African campaign. They were as follows:

On the Eritrean front:

Defensive Works, *i.e.*, forts, redoubts and entrenched camps, with parapet walls of dry stone masonry, surrounded by wire entanglements.

Wire Ropeways. Most of these were across river beds, to maintain communication during spates.

Railways. The Massaua-Agordat line was completed and improved. This involved duplication of the line in various places and the construction of several bridges.

Water-Supply, including sinking of wells, tapping springs, constructing reservoirs, laying pipe-lines, etc. The supply was so well-organized that, in spite of the dryness of the country, water was the one thing that the troops were never short of.

Other works on which engineers were employed were searchlights, temporary and permanent electric light installations, and the construction of hospitals, barracks, stables, bakeries, etc.

On the Somali front, engineers were mainly employed on road work, signalling communications and water-supply. The existing roads were practically only tracks; they had to be improved and river beds bridged where necessary. Signalling communication was maintained by radio. Water-supply consisted mainly of water storage and of making tainted water drinkable.

Il problema dell'addestramento della specialità radiotelegrafisti al servizio R.T. d'insieme in reti complesse.

Colonel Agostino discusses various problems in the organization and work of wireless units.

Abbaco per il calcolo dei ponti di circonstanza.

Lieut.-Colonel Steiner explains the use of a graph for calculating the dimensions of scantlings in wooden bridges. He shows how this graph can be used for solving problems not mentioned in tables in common use.

The graph has been worked out on the assumption that beams are simply supported and the calculations have been made for evenly distributed loads. Where concentrated loads have to be considered, the corresponding distributed load (having the same bending moment) should be calculated.

The writer works out two examples, one for a foot-bridge with 6.5 metre spans to carry infantry; the other for a bridge with 6 metre spans, to carry light cars. He then goes on to show how the graph can be used for strutted beams.

Come si deve effettuare l'isoonda di maglia nelle minori stazioni r.t.

Major Malerba describes the method of controlling iso-waves in a system of radio-stations.

Contributo allo studio dei movimenti di terra per la costruzione degli aerodromi. Lieut.-Colonel Pallavicino.

Recent increases in the air force have necessitated the construction of a large number of aerodromes. When aviation was in its infancy, any fairly level plot of ground, clear of trees, would answer the purpose of a landing-ground. Nowadays the great weight and speed of aeroplanes demand perfect levelling and a much larger area for a landing-ground, amounting to 100 hectares (247 acres) or more, and a straight run for landing, approximating to 2,000 metres.

The ground need not be absolutely level, provided it has a uniform slope, which should not exceed 2 per cent. If a change of slope is unavoidable, it should be a gradual one. Some of the points to be noted in selecting a site are: (*a*) the greatest length should be in the direction of the prevailing wind, (*b*) the surrounding ground should be such as not to obstruct landing in any direction, (*c*) drainage should be good, with a minimum number of drainage lines. In sandy ground, rain water will be absorbed by the soil to a great extent. Clay soil may need a system of drain pipes.

The levelling of a landing-ground will usually require a great deal of earthwork: the problem is to reduce it to a minimum. The first requirement is an accurately contoured plan. In some cases the contours may have to be at 10 cm. (4 inch) intervals. These contours of the existing ground are shown in black; those of the ground in its final state are shown in red. The location of the red contours requires much care, and is largely a matter of trial and error. The writer explains how the most economical system of levelling can be carried out, in which the excavation will, as nearly as possible, balance the filling.

Le teleferiche militari con funi ancorate ad entrambe le estremità.

In Chapter IV of his treatise on military ropeways General Bellusci deals with the load carried hourly and with the design of the parabola. In this instalment he gives us

formulæ for determining (1) the maximum power of the motor in the " continuous automatic " system as a function of the hourly load to be carried uphill, (2) the braking power in the " continuous automatic " system as a function of the hourly descending load, (3) the maximum motor power in the " continuous intermittent " system for the transport of material uphill, (4) the braking power in the " continuous intermittent " system for descending loads.

A.S.H.

REVUE DU GENIE MILITAIRE.

(*September—October*, 1937.)—*Le Génie à la prise de Constantine* (13 *Oct.*, 1837). By Captain Fadeuilhe. An article of 96 pages describing very fully the campaign of the expeditionary force which captured Constantine a hundred years ago. In a fortnight, the little force, about 6,000 infantry and 800 cavalry, under the command of General Comte de Damrémont, Governor-General of the French possessions in Africa, marched from its advanced base at Medjez Amar, about half-way between the port at Bone and Constantine, and after a brief siege carried the place by assault. The engineers accompanying the force consisted of 10 companies of sappers and an engineer park. The commandant of engineers was Lt.-General Baron Rohault de Fleury; and he had a considerable staff of assistants and aides-de-camp. Among the junior engineer officers on the staff was Captain Niel, who became a Marshal of France in 1849. The town was taken on October 13th, by the old-time method of breaching the walls and assault. The Arab defenders numbered about 8,000. The French casualties were 57 officers and nearly 600 other ranks, excluding sick, of which there were a large number. The engineer casualties were 8 officers and 57 men; most of these occurred at the breach.

Étude d'ouvrages suspendus en campagne. By Lt. Ferrandon. Suspension bridges to carry present-day loads in the field are not much in fashion; they require methods of stiffening which are often impracticable in an improvised structure. Lt. Ferrandon, however, gives an example, fully worked out and diagrammatically illustrated, of a stiffened suspension bridge of 120 metres span, to carry a concentrated load of 25 tons. The materials for such a bridge weigh only 160 tons.

(*November—December*, 1937.)—*Les dispositifs de tir sur but mobile à grande vitesse.* By Captain Thuaire. A short description of an arrangement installed at the artillery instruction camp at Larzac for running " tank " targets at speed. Instead of a complicated system of ropes and pulleys, with their attendant difficulties at sharp bends, the trolleys carrying the target run by gravity down a sinuous track. The track is an ordinary 60 cm. line; the maximum gradient is 1/20, and an average speed of the target is 22 kilometres an hour, say 15 m.p.h. A maximum speed of 25 m.p.h. is attained. The trolleys are hauled back by horses to their starting-point by another route, more or less direct.

Renflouement d'une voiture automobile tombée dans la Saône à Lyon. By Major Croux. The French Engineers are often called on to carry out tasks for the civil authorities which give them practical experience, and furnish opportunities for junior officers to handle men in unusual circumstances. In this case, a motor-car containing four persons plunged through a parapet on a bridge over the Saône at Lyons and fell into deep water, on 6th December, 1936. Several attempts to locate the wreck were made by the local authorities, including two special salvage enterprises, but they were all unsuccessful. At last, recourse was made to the 4th Engineer Regiment, and a detachment of sappers (1 officer, 90 other ranks) was told off to recover the car. After five days' work they were successful.

The operations are very closely described day by day; even the exact times at which the plant and stores arrived on the spot are given. In fact, the article is written with a view to making a complete study of the operation.

