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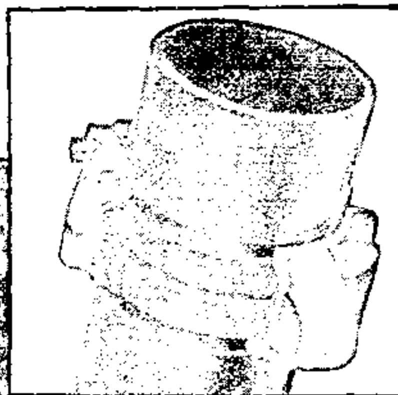

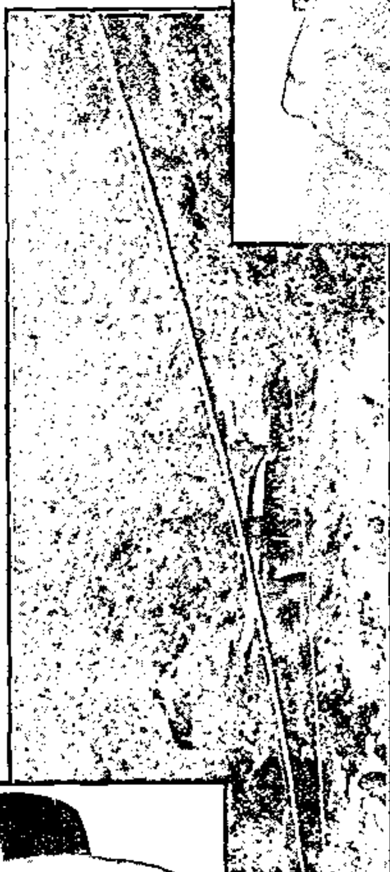

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North side of Nahakki Ridge.

[*Frontispiece.*]

Engineer work in the Mohmand operations 1935 - North side

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ENGINEER WORK IN THE MOHMAND OPERATIONS, 1935.

By "COMENGER."

IN the summer of 1935, there was friction between the M.E.S. and the local tribesmen over the question of rates of pay for repairs to the Gandab Road. Upper Mohmand malcontents took advantage of this to stir up trouble. The Haji of Turangzai and his three sons, the brothers Badshah Gul, supported by the Faqir of Alingar, raised a *lashkar* and moved down the Gandab Road. In contravention of the terms to which they had submitted in 1933, they prevented access to the road and started doing damage to it.

The Peshawar and Nowshera Brigades with artillery and No. 3 Field Company, K.G.V's.O. Bengal Sappers and Miners, were therefore concentrated at Pir Kila. On the 23rd August this force advanced up the road. After meeting determined opposition, the Nowshera Brigade reached Dand, seven miles from Pir Kila, late in the evening. Little serious damage to the road had been done by the tribesmen. Any work necessary to allow the passage of wheel transport was carried out by the sappers and infantry. On the same day, gangs of coolies under M.E.S. supervision were put to work on the road.

On the 24th August, covered by troops from the Nowshera Brigade, the sappers started clearance of the mile of road beyond Dand and carried out temporary repairs to an important retaining wall which had been partially demolished by the tribesmen. On the 25th August, the Peshawar Brigade reached Ghalanai without encountering serious opposition. The sappers cleared obstacles off the road and did some essential temporary repairs. Mechanized artillery and lorries all reached Ghalanai without any difficulty.

Damage by the tribesmen to the road was not serious. The surface, however, was in a very bad condition, chiefly due to blockage of the drains by the tribesmen during the recent rains. Some culverts and retaining walls were damaged and the road was strewn with boulders. By the 28th August, M.E.S. road repair and maintenance organization under a field engineer had been established between Pir Kila and Ghalanai.

In spite of action against the tribesmen, their attitude continued hostile and the *lashkars* remained in the area. It was therefore decided to advance to Nahakki and extend the Gandab Road from Yusuf Khel over the Nahakki Pass into the Nahakki Plain.

Two brigades from Rawalpindi, a cavalry regiment, additional Artillery, Light Tanks and No. 5 Field Company, K.G.V's.O. Sappers and Miners, were moved into the area of operations.

On the 9th September, the whole force officially became known as "Mohforce," independent of Peshawar District.

The chief tasks of the R.E. during the ensuing operations were water-supply, including an eight-mile pipe-line, the construction of a road over the Nahakki Pass and the maintenance of the existing Gandab Road from Pir Kila.

R.E. Organization.

An officer was appointed C.R.E. Mohforce, with a Brigade Major and Staff Captain as his staff.

Under his command were the following :—No. 3 and No. 5 Field Companies, K.G.V's.O. Bengal Sappers and Miners; four field engineers found from sapper officers in Peshawar District, including one officer from the Field Troop at Risalpur, who arrived a considerable time in advance of the orders authorizing his move; an M.E.S. Works detachment. This latter eventually reached a strength of nearly 300 men. It consisted of M.E.S. subordinates for the supervision of tribal labour, stores and clerical staff, E. and M. staff, pipe-fitters and engine-drivers.

Stores and Transport.

All engineer stores required in the area of operations were issued from the Advanced Section Base Engineer Park. This was established at road head, first of all at Ghalanai Camp and subsequently at Wucha Jowar Camp.

This advanced park was supplied by the Base Engineer Park at Peshawar. The M.E.S. workshop at Peshawar was put under the O.C., B.E. Park. In this workshop, the inspection and repair of all plant was carried out, and also the manufacture of numerous articles, such as spare parts for machinery, sand and shingle screens, sprayers

and pipe fittings for improvised water-lorries and special light-steel water-tanks for storage of water in certain piquets.

Altogether about eight hundred lorry-loads of tools and stores were dispatched by the Base Engineer Park in the course of seven weeks.

A Ford 30-cwt. lorry and a 15-cwt. van were purchased at the beginning of the operations. These were kept directly under the C.R.E. They proved invaluable for the transport of urgent stores within the area of operations and for the rapid movement of small working parties. There were also four field company lorries which were in continual use. Transport forward of roadhead was by camel, pack-mule and donkey.

Water-Supply.

Between Pir Kila and Ghalanai there was ample water at places near the road in the Gandab Khwar nullah. Permanent posts were supplied by lorries or mules from water-points established close to the main road. Thirty hired civil lorries were converted into water-lorries by fitting into each lorry three 150-gallon galvanized iron tanks connected to a sprinkler in the form of a perforated two-inch pipe. These lorries were used for road watering and for filling water-tanks erected close to the permanent piquets.

At Ghalanai.

In the nullah near Ghalanai underground streams come to the surface at places in the form of springs. Drinking water for the camp was pumped from one of these springs by a Merryweather pump through a short 4-inch victaulic pipe-line to two 10,000-gallon storage tanks erected on high ground near the perimeter. Animal water-points were provided in the nullah.

As soon as an advance to Nahakki took place, camps were to be established at Katsai, Wucha Jowar and in the Nahakki plain. It was hoped that local springs and wells would provide sufficient water for the brigade that would be at Nahakki. There was, however, no water near Katsai and Wucha Jowar. Camps at these places would, therefore, have to be supplied with water pumped from the nullah near Ghalanai.

The operations took place at a time of the year when the local sources of water were at their lowest. Moreover, 1935 had been an exceptionally dry year and there was less surface water in the nullah than during the 1933 operations. The surface springs at Ghalanai were only sufficient for the local supply of the camp. It was therefore necessary to try and tap the underground streams that were known to exist in the bed of the nullah in order to obtain sufficient water for camps forward of Ghalanai. No. 3 Field Company started

excavation in the nullah bed at a point one and a half miles from the camp where water had been obtained in 1933. The yield from this well proved to be only three thousand gallons per hour. The site was also unsuitable for the main pumping-station, owing to difficulties of protection, as was shown by the following incidents.

In anticipation of the advance to Nahakki, a few hundred yards of four-inch victaulic pipe-line had been laid. During the night, several lengths of pipe were removed by the tribesmen in close proximity to a piquet. A booby trap laid the next day proved fruitless, as the tribesmen carefully removed the lengths of pipe on each side of the booby trap the following night. On another evening a detachment of sappers in a lorry went up the nullah to bring back to camp a Merryweather pump, which had been used to keep down the water-level during excavation of the well. On arrival, they were greeted by rifle-fire at unpleasantly close range from tribesmen who were following up the withdrawal of a column which had been engaged on a local operation during the day. The sappers had to withdraw under their own covering fire leaving the pump behind. Next day it was found that all movable parts had been removed from the pump.

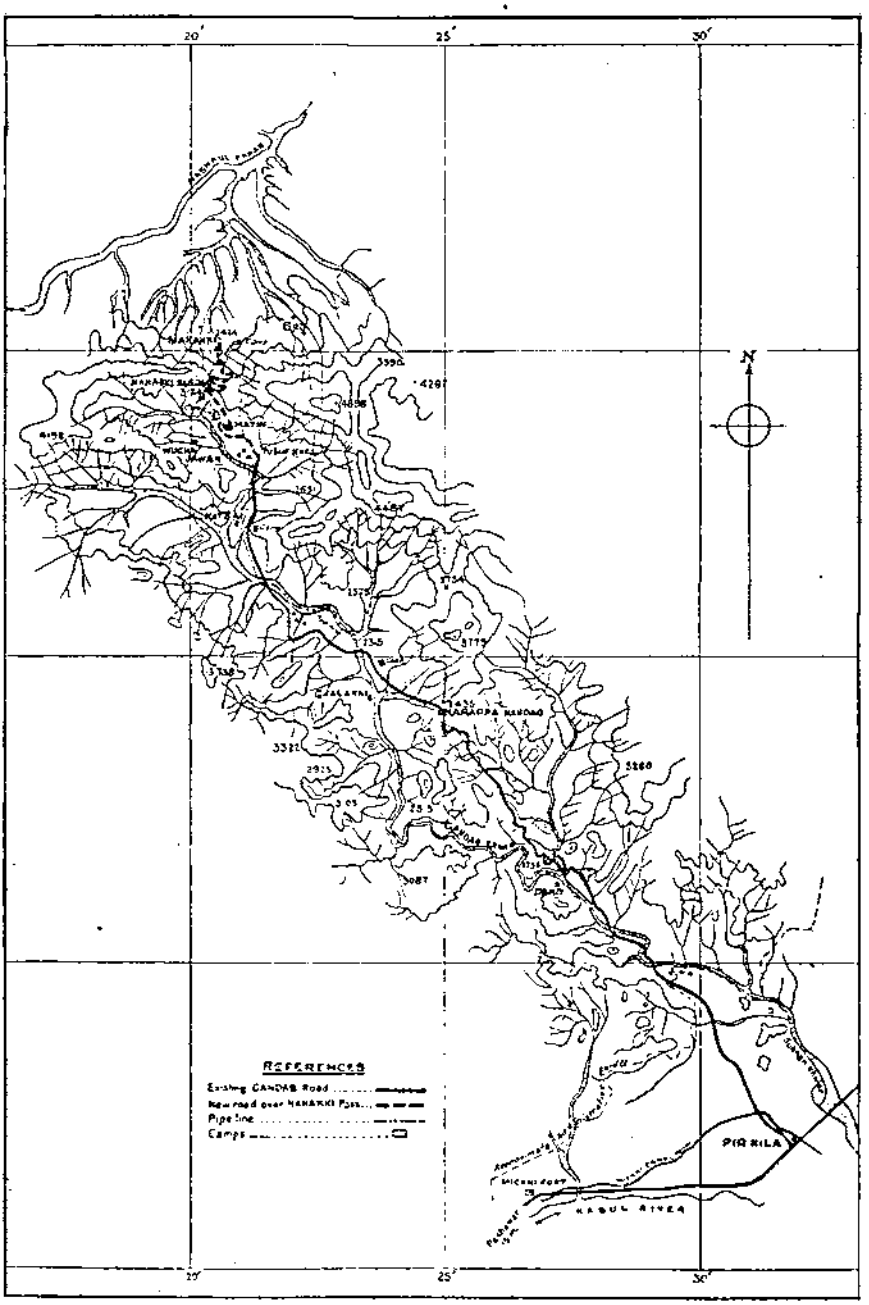
In the meantime, the Field Engineer, who was a water-diviner, had been exploring the nullah. At a place where two small streams leaked through the sides of the nullah there were indications of another stream in the nullah bed. After excavation to a depth of six feet this stream was reached. The leaks from the sides of the nullah were increased by blasting. The three streams were then collected in a "diggi" excavated in the nullah. The yield was about 8,000 gallons per hour, which was sufficient for the camps at Katsai and Wucha Jowar.

Advance to Katsai.

The first phase of the advance to Nahakki was the establishment of a brigade at Katsai. The sappers had to lay 3½ miles of 4-inch victaulic pipe-line and provide water at Katsai by the evening.

Two field companies, less one section, and one battalion of Infantry were detailed for this work. Without special fittings, 30-cwt. lorries were not suitable for carrying victaulic pipes owing to their length. The only 3-ton lorries available for carrying pipe on the day of the advance were six belonging to the medium battery. All the pipe was stacked in lorry-loads beforehand to facilitate quick and economic loading. A simple drill was evolved for marking the pipe-line alignment and for the loading, unloading, laying and connection of the pipes. The infantry battalion detailed for the job on the actual day carefully rehearsed the drill with the field companies beforehand. They laid about 500 yards of the future pipeline, which was close to Ghalanai Camp, before the actual day of the

THE GANDAB VALLEY.



advance. The erection and running of the pumping plant was allotted to the M.E.S. detachment, under the supervision of a British E. and M. N.C.O. and the Field Engineer. Nothing was known of the date of the operation until three o'clock on the previous day. By that time the erection of the pumping plant was incomplete and the length of pipe-line that had been laid was untested. As both the pipe-line and the pumping plant were outside the camp perimeter, only a little more work could be done that day.

The troops moved out of camp before daybreak on the 11th September. Pipe-laying began at dawn (about 6 o'clock). At first progress was delayed by traffic congestion. Later it was discovered that a large number of rubber joint rings were perished and that there were insufficient spares to complete the pipe-line. An additional supply eventually arrived from the Base Engineer Park at Peshawar and the pipe-line was completed by 3 o'clock in the afternoon. During the day, 5,500 yards of pipe had been laid, including its burial where it crossed roads and tracks, and some pick and shovel work where it had to cross small nullahs.

As soon as pumping started, a large number of bad leaks were discovered due to split pipes, faulty joint rings and valves. Every new leak that appeared meant stopping pumping in order to carry out repairs. A further difficulty was that the victaulic pipe was in various lengths, causing delay in the replacement of damaged pipes.

By 1630 hours, no water had arrived at Katsai Camp and the covering troops were about to withdraw. Orders were given to collect all the road water-lorries at Ghalanai and to dispatch them, under an escort of light tanks, to Katsai. At last, at 1645 hours, water began to arrive through the pipe-line. The water-lorries were, however, sent up in case the pipe supply failed during the night. The tribesmen did not put up any opposition during the day, but sniped Katsai Camp very heavily that night and during the following nights.

A concrete tank of about 8,000 gallons capacity, which had been constructed at Katsai during the 1933 operations, was used for storage of water. Subsequently, a 40-ft. by 40-ft. tarpaulin was dug into the ground to give an additional 20,000 gallons storage capacity.

Advance to Wucha Jowar.

Preparations were then begun for the advance over the Nahakki Pass to establish a brigade in the Nahakki Plain. At the same time, Force H.Q. and a brigade were to move into camp near Wucha Jowar, at the foot of the Nahakki Ridge. Piped water-supply, pumped from the storage tanks at Katsai, had to be provided as early as possible on the day of the operations at Wucha Jowar Camp.

A few days before the advance, an R.E. reconnaissance of the area about Wucha Jowar was carried out in light tanks. Valuable

information was obtained as to the best alignment for the pipe-line. It was also ascertained that about half a mile of road over several deep nullahs would have to be constructed to get lorries into the camp.

For the actual operations, one section of No. 3 Field Company was detailed to accompany the brigade to Nahakki for water-supply duties. One section of No. 5 Field Company was allotted the task of constructing at Wucha Jowar the water-storage tank, consisting of a 40-ft. by 40-ft. tarpaulin dug into the ground. This section had also to pitch and dig-in the R.E. tents at the new camp.

The two field companies, less these sections, and an infantry Battalion had to construct the pipe-line and, with the assistance of the 50-h.p. Diesel road builder and a road grader, to prepare the approach road into the camp.

The pumping plant was erected at Katsai by the M.E.S. water-supply gangs and protected from sniping by a sandbag wall.

The troops moved out of camp during the night 18th/19th September. By dawn (6 o'clock) the leading troops were on the Nahakki Kandao without meeting opposition. By ten o'clock in the morning they had reached the Nahakki Plain and cavalry and artillery were engaging small parties of hostile tribesmen.

In the meantime, the engineer work was proceeding without a hitch. The organization for pipe-laying was the same as for the Katsai operations. By two o'clock in the afternoon, water was flowing into the newly-constructed storage-tank. At the same time, lorries began to drive into the camp over the newly-constructed length of road. During the day, 3,600 yards of 4-inch victaulic pipe had been laid, a further 500 yards having been laid before the day of the operations.

During the next few days, the pipe-line was extended a further 700 yards to the site of the future road-construction labour camp, the water being pumped from the storage-tanks at Wucha Jowar Camp.

At Nahakki.

By this time, the water situation at Nahakki was causing considerable anxiety. The local sources of supply were quite inadequate and a water convoy of mules had to be sent daily from Wucha Jowar. The Field Engineer had explored the whole area. There were indications of water at a considerable depth below the surface. As the ground was hard rock, it was not practical to attempt to tap these underground streams. The yield from one spring, however, was appreciably increased by blasting.

It was therefore decided to extend the pipe-line over the Nahakki Kandao and pump water from the labour camp storage-tank to Nahakki Camp. The work was done by the sapper and miner

companies and an infantry working party. Camels were used as transport for the pipe. Owing to the steepness of the ascent and descent of the Nahakki, attention had to be paid to providing secure anchorages for the pipe-line. A water-point was erected at the top of the Nahakki Pass for road construction purposes and one 400-gallon tank was inserted as a break pressure tank on the descent to Nahakki Camp. An eight-mile pipe-line was thus completed, through which water was pumped from Ghalanai to Nahakki in four stages against a total head of 1,100 feet.

Water-supply difficulties did not end with the completion of the pipe-line.

The requirements of the force were high, due to the hot weather and the number of animals that had to be kept at Wucha Jowar for the supply of the Brigade at Nahakki.

The daily requirements of water were as follows :—

Ghalanai Camp	53,000 gallons.
Katsai Camp	5,000 gallons.
Wucha Jowar Camp	52,000 gallons.
Labour Camp	8,000 gallons.
Nahakki Camp	30,000 gallons.

In addition, water, when available, was required for washing, road construction and road maintenance.

The available pumping plant consisted of duplex and three-throw ram pumps driven by steam. Their capacity varied from 6,000 gallons to 2,000 gallons per hour against a head of 400 feet. There were also two Merryweather Pumps specially prepared in the workshops to deliver 3,500 gallons per hour against a head of 350 feet. The pumps and steam boilers were old and not in a good state of repair. They frequently broke down. On one occasion, the boiler connected to the three-throw ram pump at Katsai developed ten leaky tubes in the space of a few hours. At the same time, the duplex pump at this station was out of action, due to a broken valve. A spare pumping set from another station had to be hurriedly brought up and installed.

The portable boilers were unwieldy and the road machinery caterpillar tractors had to be used for towing them. One boiler fell over the side of the road down the hill near Dand owing to a slipping clutch on the tractor that was towing it. The unreliability of most of the steam plant, due to age, was accentuated by the excessive hardness of the water.

At one period, signs of failure in the sources of water-supply at Ghalanai caused anxiety. The Field Engineer, however, located another source in the nullah which was opened up and brought into use.

The maintenance of the pipe-line and the running of the pumping plant were carried out by M.E.S. employees, who were mostly Shin-

waris from the Khyber. In spite of difficulties, the resourcefulness of the Field Engineer and the excellent work of the Shinwari gangs prevented any serious dislocation of the supply of water during the whole course of the operations.

Road Construction over the Nahakki Pass.

The specification for the road was as follows :—

Ruling gradient, 1 in 20.

Clear width between the roadside drain and parapet wall, 15 feet on the straight and 20 feet at bends.

Minimum cut into the hillside, 13 feet.

As it was probable that maintenance of the road and improvements to it would not be possible after the withdrawal of the force, it was specified that all important retaining walls should be in cement mortar. Particular attention was to be paid to drainage and the provision of an adequate number of culverts.

Alignment.

On the 18th September, the day on which troops occupied Nahakki, a reconnaissance of the Nahakki ridge was carried out. The hill slopes on the south side varied between 1 in 1 and 1 in 2. The ground appeared to be mostly soft rock intersected by a number of small dry nullahs. In order to be able to start road construction as soon as possible, the alignment on the south side of the hill from the top of the pass to the existing road-head at Yusuf Khel was surveyed and marked on the ground on the 19th September.

On the north side of the ridge, the hill slopes were steeper than on the south side. They varied between 1 in 1 and 1 in 1½ with a number of short stretches of 3 in 1 and 2 in 1. Small razor-edged spurs jutted out from the main ridge and the dry nullahs between these spurs joined on the lower slopes to form fair-sized watercourses. The ground was all rock which looked uncompromisingly hard, a fact that was fully confirmed when work started.

An alignment was attempted running in an easterly direction with a view to reaching the Nahakki Plain near Sro without any hairpin bends. A narrow spur with a vertical cliff on one side, was, however, encountered which would have necessitated tunnelling in hard rock for about 120 feet. After some more abortive attempts an alignment was found which, by the introduction of three hairpin bends, avoided the most difficult parts of the hillside. It was possible to give a minimum inside radius of 50 feet and a level road gradient at each of these bends. There was one disadvantage to this alignment. Owing to three stretches of road being directly below each other on a steep hill slope, work was delayed by the inability to work on the whole length of road at the same time.

The survey and marking of the alignment on the ground was completed on the evening of 22nd September. The total length of road to be constructed from existing roadhead at Yusuf Khel to the Brigade Camp on the Nahakki Plain was 5 miles, of which $3\frac{3}{4}$ miles was on the Nahakki Ridge and the remainder on level ground on each side of the ridge.

On the 19th September, all available sappers, local tribal labour and the road machinery (50-h.p. diesel road-builder and a road-grader) started work between roadhead and the hairpin bend at Matin. The machines very quickly completed the road formation as far as the beginning of the ascent near Matin when hard rock began to limit their activities.

Contractors.