The depth of the river, from 20 to 35 feet, and its rapid current, combined with the failure of all previous attempts, gave rise to all sorts of opinions as to where the wreck would be found. A powerful electro-magnet was used, together with long poles or boat-hooks. On the third day, the magnet fastened on to the submerged car, the boat-hooks confirming the discovery by bringing up fragments of its upholstery. The car was then lifted by chains clear of the bed, and brought near the bridge from which it fell, so that hoisting gear could be adjusted. An electric lamp was submerged which showed up the plated parts of the car, in spite of the murky water.

So great was the local interest in the work that several persons spent the night on the quay-side in order to see the final stage. It was December 27th! A diver went down to adjust the cables, and by midday the car and its occupants were handed over to the civil authorities. The salvage party were rewarded with 2,000 francs from the town, and 300 francs from M. Herriot, the mayor of Lyons. Congratulations poured on them from all quarters. The work was successfully done.

Calcul graphique des problèmes de traction en voie de 60. By Colonel Metrot. Describes the construction of scales and graphs to facilitate the calculation of loads and speeds permissible on 60 cm. track. The author is of opinion that military engineers do not take sufficient advantage of such graphic and slide-rule methods. Their value in the theoretical study of such problems is undoubted, and a knowledge of their construction goes a long way towards an appreciation of the practical side, which is the military engineer's chief objective. So many indeterminate factors crop up with light railways in the field that the practical side must be uppermost.

L'Avenir de la fortification vu en 1915 *par des Allemands.* By Lt.-Col. Montigny. So rapid was the fall of the French and Belgian fortresses in 1914, that the uses of modern fortification were at one time almost universally discounted. The heavy artillery of the Germans and Austrians had made such short work of the steel and concrete of the "impregnable" fortresses that a false impression was created. But among German authorities, the retired veteran Frobenius was of a different opinion, and his studies in 1915 are the subject of Lt.-Col. Montigny's article. The fortresses failed because they were left to their own devices, instead of being used as strong points in the main line of defence. The enemy's guns were allowed to do their battering unmolested. Quite a different story can be told of the defence of Verdun in 1916. Here the fortifications were properly used, and though they suffered severe damage, they were not wholly captured.

The essentials deduced by Frobenius are that the garrison should operate in advance of the works; that the forts should be small and scattered (the German "Feste" idea); and that the field armies should collaborate closely with the fortresses.

W.H.K.

REVUE MILITAIRE GÉNÉRALE.

(*October*, 1937.)—*Réflexions sur le danger aérien.* By Vice-Admiral Castex. The increase in speed, size and range of modern aeroplanes has brought every country in Europe within the zone of aerial attack; and there are now many aspects of the risks which must be considered. Although the author is chiefly concerned with the naval risks, he also discusses the new problems which confront the land forces and the civil populations. France, he points out, has the benefit of great advantages in Northern Africa of expanding her air defence in depth. The exploitation of these geographical advantages, he suggests, may have something to do with Germany's intervention in Spain and her desire to have some footing in that country to embarrass the French in a new direction.

The article touches on parachute landings, the dispersion of railways and communications, and the removal of Government centres to pre-arranged localities. The

experiences of Madrid, horrible as they have been, have not yet resulted in the evacuation of the city.

Une Volonté. By Henri Gache. An account of the short campaign in Morocco in 1908, conducted by General d'Amade, to whom the author was aide-de-camp. General d'Amade was a man of firm decision and knew what he wanted. The operations described are typical of the numerous expeditions conducted at that time against the insurgent tribes of Northern Morocco. They are only briefly described.

La Genèse de la Marne. By Lt.-Col. Malcor. A clear exposition of the causes of the failure of the German plan in 1914 on the Western Front. The author bases his account and comments entirely on the German "Reichsarchiv." He sketches the characters of the German Army commanders, and shows how a psychological study of the leaders explains many of the shortcomings which interfered with the German plan. Moltke's unfitness for the Supreme Command, his confidence that all the meticulous study of the problem would obviate interference with the army leaders, and, when he did interfere, his mistake in making Kluck subordinate to Bulow and hampering his wide sweeping movement, are not alone among the faults discussed. Bulow's brilliance as a tactician, and the general respect for his intellect and experience caused him to think too much of his own problems, and too little of the whole drama in process of enactment. Kluck was freed too late from the encumbrance of Bulow; and Moltke postponed too long the resumption of higher direction.

Préparons-nous la guerre de mouvement ou la guerre de stabilisation? By Commandant de Cugnac. The French Army is being trained, as are most European armies, for a war of movement. There is no preparation for stabilized warfare. Indeed, all the modern weapons are being forged with a view to breaking down any organized position and preventing that expensive deadlock which held the armies of 1914–18.

But the author thinks that this is a mistake, and that some form of static warfare must be experienced, and ought to be prepared for. If frontier defences perform their task, what else would an attack on them be but an attack against an organized position? All phases of warfare must be studied.

Esprit guerrier allemand et français. By Lt. Leguebe. An article in the "mystic" style.

(*November*, 1937.)—*L'Affaire de la Chenal en* 1743. By General Dentz. An episode in the war of the Austrian Succession. A Franco-Spanish Army under Las Minas attacked a Piedmontese force under the King of Sardinia, who held a strongly fortified position in the mountains. The article shows that the approach march and plan of attack was sound, but the tactical execution was faulty, and the larger force was beaten. The affair was badly prepared, and Las Minas went into it with over-confidence.

La conduite de la guerre. Joffre et l'année, 1915. By Colonel Menu. The year 1915 was a year of vain attempts to break the German line in the west; attempts which had to be made in order to relieve the pressure on the Russians, but they had to be made with totally insufficient means. In 1914 the Russians attacked before they were ready, in fulfilment of their promise to the French. Joffre was no less under obligation to continue to attack. The French sacrifices in 1915 were not in vain.

The author gives a fairly long review of the operations on the Russian front 1914–15; and then shows how Joffre's actions had their effect on the eastern war. The French operations in Champagne—Joffre's favourite theatre—in February and March, 1915, prevented the dispatch of any German divisions to Russia. The British attack on Neuve Chapelle, incidentally, had some share in this.

For the Germans, the Russian front was the important theatre in 1915. The Russian successes in the Carpathians forced them to stand on the defensive in the west, while they attacked Russia in the Polish region to relieve the Austrians. The lack of rifles in the Russian Army, more than the lack of gun ammunition, destroyed the chances of resisting the German attack. Appeals to France for rifles and munitions could not be met. The blame for failure to arm the men they recruited rests solely

with the Russians themselves, but Joffre did all he could to relieve the situation. Ill-supplied himself, he launched the big French offensive in Artois in May, and renewed it in June. In September he attacked again on a great scale in Champagne, while the British attacked at Loos. Throughout the year Joffre exerted himself incessantly to help the Russians. Disappointed with the slow rate of British reinforcement—(here the author overlooks the steady increase in the number of British divisions arriving in France in spite of our heavy commitments in fighting Turkey)—Joffre never lost hope, and his solid worth to the Allied cause cannot be too highly rated.

The article shows well how much the French efforts in 1915 contributed to preventing Germany from winning the war in the east. Although he omits all mention of Ypres, 1915, and Loos, he has made good his claims. Two clear diagrams illustrated the movement of reinforcements from west to east and vice versa in 1914–15.

Principes et conditions de la guerre. By Lt.-Col. Béthouart. The article begins with an affirmation of the immutable principles of war, and then applies them to modern conditions. The army to be maintained must be the army required by the national policy. Modern war is a question of stocks of material. Industrial mobilization must get down to the production of war material with the minimum of delay, and so on. A good many axioms are sprinkled about.

Que doit lire un Officier ? By Lt.-Col. E. Mayer. This is not a list of books recommended. Very few books are mentioned. Beginning with a story of how he found Foch one day in the middle of manœuvres reading Zola's *La Débâcle*, the General explaining that he made it a rule to give at least one hour a day to mental recreation and would read any subject so long as it was not military, Colonel Mayer enlarges on the wisdom of training the mind with methodical study.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*October*, 1937.)—*La Guerre de la Succession d'Autriche.* By General Van Egroo. A concise account of this war so far as the Belgian theatre of operations was concerned, with a chapter on the art of war as practised at that period. Marshal Saxe was the outstanding figure of the war. The five campaigns are briefly but clearly described.

Modalités d'emploi de l'artillerie. By Lt.-Col. Sottiaux. As the author points out, the tactical employment of artillery is now a normal feature in all forms of training exercises, and is no longer a mysterious art left to the specialists. All commanders of formations have now to handle artillery, or at least to know thoroughly the principles of its employment.

The article chiefly deals with the question of artillery command in a divisional operation.

La Révolution Brabançonne dans le Duché de Limburg. By M. Leconte. This is the second instalment of this article. It describes in minute detail the operations of the small parties of the volunteers of Limburg in defence of their country in 1790–91. The fighting described took place chiefly around Liége. Many extracts from contemporary accounts are given, and contain details of barbarous massacres of inhabitants.

(*November*, 1937.)—*Discours prononcé à l'inauguration du Mémorial Américain, à Waereghem, le 8 juillet* 1937. An address by the Belgian Minister of War, Lt.-General Denis, at the unveiling of the memorial to the American Army.

Dixmude : 17 Octobre—10 Novembre, 1914. (*Pages d'histoire de l'armée Belge.*)—By Major Wanty. The first instalment of a very interesting study of the operations at Dixmude in the early days of the war. Beginning with an account of the preliminary operations of the Belgian forces leading up to the battle, the author describes the occupation of Dixmude by Admiral Ronarc'h's Naval Brigade on October 15th,

the first contacts with the Germans, the fighting on October 17th; the first stages of the Battle of the Yser, and the Franco-Belgian sortie on October 19th. The concentration of the Belgian Army (6 infantry and 2 cavalry divisions) on the Yser was covered by their 1st and 4th divisions on a line between Eerneghem and Cortemark. The Germans were bringing up their new Fourth Army, consisting chiefly of the hastily formed Reserve Corps.

The French Naval Brigade, whose defence of Dixmude forms a brilliant page in its history, was ordered to hold the eastern outskirts of the town as a temporary bridgehead to protect the movements by rail between Dixmude, Furnes and Nieuport, and then to withdraw to the west bank of the Yser. On the evening of October 15th, orders from General Foch, who was now in command of the Northern Group of French Armies, prescribed the withdrawal of the Naval Brigade, but on the urgent representations of the Belgian G.Q.G., the brigade was allowed to remain for the defence of Dixmude, under the orders of General Michel, commanding the Belgian 4th Division. After holding the outposts on the east of the town until the movements *via* Caeskerke had been completed, about 9 a.m. on the 16th, the brigade withdrew under cover of a thick mist to the west bank of the Yser, and there put up a firm resistance to the German attacks.

But it is not only with the exploits of Admiral Ronarc'h's brigade that the article deals. The Belgian operations leading up to the Battle of the Yser are also described very fully and clearly. The arrival on the Belgian right of General Bidon's Group (2 Territorial divisions and 4 cavalry divisions), secured that flank, and enabled the Belgians to strike out at the German advance.

La Révolution Brabançonne dans le Duché de Limburg. By M. Leconte. A further instalment of this interesting fragment of history. Much detail is furnished, and in the absence of maps this tends to obscure the narrative; the general map issued with the first instalment is by no means easy to read.

Technical review: Sur le mouvement d'un projectile d'artillerie autour de son centre de gravité. By Captain Hecq. A mathematical study of the subject.

(*December*, 1937.)—*Le coup de main sur Canopus-Trench, du 28 juillet*, 1918. By Captain Renier. Describes, with full details of orders, etc., a raid carried out by an officer's patrol of the 7th Belgian Infantry Regiment on Canopus Trench in order to obtain prisoners for identification. A heavy attack by the Germans was expected in the Brielen sector, north-east of Ypres. Canopus Trench was one of the old British trenches, long familiar to the divisions which held the left of the British line. It skirted the S.W. edge of Kitchener's Wood (named Bois des Cuisiniers on the sketch map accompanying the article!).

Une année de guerre en Espagne (*July*, 1936—*July*, 1937.)—By Major Wanty. An impartial review of the first twelve months of the Spanish Civil War. The moderate estimates of the opposing forces are a feature of the article, and serve to explain the difficulties encountered by the Nationalists and the inability of the Government to suppress the rebellion at the outset. The regular army was split almost equally; and although General Franco had the advantage of the superior troops from Spanish Morocco—trained and hardened to warfare—as well as of the extensive help from Italy and Germany, the widely scattered areas over which he had to secure the mastery reduced his superiority.

The heterogeneous composition of the forces on both sides is made clear. The Government forces are hampered by the two very distinct parties represented by Valencia and Barcelona; and by grave political dissensions which interrupt their military plans.

Short accounts are given of the operations preliminary to the attempt on Madrid; and the subsequent attempts to cut off the Government's communications with Valencia. Several times the Nationalists were almost successful. The failure to take Madrid was set off by the more successful operations against Bilbao.

Although it is too early to criticize the various moves, this review of the first year

of the war gives us a very useful summary. Several explanatory sketches are added; and the article is to be continued.

La Révolution Brabançonne dans le Duché de Limburg. By M. Leconte. The fourth instalment of this account of a very confused conflict, with details and documentation to satisfy a specialist in the history of this period.

Les relations entre le Gouvernement et le Commandement. (*Expériences françaises*, 1914–18.) By Captain Fraeys. A series of quotations, chiefly from a book by Lt.-Col. Bugnet, recently published, entitled *Rue St. Dominique et G.Q.G.*, illustrating instances in which there was conflict between the French High Command and the Ministry of War, and how the difficulties were met. The examples range from the Government order at the beginning of the mobilization that all French troops were to be kept back 10 kilometres from the frontier, in order to avoid incidents, the order to Joffre to detach at least three army corps for the defence of Paris, the Government promise to send five corps to the support of Belgium, the difficulties between Joffre and the succession of War Ministers (among them Gallieni) and, when Joffre had gone, the increasing pressure by the Government to influence the conduct of operations (Nivelle offensive). The theory of responsibility was clear and was not disputed by Joffre or any of the leading soldiers; namely, that the Government was responsible for the conduct of the war, and the Commander-in-Chief for the conduct of operations. The difficulties arose from the interpretation of this formula.