Previous experience of hill road construction under similar conditions had shown that the most rapid method was to give the work to selected contractors. It was known that there was nobody among the local Mohmands with sufficient experience to be given a contract. The Gandab Valley Mohmands are not good workers and in any case were fully employed on the maintenance of the existing road.

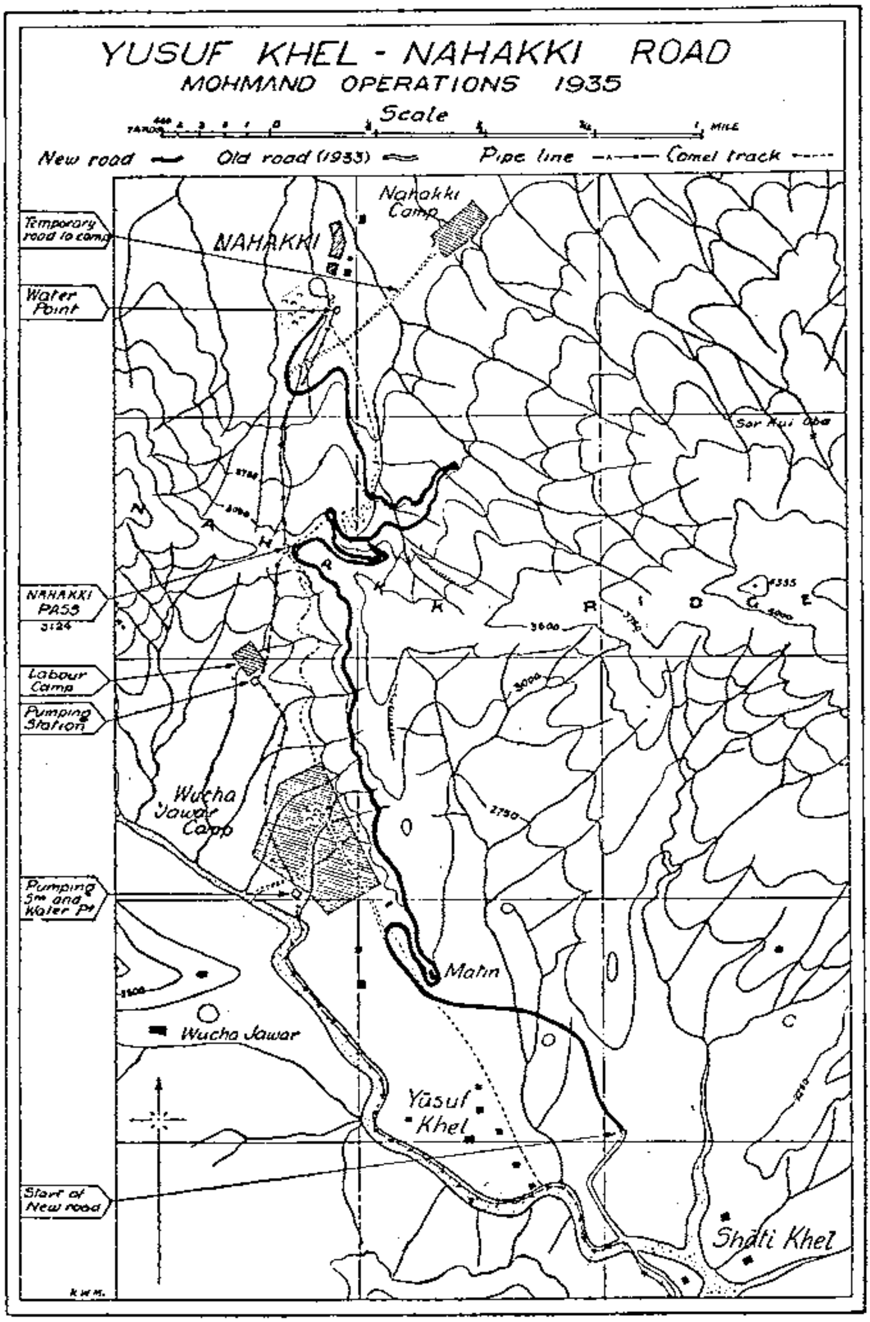
These facts had been appreciated beforehand. Certain contractors who could produce the best type of labour, namely Shinwaris, Malagories and Afridis, from the Khyber, and Khattaks from the Cherat Hills, had been previously warned. On the 20th of September these contractors were summoned to Wucha Jowar. Four tenders were accepted. All contracts were on a piece-work basis, so that the length of road allotted to an individual contractor could be increased or decreased according to the amount of labour he produced and the quality of his work.

Contractors' labour began to arrive on the 23rd September and by the end of the month had reached a strength of over three thousand men, including two hundred and fifty stone-masons and a number of blacksmiths for sharpening tools. The site of the labour camp was protected by the permanent piquets and *khassadars* were made to live in the camp as local protection. All tentage, tools, stores and explosives, except country-made gunpowder, were issued to the contractors from the Advanced Engineer Park at Wucha Jowar Camp. A full field scale of sanitary accommodation, regularly white-washed and inspected, was provided in the labour camp, but was not appreciated by the coolies to the extent that the medical authorities had hoped.

Allotment of Work.

After the arrival of the contractors' labour, the allotment of work was as follows :—

Contractors.—The construction of $3\frac{1}{4}$ miles of road on the Nahakki


YUSUF KHEL - NAHAKKI ROAD
MOHMAND OPERATIONS 1935
Scale
New road
Old road (1933)
Pipe line
Camel track
Temporary road to camp
Water Point
NAHAKKI PASS
Labour Camp
Pumping Station
Pumping Stn and Water Pt
Start of New road
Nahakki Camp
NAHAKKI
Wucha Jawar Camp
Wucha Jawar
Matin
Yūsuf Khel
Shāti Khel
Sar Kui Oba
N A H A K K I R I D G E
3000
2750
K.W.M.

Ridge. In this section, 36 culverts of spans up to 4 feet, two 8-ft. span culverts and three concrete causeways 20 feet long had to be constructed. M.E.S. subordinates under the Field Engineer supervised the work. The skilled work of the tribal labour employed by the contractors and the speed with which they blasted a road out of a solid rock face impressed everybody.

Road Machinery and Direct Labour under M.E.S. Supervision.—(*a*) The completion of the road between Yusuf Khel and the foot of the Nahakki Ridge. This section of the road was made 30 feet wide.

(*b*) The construction of a 12-foot concrete causeway and four culverts.

Field Companies and Infantry Working Parties.—(1) No. 3 Field Company. (Lived in Nahakki Camp.)

(*a*) The construction of 400 yards of road, including culverts, on the lower slopes of the north side of the Nahakki Ridge.

(*b*) The construction of a 10-ft. span reinforced concrete bridge with masonry abutments.

(*c*) The construction of about 1,000 yards of road on the Nahakki Plain into the Brigade Camp.

(2) No. 5 Field Company. (Lived in Wucha Jowar Camp.)

(*a*) The completion of the hairpin bend round Matin including a length of retaining wall.

(*b*) The construction of two culverts at the foot of the Matin Spur.

(*c*) The construction of a 15-foot span bridge and about 60 yards of road on either side of it. The bridge consisted of a reinforced concrete slab on rolled steel joists and masonry abutments. The road on one side of the bridge had to be hewn out of a nearly vertical rock face. A high masonry retaining wall had also to be constructed.

The whole of this work was completed in three weeks, which was a very fine performance.

Working parties with the field companies up to the 15th October varied in strength due to operations. After the 15th October, when the tribes formally submitted, the strength averaged two thousand men per day working in two four-hour reliefs of one thousand men each. In addition to the infantry, the artillery, Tank Corps and medical units all found working parties.

Power Tools.

Three Holman diesel engine compressors (130 c. ft. capacity) with rubber-tyred wheels and two petrol-driven compressors were used for driving rock drills. These were all run and maintained by M.E.S. employees. A tool-sharpening machine, driven by one of the compressors, was also in permanent use. The Holman diesel

Photo 1.—Road alignment south of Nahakki Pass, showing camel-track beneath road.

Photo 2.—View of Nahakki Pass from south.

Engineer work in the Mohmand operations 1935 - Photos 1 & 2

Photo 3.—Part of North-side alignment, showing 1st loop, top-left.

Photo 4.—A culvert constructed of 9ft.-span elephant-shelter sections, with masonry abutments, and 1st loop at top.

Engineer work in the Mohmand operations 1935 - Photos 3 & 4.

Photo 5.—Contractor's labour on construction of 1st loop.

Photo 6. 1st loop completed.

Engineer work in the Mohmand operations 1935 - Photos 5 & 6

was spread to a depth of about 1½ inches on the surface. The whole road was then finally watered and rolled.

Except for two days' torrential rain, when nearly all work ceased, road construction was never interrupted. There was a danger that sniping at night might cause many of the coolies to desert, but, although Wucha Jowar Camp nearby was sniped with regularity, the tribesmen never molested the labour camp.

On the 8th October, after eighteen days' work, the Force Commander drove in his car to the top of the Nahakki Pass.

The whole road to Nahakki Camp was completed, including surfacing, by the 28th October, thirty-eight days after the first sapper started work on the Matin Spur.

THE MAINTENANCE OF THE GANDAB ROAD.

The length of the road is twenty miles and along it four Brigades and attached troops had to be maintained. Part of it is an earth road, thirty-five feet wide, stabilized with gravel, and part of it is a tortuous hill road, twenty feet wide, with a rock sub-grade and steep gradients.

A road of this specification, with proper maintenance, can be expected to stand up to a traffic density of about three hundred vehicles a day. Owing to the difficulty of supervising maintenance work, and to the damage done by the tribesmen, the road was not in good condition when operations began. Before any work could be done, six hundred to a thousand vehicles a day were using the road. Its condition therefore deteriorated with the most alarming rapidity.

The Field Engineer in charge of the road was faced with several difficulties.

(*a*) Traffic was continuous during working hours.

(*b*) The hours of work were limited to the period during which the road protection troops were in position.

(*c*) Except at Pir Kila, and in the area between Ghalanai and Yusuf Khel, there are no villages near the road from which labour can be obtained. For tactical and administrative reasons, labour camps could not be established and so coolies working on some parts of the road had eight miles to go daily to their work.

Some of the labour was obtained through contractors in Peshawar district, but the remainder was obtained by the personal efforts of the Field Engineer from the Lower Mohmand *maliks*. He was luckily a fluent Pushtu speaker.

The first work to be done was the clearance of the roadside drains and the repair or renewal of all damaged culverts and retaining walls. In order to reduce the possibility of future damage to the road by tribesmen, dry walling was replaced by masonry in cement mortar.

Photo 7.—Infantry labour on excavation of approach to bridge.

Photo 8.—Approach nearing completion, retaining wall completed.

Photo 9.—15-ft. R.C. slab bridge on girders nearing completion.

Engineer work in the Mohmand operations 1935 - Photos 7 & 9

compressors were more satisfactory than the petrol-driven type, proving more economical, reliable and mobile. Two Holman compressors were hauled by coolies over the Nahakki Pass along the camel track which had a bad surface, frequent hairpin bends and gradients of 1 in 3. It was found that one compressor running two drills could make between seventy and a hundred 2-ft. bore-holes in hard rock in an eight-hour day's work. This was the equivalent to the work of about eighty skilled men boring holes with hand-tools.

Culverts and Causeways.

Corbelled stone-masonry in cement mortar or tar barrels in cement concrete were the types used for all small culverts. Culverts of spans of 4 feet to 10 feet were normally R.C. slabs on cement masonry abutments. Two 9-ft. span culverts were constructed of elephant shelters on masonry abutments. Wherever possible, causeways were constructed instead of bridges across dry nullahs, as being less liable to damage in the future by the tribesmen and by spates. They consisted of a roadway of 4 inches of cement concrete reinforced with wire-netting laid on rammed boulder filling and walls of cement masonry on concrete foundations.

All culverts and causeways were constructed to give a roadway of 18 ft. clear width.

Rapid-hardening cement was used as far as possible for all concrete work but, owing to difficulties in obtaining sufficient quantities, ordinary cement had to be used for much of the work.

A total of two hundred and fifty tons of cement was actually used, including the requirements for the construction of retaining walls.

Explosives and Blasting.

With the exception of some country-made gunpowder used by the contractors, gelignite was the only explosive used. Four-ounce charges, well tamped into bore-holes 2 ft. deep, produced the most satisfactory results.

Owing to the amount of blasting that had to be done, it was necessary to restrict it to certain definite periods every day, during which the track over the hill was closed to all traffic. In spite of the notorious carelessness of the tribesmen in handling explosives, there was only one accident, when a coolie was killed by a flying stone at a distance of several hundred yards.

During the construction of the road, six tons of gelignite were used.

Consolidation and Surfacing.

After the completion of the road formation, parties were employed removing inequalities in the sub-grade and generally grading it. The road was then watered, and rolled by a 3½-ton diesel road roller. Gravel, transported from local nullahs in lorries and on pack mules,

was spread to a depth of about 1½ inches on the surface. The whole road was then finally watered and rolled.

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The repair to the road surface, except on the hill section, consisted of recambering and the removal of ruts. The road was then watered, surfaced with screened shingle and consolidated by the traffic. Shingle containing a proportion of sharp sand and screened to exclude stones over $\frac{3}{4}$-inch diameter proved to be the most satisfactory.

Subsequent maintenance consisted of the immediate removal of ruts, frequent watering and renewal of the gravel surface. Most of this work could be done best by the autopatrol but, as only one was available, most of the work had to be done by hand, assisted by drag scrapers and broom drags towed by lorries.

The hill section of the road was more difficult. The real solution was metalling, but this was quite impossible owing to the intensive traffic. Holes and ruts were therefore filled with broken stone from the hillside and surfaced with screened shingle from the nullahs. The road was then watered frequently and eventually consolidated by the traffic. The results were excellent. By degrees, without the use of any road rollers, the road became practically a water-bound macadam road.

The average strength of the labour employed on the road was 750 men daily. They were organized in gangs under mates and supervised by M.E.S. subordinates.

Owing to the short hours of work, the rate of pay of coolies was slightly lower than the peace-time rate of the permanent gangs. The Mohmand labour from the Ghalanai-Yusuf Khel area demanded increased pay and on this being refused, promptly "struck." When it was firmly pointed out that they would be replaced by imported labour, they returned to work without getting any increase of pay.

About 200 tons of screened shingle were required daily. Forty hired civil lorries and a number of donkeys were used for the carriage of this shingle. The lorries were also used for taking coolies to the more distant parts of the road. Twenty-five civil lorries, fitted out as water-carts, were in continual use for road watering.

At the end of the operation, the road surface was in better condition than it ever had been before. On straight stretches, when traffic conditions permitted, a motor-car could be driven at 50 miles an hour with perfect safety and comfort.

With the exception of the seven miles of hill road, it was an earth road stabilized with gravel. The ability of a road of this type to stand up to heavy and continuous traffic was fully demonstrated. The cost of maintenance during the period of the operations was undoubtedly high. If, however, one takes into account the low cost of initial construction, the speed with which it can be made and the small maintenance costs under normal conditions, its value becomes apparent.

MISCELLANEOUS R.E. WORK.

There were many other small jobs for the sappers to do. The mule-track over the Nahakki was improved to take camel transport. Sappers and infantry completed this work, which included considerable blasting, in two days. Later the track was further improved to allow the light tanks to get to Nahakki. The negotiation of the pass by the tanks was a severe test of driving. The maximum width of the track was nine feet with a steep *khud* on one side; the surface was bad; there were countless hairpin bends and gradients of 1 in 3. Nevertheless, all the tanks got to the other side without mishap.

Assistance was given to the infantry in the alignment of mule-tracks to the more inaccessible piquets.

Tracks fit for M.T. were constructed from the main road to two of the larger permanent posts near Dand.

No. 3 Field Company successfully demolished a village tower in the Nahakki Plain in conjunction with a local operation. R.E. reconnaissances accompanied columns up the neighbouring valleys with the object of locating sources of water and finding possible alignments for mule-tracks and M.T. tracks.

Each company ran a small workshop for sharpening and repairing tools and for making various articles, including "Belisha" beacons demanded by the A.P.M. Sappers had to be found also to run the field company Petter engine pumping sets which were used for local water distribution in camps.

All these jobs used up sappers and so considerably reduced the number that were available daily for work on road construction.

THE END OF THE WAR.

On the 31st October, the brigade at Nahakki withdrew, followed in succession by the other three brigades. All surplus R.E. stores had been back-loaded previously. There remained the dismantling of the pipe-line and pumping plant to be arranged to conform with the withdrawal programme of the Force, so as not to deprive camps of water before they were vacated. This was simplified by the provision of twenty-five 3-ton R.I.A.S.C. lorries.

By the evening of the 2nd November, all the pipes and pumping plant, amounting to eighty lorry-loads, had arrived back at Peshawar. A few days later No. 3 Field Company, which had been left to accompany the rear brigade, reached Peshawar.

All the sapper officers with "Mohforce" must have gained some useful practical experience. They certainly became very fit, due to plenty of walking over the hills and to the excellent food provided by the officer who ran the Sapper Mess at Wucha Jowar.

The war helped to pass some of the hot weather and then most conveniently came to an end in time for the polo players to get their ponies fit for the first tournament of the season.

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 I.

PREAMBLE.

THERE is no precise information concerning the date of the founding of the British Standing Army and the beginnings of modern military architecture. About 100 years elapsed between the period when local defensive architecture, as represented by the castle and baronial hall, was rendered ineffective by the use of gunpowder, and the introduction of buildings to quarter an army maintained by the Crown. The following thesis purports to trace the gradual development of military architecture from the original Barn Barracks, which, it is understood, existed about 1680, near what is now Trafalgar Square, to the present highly organized and complex buildings required to maintain the standard of health and comfort deemed necessary for the efficiency of the British Regular Army.

When the state of our rapidly developing civilization made it necessary to form a standing army, Parliament offered great resistance at any attempt to provide permanent accommodation for it, and in the reign of James II it was decreed that private individuals should afford quarters to soldiers at the remuneration of eightpence a week. In many cases, after ransacking the civilian houses, the soldiers would leave without paying any dues and, the military being in possession of great power, it was impossible to obtain redress. Continual abuses of this nature made the people realize the necessity of separate accommodation for professional troops.

The first known instance of specially erected permanent barracks is found in Ireland about 1697, and by 1699 a Barracks Department made its appearance in that country under the superintendence of engineer officers, who made contracts for the erection of buildings for the housing of the Army. Under these contracts, the work was executed at the lowest possible rates; sanitation and hygiene were not considered and the number of beds that could be accommodated on the floor determined the superficial area.

About 1700, the first official estimate for barracks was submitted

to Parliament. The proposed accommodation would seem in the light of modern conditions to have been deplorable. A barrack block, built under the sanction of these estimates, contained rooms eighteen feet by seventeen feet, and each room was calculated to hold five double beds giving a floor area of only thirty square feet per person. This unsatisfactory state of affairs was a source of pride to the then Board of Ordnance, which stated that "thirty square feet was as *little* room as could well be allowed for good management."

According to contemporary accounts, the misery of the troops was intense, and in 1704, a regiment garrisoned at Portsmouth was reduced by sickness and death to one-half its original numbers in one year. It is interesting to note that Parliament readily granted at this time £350,000 to build fifty churches, considered then as a pressing want. These conditions continued for several years until about 1740, when the quartering of troops really began to present great difficulties to Ministers of the Crown. The solution of providing barracks in various parts of the country and making a military career a fulltime occupation was thought to be inexpedient, as the general public were inclined to consider the provision of barracks a means of legalizing slavery. It is not clear what imaginary connection there was between slaves and soldiers; however, the Ministry did not dare make the necessary proposals.

Throughout the rest of the century, the same attitude prevailed and the public preferred to continue to let the soldiers die from sickness, etc., brought on by exposure, than erect permanent buildings for them. It was held that a more intimate connection between soldier and citizen would exist if the soldiers were quartered at private houses, notwithstanding that this method of billeting was probably the greatest social evil then endured by the people. It was not until about 1792, when a Barracks Generals Department commenced to control the erection of barracks throughout the country, that a more satisfactory state of affairs, from a public point of view, appeared.

This Department, however, seriously abused its privileges and its members obtained money in considerable amounts for schemes which never matured. In the year 1804, questions in Parliament revealed that no real accounts or records had been kept for the previous ten years. In the light of this evidence, the heads of the department were forced to resign and the Board of Ordnance once more took over the duties.

1800—1865.

Unfortunately, there is no doubt that as late as the first half of the nineteenth century, the housing of the soldier was deplorably neglected. The Board of Ordnance on taking over the duties of the

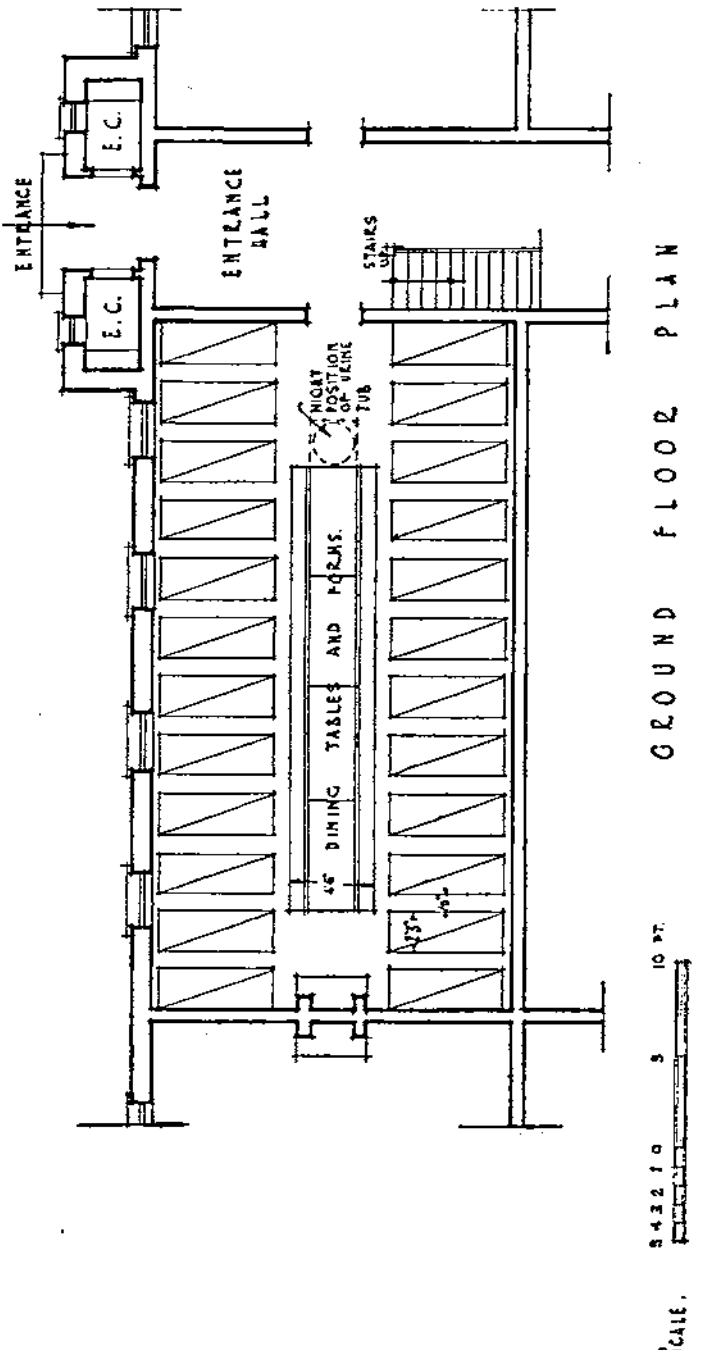


Fig. 1.—BARRACK-ROOM ERECTED AT COLCHESTER.