W.H.K.

REVUE MILITAIRE SUISSE.

(*October*, 1937.)—*Notes de tactique à l'usage des futurs capitaines.* By Colonel Lederrey. A "refresher" course of tactical principles for junior officers, brought up to date and in accordance with the Swiss Field Service Regulations, by an instructor of the Central School, First Division. The principles are put very pithily and are easily read. They are grouped under headings which facilitate rapid revision.

Impressions et expériences de la guerre d'Espagne. By Captain Bauer. The author spent nearly a month in Spain last summer, and has gathered his impressions from personal observation. He was given every reasonable facility for observation, but, as he explains, he did not see all he wished to. The "fighting front," including all its salients, at the time of his visit, was 1,750 kilometres long (say, 1,100 miles). That is to say, nearly three times as long as the Western Front in the Great War. The opposing forces, of course, are strung out very thinly, and there is no depth anywhere. Franco depends on a single lateral railway—Irun to Seville—and it is curious that the Republicans have not made any serious attempt to cut this vital artery. The absence of any bold strokes by either side is probably accounted for by the fact that roads and railways do not permit them. The author does not tell us how much Franco depends upon his German and Italian contingents; he estimates their number at about 60,000 men.

The failure of the Government to make any striking attempt to relieve Bilbao and Santander last summer was probably due to political jealousies; military strategy should have dictated some sort of counter-effort. The article is to be continued.

L'emploi des fusils-mitrailleurs sur trépied. By Captain Daniel. A short article describing the complementary nature of the Swiss light automatic on tripod mounting with regard to the normal machine-gun. The former is a company weapon; and the latter is a battalion weapon.

(*November*, 1937.)—*Notes de tactique à l'usage des futurs capitaines.* By Colonel Lederrey. A continuation of the "aide-memoire" on elementary tactics begun last month.

Impressions et expériences de la guerre d'Espagne. By Captain Bauer. Conclusion

of the article. The situation on both sides appears to be that neither dare embark upon operations on the grand scale. A push by Franco's forces in one corner of the loosely-scattered theatre is responded to by a raid elsewhere by the Government side. For both sides, says the author, this war has been, and will continue to be, a war of lost opportunities. The Spanish soldiers, on both sides, have given proof of remarkable powers of resistance. The civil population has withstood terrible punishment from air attacks. The National Army comprises most of the officers who had wide experience in Spanish Morocco; they had already shown themselves capable leaders. The best elements of the Spanish nation appear to be on the side of General Franco, in the author's view. He makes no prognostications as to the outcome of the struggle.

Le Meeting Aéronautique international de Zurich. By Captain Schlagel. Conclusion of the article begun in the September number. Descriptions, with photographs, are given of the principal novelties exhibited by various nations. The next meeting will be held in 1942.

W.H.K.

MILITARWISSENSCHAFTLICHE MITTEILUNGEN.

(October, 1937.)—Changes in Mountain Warfare.

Colonel von Wittich discusses the changes that have taken place in mountain warfare since the Thirty Years' War. Previous to that time the extensive use of cavalry rendered mountain warfare practically impossible, and, in fact, little use was made of it before the French Revolution.

It is interesting to compare the views, during the Napoleonic wars, of Napoleon himself with those of one of his opponents, the Archduke Charles. Napoleon maintained that a strong mountain position should not be attacked. The enemy's flank or rear should be threatened so as to compel him to abandon his position without fighting.

The Archduke Charles, on the other hand, considered that in the mountains, an attacking force has the advantage over one standing on the defensive. The danger of defensive warfare is the splitting up of one's forces over a large area. These views correspond, to some extent, with those of Clausewitz.—*(To be continued.)*

Panics and their Avoidance.

Lieut. Epp quotes a number of examples from the World War of panics that have seized bodies of troops.

Mass psychology differs from that of the individual, and is, as a rule, on a much lower plane and not guided by reason. The causes that give rise to panics are many. Troops are most liable to them when hungry and exhausted after a long day's march or battle; panics occur chiefly at night, in fog, in dense woods, when danger is unseen. A commander may stem a panic by force of example at the outset, but, once a body of men has become completely out of control, nothing will stop them short of complete exhaustion or an impassable obstacle such as a river. The war has shown that the impressions of the first battle are lasting. If their first battle was a panicky retreat, the troops engaged will be liable to recurring panics. Panic-stricken troops are capable of far greater physical efforts than they would be in ordinary circumstances and they have been known to cover almost unbelievable distances.

In the various instances quoted by the writer some panics have been successfully quelled by capable leadership, in others heavy casualties have been caused by troops firing on their own men, some have grown to such a scale as to cause complete disasters.

The Colonial Policy of the German Reich.

The origin of the German colonial empire dates back to 1884, when Germany acquired German South-West Africa, Togo and New Guinea. The last expansion of territory was achieved in 1911—*i.e.*, a portion of the Cameroons—this by arrange-

ment with France. Under Article 119 of the Versailles Treaty, Germany renounced all claims to her colonies in favour of the Allied and Associated Powers.

In this article Captain Sohol puts in a strong plea for the restoration of all German colonies. He explains the German point of view, and the attitude towards it taken up by Great Britain and France.

Italy, having conquered Abyssinia, is now satisfied with what she has got, and is in sympathy with Germany's colonial aspirations.

The British are aware how desirous Germans are to be on friendly terms with them. But they must choose between allowing the Germans a share of the world's wealth and risking the possibility of a future conflict. If it should come to the latter, Germany will have to look for allies, and she may have to fall back on Russia, unlikely as such a contingency may appear now. Such a combination would be momentous for the whole white race.

The Civil War in Spain.

General Wiesinger gives us a fifth instalment of his article on the civil war in Spain, and deals with the period ending 15th September, 1937.

General Franco commenced operations against Bilbao on the 1st April; he did not succeed in occupying that town till after a struggle lasting two and a half months. To relieve the Basque front, General Miaja launched an offensive westwards from Madrid, thus compelling Franco to withdraw troops from the Basque front. Eventually the Nationalists succeeded in holding the new line they had established.

Other operations carried out were an offensive in Aragon, a Nationalist campaign against Santander, and an advance on Gijon and Asturias.

In the writer's opinion there can be no doubt of the result of the war in the Nationalists' favour.

The Employment of the Air Arm in Naval Warfare. By R. Landy.

The news of the sinking of the 14,000 ton Spanish cruiser *España* by aircraft gave colour to the idea that the day of the big battleship is over. In the writer's opinion this view is entirely erroneous. A battleship does not offer an easy target to a fast flying bomber, and the damage that the latter can do, even with a heavy bomb, on the thick deck armour of a modern battleship is not serious. Moreover, a battleship will ordinarily have an escort of destroyers, which will compel aircraft to keep a considerable distance away.

But the ships that are likely to suffer severely from hostile aircraft are troopships, whether sailing alone or in convoy. They will not stand a chance under a mass air-attack, even with small bombs, and, although they may be armed with anti-aircraft guns, as they probably will be, these will not be sufficient to beat off a mass attack.

(*November*, 1937.)—*Twenty Years Ago. Karfreit*, 1917. By Major Heydendorff.

A brief account of the break-through battle of Karfreit (Caporetto), in which the Austro-Hungarian forces, with the support of the 14th German Army, inflicted a smashing defeat on the Italian forces.

Changes in Mountain Warfare.

With this instalment, Colonel von Wittich concludes his article on mountain warfare, which will shortly be published as a separate pamphlet.

Before the World War, it had been accepted as a general maxim that mountainous country was unsuitable for warfare on a large scale. The war brought about a complete change in these views. The campaigns in Italy, in the Balkans, the Carpathians, Transylvania, and even in parts of France were fought in mountainous country.

The writer suggests that the Central Powers might have done better if they had not regarded the western front as the main theatre of war, and had taken advantage more fully of the opportunities that offered themselves in Serbia in 1914, in Macedonia in 1915 and 1916, and in Italy in 1917. The whole of Europe formed the main theatre, the campaigns in Asia and Africa were the only "side shows."

With regard to the future: after touching on General Douhet's well-known theories, Colonel von Wittich points out that, in mountain warfare, an air force will only be able to play a secondary part, tanks will be almost useless, and gas will be far less effective than in the plains. Artillery will have to play a more important part than ever in the support of infantry.

Panics and their Avoidance.

Lieut. Epp's article is concluded in this number. Various instances are quoted of panics that occurred in the World War. Panics are easily caused by new weapons used, perhaps for the first time, or without warning. The tank attack launched at Cambrai, on the 20th November, 1917, without a preliminary artillery preparation, caused a severe panic amongst the German troops. Similarly, gas attacks, unexpectedly delivered by the Austrians on the Italians, who were not, at the time, provided with gas masks, overcame all resistance and led to a rout.

In a future war, the strain on men's nerves will be increased by modern developments in armament and machinery. An army's flanks will not be closed, as they were in the World War, and the possibility of finding troops dropped by parachute in one's rear may be a source of panic.

The writer concludes with a few suggestions for training troops in peace-time. Commanding officers should on no account leave their men at a critical time, *e.g.*, a retreat. Care should be taken never to let the younger generation dwell on the horrors of war. Physical training should be designed to harden troops, and night operations should be constantly practised.

The Conflict in Eastern Asia.

General Wiesinger, who has been writing a series of articles on the civil war in Spain, is turning his attention to the Chino-Japanese war. In this instalment he describes the events that took place up to the 30th September.

Eastern Asia has been in a state of war ever since 1931, with intermediate pauses to allow of fresh preparations for fighting. After the World War, Japan's first objective was Manchuria, to which the province of Jehol was added, for Japanese trade and colonization. The vassal province of Manchukuo, raised to the dignity of an empire, is the gateway to the five northern Chinese provinces, rich in iron, coal, oil-shales, timber and ground nuts, in all of which Japan is deficient.

The writer describes the distribution of the opposing armies in North China, and the operations that have taken place there since the beginning of July. The Japanese attack south of Peiping resulted in a break-through of the Chinese position. The Chinese have fallen back to a second position about 250 km. south of Peiping.

In their attack on Shanghai, the Japanese were unable to secure Wusung as a landing-place till the 7th September. By the end of that month they had taken up the offensive against the Chinese positions at Shanghai.

The Necessity for the Study of Geology in the Defence of Austria. By Professors Stiny and Kuehn.

Some suggestions for the instruction of officers in geology in peace-time.

(*December*, 1937.)—*The Crossing of the Andes "El Paso de los Andes" in the Year* 1817.

General Knaus, who has made a special study of San Martin's march across the Andes in 1817, considers that this little known exploit deserves the attention of military students as much as Hannibal's and Napoleon's crossings of the Alps in 218 B.C. and A.D. 1796 respectively.

General San Martin collected his force of Chileans and Argentineans for the invasion of Chile at Mendoza, in the province of Cuyo, and formed it into two columns, that started in the middle of January, 1817. The main column, under San Martin, with O'Higgins in command of the main body, crossed the Andes north of Mount Aconcagua. The other column crossed south of Aconcagua, and the two columns united near Los Andes. They met with little opposition on the way, but the men

suffered considerably from a form of mountain sickness, and the force lost a large proportion of its horses. The united columns met the Spanish royalist force on the 12th February and defeated it in the battle of Chacabuco. Two days later San Martin occupied Santiago, while the royalists retired to Valparaiso.

The operations are illustrated by a good map.

Total War. The Extent of a War of To-morrow.

Lieut.-Colonel Ringel discusses the question of the next war, in which the whole population will take part, and the distinction between soldiers at the front and civilians working for their country will become less and less. One feature of modern warfare is that of propaganda—which helped the Italians to win the war in Abyssinia—it will be intensified by the use of radio. In a future war not only armament works, but the whole country, will be a target for attacking aircraft. The protection against air attack is an extremely important matter, but it furnishes a difficult problem in a small country.

The next point with which the writer deals is the organization of industry, which he discusses under the following heads :

(1) The sub-division of available man-power between defence force and home front.
(2) Mobilization of finance.
(3) Study and research in matters relating to armament.
(4) Security of food supply.
(5) Accumulation of necessary raw materials.
(6) Arrangements for reorganization of industry.
(7) Smooth functioning of trade.
(8) Anti-aircraft defence.

Engineer Organization.

Colonel Janowski discusses the question whether technical troops in Austria should be trained on general lines, in view of the tasks that they may be called upon to perform in war-time, or whether specialization should be encouraged as much as possible. It is clear that engineer units could not have enough specialists of all kinds for every possible task on which they might be employed, and some kind of compromise is necessary.

In a table that the writer has drawn up, he proposes to employ all men for the first three months in military and technical training. During the remainder of the first year, about half the men are employed in general training with the engineer battalion, the other half as specialists at their trades. During the second year of service the process is reversed.

As regards organization, an engineer battalion would consist of a headquarters company and three other companies, one of the latter being motorized.

A.S.H.

WEHRTECHNISCHE MONATSHEFTE.

(*October*, 1937.)—*Anti-tank Guns.*

A description, with photographs, of some of the latest anti-tank guns, viz. :—

The Swiss 47 mm. infantry gun.
The Swedish (Bofors) 37/81 mm. infantry and anti-tank gun.
The Dutch 47/75 mm. infantry and anti-tank gun, with interchangeable howitzer barrel.
The German 3.7 and 4.7 cm. anti-tank guns (Rheinmetall-Borsig A. G. Düsseldorf).
The Swedish (Bofors) 37 mm. anti-tank gun.
The Danish (Madsen) 37 mm. anti-tank gun.

Reconstruction of the German Fortresses 50 Years Ago. By Colonel Heye.