Barrack Department continued to follow the same type of plan and design as had been used during the previous century. No special thought was given to the health or comfort of the men or officers, and quarters were merely erected to a more or less standard design and filled to overflowing.

Fig. I on page 525 shows the plan of a typical barrack-room erected at Colchester, similar blocks were erected in various parts of the country, and an analysis of one will illustrate the whole.

The space allocated by Parliament to each man was 450 cubic feet. This meagre allowance was greatly diminished in almost all cases and in many barracks it was reduced to under 300 cubic feet. This was occasioned by the excessive number of men enlisted where provision for them did not exist. The space between beds as laid down in the regulations was one foot, a small enough amount under the best conditions; but in times of stress and regardless of the consequences, beds were drawn together and when all available room had been occupied, double tier beds were used.

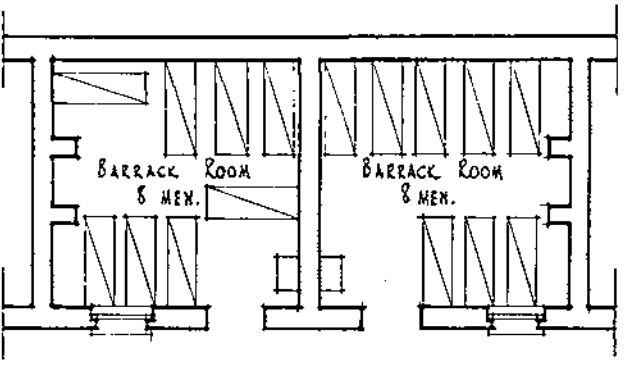
Separate dining accommodation was not provided and the men were forced to feed in the barrack-room itself amongst the beds. A long table, 2 ft. 6 in. wide, was placed in the centre of the room and the men sat on either side on forms. These tables and forms occupied 4 ft. 6 in. of the width of the room and, as the beds on both sides accounted for 12 ft. 6 in., two gangways of 1 ft. for access to the beds was all that therefore could be allowed. The kitchen was usually a considerable distance from the barrack-room and by the time food arrived it was probably cold. Such conditions would entail terrible hardships, but when the proposal was made that a separate dining and cookhouse block should be built, the soldiers were, curiously enough, not enthusiastic, the reason being due to the fear that the military hierarchy would close it at periods convenient to themselves, or turn it into a barrack-room.

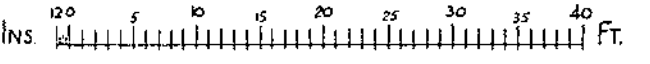
Ventilation at night must have been intolerable; all doors and windows were closed and the only means of air circulation was by means of one fireplace on an end wall. To make matters worse, urine tubs were allowed in the room during the night. These wooden tubs were often rotten and loathsome with disease and smell; it is on record that the serjeants had to have windows thrown open for ten minutes before entering in the mornings. Men were then coughing very badly, many of them sick, and in some instances cases of suffocation were revealed. The ablution-rooms were not often in the same building and were very poorly equipped, baths being rare, and dirty iron wash basins everywhere in evidence.

Perhaps the most disgusting conditions, however, prevailed for the married soldiers, six of whom were allowed per 100 men. No separate accommodation was provided for them at all, an extra allowance of a few square feet being allocated to them in the

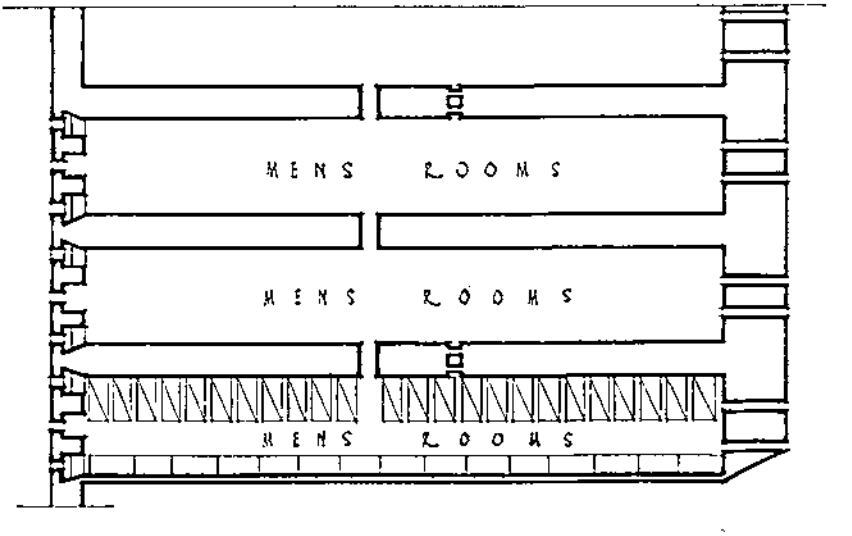
TYPICAL EXAMPLES OF OVERCROWDED BARRACK-ROOMS.

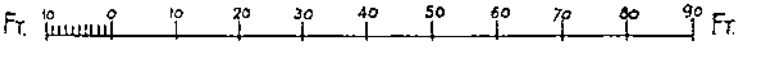
Fort George, Guernsey.





Orange Bastion, Gibraltar.





barrackroom; man and wife were then separated from the rest of the soldiers by a curtain. Such indecent conditions should never have been allowed in Government buildings, but it continued for a number of years and was favourably commented upon by some officers.

These conditions contributed to the deterioration of the health of the men to such an extent that in 1845 the mortality rate in the army was more than twice that amongst the civilian population. This alarming death rate was attributed mainly to pulmonary diseases, and there is little wonder, considering that the accommodation and state of barrack-rooms was considerably worse than that of H.M. Prisons.

It was not until 1855 that the public became aware of the conditions under which these men were serving and during that year the first important investigation into the conditions of barracks was made. Although the 1838 regulations stated that barracks were not to be overcrowded, it was not until the publication of the *Engineer Regulations* of 1851 that a definite cubic space of 450 cubic feet per man was fixed. However, the notable Committee under Lord Monck collected sufficient evidence to prove that regulations had been ignored, and justified immediate attention to the question of remedying outstanding defects. It also accentuated the necessity of providing better accommodation for the comfort and convenience of the soldiers, and for the creation of a higher standard of social habits amongst them.

The revelations regarding the accommodation of married soldiers is next in importance to the evidence relating to overcrowding. The chief recommendations of Lord Monck's committee were confined to rectifying these two great evils by laying down a reasonable cubic space per man and arranging for the construction of separate quarters for married soldiers.

The Committee also advertised and offered prizes for the best plans, to be prepared by civil architects, of infantry and cavalry barracks. The prizes were duly awarded, a Mr. Wyatt winning the prize for the Knightsbridge Barracks and a Mr. Morgan for Chelsea Barracks, but the plans were too costly and not considered sufficiently satisfactory to act as models for future schemes.

In 1857, a Royal Commission was assembled to make further enquiries on this subject and many startling disclosures were made, including the fact that the death-rate among soldiers was still twice that of the civil population.

Among the major proposals of the aforesaid Committee and the Royal Commission were the regulations that every married man should be allowed a separate room in a detached quarter, and that no women should be allowed in the barrack-rooms under any pretext. A space of at least four feet should be provided between beds and

a space of eight feet between the ends. The dining-room and kitchen should be a separate building ; canteens, which should be large and airy, should be supervised by a committee of officers ; the ablution rooms to be attached to the sleeping quarters ; and all barracks to be lit with gas, regardless of cost. In new barracks a reading- and writing-room should be provided, an appreciated innovation. The first suggestion for the improvement of officers' quarters emanated from these committees ; field officers, staff officers and captains were to be provided with quarters suitable for married men in their respective ranks ; improvements and additions to the mess accommodation were included.

The next committee convened dealt with the proposals made by the Royal Commission and £100 per barrack was placed at its disposal to make the necessary improvements. This amount was found to be totally inadequate. Nevertheless, the Committee made many valuable suggestions on the construction of new barracks, and to this day remains a very active body under the title of the Army Hygiene Advisory Committee. The years between 1851 and 1865 mark the birth of military design as it is known to-day. In no succeeding year has so much energy been expended on investigating this subject, or so much evidence collected to further the interests and comfort of the men who were required for the defence of their country, and who were at that period housed worse than many of the most dangerous criminals.

Barrack Design.

The development of the individual units of a battalion barrack is the subject of a specialized study, and it has been considered advisable for the purpose of this thesis to trace the development of each unit rather than treat the subject as a whole.

After the recommendations of the various committees already mentioned had had time to become effective, it was realized that the method of provision of barrack accommodation was still inadequate ; although the suggestions outlined by the committees were primarily related to sanitary conditions, the structural improvements to barrack blocks were rightly considered essential. In the recommendation of the Royal Commission definite allowances of cubic space were laid down for each soldier, 600 cubic ft. at Home Stations and 800 cubic ft. abroad.

But these cubic spaces were not actually authorized until 1900, when the figure of 800 cubic ft. for abroad was raised to 1,000 cubic ft.

Based on this scale the total cubic contents of all the barracks in the United Kingdom was found to fall short of the necessary accommodation by about one-third. The space between beds, although

commented upon as an important consideration, does not seem to have been finally standardized till a much later date.

Of the primary barrack blocks built to conform with the new regulations, that housing a company of infantry is the first of note. The design reproduced on page 531 shows a great advance in planning on the types executed before 1870. This new type is a double-storeyed block, comprising two 24-men barrack-rooms on each floor; between these rooms were two ablution-rooms and an N.C.O.s' room conveniently placed for supervision. The spacing of the beds is still cramped, some beds being only one foot apart and three in a row being now regarded as unhealthy; there are, however, wide spaces at the windows and at the sides of the fireplace.

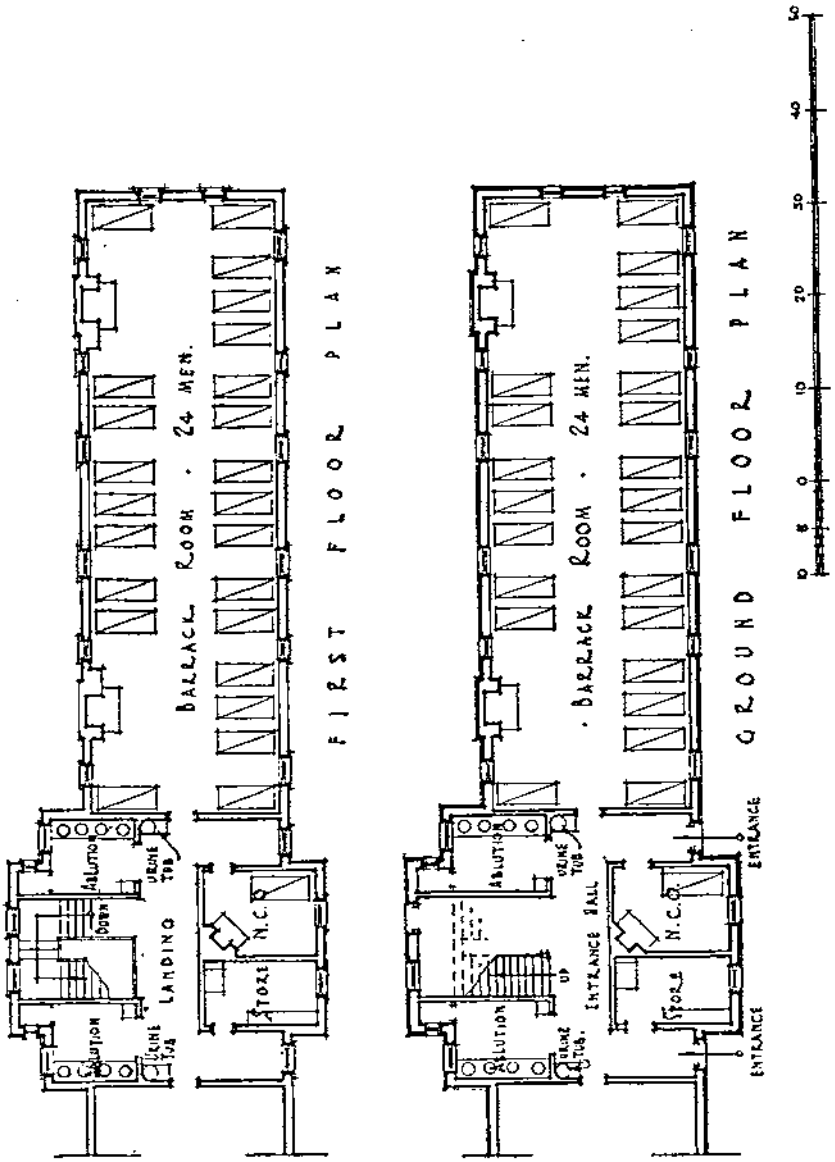
Twenty-four men were found to be a convenient division for administration purposes, but required a room very difficult to warm uniformly, the two fireplaces provided being hardly sufficient; and the window space for such a large room seems to be inadequate. The ablution-rooms off the main passage appear to be in an unhealthy position and the urine tub, although now out of the barrack-room, is still provided.

By 1900 this type of barrack block had been replaced by a design incorporating barrack-rooms, baths, cookhouse and dining-rooms. This latest design showed considerable advance upon its predecessor, and was known as the verandah type barrack block; the plan is reproduced on page 533. The accommodation of the men's rooms was reduced to twelve, and the blocks consisted of two double-storeyed buildings facing inwards towards the dining-room and cookhouse built between them; inter-communication was effected by means of covered ways and verandahs.

Eight of the 12-men rooms formed a company wing which was interspaced with passages, leading from the verandah to the ablution-rooms at the back; this disposition of the sanitary annexes would be distinctly more healthy than the former type. The smaller rooms are easier to heat and the spacing of the beds is a great improvement. Uniform ventilation is obtained but the urine tub still exists and is placed in a very unhealthy position.

The dining block, placed centrally in front of the barrack-rooms, was divided in half by a screen. The cookhouse was placed between the two dining-rooms and a covered way was the only protection to the serving of food to the dining-rooms. Bathrooms and drying-rooms were provided at either end of the cookhouse. This type of plan, although serving the purpose of housing troops better than its predecessors, produced a very poor elevation. The blocks were so awkwardly situated that no elevational treatment, as a whole, was possible. The verandah and the projecting rooms break up the horizontal effect completely, and the cast-iron columns and railings give the building a very cheap appearance.

COMPANY INFANTRY BARRACK BLOCK.



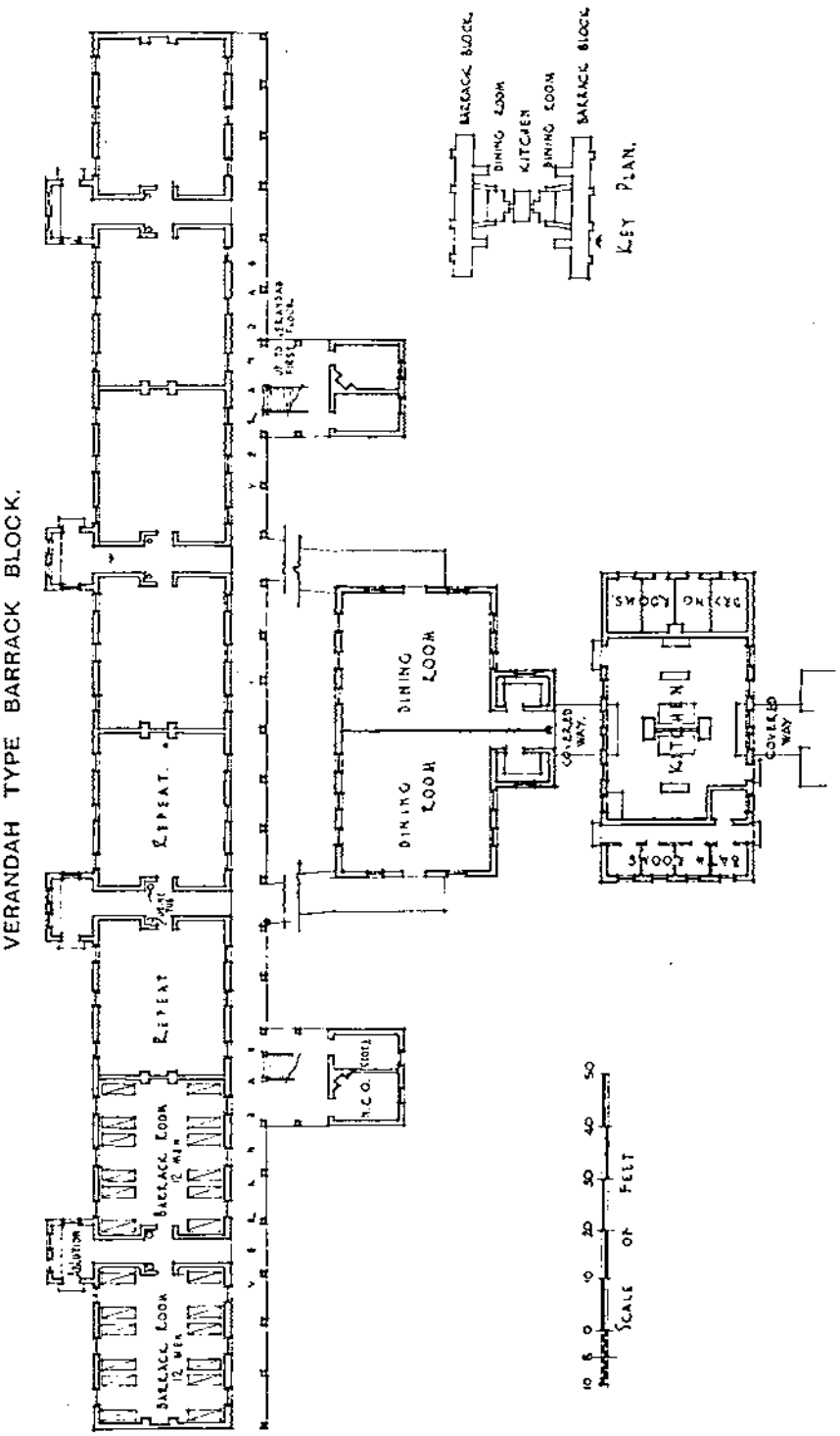
With one or two minor variations in planning, the verandah type barrack was used for quite a number of years as a basis for all buildings of that nature; and although it proved efficient, questions were asked in Parliament, about 1905, as to the advisability of providing each man with a single room or cubicle. As a direct outcome of these questions an order was eventually issued stating that all new barrack-rooms should be so planned that they could be converted into cubicles with partitions and without structural alteration.

In 1908, when the proposed barracks at Redford, Edinburgh, were under consideration, it was decided that the cubicle arrangement of the men's rooms should be given a trial. The upper floors were devoted entirely to cubicles and rooms necessary for sanitary purposes; the size of the cubicles was decided at about nine feet square, and they were arranged in long rows on either side of a central corridor; the ablution-rooms, etc., were placed at intervals in annexes.

The ground floor consisted of all the other rooms necessary for a battalion barrack. The dining-room was placed in the centre of the plan, so as to be accessible from all sides, the kitchen and rooms essential thereto were placed to the right of the dining-room and were directly connected to it by a servery; the regimental bars and store opened off the sides of the dining-room. Behind the dining block, but connected to it by corridors, a large bath-house was situated; it consisted of a number of lavatories, conveniences and slipper baths built round an area. Soldiers' games-rooms, smoking-rooms, gymnasium and common-rooms were all placed in front of the dining block and connected to the rest of the scheme by corridors.

This design was one of the first to incorpocate all the requirements of a battalion barrack in one building; the planning of the dining-room and kitchen worked excellently, and the provision and disposition of the soldiers' common-rooms were ideal. However, the provision of a separate cubicle to each man proved to be a failure, in that the supervision, which is found necessary to check immoral practices, was impossible. At a later date the cubicle divisions had to be removed and the space made into large barrack-rooms.

The advent of war in 1914 stopped further development and work of a permanent nature. Seven years later, in 1921, when new barracks were once more required, the price of building materials had reached an abnormally high level; as money was difficult to obtain from the Treasury, the Directorate of Fortifications and Works, formed in 1918 to control military building, was forced to erect buildings as economically as possible. To attain this end a " standard " plan known as the " Light construction type barrack block " was produced. The general disposition of the barrack-rooms was very similar to that in the old verandah type, the N.C.O.'s room, staircase


VERANDAH TYPE BARRACK BLOCK.
BARRACK ROOM 12 MEN
REPEAT
DINING ROOM
DINING ROOM
KITCHEN
COVERED WAY
COVERED WAY
SCALE OF FEET
KEY PLAN.
BARRACK BLOCK
DINING ROOM
KITCHEN
DINING ROOM
BARRACK BLOCK

and sanitary annexes being placed between the two barrack-rooms. Steel frame construction with 4½-in. stuccoed brick walls was used and asbestos tiles formed the roof. One dining-room and cookhouse served several of these blocks and was built on a convenient and detached position on the site. It was constructed in the same manner as the barrack block and its plan showed little improvement on those erected before the war.

In 1929 the falling prices brought this light construction type to an end, and hand-made tiles, facing bricks and stone dressings came to be incorporated in the new buildings. At first the difference in the plans was hardly perceptible, a flue with two fireplaces was built in the centre of the rooms in an endeavour to provide uniform heating, but its unsightliness, together with the fact that it was not as efficient as was expected, led to the fireplaces being placed on the walls again.