After the termination of the Franco-German War in 1870–71, the question of the fortification of Alsace-Lorraine and of the line of the Rhine was taken up seriously. Cologne, Metz and Strasbourg were provided with a girdle of forts. In 1886, when General Boulanger was French War Minister, there was a war scare: fortresses were declared out of date, and between 1887 and 1891, large sums were spent on converting the fortresses to comply with modern conditions. Colonel Heye discusses the changes in the design of fortresses owing to the increased power of artillery, the invention of smokeless powder, the introduction of high-explosive shells and the increased use of indirect fire.

For Germany, the history of her fortresses lies largely in the past. She has lost her fortresses in Alsace-Lorraine and Poland. But their history teaches a valuable lesson, *i.e.*, to keep well up to date and to look ahead for future developments.

Problems to be solved by the Engineer on the Relation between Oil Supply and Consumption in War Time. By Captain Ruprecht.

It is estimated that the annual consumption of mineral oil by a great power in war-time will amount to something between twelve and twenty million tons, or, roughly, five times that of peace-time. The only countries that can obtain such a supply, without relying upon imports, are the United States, and, to a lesser degree, Russia. Other countries must try to find substitutes for imported oil, and must also keep a reserve of imported oil for use in an emergency. Two of the substitutes are: oil produced from coal, and alcohol. The former is expensive, and requires the employment of a large number of miners, as well as of other skilled labourers. Alcohol is largely obtained from potatoes, and its use would entail the sacrifice of an important article of food that is indispensable in war-time.

It is not feasible to maintain two entirely different kinds of machinery for transport, one for peace-time and one for war-time, so the problem for engineers resolves itself into designing engines that can be worked equally well with different kinds of fuel.

The Technics of Welding for Military Purposes. By H. F. Flieger.

The writer dwells on the superiority of welded joints over riveted joints in constructive work. In the case of oil tankers, the use of welded joints has given a saving in weight of 30 per cent. and consequently less draught and easier handling, a smoother surface and therefore greater speed, while the joints are more watertight. These advantages are apparent in the "pocket" battleship *Deutschland*. Welding is of great importance in aeroplane construction, and the writer considers that use might be made of it for military purposes, *e.g.*, in bridge construction, in pontoons, water tanks, etc. Engineer units should be supplied with electric and oxy-acetylene welding plant, and should have a number of men trained in their use.

Ring Targets.

Major Mouths suggests a modification of the ordinary target with concentric rings, which will be fairer to good shots, and will eliminate some of the element of chance offered by the targets now in use.

(*November*, 1937).—*Australia as the Industrial Basis of British Defence in the Far East.*

Captain Ruprecht traces the recent industrial development of Australia and her relations with the mother country. He points out how the balance of trade is greatly in favour of Great Britain, mainly on account of the interest paid on Australia's external debt. The reduction of this debt could be helped by making Australia the armoury of Britain in the Far East; a policy that is both commercially and strategically sound.

Singapore is very much nearer Australia than to Britain, and cannot be reinforced from the land side; hence the great value of support from the former country. Australia possesses large resources in coal and iron, besides other minerals, including gold, and has, during recent years, made great strides as a manufacturing country.

It is now recognized both in London and in Australia that future immigrants can

be better supported by developing industry than by extending agriculture. But it is necessary to give every encouragement to immigration, if only to check the pressure of the Japanese to expand in a southerly direction.

The Defensive Power and Mobility of the Czechoslovakian Multi-National Army. By S. H. Kocab.

The writer explains some of the difficulties that face the Czechoslovakian Army. The army consists of Czechs: 49 per cent., Germans: 22 per cent., Slovaks: 17 per cent., other nationals (Poles, Hungarians, Rumanians, Ruthenians): 11 per cent. Orders are invariably given in the Czech language—the official language of the country. The different nationalities are thoroughly mixed, but an endeavour has been made to keep a preponderance of Germans, Hungarians and Poles in Czech garrison towns, while Czechs and Slovaks are sent to German or Hungarian districts.

In spite of the disadvantages of such a mixed army, it is a force that it will not do to undervalue.

A Review of the Performance of Automatic Weapons.

Dr. Staeger compares the efficiency of four different automatic weapons, viz., the 13 mm. and 25 mm. Hotchkiss, the 20 mm. Oerlikon and the 40 mm. Bofors.

Taking into account the muzzle energy, the weight of the weapon, and the number of shots per minute, the 20 mm. Oerlikon comes out best in comparison with the others.

Tank Traps. By G. Burstyn.

Cases may occur when it is necessary to block a road to stop the advance of tanks without damaging the road in such a way as to prevent its use by one's own force.

A portable steel frame-work has been designed for this purpose, and is illustrated by sketches in this article. The frames are used in pairs. They form right-angled triangles in section, the base being a ramp up which the tank climbs. It then drops down the vertical side, and then finds itself up against another vertical face too high for it to climb. The position for such a tank-trap is naturally under fire.

The design has been patented in Austria, and a patent has been applied for in Germany and in Hungary.

Mechanical Excavators for War Purposes. By P. Wiesenthal, Engineer.

A suggestion for using Diesel-driven mechanical excavators for digging trenches in back areas.

Metal Spraying and its Suitability for Military Purposes. By Dr. Karsten.

The metal-spraying process was invented by Dr. Schoop in Zurich 25 years ago, and, although it is used in many industries, it is only recently that it has been studied scientifically. The process is explained in this article. The latest development is the electric spraying pistol, invented by Dr. Schoop. In this the fine particles of metal to be sprayed are heated to a temperature of 4,000° C., sufficient to melt such refractory metals as chromium, wolfram, molybdenum and platinum.

The process is likely to be very useful for armament work, particularly in the event of a scarcity of the rarer metals. In ship construction the outer steel plates could conveniently be coated with copper. Not only metallic substances, but also non-metals, such as cement, glass, cardboard and wood, can be coated with metal. It is suggested, for instance, that metal cartridges might be replaced, in an emergency, by cartridges of stiff paper, coated with copper and nickel, thus saving an appreciable amount of weight.

Depth Charges.

Major Mouths describes the action of depth charges and gives sketches explaining their action. To avoid the danger of explosion to the ship that uses them, while in close proximity to a submarine, they are usually fired from a sort of mortar, or dropped from an aeroplane.

The writer is a little sceptical of their value. It is difficult to determine their effect. During the World War very few submarines, on either side, were sunk by depth charges. But depth charges and the methods of using them have probably improved considerably since those days. A.S.H.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*November*, 1937.)—*My Activities.*

An account, written by himself, of the work carried out by General von Claer as Chief of the Engineer and Pioneer Corps, and Inspector-General of Fortifications.

Ferrying and Bridging Equipment for Mountain Engineers.