In 1934 the combined barrack block, bath-house and dining-room again came under review. The proposed plan showed barrack-rooms built in the shape of a " U " with the dining-room and cookhouse for the men and corporals forming an extension to the bottom member on either side. The accommodation of the barrack-rooms was decided at twelve men ; difficulty was experienced, however, in the arrangement of windows, as each man had now to be provided with a steel wardrobe for his civilian clothes ; these wardrobes were naturally required at the side of the men's beds, an arrangement which caused a number of windows to be eliminated, thus reducing the area of glass available for sunlight and ventilation. Baths and lavatories, etc., in this plan were placed where the vertical members of the " U " meet the horizontal member ; unnecessary crossing of communications to the ablution-rooms was thus minimized and supervision improved by the placing of an N.C.O.s' room between the barrack-rooms and bathrooms.

This plan became merely a preliminary study in what was to prove one of the greatest advances of barrack construction ; namely, the Sandhurst Type Barrack Block. Buildings, resulting from the combination of the barrack-rooms, sanitary accommodation and dining-hall and cookhouse under one roof, eventually became known as Sandhurst Type Barrack Blocks.

The latter months of 1934 and the early part of 1935 saw this country in a very precarious position as regards its defence forces. Our policy of disarmament, which it was hoped would set an example to other powers, had failed dismally, and any authority the League of Nations held was waning rapidly. Continental powers, in particular, were rearming at a feverish rate and at enormous cost, while we were slowly letting our defence forces sink into a state of decay.

In view of our disarmament policy, the British Regular Army had fallen in numbers to a degree that called for immediate investigation.

Difficulty was experienced in raising the necessary men, from the units available, to do the policing in our various colonies, and reserves were called up when an emergency arose in Palestine. These events caused alarm throughout the country and whole days were devoted to their discussion in Parliament. Public opinion was eventually roused sufficiently to welcome with enthusiasm a large modernization and rearmament programme embracing the three services.

As a result of this rearmament programme, a general move was instigated to increase the comfort and convenience of the soldiers in barracks, as a preliminary step towards attracting men to the colours with the view of making soldiering a profession.

As a direct result of these factors the Sandhurst Type Barrack Block came into being. Where new construction for a battalion or more was deemed advisable, it was suggested that a number of 60-men barrack blocks should be erected, together with a cookhouse and dining-room and bath-house to serve the whole. It was not long before this proposal was carried to its logical conclusion, namely, one building for housing and feeding one unit.

The original sketch plan for the Sandhurst Type Barrack Block consisted of five blocks of buildings, three storeys high. Three blocks were placed in a row, with the other two occupying positions 100 feet in front of the end blocks of those in the row. The isolated blocks were connected to the main building by covered ways. The central block contained the dining-hall and cookhouse on the ground floor, with barrack-rooms on the floors above. The other four blocks were devoted entirely to barrack-rooms and sanitary accommodation.

This plan was short-lived, however, as objections were raised to the covered ways connecting the buildings. These objections were overcome by moving the central dining-room and cookhouse block to a position midway between all blocks, the resulting plan being very similar to that illustrated on page 537. At this time N.C.O.s' rooms occupied the position taken up by the sitting-rooms on the plan illustrated.

Early in 1936 it was evident that numbers of the Sandhurst Type Barrack Blocks would have to be erected throughout the country. The Army Council, therefore, decided to submit the proposed plan, as described above, with elevations to the Royal Fine Arts Commission for their assistance in the design of the buildings. At the same time the proposals were submitted to all commands for their criticism and comments. It is worthy of note that all concerned welcomed this new barrack block as a definite advance in barrack design.

The plan of the Sandhurst Type Barrack Block as it is to-day is illustrated on page 537. It will be seen that the accommodation of the building is such that a soldier has not to leave the building for sleeping, washing or feeding purposes. The dining-hall is equipped

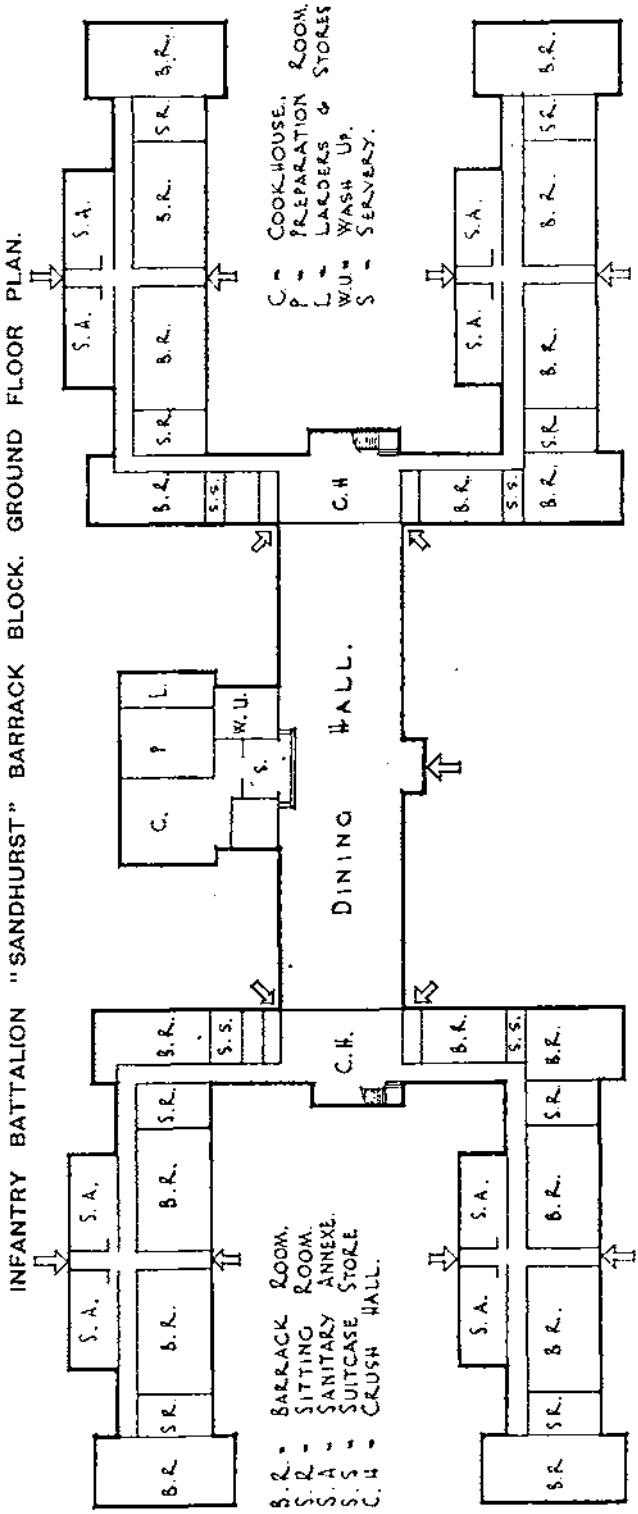
with a self-service counter ; food is placed, directly from a hot plate, on to this counter and the men help themselves to what they require. This is a new system of feeding in the British Army, although it has been in practice in America for some time. It is hoped by this system to give a greater variety on the menu, and to save the waste that was occasioned by cooking food for men who did not want it. A new seating arrangement is being considered, where the men will sit at tables for four instead of at tables holding twelve. The cookhouse portion of the plan has been re-designed, to facilitate the easy passage of food, from the larder to the cookhouse, and then to the serving counter. It is now capable of preparing, cooking and serving excellent meals for 600 men.

The sanitary annexes have undergone complete revision. The synopsis scale has been given an elastic base for calculating the number of sanitary appliances in Sandhurst Type Barrack Blocks. A combined increase over the synopsis scale is permitted when considering the fittings in one annexe, say, for 50 men. Hot as well as cold water is to be laid on to all ablution ranges. In the light of modern sanitation these measures are a necessity, and are real steps forward in providing for the comfort and convenience of the soldier. The sanitary annexe also contains a drying-room, cleaning-room and a suitcase store. All these rooms are innovations that are required to maintain the health and cleanliness of the modern soldier.

In contrast to the older barrack, the barrack-rooms in the Sandhurst Type Barrack Block hold approximately 12 men. This reduction from 24 or 30 is a great improvement in the hygienic planning of barracks ; one of its benefits being greatly to facilitate segregation in the presence of an epidemic disease, thus limiting its extent. This argument points to a further reduction, not forgetting the unsuccessful cubicle experiment, but with the knowledge that the verandah type of plan in 1905 only accommodated 12 men per room.

After considerable argument, the low-pressure hot-water system of heating the barrack-rooms was decided upon. Heating barrack-rooms by coal fires has been criticized for some time, on the score that men tend to crowd round the fires in cold weather and disseminate dangerous infections, such as cerebro-spinal meningitis and influenza. Directors of hygiene have often recommended the panel system of heating barrack-rooms, but until more money is forthcoming for expenditure on barracks, the radiator system will be appreciated as a step in the right direction.

With the passing of the fireplaces from the barrack-rooms, thought had to be given to a scheme whereby the soldier may find some place, in the barrack block, for relaxation. Sitting-rooms were introduced to further this end ; and in order to find space for them, it was decided to accommodate the N.C.O's elsewhere and enlarge and use


INFANTRY BATTALION "SANDHURST" BARRACK BLOCK. GROUND FLOOR PLAN.
B.R. - BARRACK ROOM.
S.R. - SITTING ROOM.
S.A. - SANITARY ANNEXE.
S.S. - SUITCASE STORE
C.H. - CRUSH HALL.
C. - COOKHOUSE.
P. - PREPARATION ROOM.
L. - LARDERS & STORES
W.U. - WASH UP.
S. - SERVERY.
DINING HALL.
C.H.
B.R.
S.R.
S.A.
S.S.
C.
P.
L.
W.U.
S.

their rooms for sitting-rooms. In the Sandhurst Type Barrack Block sitting-rooms are provided at the rate of approximately one to every 25 men, and at the scale of ten square feet per man. They are to be panelled in pulpboard, have a brick fireplace as well as central heating, a polished hardwood floor and be sumptuously furnished with divans and chairs and provided with a plug for wireless. The introduction of this type of room into a barrack block will create a higher tone of social habits among the men, and their provision should be encouraged. Only by raising the soldiers' standard of living to that of the civilian, will the men of to-day join the ranks and make soldiering a profession.

In the last two years barrack design has undergone drastic revision, and is still in a period of transition. Although vast improvements and additions have been granted in the form of extra rooms, etc., there is still much progress to be made, before barracks may be described, from a modern hygienic standard, as up to date.

MARRIED SOLDIERS' QUARTERS.

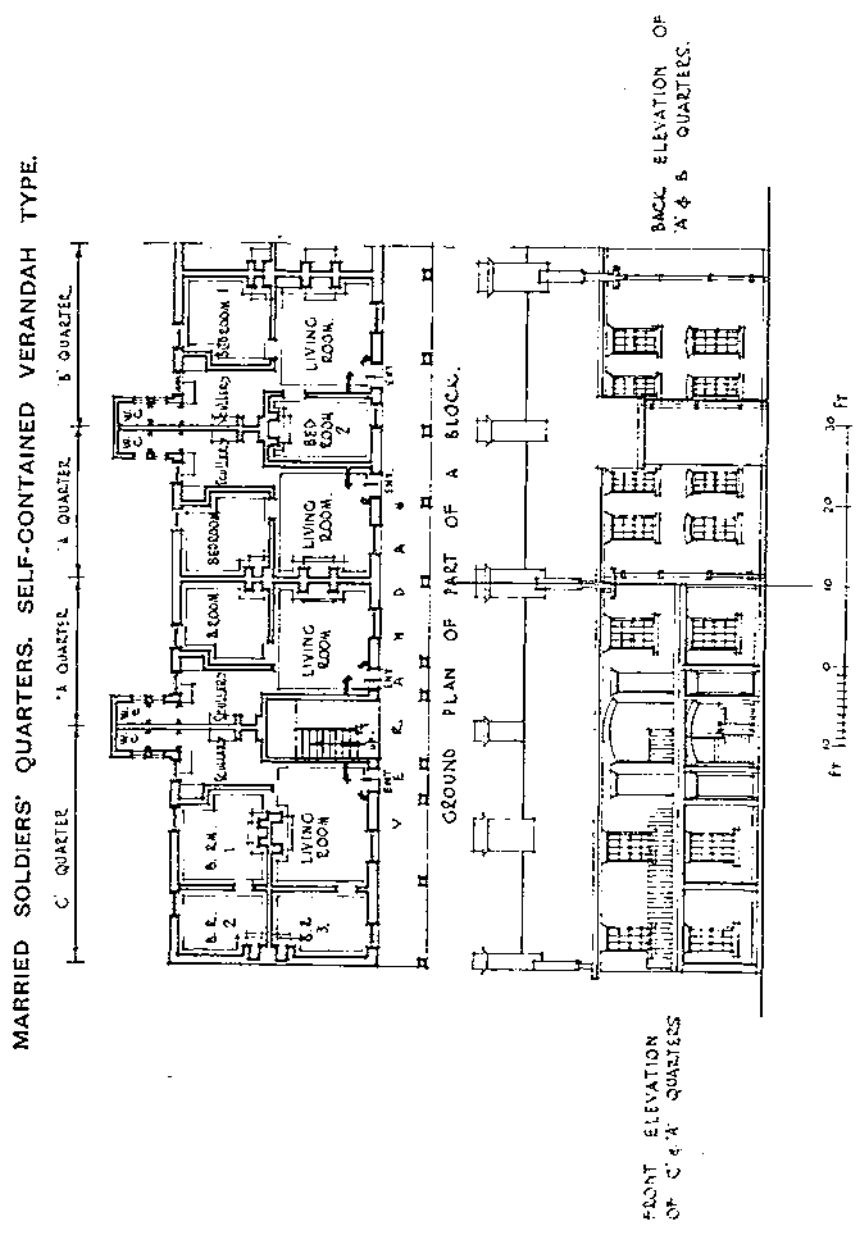
Following upon the highly unsatisfactory conditions to which reference has already been made, quarters for married soldiers were designed, consisting of single rooms, arranged four on a floor and built to two or three storeys in height. This primitive arrangement, however, was short-lived, and the first concession to comfort was the addition of two extra rooms, making, as it were, a kind of flat comprising a living-room, a bedroom and a scullery; the sanitary conveniences were detached from these quarters and situated in a special block nearby. The next development of this communal type of dwelling was the combination of conveniences and quarters, the connection being by means of a verandah: along with this improvement, the obvious justice of allotting the different-sized quarters according to the number of the family instead of according to rank was recognized.

About 1895 these quarters were reduced to three types, "a," "b" and "c," there being no difference between them in internal finish. Whereas each quarter possessed a living-room, scullery and a w.c.,

the "a" quarter had one bedroom;
the "b" quarter had two bedrooms;
the "c" quarter had three bedrooms.

These quarters constitute the "self-contained verandah type," and are illustrated on page 539.

Although the provision of this means of accommodation for the married soldier was a distinct improvement, jealousies and discord arising amongst the residents were the main factors which caused the authorities to consider, in the provision of new quarters, a


MARRIED SOLDIERS' QUARTERS. SELF-CONTAINED VERANDAH TYPE.
C QUARTER
A QUARTER
A QUARTER
B QUARTER
LIVING ROOM
BED ROOM 2
BEDROOM 1
LIVING ROOM
BEDROOM
LIVING ROOM
B.R.
LIVING ROOM
B.R. 1
B.R. 2
LIVING ROOM
B.R. 3
GROUND PLAN OF PART OF A BLOCK.
BACK ELEVATION OF 'A' & 'B' QUARTERS.
FRONT ELEVATION OF 'C' & 'A' QUARTERS
0
10
20
30 ft
ft

cottage or unit type. These latter quarters bore a striking resemblance to the miners' cottages which were erected in large numbers in certain localities about the same time. Each cottage had a porch entrance, two living-rooms downstairs, two bedrooms upstairs, and was planned so that by building up one bedroom door and opening up another, two " b " quarters could be converted into an " a " and " c " quarter. This method of planning proved economically sound, and is in use to the present day.

This type may have been adequate for its purpose, but the design was such that the appearance of about forty houses in long rows was very unsightly ; at this particular period, however, the arrangement was one so general as not to excite adverse comment. The lack of architectural merit about these schemes caused the authorities to reconsider their general appearance ; this was effected by planning in a way which lent itself to more symmetrical and proportional elevations, as will be seen from the illustration on page 541. A 9-in. party wall formed the division between quarters, a living-room and scullery opened off a passage through the quarters connecting entrance and stairs, the w.c. being erected as an outbuilding. The bedrooms were on the first floor above the living-room and scullery ; unfortunately, no bathroom was then provided. The first floor plan seems to be wasteful in passage space, and the latter might have been used to greater advantage if it had not been required in order to facilitate conversion to " a " and " c " quarters.

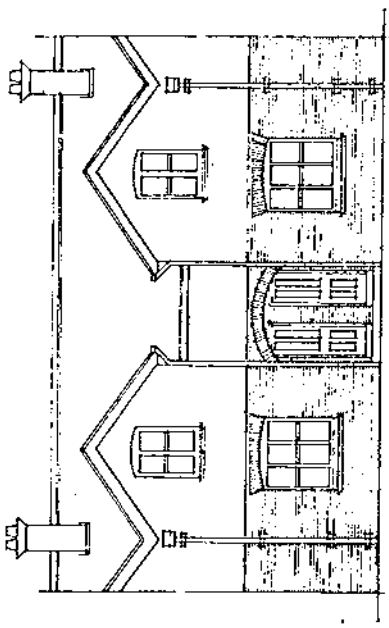
The elevational treatment, in stucco with a good quality brick base, and a Westmorland slate roof, was a great improvement on the previous design ; and would probably have been improved if executed completely in brick, or stucco, as the stopping of the brickwork at the ground floor ceiling level tended to cut the elevation horizontally into halves. This later design showed more originality in the planning than the cottage or any previous type, and was a decided advance in the provision of married soldiers' quarters.

The use of this plan as a general basis for all schemes continued until the outbreak of war in 1914, the most important deviation being the addition of a sitz bath-closet to the sanitary accommodation. This innovation may not have appeared of great value when approved, but it eventually led to the provision of the slipper bath, now in general use.

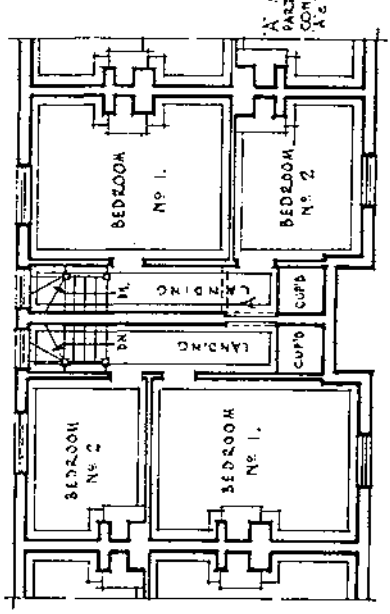
After the war the economies, that cramped the natural development of the barracks for such a long period, similarly affected the married soldiers' quarters. For a number of years quarters were erected with asbestos slates, stuccoed partitions and wallboard, etc., regardless of elevational considerations.

What is probably one of the first schemes of importance in military housing occurs at Willan Street, London, where a six-storey block of flats was erected in 1925. The block plan is in the shape of the

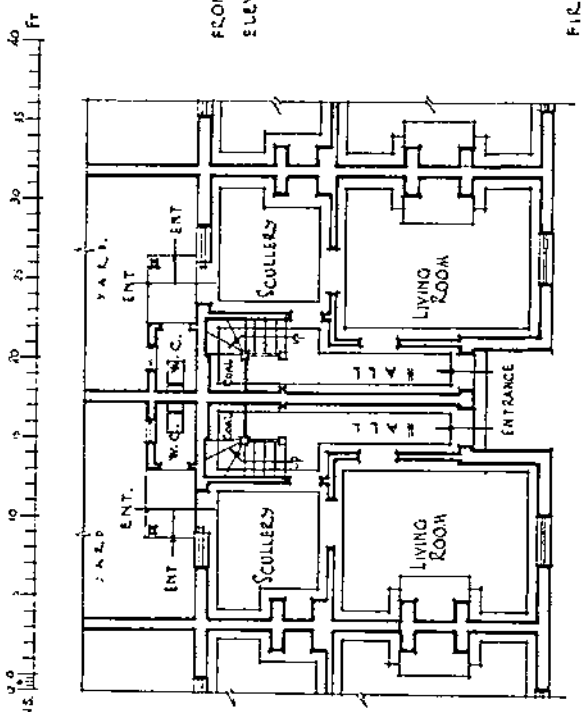
CONVERTIBLE "B" TYPE, MARRIED SOLDIERS' QUARTERS.



FRONT ELEVATION.



FIRST FLOOR PLAN.



GROUND FLOOR PLAN.

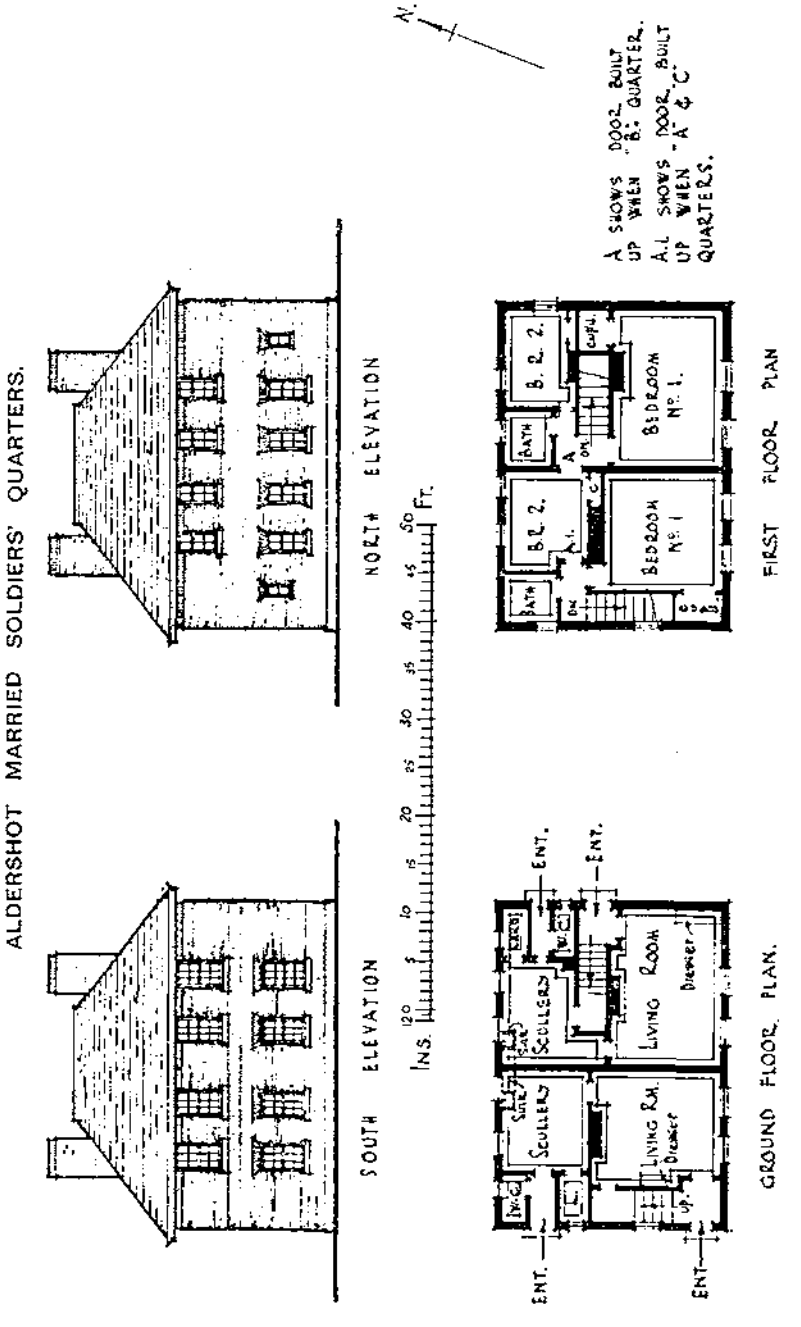
letter " L," the lengths being divided up into seven and five units. The accommodation here provided included an internal w.c. and a bathroom containing a slipper bath but no wash basin. It is gratifying to note that the military authorities recognized the necessity of a separate bathroom soon after the war. The flats were planned to be convertible to " a " and " c " quarters, and were entered from balconies which extended along the rear elevation to economize on internal staircases.

On the conversion of two " b " quarters to an " a " and " c " quarter, a difficulty occurs regarding the thickness of party walls. When two " b " quarters are together there is a 9-in. division wall between them, but when converted to an " a " and " c " quarter, the party wall in places is reduced to the thickness of a 3-in. partition. Under certain bye-laws this practice would be illegal, but the War Department usually builds on its own land and is exempt from local Government regulations.

A later design of note is the semi-detached quarter, which was erected at Aldershot in 1928, and is illustrated on page 543. The plan is rectangular, and is divided by a 9-in. party wall, which, for reasons given later, was placed slightly out of centre. The sculleries and living-rooms face north and south respectively ; in one instance the staircase rises on the west wall and in the other between the scullery and the living-room. Two entrances are provided to each quarter, one to the living-room and one to the scullery, and in both cases the w.c. and larder are built on either side of the scullery passage, which forms a convenient ventilating lobby for the w.c. The different situations of the upstairs landings occasioned by the position of the party wall enables the right-hand side house to appropriate the north bedroom of the left-hand side house when conversion is necessary.

The use of better building material had once again become common practice, and a rustic brick elevation with a brick-on-edge treatment under the eaves, Welsh slates, double-hung sash windows to the main rooms, and casements to the smaller rooms, all tended to give the design a very pleasing but dignified domestic appearance.

As the number of quarters to be provided was increasing, it was evident that all sites could not have the same aspect, and standard plans were prepared to suit as many sites as possible. The north and south aspect plans more or less followed the lines of the immediately preceding design, except that corner blocks had to be planned as two " a " quarters. Every endeavour was made so that the orientation of these buildings would give the maximum amount of sunlight to the living-rooms. Perhaps this question of orientation is not considered enough in the site planning of present-day housing schemes, and in very many cases of speculative building the same design of house is used on both sides of a street. Before 1929 the


ALDERSHOT MARRIED SOLDIERS' QUARTERS.
SOUTH ELEVATION
NORTH ELEVATION
Ins. 120 5 10 15 20 25 30 35 40 45 50 Ft.
GROUND FLOOR PLAN.
FIRST FLOOR PLAN
A SHOWS DOOR BUILT UP WHEN B. QUARTER.
A.1 SHOWS DOOR BUILT UP WHEN A & C QUARTERS.
N.
ENT.
SCULLERY
LIVING RM.
DRESSER
LIVING ROOM
BEDROOM No. 1
B. R. 2.
BATH
CUPD.

Directorate of Works at the War Office also tended to ignore the position of the building, with regard to the maximum amount of sunlight obtainable; but from this time onwards the aspect of the quarters was one of the main considerations in the preparation of a design.

The bathroom fittings in 1929 included a bath but no wash basin, the soldier and family having to wash in the sink in the scullery or by means of bowls. Additional amenities, however, were provided in the form of an enclosed dresser fitted in the living-room and a portable copper, gas or coal operated according to the local conditions, fitted in the scullery, together with a hot-water cylinder for provision of a constant supply of hot water. Linen and accoutrement cupboards were built in the bedrooms, and a perambulator space and internal coalhouse were included in the accommodation.

Quarters planned on these lines are now built in blocks of two, four or six, and in double corner blocks. There are various designs for each type, so as to include the use of bricks and stucco, tiles or slates, etc., to suit local practice and for the variation of a lay-out. The method of planning that enables two " b " quarters to be converted to an " a " and " c " quarter, although introduced in 1900, is still found to be the most economical method of provision. As soon as a soldier's family increases to three or four, an extra bedroom is easily given to him without more structural alteration than that of building up a doorway; and as the number of a family is doubtful, convertible " b " quarters are always convenient.

The building of quarters in small units has proved too expensive in London and similar areas, and a communal flat building in London incorporating the latest additions and improvements has recently been completed at St. John's Wood Barracks, facing Primrose Hill and Finchley Road.

The completed block is five storeys high with *maisonettes* in the roof. Two staircases provide means of communication to balconies running along the south sides, the balconies in their turn giving access to the flats. The quarters are planned on the " a," " b " and " c " convertible method already referred to; the accommodation being the same as in the detached or semi-detached blocks. Fireproof concrete floors covered with linoleum are used throughout the building and each flat is provided with its own hot-water system.

The kitchen equipment consists of a fitted dresser and built-in larder; the bedrooms all have wardrobes and the main ones are provided with an accoutrement cupboard. Gas ranges are used for cooking, electric light and power points are standard fittings, and communal rubbish chutes are provided in convenient places. The absence of a wash-basin in the bathroom in the light of modern sanitation is conspicuous.

The elevation to Finchley Road is built in two different coloured

rustic facing bricks, which produce a horizontal band effect. Lombardic tiles over the end blocks form a very interesting variation and finishing feature.

From the foregoing pages it will have been gathered that great strides have been made in the design of married soldiers' quarters in the last few years. The Barrack Synopsis Committee have recently approved the addition of a washbasin to the list of bathroom fittings in every married soldier's quarter. This addition brings all married soldiers' quarters in line with the great housing schemes now being executed throughout the country. The quarters that are now being built are better, both in construction and planning, than modern civilian houses; and, in the provision of fittings, are far in advance of the buildings erected by the most generous speculative builder.

(To be continued.)

AN ARAB "MOUSE-TRAP" AND OTHER BOOBY-TRAPS. PALESTINE, 1936.

By CAPTAIN E. C. W. MYERS, R.E.

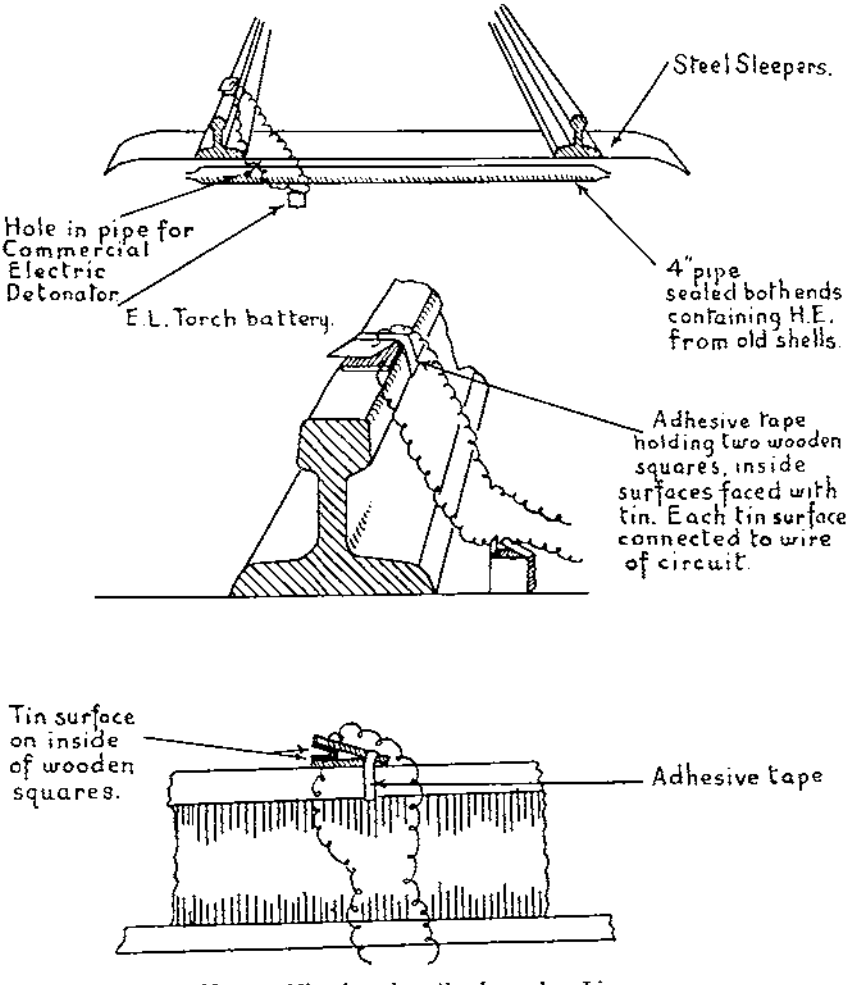
THIS article records some of the hitherto unpublished accounts of booby-traps encountered in Palestine last year. It deals chiefly with Arab-constructed traps which were met by the 42nd Field Coy., with one or two additions, as no account of booby-traps in Palestine would be complete in any form without mentioning some of the incidents which occurred in connection with counter-booby-trap work carried out by the 2nd Field Coy., R.E.

Though the 42nd Field Coy. did no counter-booby-trap work, the 2nd Field Coy.—and later others—employed it largely and effectively, it being often the sole means they had at their disposal to protect their commitments. Full details of the methods they employed can be obtained from a report already submitted to the S.M.E.

Railway Booby Traps.

Early every morning in the Railway Superintendent's office on Lydda station, we used to have a post-mortem on the previous night's shoots and bags of the many armoured trolley, engine and armoured truck patrols, before fixing our plans for the following night's entertainment.

I remember one hot morning coming out of the office after one of these conferences and seeing a soldier of the South Wales Borderers gingerly wheeling a barrow up the station platform. In the barrow he had a long bit of heavy piping. He had just come in off a line inspection patrol, on foot, of the steep and dangerous railway track between Jerusalem and Artuf. After the passing of the dawn armoured truck and engine patrol from Jerusalem, some crafty Arabs had quickly laid a trap in the hopes of catching the next train—which was sometimes the first passenger train of the day down from Jerusalem, and sometimes the returning dawn patrol, depending upon how much the latter had been delayed. The S.W.B. foot patrol had seen a tiny bit of wood, some 2 in. by 2 in., on the line, and upon inspection had discovered a dangerous mine, which they sensibly disconnected and successfully brought down to Lydda for inspection. Their alertness had saved a nasty derailment, and perhaps many lives. The trap is, I think, sufficiently described by the sketch No. 1.



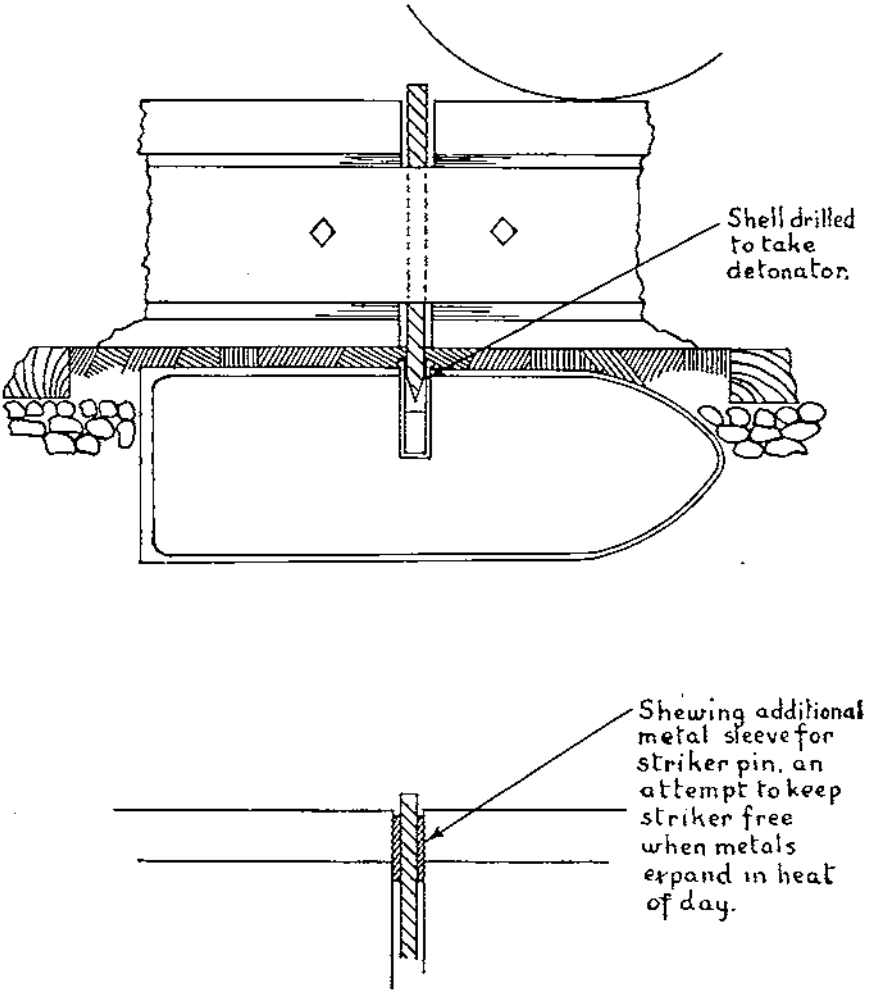
No. 1.—Mine found on the Jerusalem Line.

A form of traps the Arabs were constantly using or trying to use consisted primarily of an old war-time shell, drilled on its side to take a fuse or percussion detonator. The sketch on page 548 shows the method employed.

Though military patrols often discovered these traps, several times the latter went undiscovered. Sometimes the trap, undiscovered, didn't go off because it had been laid in the cool of the night, when the gap between the rails was large; the heat of the day expanded the rails and caused them to grip the striker pin, so that the wheels of the train merely bent it over or squashed it.

I remember on one occasion, when a fat and amusing "Levantine" Palestine railway civilian official was travelling up to Lydda from Kantara on the famous "No. 2"—the nightly "express" (?) from

Egypt to Haifa. While asleep in a first-class compartment, in only his night-shirt, his boots, which he had left on the floor of his carriage, got blown into uncountable pieces by what was believed to be such a bomb as described above. I am glad to say that this good-natured official was unhurt. This was a curious case because the engine had



No. 2.— A percussion type Mine, often found on Palestine Railways.

failed to set the bomb off immediately, and it had gone off under the first coach. Perhaps it can be accounted for by the excessive speed of the "express"—unlikely. . . . Another explanation might be that the Palestine railway track is far from truly laid, and it might have been possible that the wheels of the engine—on the side the bomb was—were "in the air" when they passed over the bomb! A more likely explanation seems to me that this time the bomb was

connected up electrically and fired by some Arab in attendance locally, who collected his wire afterwards and disappeared in the darkness, unseen.

When the Arabs in due course discovered that there was such a thing as a coefficient of expansion of iron, they put a metal washer or sleeve in between the rails in an attempt to keep the pin free to move. A sketch of this will be seen under drawing No. 2.

This principle of percussion type mines, using old shells, was often employed on the roads as well as on the railways. The Arabs also used many types of trip-wire traps on the roads, usually of the type that the breaking of the trip wire caused an extended spring to be released, together with the striker pin on to the detonator. A rather ingenious one on the principle of the common mouse-trap, found at the entrance to a sangar, is described later.

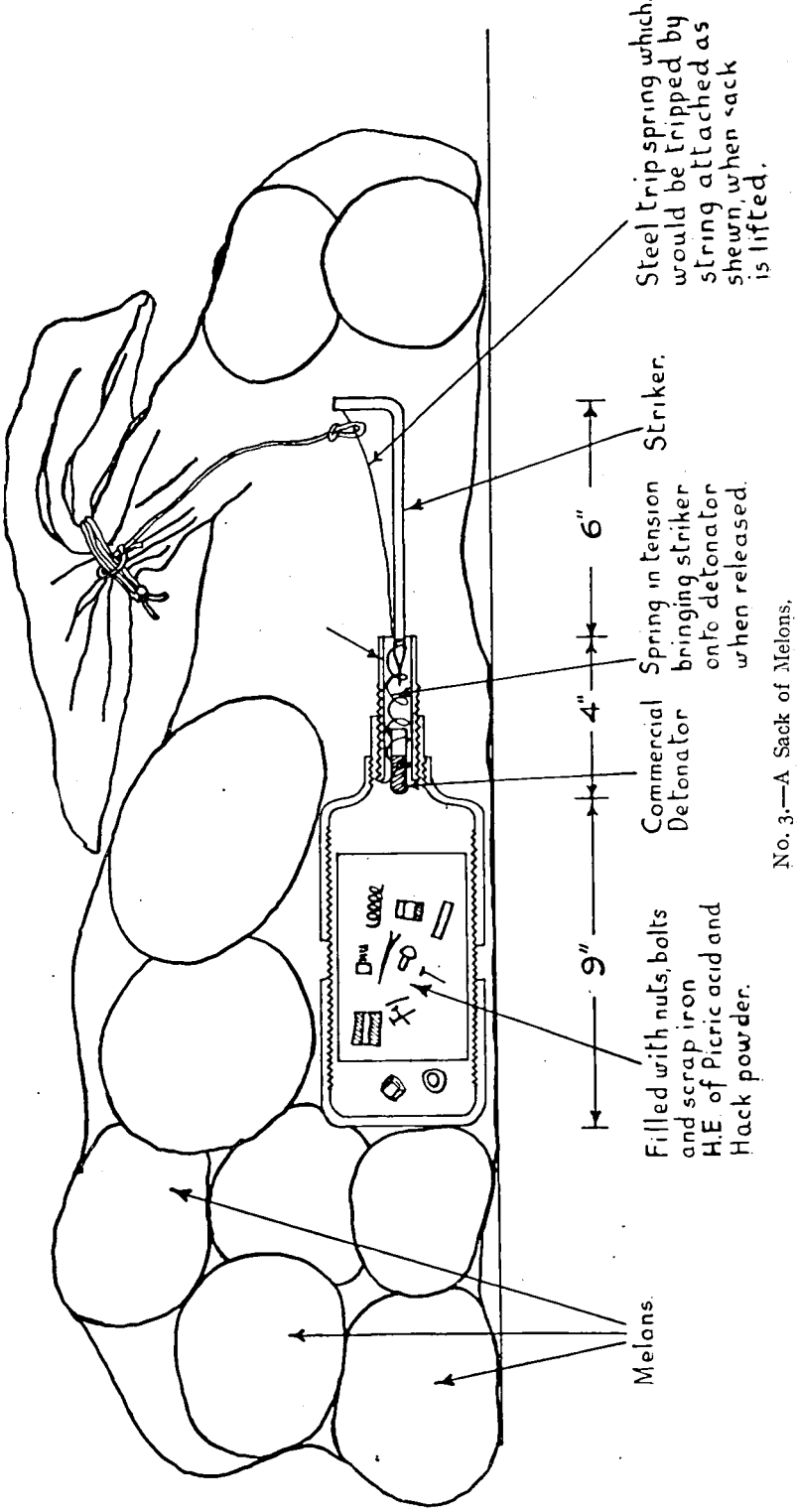
Road Booby-Traps.

Anyone who was in Palestine last year will have heard of " Windy Corner," in the " Valley of Death "—duly signposted by some wit to that effect—on the treacherous Tulkarm-Nablus road, the scene of many skirmishes and actions.

About a mile from " Windy Corner," at a place called Nur-esh-Shems, there is a large quarry, worked by convicts from a settlement alongside. As this was practically the only quarry unaffected by the general strike throughout the whole of Palestine, the output of stone for the many essential services (road and railway ballast—the latter particularly needed because of the many derailments and wrecking of the lines) became increasingly important. To increase the output, a detachment of the 42nd Field Coy., R.E., was sent to the quarry and employed on drilling with compressors and on large-scale blasting. One day, an N.C.O. from this quarry was called out to investigate some suspicious wire at " Windy Corner." He discovered no less than ten old six-inch shells, buried at a few feet intervals, about a foot under the side of the road. Each shell had been drilled to take a detonator in its side. But it was apparently the work of an " enthusiastic amateur," as he had poked his wire terminals invariably into the ends of " No. 6 " commercial detonators (not electric ones). Perhaps he was considering using H.T. mains from Tulkarm with the telephone wires which ran alongside !

A Bag of Melons.

One day a telephone message was received at our Company H.Q. at Sarafand from the police of a village called Rehovoth, some half a dozen miles away, " Would an R.E. Officer come at once please to inspect a very dangerous mine found in a sack." This turned out to be a rather ingenious trap laid, apparently by Arabs, on a track frequented by Jews and donkeys laden often with sacks of melons.