Major Geiger discusses the problem of the best kind of bridging equipment suitable for the requirements of Mountain Engineers. The waterways likely to be encountered by these units are the headwaters of rivers in South Germany, Switzerland, Austria and Northern Italy, all of varying depth, with a swift current, and liable to sudden spates. The ordinary loads that bridges are required to carry are laden pack animals and two-wheeled mountain carts, whose weight, including draught animal and driver, does not exceed 1 ton. In special cases field wagons weighing 2 to 3 tons may have to be carried, and partly motorized units may have loads requiring an 8-ton bridge.

The bridging materials that may be required are:

(1) light floating equipment suitable for strong currents,
(2) light trestle bridges, to carry infantry across mountain streams,
(3) either trestle, suspension, or girder bridges to carry draught animals,
(4) 3- to 8-ton bridges.

A description, with illustrations, is given of a trestle bridge (Swiss pattern), in which the trestles are triangular in shape and consist of round poles obtained at site. Two trestles go to each pier. The transom (forming the base of the triangle) is raised to the necessary height above the bottom of the legs, and the ends projecting beyond the legs carry the roadway. The bridge is suitable for light loads and small spans; with the increase of either the timbers become too heavy for easy handling.

The writer next discusses the question of standard bridging equipment, capable of being carried on pack animals or in light carts. A small quantity of floating bridge equipment is necessary, as well as standard lengths of wood suitable for legs and transoms of trestles. These lengths can also be used as struts in a single- or double-lock bridge; they can be made up into a wooden girder, and can also be used as suspenders in a suspension bridge.

The following materials are necessary for crossing mountain streams, whether standard or extemporized bridging equipment is used:

(*a*) a proportion of spare anchorage cables,
(*b*) special chains to take the place of anchors, as the latter can seldom be used in mountain streams,
(*c*) waterproof clothing for work in the water,
(*d*) several ferrying cables.

The article concludes with a suggested organization for mountain engineer companies and a mountain engineer bridging column.

Obstacles as a Means of Defence in a protracted Resistance. By Lieut. Koller-Kraus.

In this article, as in many others of the same nature, the word "Sperre" is used to indicate a demolition, mine (real or dummy), trap, or obstacle (natural or artificial) that will hinder or delay the enemy's advance.

A distinction is made here between obstacles immediately in front of a line of resistance, and those covering the gaps between such lines. In the former case, the obstacles must produce their full effect before the retirement of the defending force begins. They must be under fire of the weapons in the line of resistance. The latter must supplement the fire of the artillery in places where artillery fire can have no effect.

In the intervals, the engineers' main task will be to stop the advance of horse and motor transport after the infantry have forced their way through. Mines will prove useful.

Training of Units in Obstacles and Demolitions by Skeleton Schemes.

Captain Deyle shows how schemes may be set and carried out, partly on the

ground, and partly with the aid of maps, to train officers and N.C.O's, with skeleton formations, in erecting obstacles and carrying out demolitions.

Engineers in Manœuvres. Demolition of a Bridge in Rear of the Enemy.

A description of the demolition of a bridge during manœuvres. A surprise attack was effected with the help of a motor-boat and facilitated by the want of vigilance on the part of the guard placed on the bridge.

A Winter Exercise in Dam Construction.

Captain Drueck describes the construction of a series of four dams across a hill stream. The work was completed by the 19th Engineer Battalion in 8 days. The dams were made by driving a row of wooden piles about two metres deep into the bed of the stream, then nailing a wall of planks to the piles on the upstream side, rendering it watertight with roofing-felt, and packing earth against the latter, finally revetting the earth slope with grass sods. The piles were strutted on the downstream side. The portion of the dam used as a by-pass during construction was converted into an overflow when the dam was completed, the sloping spill-way being made of planks.

Obstacles in the Winter.

Captain Blumenthal discusses the effect of wintry weather on the problem of holding up the enemy's advance by means of obstacles and demolitions. He considers three sets of conditions: (1) a thaw, or light frost, (2) severe frost, frozen water-channels, absence of snow, (3) continuous severe frost and heavy snowfall.

During severe frost the hardness of the ground makes it difficult to lay mines or erect wire entanglements, and it is difficult to conceal work of any kind. When the ground is frozen, marshes and rivers cease to be obstacles and present no difficulties to an enemy's advance. The demolition of bridges has less effect than it would have under ordinary weather conditions, but that is no reason for neglecting it altogether. In severe weather, troops will be tied down to billeting in houses; the mining of houses likely to be occupied by an enemy will be an effective way of causing him loss.

The Secret of Road Construction in Abyssinia. By Major Strobl.

The result of the Abyssinian campaign depended to a great extent upon the work done by the 100,000 pickaxes of the men employed on road construction. Roads were made with the simplest tools: picks, shovels, jumpers, crowbars and sledge-hammers, and a large quantity of explosives was expended. No mechanical excavators or other American methods were used. Most of the road metal was broken by hand. Such machinery as was used was of the simplest kind, and consisted mainly of road rollers and bitumen mixers and sprayers.

The labour employed on road construction consisted of regular engineer units at the front, who selected the alignment and made a passable track, and were followed by "centurion construction battalions." These, in turn, were followed by contractors, who worked upwards from the base, making a permanent roadway. But these methods were found insufficient, and practically the whole army, both Italian and native, were employed on roadwork at times.

The tracks constructed by the engineers were of the simplest kind: mere fair-weather surface roads, following native tracks in many places. The temporary roads that followed them, made by the "centurion battalions," were 2.5 metres wide, with steep gradients and sharp curves. Where rock was handy a soling coat was laid down, the surface was smoothed slightly with small stone, but not rolled. Simple drainage was provided. Altogether, 1,435 km. of these temporary roads were constructed.

The contractors' roads followed the temporary roads in places: in others new alignments were made: the roads were fully bridged and drained and were surfaced with bitumen-sprayed metal, wide enough to take two lines of traffic. The total length of contractors' roads was 873 km.

Suggestions for Training in Rifle Practice.

Captain Meltzer offers some suggestions for training recruits in rifle practice.

Precautions against Mines, and Water-Supply for the Carpathian Corps in 1917.

Professor Scupin describes a few personal experiences as a geological expert in the Carpathians.

After the disastrous mine explosion in the Wytschaete salient, all corps were required to get technical advice as to whether danger of mine-explosions existed in their area. The writer was called upon to examine the area occupied by the 1st Infantry Division in the Carpathians. He found that under the ground surface there was a thick stratum of very hard Carpathian sandstone that nothing but a mechanical drill could penetrate. Below this stratum was a layer of shale that could be tunnelled through with a pick. However, by examining the dip of the strata, he found that the shale stratum could not be penetrated from the enemy's side, so that the German position was safe against mining.

In connection with water-supply two instances are mentioned. In one case, in the Carpathians, Professor Scupin was able to determine the area of land to be enclosed to ensure an existing pure water-supply being kept safe from contamination by grazing cattle. In the second instance, in the Bukovina, the Russians had poisoned the wells, by throwing in the dead bodies of cattle. The writer's expert knowledge enabled him to find a site for a borehole which yielded a pure supply, free from risk of contamination from any of the poisoned wells.

Vibro-concrete in the Construction of Fortifications. By Oberinspektor Molt.