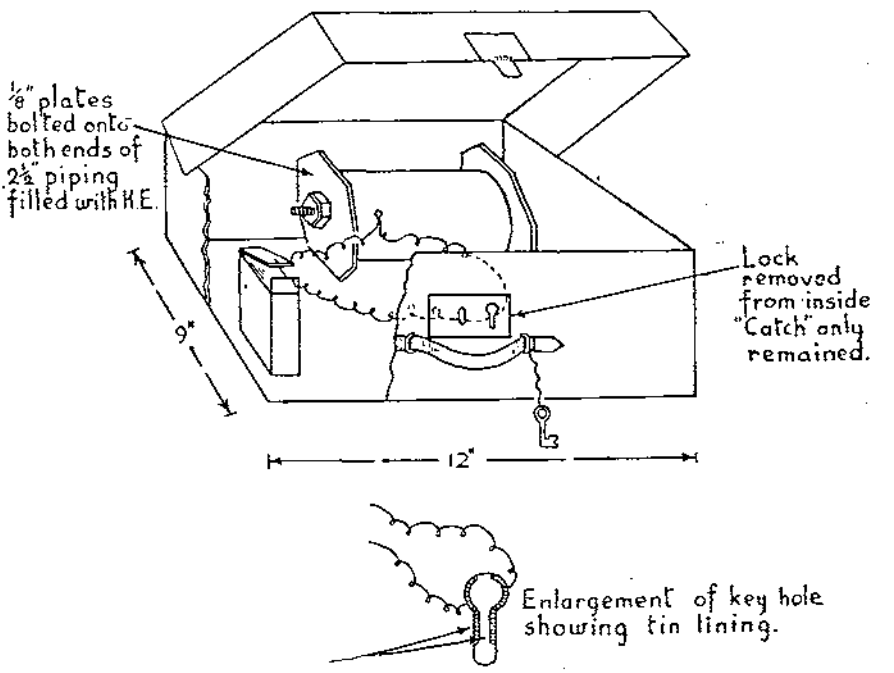


No. 3.—A Sack of Melons.

A crafty Arab had deposited a sack beside the track, presumably to represent one which had inadvertently been left behind, or dropped off a donkey. I didn't actually see the trap myself, so don't know what it was that gave it away. From the foregoing drawing it will be seen that you had only to lift the sack up by the neck, to release the trip spring and the striker. The neck of the sack was carefully undone by the R.E. party, and a 200-yards length of wire attached to the string. When the end of this wire was pulled the outfit went off very thoroughly, and nuts and bolts and old iron flew over the heads of the R.E. party, a total distance of over 250 yards. A mixture of picric acid from shells and black powder had apparently been used.

An Attaché Case.

An R.E. Officer was once summoned to the police station at Jaffa to inspect another type of " infernal machine," this time enclosed



No. 4.—The Jaffa Attaché Case.

in a small attaché case. It was, however, rather " fishy " on account of its weight, and by the fact that the key was attached by a string to the handle, also the key-way had been tampered with (the lock having been removed from the inside). It transpired that this " machine " had been manufactured by some youths in Jaffa and had been left in a railway compartment in a train going on to Tel-Aviv, addressed to a notable " Jew " of that town.

I forget exactly how the case came into the hands of the police—whether the Jew to whom this case was addressed valued discretion above his curiosity, or whether the Palestine railway officials smelt a rat.

I think the foregoing sketch shows how one had only to insert the key in the key-hole for the electrical circuit to be completed, not to mention the rapid completion, as well, of the life of the "opener."

The Mouse-Trap.

I now come to what I call the "mouse-trap." Under the direction of their chief of staff at this time, one Fauzi Kawhaji, an Iraqi—one time Syrian—soldier of no mean ability (I believe he had been to St. Cyr), the Arabs learnt to realize the value of preliminary reconnaissance and of detailed plans before their attacks.

In many cases in their hold-ups on roads, they would be firing from well-concealed and perfectly protected stone sangars far up on the rocky hillsides. In these sangars, they used carefully to make rifle loop-holes with rifles built into them, during daylight, exactly trained on to the portion of the road they wished later to hold up or snipe.

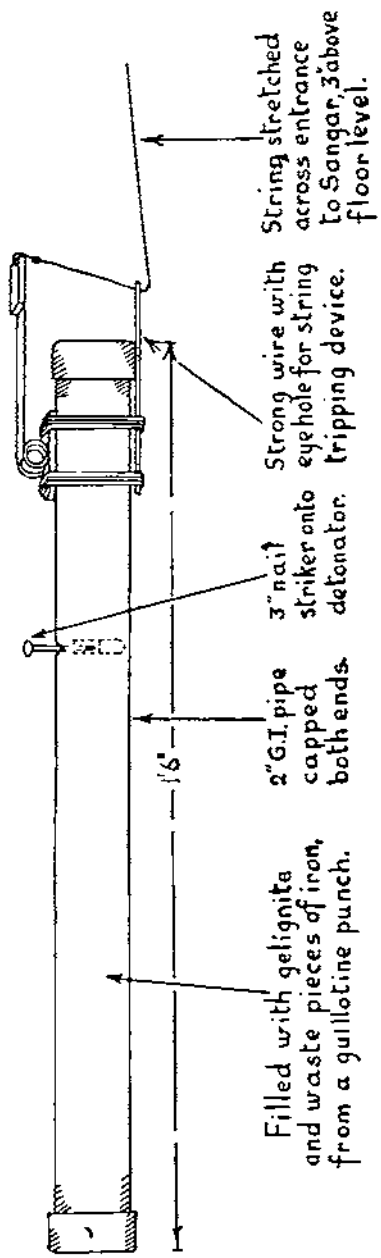
Arabs had been giving a lot of trouble sniping at the Nur-esh-Shems quarry (already mentioned) every night, and a party of Infantry and R.E. were sent out to see what snipers' nests they would find. Eventually they came upon a sangar which had been neatly prepared against day-time intruders. A string had been laid across the entrance, about 3 feet high, fastened at one end to the wall, at the other to the "mouse-trap" in the sketch No. 5. The string was thin and not easily seen, and one had only to break this or give it a sharp tug for the trap to be released.

Water-Supply Protection.

One of the commitments of the 2nd Field Coy., R.E., was the protection of the all-important water-line to Jerusalem. This pipe-line for a large part of the way runs alongside the main Jaffa-Jerusalem road, buried only to a depth of a few feet, with a manhole every few kilometres.

The Arabs had already made several attacks on the pipe-line—sometimes by digging down to the pipe and firing a rifle-shot or two through it—sometimes by trying to blow it up. It was a comparatively easy job to shut off the water at the nearest manholes and repair the pipe. But as these attacks of sabotage continued, it was feared that the Arabs would begin to realize that they could do much more harm by attacking the manholes themselves. So the 2nd Field Coy. resorted to laying booby-traps in the manholes to prevent Arab interference at these dangerously accessible places.

A notice was duly published and circulated to the effect that the booby-traps were there. But in spite of this precaution, the first bag



No. 5.—The Mouse-Trap

was a " water official " on inspection. In one way, it was a fortunate case, for this " water official " merely had the seat of his trousers severely plastered with stones and pebbles. I believe he was moved some few feet, also, by the impact. But he wasn't killed or seriously wounded. Consequently the 2nd Field Coy. increased all their charges from 2 lb. to 5 lb. of gelignite. These charges were placed outside the manholes to avoid damaging the pipe-line itself, and worked on the principle that the opening of the manhole caused an insulated wire to draw an uninsulated portion of itself through and into contact with the other wire, uninsulated, which was looped round it, thus completing the electrical circuit.

Another incident in connection with the Jerusalem pipe-line is perhaps worthy of record. I think it was before the traps were laid in the manholes, that one particular manhole was constantly being interfered with—though the pipe-line or connections in this manhole were never damaged. A watch was kept on this place, and it transpired that it was being used as a half-way house for the smuggling of tobacco to Jerusalem from the coast.

Counter-Booby-Traps.

On the Nablus-Jerusalem road, the Nablus detachment of the 2nd Field Coy. had repeatedly been called upon to repair a large hole in the abutment to the road on the outside of a particularly dangerous bend. As fast as the gap was repaired, the following night or night after, the Arabs would come along and pick it all out again. So the N.C.O. in charge of the R.E. Detachment, a wily chap, who later got a decoration for all his good work in Palestine, laid a trap for his tormentors.

The next time his party was called out to repair the road, he laid an electric cell in the hole, connected to a few pounds of gelignite and disposed of his two leads, fastening one to a stone which the Arabs would obviously remove, and winding the other, bared, in a loop round the first wire. The stone had only to be lifted for an uninsulated portion of the wire to be drawn into contact with the bared wire wrapped round it, on the same principle as the manhole booby-trap.

Two days later, in their summary of the previous day's disturbances, words to the following effect appeared in the *Palestine Post:* " In an attempt to lay a mine on the Nablus-Jerusalem Road at Kilo . . . three Arabs were seriously injured, the charge having apparently exploded prematurely." (! ! ! ! ! We knew better.)

There were numerous observation posts in the form of sangars built by our troops during the disturbances. After the strike was over, we didn't want to demolish these sangars immediately in case disturbances broke out again—so a notice in Arabic was put outside these unoccupied sangars across the entrances, informing intruders

that it was dangerous to enter. The notices were connected up so that it was practically impossible to enter the sangar without removing the notice, and its removal set off a booby-trap of a few pounds of gelignite. After one sangar scored its mark, no others were interfered with. This work was chiefly carried out by the 12th Field Coy.

Source of Arab Explosives.

Anyone reading this article might wonder how the Arabs got hold of such an endless supply of explosive. There were two chief sources ; firstly from quarries. A large amount of quarrying goes on in Palestine. At the beginning of the strike, all these quarries closed down with the exception of the one at Nur-esh-Shems, worked by the convicts—and the R.E.! Vast quantities of explosives and detonators were pilfered from the explosive stores of these many quarries, and experts in the use of these explosives were available to render their services.

The second source came from an apparently inexhaustible supply of old war-time shells, chiefly from the neighbourhood of the old Turkish and English rail-heads, near Gaza and Rafa respectively. After the war, a contractor was supposed to have blown up these dumps, in a general " clean up " of the country. In actual fact he probably did destroy most of what he found above ground—but shells in that part of the country quickly become covered with sand—and last year fresh dumps of them were continually being found beneath a foot of sand, most of them with explosives in good condition. It was not until later in the summer that the authorities ordered a thorough clean-up of the area and R.E. parties were summoned to destroy huge dumps of old Turkish and sometimes English shells. Not until this was completed did the Arabs begin to experience any trouble in getting as much explosive as they wanted for their many mines and booby-traps.

It is regretted that, owing to the unexpected withdrawal of an article, pages 556 to 564 have had to be omitted.

THE "UN-BUILDING" OF WATERLOO BRIDGE.

By ALFRED T. BEST, M.INST.C.E.,

of Messrs. Rendel, Palmer & Tritton, Consulting Engineers.

A lecture delivered at the School of Military Engineering, Chatham, on 18th February, 1937.

THE lecturer referred to a popular talk that he had broadcast on 22nd August, 1936, as reported in the *Listener* for 2nd September, 1936 (the hearing of which by some officers of the S.M.E. had led to this lecture), and to a full technical account given by Mr. E. J. Buckton and Mr. H. J. Fereday (both partners in the firm he represented) to the Institution of Civil Engineers on 28th April, 1936, published in the *Journal of the Institution of Civil Engineers* of October, 1936. He referred any who wished for details to those papers for information up to the time of their publication, but was able to bring the story up to date, the demolition being more nearly completed.

The illustrations herein are reproduced by courtesy of the Institution of Civil Engineers, the London County Council and the British Broadcasting Corporation, from lantern slides shown at the lecture.

HISTORY OF THE BRIDGE.

As is well known, the engineer responsible for the bridge was John Rennie the elder, father of Sir John Rennie. The contractors who undertook its construction were Messrs. Jolliffe & Banks. The work took six years to complete, being begun in 1811 and completed in 1817. It was a notable achievement to do it in so short a time, considering the limitations of the period as regards plant and transport.

The bridge was not undertaken nationally as a memorial of the battle of Waterloo, but by a commercial company as a toll-bridge for profit. The company was the Strand Bridge Company, and the bridge the "Strand" Bridge. But being well advanced when the battle was fought, and completed two years afterwards, it was ceremonially opened on the 2nd anniversary of the battle of Waterloo, 18th June, 1817, and named the "Waterloo" Bridge in commemoration of it.

It served its purpose well for over a century, under changes of ownership, being taken over by the Metropolitan Board of Works and set free of tolls in 1877, and in 1888 coming under the control of the newly-formed London County Council, as successors to the Board of Works.

Upon the failure of the bridge in 1923 it became the subject of controversy as to the method of its restoration, and ten years passed in vacillation and alternation between schemes for replacement by a new bridge or for patching up the old one. The engineers were prepared to do either.

In 1934, the London County Council, with a newly-elected membership having a Labour majority under the leadership of Mr. Herbert Morrison, rescinded previous resolutions and decided upon the demolition of the old bridge and its replacement by a new one adequate to carry six lines of traffic.

Demolition was commenced in June, 1934, and by February, 1937 (the date of the lecture), but little of the structure remained.

FORM OF ORIGINAL CONSTRUCTION AND ADDITIONS.

The structure, as seen in Fig. 1,* consisted of nine semi-elliptical arches of 120-ft. span, with eight piers 20 ft. thick, making a total span of 1,240 ft. The bridge was level throughout and provided a carriageway 27 ft. 6 in. wide and two footpaths each 7 ft. 6 in. wide. Although too narrow in width and in span of arches for modern traffic needs by both road and river, it was universally recognized as a beautiful bridge in elevation. The style, as is well known, was classic with Doric columns and entablature. The piers, arches and external spandrel walls were of Cornish granite with perhaps 20 per cent. of sandstone.

The bridge sprang from the high level of Wellington Street on the north bank to Waterloo Road on the south, both the approaches being carried on a series of brick arches, now mainly masked by buildings along their flanks. The river traffic was mainly through three arches, Nos. 3, 4 and 5, in the line of the deep-water navigation channel. The first river arch from the north or Middlesex shore was closed in 1867 by the construction of the Victoria Embankment, in the process of which the first river pier was incorporated in the embankment wall. As other piers in the river appeared to be in danger of undermining, concrete "aprons" surrounded by timber sheeting were formed around their bases, for protection against scour, in 1882. Up to that date, some settlement had occurred and cracks had appeared in most of the piers, but all of the arches were sound. Such settlements, as shown in Table 1, continued to be only gradual and of moderate amount until 1923, when further movement occurred which resulted in serious subsidence, especially of piers

* Opposite page 576.

Nos. 5 and 6, causing distortion of the adjacent arches, as shown by Fig. 2,* to such an extent that two arches virtually acted as one. Upon observation of this subsidence, remedial and precautionary measures were promptly applied by the engineers of the London County Council. The bridge was temporarily closed to traffic, the roadway was lightened over arches 5 and 6 and these arches were propped from the river-bed by timber piles—see Fig. 3. In this view, the sagging of the cornice can be plainly seen. A temporary steel bridge was erected alongside and opened to traffic in September, 1925.

Condition of Bridge prior to Demolition.

Table I.—Total Settlement of Piers since 1820 : inches.

Date.	Pier Number.							
	1	2	3	4	5	6	7	8
1881	4·7	0·6	0·6	1·9	2·1	1·6	0·7	0
1901	4·9	2·7	1·8	3·5	5·5	5·0	2·3	0·6
1924	5·1	4·1	3·7	6·4	28·4	10·1	2·9	0·6
1931	5·4	5·5	5·1	7·0	28·9	13·0	3·2	0·6
1934	5·4	6·4	6·1	7·3	29·1	13·8	3·2	0·6

In the condition described and under careful watching, the bridge remained while the controversy about the manner of dealing with it dragged on.

Demolition.

When the decision was finally taken to renew the bridge instead of reconditioning the old structure, the first steps taken were to lighten it throughout by removal of parapets and roadway and so much as could safely be then removed of the spandrel walls. It was at this stage that to the surprise of the public (though, of course, not of the engineers, who were conversant with old drawings), it was revealed that the bridge was hollow ; and not only so, but it was not entirely of stone. The internal spandrel walls were of brickwork and at such intervals that the spaces between them and over the piers and

* Opposite page 576.

haunches formed between 60 and 70 cavities, each about 3 ft. wide, 70 ft. long and 18 ft. high. The interior of one of these cavities is shown in Fig. 4. They were decked over with York stone corbels and slabs which, in turn, were covered by clay filling under the roadway. The clay filling was found, after being in place well over a

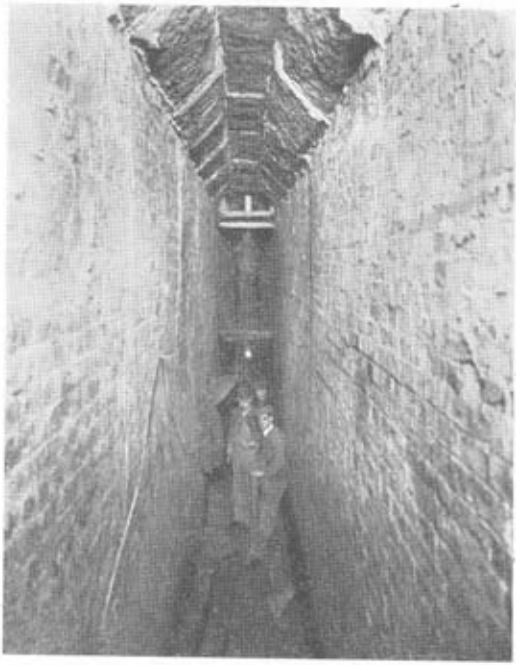


FIG. 4.—One of the Cavities between the "Spandrel" Walls.

century, to be still moist and plastic. In the void spaces between the spandrel walls and under the York slabs long stalactites had formed.

After the removal of the upper parts of the structure to lighten it, the next step had the anomalous appearance of building an additional bridge rather than removing one. A scheme of safe demolition that had been provisionally formulated by the County Council's own engineers was adopted and developed by the consulting engineers specially appointed to direct the works, and was duly carried out by the contractors, with the satisfactory result in the end, though the

Waterloo Bridge - Fig 4

Fig. 3.—Arch No. 5 supported by piling.

Waterloo Bridge - Fig 5

Fig. 6.—Arches partly reduced to 12-foot wide "middle strip."

Waterloo Bridge - Fig 6

process at times seemed tedious, of reaching completion without any collapse prematurely occurring.

The scheme, as shown in outline by Fig. 5,* consisted in the provision of overhead gantry girders in four rows spanning all arches, except No. 5, which was already propped. These girders were of steel lattice construction, supported on temporary concrete stools or bearing pedestals, built on top of the existing piers, and they served to support sheet steel centering under the masonry arches, also to carry the travelling cranes used in the demolition. The centering was suspended by rods passing through holes drilled in the granite (a very laborious item in itself) and the suspension rods eventually put under strain by jacking. By this device, coupled with a systematic programme of "nibbling" or breaking away the stones in a given order—with the effect seen in Fig. 6—they were removed in such a way that loads and stresses were always under observation and control, and the process accomplished without any sudden jerk or undue vibration which, when one arch was broken, might have caused others to fall if not thus safeguarded. (Although unhappily four lives were lost on the demolition contract—three at date of lecture and another a week later—this number is not abnormal for such hazardous works, and any major disaster would inevitably have caused a much larger death-roll.) In the removal of the arches, stones were taken out one by one, working on both sides evenly together until there only remained a central strip of each arch about twelve feet wide. Then, by jacking as stated, the weight of the arches (now very much reduced, but still heavy) was transferred through the suspension rods to the steel gantry girders overhead, which bent under the load to an exactly calculated amount. Then only, the arch strips (no longer carrying even their own weight) could be broken at the keystones without shock and the remaining voussoirs lifted, stone by stone, lowered by crane into barge and taken away.

Details and Incidents.

The weight of the old bridge is computed to have been about 100,000 tons, or 10,000 tons on each pier and abutment. The distribution of load is illustrated by Fig. 7. The sectional area of each pier was about 900 sq. ft., that of the pier and cutwaters 1,300 sq. ft., and that of the footings and foundation raft (exclusive of apron) was 2,700 sq. ft. Consequently the load per square foot coming on the foundation would have been under 4 tons if evenly distributed: but the spread of the footings was made so abruptly that these broke away, reducing the effective loaded area to that of the pier and cutwaters, and increasing the mean unit load to about $7\frac{1}{2}$ tons. The load being thus doubled in intensity, by halving the area of distribution, it is not surprising that even hard clay yielded

* Opposite page 576.

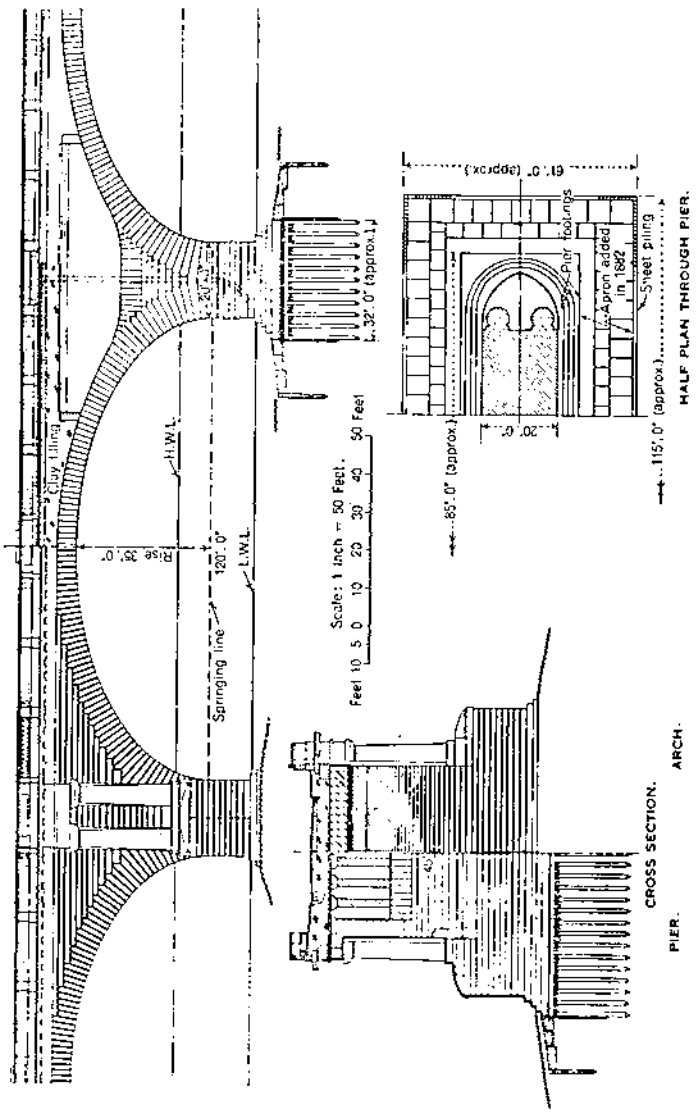


FIG. 7.—Typical Pier and Arch.

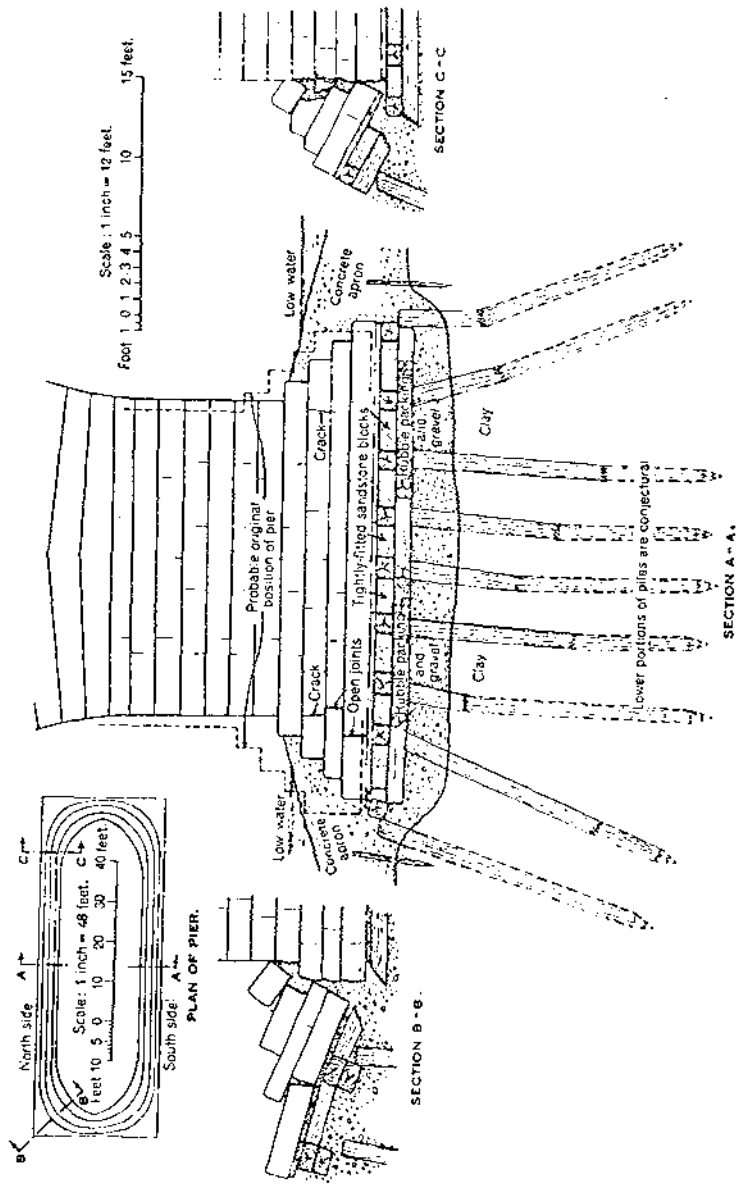


Fig. 8.—Pier No. 5: Conditions found during Demolition.

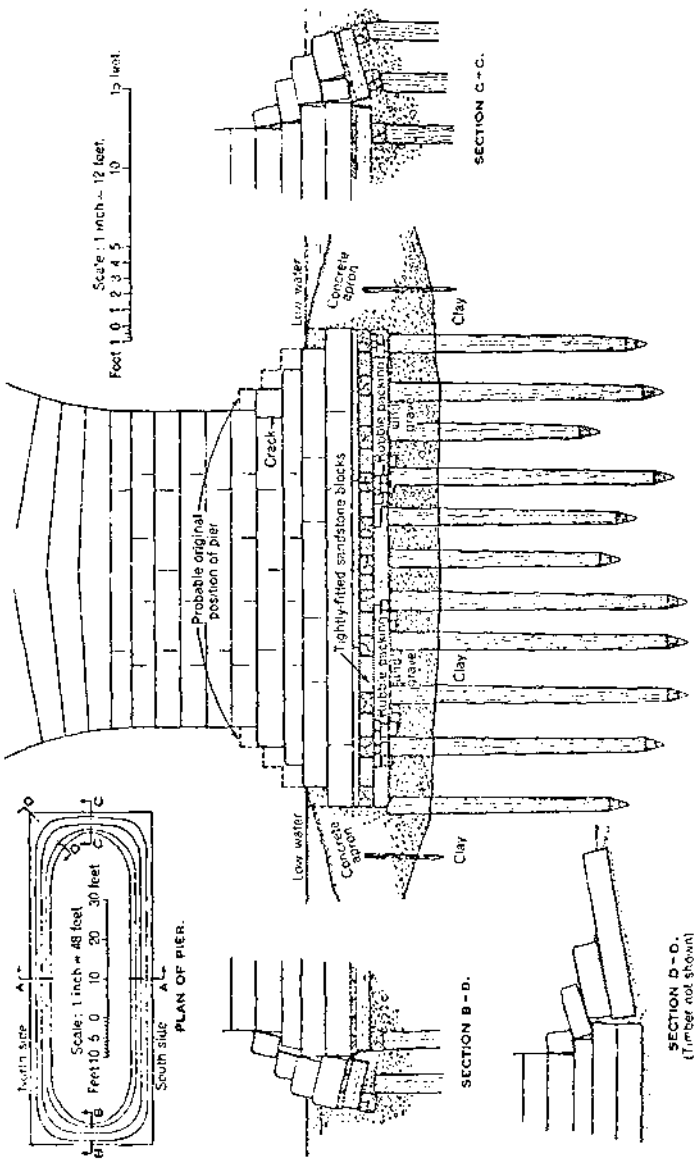


FIG. 9.—Pier No. 6: Conditions found during Demolition.

under the pressure. As a homely illustration of this, if a gardener wanting to tread on soft soil puts a board under his foot but chooses too thin a board, it breaks and his foot sinks in just the same. Rennie himself must have recognized this fault in the design, because he made the projection of footings much more gradual and therefore stronger at London Bridge, which he designed a little later.

The masonry footings stood on a timber raft or grillage, and this on timber piles. A good deal has been said about these piles under the foundation rafts, and settlement of the bridge has been attributed by some people, but probably wrongly, to failure of the piles. The state in which some of these were found is shown by Figs. 8 and 9. Apart from breakage of those under pier 5, apparently occasioned by lateral movement, their condition was extraordinarily good on the whole, but in fact it would not have mattered much if they were not, since the true foundation was the raft. In form the piles were round tree-trunks, and in many cases the natural bark was found still adhering The sheet piles driven round the aprons laid in 1882 were found in even better condition These were truly squared timbers, believed to be of American elm, so closely driven and firmly embedded that their extraction was very troublesome. In order to keep the coffer-dams within moderate dimensions their width had been made such as to leave these apron piles outside, for extraction by diver, but this proved more difficult than was expected, and at one time no less than 18 divers were employed. The piles were in such good preservation that they were sold for re-use of the timber. A certain quantity of this found an interesting use in making doors for the Coronation annexe to Westminster Abbey, which were left in the soft grey colour resulting from long immersion of the wood.

Other old material reserved for re-use is the quantity of granite that has been stored at Harmondsworth, up the river, nicknamed the "New Stonehenge" in consequence. Quite early in the course of demolition the moulded balusters were offered for sale to the public at £1 apiece and bought in hundreds. They were dispatched to all sorts of addresses, ranging from East Linton in Scotland (Rennie's birthplace) to Southern Rhodesia, and even to far-off Australia.

It was remarked that, by a strange anomaly, the demolition had necessitated—as a step in the process—the building of a considerable amount of new temporary work which, in turn, required demolition when its purpose was fulfilled. But means had been taken to facilitate this removal. The concrete pedestals were honeycombed with holes for the insertion of "hydraulic cartridges" to break them up, and the steel gantry girders were so framed as to be self-supporting while being removed by "cantilevering back": the removal at successive stages is seen in Figs. 10 and 11.

A new navigation channel had to be dredged, to enable river

FIG. 10.—View of Bridge from the Victoria Embankment (December, 1935).

Waterloo Bridge - 7

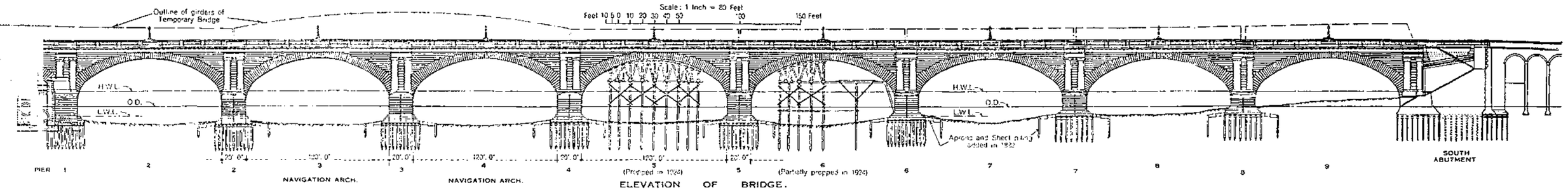
FIG. 11.—One of the Piers (No. 3) now to be removed, after diversion of the navigable channel. View taken at low tide (August, 1936).

traffic to be diverted and pier No. 3 to be taken in hand. An amusing incident was that of the complaint from residents ashore that they were disturbed by the clanking of the dredger at night when engaged in deepening the channel diversion. Night working was consequently stopped. The next complaint came from the crew of the dredger, that they could not sleep at night because of band music ashore in the direction of the original complaint!

So, in aspects grave and gay, with interests technical and human, the work drew to a conclusion. Soon the old bridge would be gone, while the river would continue in its course, ever changing in its particles yet unchanging in its entity. So, too, will the stream of traffic across it continue, as a new bridge comes into being.

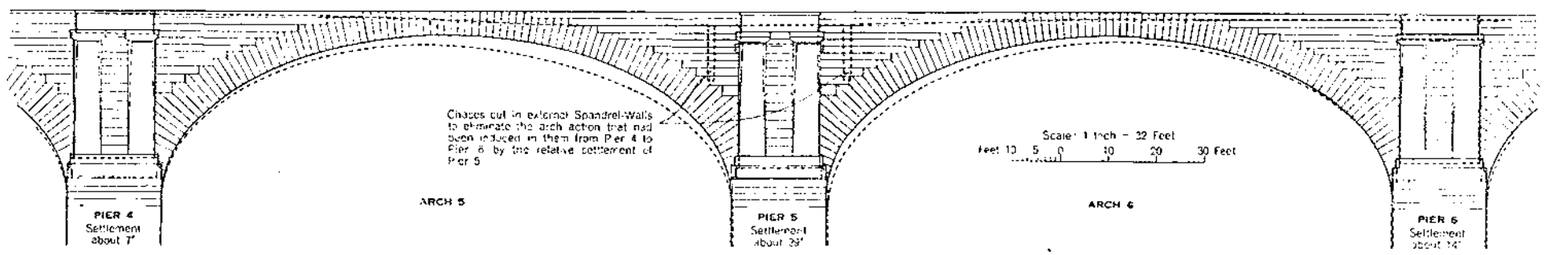
The lecturer concluded with an expression of hope that the new bridge, when it comes, will be accepted as not unworthy to succeed the noble structure that has gone, in the unfortunately necessary demolition of which his own small part has been (as expressed when broadcasting) in team work, and at least as useful as that of the fly in the fable, which buzzed round the horses' ears all up the hill and when they were getting to the top said, "Now we're nearly there; but it's been hard work, hasn't it?"

Fig. 1.



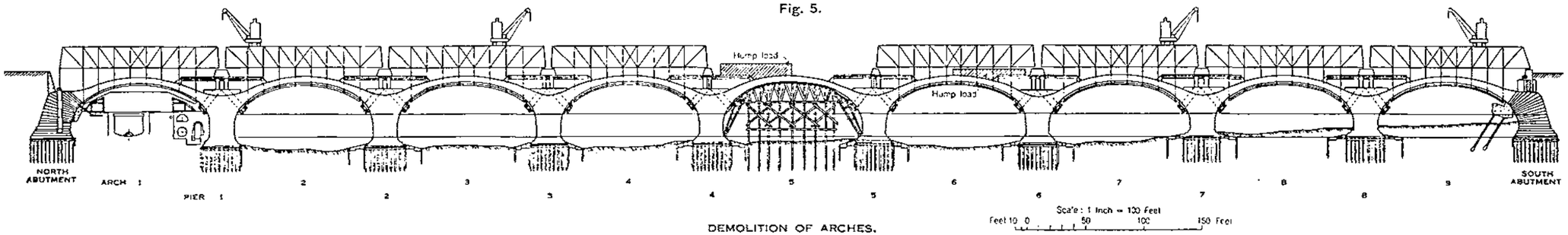
ELEVATION OF BRIDGE.

FIG: 2.



DISTORTION OF ARCHES NOS. 5 AND 6.

Fig. 5.



DEMOLITION OF ARCHES.

THE YOUTH MOVEMENT IN ITALY.

At long last Great Britain has realized the low physical standard of a considerable proportion of its population. The Keep Fit movement is beginning to catch the popular imagination and steps are being taken by the Government and by various voluntary organizations to put the matter right. As these steps are unco-ordinated, however, progress is likely to be slow and unsatisfactory. It is therefore interesting to note that Italy in this respect is some ten years ahead of us and it is worth considering the Italian system and possibly learning some useful lessons from it.

The British mentality reacts violently against anything connected with a dictatorship. It is believed to be a rule of force and repression. In the Italian youth movement there is, however, as much repression as in the average British public school or military college; in fact there are many points of similarity in the two systems.

As in the case of a public school, entry into the Fascist youth organization is voluntary. Having entered, the Fascist boy learns to obey orders, to work for the team and to lead a decent existence. He acquires a pride in the institution to which he belongs and appreciates the advantages and privileges which membership confers.

The advantages are so considerable that almost all Italians, certainly all the poorer ones, join. Membership, however, begins practically at birth. This is important, as the standard of discipline in the Italian home is not high, which is unfortunately true of many British homes.

The universality of the movement is its strongest point. It is only possible in a totalitarian State where a central control can ensure an effective, sound and economical organization, embracing all classes without distinction. A few of the well-to-do still hold aloof, but their numbers are dwindling—possibly from weariness of unpopularity, but generally through conversion to an obviously good cause.

The outward manifestations of the movement are unattractive to the tourist or superficial student. He sees boys of varying ages marching up and down, saluting and shouting in a way foreign at any rate to British ideas. Boys of from eight to ten years of age undoubtedly look ridiculous carrying miniature rifles. There is an atmosphere of jingoism which compares unfavourably with that of the Boy Scout movement. But Mussolini appreciated from the beginning that, in order to reawaken something of the old Roman

spirit in the Italy of to-day, he had to catch the imagination of the masses and fire them with the desire for glory and conquest. In all probability he has done it in the only way possible, an appeal to martial instinct being the only real hope of success.

The Opera Nazionale Balilla, or O.N.B., as the organization is called, was officially established on 3rd April, 1926, and its development in the ten years of its existence has been so rapid and so successful that it bids fair to produce a complete transformation in the physical standard of the nation in one generation. Transformation of character will obviously take longer but is none the less inevitable if the work is carried on.

As stated in a recent semi-official publication, the habit of physical exercise had been lost during a period of decadence and, although from the time of the unification of Italy onwards, sporadic attempts were made to encourage the young to lead a healthy outdoor life, little progress was made until the coming of the Fascist Régime paved the way for a national effort. Since then there has been no looking back.

The O.N.B. deals with children from birth until the age of 18 and is directly under the Ministry of Education, which also controls more or less directly all the scholastic institutions, universities, etc., in the country. Co-ordination of activities in both spheres therefore presents no difficulty.

The President of the O.N.B. and its driving force is Signor Renato Ricci, Under-Secretary of State for Education since 1925, and a member of the Fascist Grand Council. Signor Ricci is a man of forty-one and a most unobtrusive worker. He is considered by many, however, to be one of Italy's best men and his influence over the younger generation is said to be enormous. They worship him.

When a child is born, provided the parents are members of the Fascist Party, he or she comes automatically under the general care of the O.N.B. The parents are entitled to free medical attendance and to assistance in the form of food and clothing according to their needs. They are also entitled to send their offspring for a month or more in each year to one of the 3,000 summer colonies, established at the sea and at different elevations in the mountains, throughout the country. This arrangement is proving very popular as it relieves the parents for a time of the usual cares and worries and allows them to have a holiday. While the child is away the mother, if in a poor state of health, can obtain special medical treatment to get her well before the child returns.

These summer colonies are up-to-date buildings situated in delightful surroundings and provided with all modern conveniences in the way of nurseries, bathrooms, playrooms, playgrounds, gymnasia, etc. Judging from personal inspection and from first-hand information they are most efficiently run and in the past year

nearly a million children have been admitted. Each is in charge of a matron with a staff of qualified nurses, cooks, etc., and there is usually accommodation for some 300 to 600 at a time.

Children go to these colonies each year until they reach the age of eight. Those of about the same age are sent together but they go to different ones each year. To ensure continuity in treatment medical history sheets, showing the rate of each child's growth and development, are carefully maintained.

The curriculum for children up to the age of four years is according to modern practice. For those from four onwards the daily programme would hardly appeal to English children, as little attempt is made to encourage games. Its object is to produce a good Fascist citizen and its training is military in character.

Before breakfast, children parade and the national flag is hoisted with all due ceremony; a Fascist hymn is sung and the "Salute al Duce" carried out in the proper manner. During the morning there is a period of physical training followed by a walk in the country, starting and finishing in proper formation. Supervision by trained instructresses is continuous and their task is to interest the minds of the young not only in matters useful but also to inculcate in them the spirit of the old Roman Empire and its reincarnation—the Fascist Régime.

After dinner, there is a period of compulsory rest; then recreation which, however, is not as yet well organized although improvements are being made.

A tea-supper is followed by elementary drill consisting of marching and saluting and at about 6.30 p.m. the flag is lowered with proper Fascist ceremony and the children go to bed.

This is the kind of programme in force and there seems to be little variation. It is obviously not designed to produce a light-hearted adult and that, of course, is not its object—but to build up a nation of stern, determined men and women with one object in view, the reconstruction of the Roman Empire.

As the child grows up the military character of the training becomes progressively more marked and his impressionable mind is subjected to continuous propaganda, which at this stage can hardly fail to take root.

A boy passes through the following organizations:—

6 to 8 years	Figli della Lupa (Wolf Cubs).
8 „ 12 „	Balilla Escursionisti.
12 „ 14 „	„ Moschettieri (armed with carbines).
14 „ 16 „	Avanguardisti Moschettieri (armed with carbines).
16 „ 18 „	„ Mitraglieri (trained with machine-guns).

Each of these is organized into Legions, Centuries, Cohorts and Sections, the strength of which varies according to the grouping of population. All are within the framework of the schools.

The girls' organizations are similar, there being three categories: Figlie della Lupa, Piccole Italiane (Little Italian girls) and Giovani Italiane (Young Italian women).

In each boys' category, training is carried out throughout the year. It is of an elementary nature in the early stages and widens progressively to include sport and athletics, the handling of weapons, firing on the ranges and so forth. There are periods of physical training at school during the week and Saturday afternoon, the Sabato Fascista, is set aside for drills, excursions into the country, visits to places of historic interest, lectures on the duties of a Fascist and history talks designed to stimulate patriotic emotion. Occasionally, Saturday afternoon and Sunday are combined for week-end excursions and ski-ing or mountaineering trips.

In the summer there are the annual camps where the training resembles that carried out by our Officers' Training Corps, the work, however, being more intensive. It includes not only physical training, drill and tactical exercises, but also periods of military culture, propaganda films, lectures and so forth. There is no doubt that the enthusiasm for these camps is great and that the work is being taken more and more seriously.

The training of the girls is on similar lines and is also military in character, emphasis being laid on the important part they are to play in producing the next generation. In addition to physical training and elementary foot-drill, they are taught domestic economy, knitting, sewing, etc., and how to keep themselves fit and healthy. Courses of instruction are organized to prepare them for employment according to their social status.

In both cases, religion plays a large part in the training and the movement is therefore supported by the terrific strength of the Roman Catholic Church.

It may be asked how boys and girls can be persuaded voluntarily to join the movement. The reason is that the inducements are so enormous that only the very rich can afford not to do so. These inducements include the following:—

(*a*) *The Libretto Personale.* A sort of combined conduct and history sheet issued to a boy on joining the Balilla. It is a careful record of his services, the school diplomas gained and an estimate of his character and ability. Without it his chances of employment in after life are poor.

(*b*) *Sporting Facilities.* Football, riding, swimming, rowing, sailing, ski-ing and mountaineering are taught as part of the training and facilities are provided to enable the poorest to

take part. Competitions are frequent. They are usually run under the auspices of the O.N.B., and are keenly contested. The successes in international contests gained by Italy during the last year are undoubtedly attributable to the O.N.B. training and organization.

(*c*) *Amusement Facilities.* Members of the O.N.B. are entitled to cheap tickets to almost all places of entertainment, theatres, the cinema and to museums and national monuments.

(*d*) *Excursions.* At different times in the year excursions to places of historic interest in Italy are arranged at very low cost.

(*e*) *Careers.* Boys who do well in their pre-military training and in their scholastic work are eligible for regular and reserve commissions in the armed forces. Other careers are similarly open to them. The poorest boy is thus provided with a ladder, to the top of which he can climb if he has the necessary ability.

As the scheme develops, the whole social life of the younger generation is beginning to centre more and more on the O.N.B., and it is becoming increasingly difficult for those without private means to remain outside it—and the well-to-do are being taxed up to the hilt to pay the cost.

During his eighteenth year the boy leaves the O.N.B. and passes into the Fasci Giovanili di Combattimento, in which he remains until called up for military service.

The Giovanili organization is under the control of the Fascist Party and forms part of the National Fascist Militia. Its training corresponds to that of the British Territorial Army but is more intensive —the question of expense apparently not being of importance—and there is far more propaganda and more appeal to the youthful imagination. It should also be noted that all males, after reaching the age of 18 and regardless of whether they belong to the Fasci Giovanili or not, are required by a law, passed in 1931, to undergo courses of pre-military training designed to prepare them for the Army, Navy or Air Force. These courses are arranged by the Fasci Giovanili organization assisted by the regular forces.

In the latter part of August, as many as 30,000 selected Giovanili from all over Italy were concentrated in a camp near Rome. They gave displays of physical training before Signor Mussolini, and carried out a tactical exercise in the presence not only of the Duce but also of the Chiefs of Staff of the Armed Forces, the leading Fascist Militia generals and the foreign Military Attachés. The camp was brought to a conclusion with a Grand Review and March Past along the Via dell'Impero in Rome.

From a purely military point of view the whole system is most beneficial, as Italian military service is conscript and therefore of short duration. On joining the colours, even the rawest peasant youths now know the elements of drill and musketry, where in the past it often took weeks before even a beginning could be made.