The difficulty experienced in pouring concrete in the preparation of reinforced concrete often leads to the use of an over-wet mixture that is easy to pour and that fills the interstices between the rods of the steel reinforcement more effectually. The excess of water, however, greatly reduces the strength of the concrete, since, on drying, the space occupied by the water is replaced by air spaces, and the hold of the concrete on the steel is greatly reduced.

This disadvantage is greatly lessened by the vibro system. The vibration introduced shakes the concrete into position, and a relatively stiff mixture fills the spaces between the steel rods without leaving any appreciable number of air hollows. The power required is usually produced by electric drive, and is applied for one to three minutes.

American experiments show a decrease of 17 per cent. in air spaces and an increase of 200 per cent. in compressive strength as compared with concrete mixed in the ordinary way.

The writer considers, however, that, with our present limited experience, the vibro system is not yet suitable for fortification work; in fact, there is still some doubt as to whether ordinary concrete is not preferable to reinforced concrete for such a class of work.

A.S.H.

INDIAN FORESTER.

(*October*, 1937.)—In India, as well as in many other tropical countries, the question of building a "dry weather bridge," one which can cope with the normal cold weather flow, but is removed for the monsoon, frequently crops up. An article by Mr. R. N. Brahmawar, with photos, describes such a bridge over the Ramganga, U.P., total span 323 feet, capable of carrying carts and cars, made at the very low cost of Rs. 520, recurring cost Rs. 225 *per annum*. Cribs, shaped something like sentry-boxes lying on their backs, are made of poles strung on to 1-inch iron rods placed vertically at the corners. The whole is weighted down with stones, wall plates are fixed, road-bearers, also of poles, placed touching each other, and a surfacing of split-wood, grass and sand covers the whole. The bridge has already stood up to an unexpected flood which topped the surfacing, but did no material damage beyond bending one or two iron rods.

An extract from a broadcast talk on "The Punjab's fuel supply" relates how the the D.C., Gurgaon, once upon a time decided that as a punishment for an unspecified

crime, a certain offender should create a forest *rakh* by enclosing and protecting some of his own waste land. Twenty years later the same man sold the wood grown on this *rakh*, and was able on the proceeds to marry off both his son and his daughter.

(*November*, 1937.)—*Exploitation of Andaman Forests*, by Mr. B. S. Chengapa gives an account of survey methods employed in those islands. Two base lines, one north and south, the other, east and west, were cut through the forest, and parallel to these, subsidiary lines, 5 chains (subsequently increased to 10 chains) apart. It was then an easy matter, with tape and Abney, to produce a contoured map on the scale of 16 inches to the mile; at the same time complete data regarding the forest vegetation were obtained and recorded. This would be a rapid method of surveying, were one able to cut the forest about at will, but this is seldom the case with a government survey department.

The Biological Control of Forest Insects explains the extraordinary inter-relations of trees and insects. In a natural mixed forest, insects harmful to one species of tree are kept within bounds by predators which are generally parasites of another species. Since man tends to replace mixed forests by homogeneous stands of useful trees, predators may be killed off, and harmful species flourish abundantly. The life histories of both pests and predators are now studied diligently, and efforts are made to restore the *status quo*. Thus, the "cottony-cushion scale," accidentally imported into California, did great damage to oranges and lemons. A mission to Australia resulted in the importation of a kind of ladybird, which reduced the pest to insignificance within five years.

(*December*, 1937.)—Mr. Chengapa's paper on the Andaman forests is continued, and makes very instructive reading. As is well known, the Andamans produce excellent timber, but the islands are hilly and much indented with creeks, so that the problem of getting felled timber to the coast and ports was difficult. It was solved by building tramlines, usually level or at a very slight gradient, along the banks of the creeks, while shoots and dragpaths were made to bring logs down from above. A photograph shows an elephant pulling 25 tons along a tramway line, apparently with ease, and we are told that the elephant is a superannuated one, and that he does the round trip, two to three miles each way, twice daily and that he loads and unloads himself. These methods have reduced the cost of bringing timber by about 60 per cent. We may notice, too, the use of hollow *padauk* logs as temporary culverts.

A short note on timber joints points out the potentialities of pieces of solid or hollow bamboo instead of wooden or metal dowels.

Sir Gerald Trevor, at the close of his 34 years' service in India, writes a farewell message.

F.C.M.

CORRESPONDENCE.

STRIP ROADS IN SOUTHERN RHODESIA.

Norman House,
105–109, Strand, W.C.2.
5th January, 1938.

To the Editor, *The Royal Engineers Journal.*
Institute of Royal Engineers, Chatham.

DEAR SIR,

I was interested to read the article by Captain E. Bader on "Strip Roads in Southern Rhodesia," contained in Vol. LI of *The Royal Engineers Journal.*

I note, however, that amongst the alternatives considered, the use of bituminous emulsion was not included. Bituminous emulsions can, of course, be employed for this type of work and, as an example of what has been achieved by this means, I would quote a method of strip construction, using strengthened edges of grouted stone, which was carried out in Uganda.

Experimental traffic strips were constructed in November, 1934, over 1,145 ft. of a 2,548-ft. deviation of the Namirembe Road, just outside Kampala. The road had an average gradient of 1 in 25, and was made up of Uganda *murrum* compacted by steam roller. The constructional details of the work carried out are as follows.

Two strips 2 ft. wide and 2 ft. 9 in. apart were well rolled both by hand and a 5-ton steam roller and the *murrum* surface rendered dense, hard and clean. Small trenches 2 in. by 2 in. were cut at the edges of the strips, filled with $\frac{1}{2}$-in. chips and full grouted with Colas. After blinding with sand, these stretches were rolled hard, the object being to prevent ravelling of the strip edges under traffic. Excess sand was then brushed off, the whole width of the strips damped, and Colas applied at 3 sq. yd. per gallon, the grouted edges being treated as well as the *murrum*. Chippings, $\frac{3}{4}$-in. grading, containing a little good, coarse, clean sand, were used for blinding at the rate of 80 sq. yd. per ton. Rolling was carried out first by hand and then with a 5-ton steam roller.

After being open to traffic for three days the strips were brushed clean of excess chippings, surface dressed with Colas at 4 sq. yd.

per gallon, blinded almost immediately with clean, coarse sand and rolled as before. Rolling was continued over the complete strips throughout the experiment. To facilitate pouring Colas on the strips, two straight edges of 3-in. by 2-in. timber were laid either side. Clay, moist enough to be plastic, was packed against them and, on removing the timber, two Colas-proof, definite edges were obtained between which the Colas was readily poured. The same clay was used again and again.

It has been reported that over ten months the strips carried an average of 560 vehicles per day without maintenance and that very little wear and ravelling of the edges had become noticeable, while the *murrum* shoulders to the strips had withstood traffic action well. The cost of strip construction in this case worked out at 1s. 8d. per sq. yd., or £200 per mile of road treated.

I think, therefore, in reviewing the possibilities of the strip system, the method I have described, using Colas emulsion, calls for due consideration.

Yours faithfully,

E. G. WACE,
Brig.-General.