The general character of the training is, of course, open to the gravest criticism. It cannot but inculcate an aggressive spirit foreign to this kindly country. The propaganda is designed to overcome a sense of inferiority, but it is evidently being overdone. None of these lads see other countries, so that comparison is impossible and their conceit swells in an unrestricted atmosphere of mutual admiration. On the other hand the Italians are fundamentally a peace-loving nation and in the course of time it may be possible for one as strong as Signor Mussolini to direct their enthusiasm into peaceful channels.

The object of this article was, however, to show how the training is building up the physical and moral standard of the nation. In this respect it cannot but be successful.

NOTE.—Since the above was written the O.N.B. has been transferred from the control of the Ministry of Education to that of the Fascist Party and merged with the Fasci Giovanili into one youth organization under the title of "Gioventù Italiana del Littorio" (Italian Fascist Youth). The significance of the change is not yet apparent but it is unlikely to be followed by any marked alteration of policy or training.

THE YOUTH MOVEMENT IN ITALY.

Marching order.

Encouraging the young idea.

Balilla Moschettieri being trained in choral singing.

The youth movement in Italy

height of a building should be half its width, and a third of its length is a fairly good one, though not supported by any particularly scientific theory.

Secondly, and most important, the vital factor in the design of auditoria is the period of reverberation obtained. Sound in a building is reflected and inter-reflected between the walls, ceilings, etc., until it gradually dies away, being absorbed into the surfaces which it strikes. The period taken for the sound to die away totally is called the period of reverberation, and the whole art of acoustical design is to get this period exactly right for a given building. If the period is too short, an uncommon fault, the sound may seem " dead ; " but if too long, one word goes rattling round the building (for 8·5 seconds in the case of the cantonment church in question), making it impossible to hear the next one. The optimum period of reverberation for each size of building and each type of sound, music, speech, etc., has now been determined by co-operation between musical and scientific experts, and tables can be found in the latest editions of Kempe's and other engineering pocket-books. In general, the optimum period of reverberation is smaller for small buildings and for speech, and larger for large buildings and the deeper types of music, varying from 0·8 seconds for a 23,000 cu. ft. lecture-room to 3·5 for a 1,000,000 cu. ft. hall, where choral music is performed.

Having chosen the optimum period of reverberation, the method of obtaining it must be considered. The secret here lies in the fact that all building materials, woodwork, concrete, etc., have fixed coefficients of absorption for sound, and tables for these coefficients have been prepared by research workers and are now available in engineering pocket-books. In general, hard, shiny materials reflect sound more and absorb it less, and soft porous surfaces are the best absorbents. The coefficient for concrete is as low as 0·015, while a soft carpet absorbs 0·2 of the sound which strikes it. The standard of comparison is an open window, which is held to have an absorption of 1, reflecting no sound at all.

The total absorption caused by a surface is given by multiplying the area in square feet by the absorption coefficient, and the period of reverberation is given by applying Sabine's formula.

$$\text{Period of reverberations in seconds} = \frac{\text{Vol. of building (in cu. ft.)}}{20 \times (\text{Total absorption present})}.$$

As illustrations of this question of absorption, readers must be familiar with the distinctive rattle of a racquet court with its hard, shiny, non-absorbent plaster sides, and with the improvement in hearing in a concert hall when the room fills up with sound-absorbing spectators, whose clothing gives up to 4·7 units of absorption per person.

ACOUSTICS.

By CAPTAIN C. F. W. MILLER, R.E.

IT has long been known that certain buildings have been satisfactory for auditoria while others, often built at great expense, have proved failures. Something of the theory of sound has been known for a great many years, but with the coming of wireless and the talkies and the increase of the roar of the cities, certain people in England and America have devoted themselves entirely to sound engineering with the result that very considerable progress has been made during the last decade, so that it is now possible to forecast the acoustic behaviour of a building with considerable accuracy. While Sir Christopher Wren had only practical experience to guide him in the acoustics of his churches, the modern talkie magnate investing his millions in a super picture-house, is quite free from hit-or-miss methods, but, with the expert aid of a sound engineer, is able to design the building exactly, even making allowance for the sound-absorbing soft clothing of an East End audience, as compared with the reflecting boiled shirts of West-Enders. The writer claims no expert knowledge, but was forced to study the subject in connection with a certain church built in an Indian Cantonment, where it was found that the congregation, which consisted almost entirely of troops—could not hear a word of the service. The local authorities had tried the usual old-fashioned expedient of stretching wires across the building, with no result; and indeed it can be authoritatively stated that stretched wires are quite useless in correcting faulty acoustics.

It must be stated that the proper way to design a building is to consider the acoustics first, along with the foundations, walls and other architectural features; but from the study of a defective building, built before the science of acoustics was so advanced, a good deal can be learnt.

What, then, are the factors controlling the acoustic behaviour of a building? Firstly, unless under very expert hands, domical ceilings, curved ends, and fancy shapes of all kinds should be avoided; as, though sometimes doing no harm, they may cause uneven distribution of sound, resulting in dead spots, sound foci and, worst of all, echoes, the latter being the effect caused by the late arrival of a reflected sound, when the difference in length of path of the direct and reflected sound is more than 1/15 second. The old-fashioned rule that the

height of a building should be half its width, and a third of its length is a fairly good one, though not supported by any particularly scientific theory.

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For a new building, then, the designer must pick his period, and then apply the formula, thus finding the number of absorbing units which are required in the whole building, including those provided by the audience.

The total absorption required having been found, an acoustic analysis of all the inner surfaces of the building can be made, and the total absorption which will be present using ordinary building materials, wooden doors, plaster walls, hard wood floor, etc., worked out. If this comes out right, well and good. If, however, as is often the case in large buildings, the absorption obtained by ordinary building materials is insufficient, special absorbents must be added. Apart from the common expedients of carpets, curtain hangings, etc., many special absorbent substances, mostly asbestos products, are on the market, having very high absorption coefficients. Some of these are in the form of boards and tiles and some are plasters; asbestos spray plaster which can be sprayed to a thickness of up to 2¼ in., while not being so attractive in appearance as some of the other materials, has the advantage that it can be applied readily to a faulty but completed building, and also that, by controlling the thickness, an exact degree of absorption (up to 95 per cent.) can be obtained.

Thus, by asbestos spraying a ceiling or part of it, or an end wall, the deficient absorption units can be readily made up, and the correct acoustic behaviour of the building assured.

To illustrate the above, a very much simplified example of an acoustic analysis is given below.

Data.

Building. Lecture Hall, 100,000 cu. ft.	..	534 wooden seats.
Optimum period (from Kempe) ..	..	1·23 seconds.

Coefficients of absorption plaster on brick	..	0·025
Plaster on wood	..	0·033
Concrete floor	..	0·015
Wood ..	..	0·05
Glass windows	..	0·027
Curtains ..	..	0·75
Carpets ..	..	0·2
Wooden seats	..	0·15
Audience ..	..	4·7 per person.

By Sabine's formula $1{\cdot}23 \text{ seconds} = \frac{100{,}000}{20A}$,

A, the absorption to produce the correct period, should be 4,065 units.

Acoustic Analysis.

	Area sq. ft.	Coefficient.	Absorption.
Walls (brick)	4,200	0·025	105
Floor (concrete)	4,400	0·015	66
Ceiling (plaster)	4,400	0·033	145
Doors (wood)	1,200	0·05	60
Windows	200	0·027	5
Audience 2/3 of 534 ..	356	4·7	1,672
Unoccupied seats 1/3 of 534	178	0·15	27

Total absorption of these materials = 2,078

and therefore 1,987 more units are required.

These can be obtained by carpeting the floor and using corkboard ceiling instead of lath and plaster.

Added absorption for carpet .. = 4,400 × (0·2–015) = 814
Added absorption for ceiling .. = 4,400 × (0·3–033) = 1,175

1,989

The example given serves to illustrate the principles and to demonstrate the pitfalls of constructing without first calculating out the acoustics. If the building had been built as first designed, the period would have been $\frac{100,000}{20\ (2,083)} = 2{\cdot}4$ seconds and the lecturer would not have been able to make himself clearly heard.

There is, however, more in the subject than this simplified example discloses. For instance, some absorbents absorb more of the higher notes than the lower ones, and there are several other factors which may enter into each case. These are left to those who wish to go more deeply into the subject, and can be studied from modern textbooks.

The art of providing the exactly correct period of reverberation for a given sound is brought to its highest pitch in broadcasting and gramophone recording studios, where, by drawing curtains, moving partitions, etc., the period is kept under micrometric control, and allowance can be made for a change from soprano singing to cello playing, or to speech, during a single performance.

It must be remembered that surfaces are not usually simple and flat as in the example. Breaks in line, cornices, etc., all provide extra absorption, and it was the fact that old churches are usually found to be full of fonts, hangings, carvings, ornamentation and knick-knacks of every kind that saved our forefathers from making churches acoustically bad. It is true, however, that the intoning of clergymen and the deep singing favoured in the liturgies are developments arising from the fact that these types of music best favoured buildings whose period was, by modern standards, rather high. The coffering

of ceilings, commonly seen in the saloons of ocean liners, is not merely for appearance, it is an old-fashioned way of obtaining sound absorption; though the old designers, no doubt, only knew from experience the results obtained, without knowing the theory behind them.

Before concluding, more mention may be made of the experience in the cantonment church. This church is built in the severe modern style, and is singularly free from ornamentation inside, its cubic capacity being 320,000 cu. ft., seating 300. Twenty readings were taken by two observers with stop-watches and their readings, which differed very little, showed that the period of this church empty is no less than 8·5 seconds, and a single loud noise could distinctly be heard ringing round the church for that length of time. The optimum period for a church of this size being 2·05 seconds, it was not altogether surprising that the congregation heard very little of the service.

By Sabine's formula, the total absorption present is given by $8{\cdot}5 = \frac{320{,}000}{20A}$ and is 1,882 units which, of course, is due to the fact that the walls and ceilings are hard plaster, the floors stone and wood, uncarpeted, and the seats, wooden chairs unupholstered. For correct absorption, apply the formula $2{\cdot}05 = \frac{320{,}000A}{20A} = 7{,}805$; therefore 7,805 units are required.

Thus 5,923 more units are required, a very large amount. The audience would supply (4·7 per man minus 0·2 per seat) × 200 = 900 units, allowing for the fact that the man sits on the seat and so its absorption can be neglected. To get the balance of 5,023 units the following expedients were recommended:—

Asbestos spraying of certain parts of the ceiling, using spray ¾ in. thick, which has coefficient 0·6. This will give—

$$(0{\cdot}6 - 0{\cdot}025) \times 7{,}850 = 4{,}515 \text{ units.}$$

Provision of unlined carpet on 3,000 sq. ft. of wooden floor, giving

$$3{,}000 \times (0{\cdot}15 - 0{\cdot}05) = 300 \text{ units.}$$

Provision of 580 sq. ft. of silk hangings at west end of church, giving

$$580 \times (0{\cdot}4 - 0{\cdot}025) = 218 \text{ units.}$$

Total, 5,033 units, considered near enough.

It cannot be claimed that this has proved successful, as the work has not yet been carried out, awaiting, as all work must, the allotment of funds. But fortunately, in a neighbouring civil station, another church was found, which had been successfully treated in a similar way a few years ago, and gave an interesting comparison. Here the acoustics are now excellent, the period being 2½ seconds, reduced from 7½ seconds before treatment, and there is no reason to doubt that the measures advocated would be equally successful in the Cantonment Church.

STRIP ROADS IN SOUTHERN RHODESIA.

By CAPTAIN E. BADER, R.E.

THE writer paid a short visit to Southern Rhodesia in June, 1936, and was struck by the novel method of road construction employed to meet the demand for good roads suitable for high-speed motor traffic, at minimum cost. As the system may possibly have some interest from a military point of view, a short description is appended.

LOCAL CONDITIONS.

Southern Rhodesia, see map,* has an area of 150,000 square miles, *i.e.* three times the size of England and Wales, and is inhabited by 55,000 Europeans and about a million natives. The white population, engaged chiefly in mining and farming, is concentrated in a few widely scattered towns and in certain favoured farming districts, which in the past have perforce been near the railways. These latter provide outlets eastwards through Portuguese territory to Beira and southwards *via* the Union of South Africa to the Cape. Of recent years motor transport has had the effect, here as elsewhere throughout the world, of making the development of more remote areas possible and consequently a demand has arisen for all-weather roads, suitable for high-speed traffic.

The distances, however, are enormous and the financial resources of the country somewhat limited. Traffic density is light, say from 100 to 800 vehicles per day on main roads. Hard granite or diorite are available in most parts of the country and about 2,500 miles of roads are lightly gravelled with these materials. The traffic, however, is sufficient to loosen the gravel in the dry weather and form corrugations in a short time, necessitating constant maintenance; this provides but temporary relief, and the roads are "washed away for five months and blown away (see Photo 1) into the veld for the remaining seven months of the year." The problem was to convert these roads into all-weather dustless surfaces at minimum cost.

ALTERNATIVE SOLUTIONS.

Various methods of improving these roads as cheaply as possible were considered:

1. Full width tarred or concreted roads were ruled out on account of prohibitive expense.

* On page 592.

2. A narrow strip of tarred road, 9 ft. wide, was considered. American experience with this system was promising, within limits. It was not adopted, however, on account of the efficiency and cheapness of 4, below.

3. Mix-in-place roads. Experiments were carried out but yielded indifferent results owing to the practical difficulty of adjusting the quantity of binder to the varying proportions of "fines" in adjacent sections of road, and other troubles. In general, it was decided that this system would be unsuitable in the hands of semi-skilled personnel where adequate supervision is impossible.

4. "Strip" roads. The principle of this construction is based on the observed fact that where traffic density is light, all vehicles tend to follow the same tracks. It was noted that on good sections of earth and gravel roads two well-defined tracks each about 2 ft. wide were formed, the rest of the road width being practically unused. If, therefore, a gravel road were provided with two durable all-weather strips 2 ft. wide, the effect as far as the traffic was concerned would be that of a first-class road surface while the cost would be comparatively low.

Preliminary Trials.

The Roads Department had but little precedent for strip construction. It was known that strips had been built previously in Australia, New Zealand and in Europe (incidentally Col. R. E. M. Russell in an article in *The R.E. Journal* of March, 1930, gave a sketch of concrete strips laid across the desert in Chile with success), but as far as could be ascertained these had been generally unsatisfactory. Trials were decided on, therefore, the following points being given special attention:

1. With concrete strips, whether the bearing value of the subsoil would vary and unequal settlement take place, resulting in cracking and an uneven road surface.

2. Whether changes in levels, etc., would cause impact reactions resulting in cracking of concrete.

3. Whether traffic turning on and off strips to pass or overtake other vehicles would cause the gravel at the edges of the strips to ravel.

4. Whether too narrow strips would be tiring to drive over for long periods.

5. Whether materials cheaper than concrete would be equally successful for strip construction.

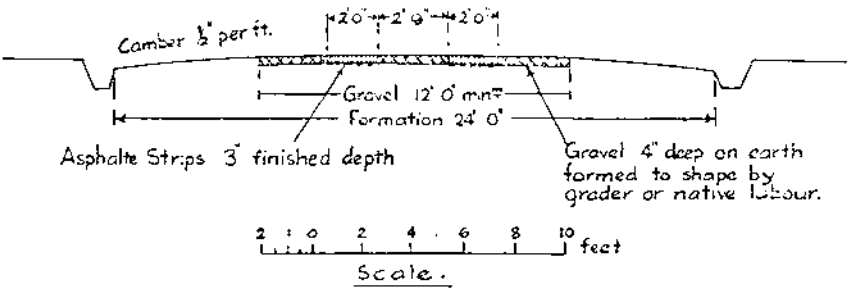
The writer has traversed the concrete strips laid experimentally some five years ago on main roads near Salisbury, Southern Rhodesia, carrying a fairly heavy volume of traffic up to 600 vehicles per day. He can confirm the opinion of the Roads Department that settlement, if any, of the sub-grade and changes in level or slope have had

no ill-effects on the 6-in. mass (un-reinforced) concrete, nor has appreciable disturbance of the adjacent gravel occurred. The amount of traffic leaving the strips to overtake or pass other vehicles is, in fact, insufficient to corrugate or dislodge the gravel. This confirms experiments made in America which established that with an hourly traffic of ten vehicles, corresponding to about 100 vehicles per day, all cars are using the strips for over 99 per cent. of the distance travelled, assuming 30 m.p.h. average speed.

BITUMEN STRIPS.

Concrete strips were successful technically, but cost about £1,000 per mile and the next step was to develop a cheaper type. After consideration of various types of asphalt construction, including hot mixes on the lines of an open graded asphaltic concrete, pre-mixed oil-sand mixtures and gravel-cutback mixtures similar to those used for mix-in-place work, it was finally decided to build the strips as a full grout. The specification was as follows :

FIG. 1.



The existing gravel road is shaped to true camber and made good with all corrugations levelled off. Two trenches are cut on each side of the centre line, 2 ft. wide, 3 in. deep (6" for concrete) and 2' 9" between internal edges, see Fig. 1. Great care is taken to ensure straight vertical edges of undisturbed gravel. The trenches are filled to ½" above road-level with clean broken 2" to 2½" stone which is lightly rolled and sprayed with " Shell " Spramex or similar bitumen of 100 penetration at the rate of ¾ gallon per square yard. A layer of ¾" to 1" keystone is applied immediately, well brushed in to fill interstices and thoroughly rolled. As soon as a strip of convenient length, say 100 to 300 yards, is completed, it receives a bitumen seal coat of ½-gallon per square yard, followed immediately by a layer of ¼" chippings well brushed in and rolled. The road is thrown open to traffic as soon as a suitable length, sufficient to warrant an

extension of the necessary deviation through the bush, has been completed. See Photos 2, 3 and 4.

On curves the strips are 2′ 6″ wide, the extra 6″ being added on the inside edges of the curve on each strip. It was noted, however, that in spite of this provision, vehicles tended to leave the strips on curves owing to the lack of sufficient banking.

The cost of these strips is about £350 per mile including occasional culverts, with bitumen at 10d. per gallon at site, stone at 7s. per cubic yard and native labour at 1s. per day. A gang of 25 natives completes about 2 to 5 miles per month.

Plant and Organization.

A suitable plant for a gang of 3 Europeans and 25 natives was found to be: one 14″ × 7″ portable stone crusher with screen and 16 h.p. crude oil engine, one tractor with four 3–4 ton trailers (12 m.p.h.), one 6-ton crude oil roller, one 600-gallon bitumen boiler (sufficient for one day's consumption of binder), one 40-gallon boiler with spray pump. The men are provided with tents and rations plus a wage of 12s. 6d. to 25s. per month.

Maintenance Costs and Savings.

Experience to date is limited, as asphalt strips have been in use for not more than about four years. The indications are, however, that whereas a gravel road with average traffic costs £35 per mile per annum, a similar asphalt strip road will cost about £17 per mile. This figure allows for gangs at the rate of 1 boy per 3 miles to scrape earth and gravel up to the edges of the strips and clear drains, also for a seal coat with chippings every four years. This considerable saving accompanies the provision of a smooth, dustless, all-weather surface and a large reduction—estimated in America at £30 per year—in maintenance costs of vehicles.

Programme.

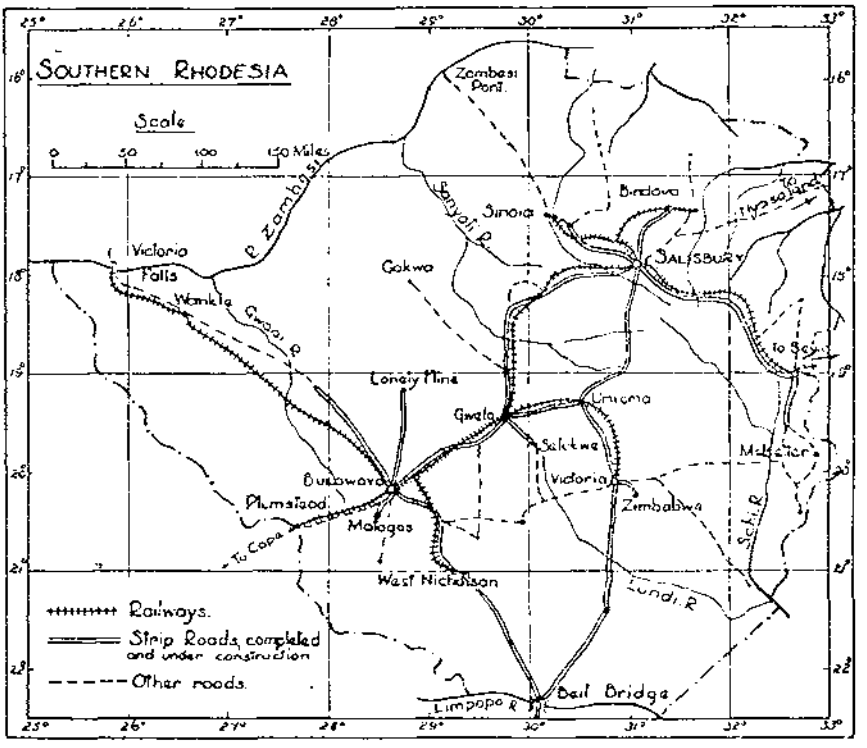
The strip system has definitely passed the experimental stage. That the engineers responsible have faith in it is shown by the extent of the current 3-year programme, see map. Construction of strip roads is proceeding over a route mileage of 1,200, for which purpose 14 gangs have been organized and equipped with £30,000 worth of plant. The rate of progress expected is 30 miles per annum for each gang, and about 250 miles have already been completed.

Traffic on Strip Roads.

Regulations have been passed whereby steel-tyred vehicles are prohibited on strips. It was noted, however, that where ox-wagons crossed the strips, no apparent damage was done. Vehicles passing

or overtaking must each take to one strip only; motor-cycles have prior right of way over all other vehicles while pedal-cycles must give way to all other vehicles.

These regulations are working well in practice; the travelling public are very pleased with their excellent roads and are co-operating heartily to make the scheme a success. Touring speeds are high;



the official speed limit is 50 m.p.h. but the writer can confirm from experience that speeds of 55–60 m.p.h. can be maintained safely and without fatigue for hours on end.

CONCLUSION.

The method of road construction outlined above may perhaps offer an economical solution to military road problems in suitable localities. The exclusion of steel-tyred traffic, however, would normally be impossible on a military road and trials would be necessary to determine the limitations of the system under these conditions.

Acknowledgments are due to Stuart Chandler, Esq., Chief Engineer, Roads and Bridges Department, of the Southern Rhodesia Government, for his valuable assistance and permission to make extracts from his paper on the subject.

Photo 1.—Car traversing dirt road at speed. Note the corrugations in the surface of the road.

Photo 2.—Spraying and rolling strips.

Strip roads in Rhodesia - Photos 1&2

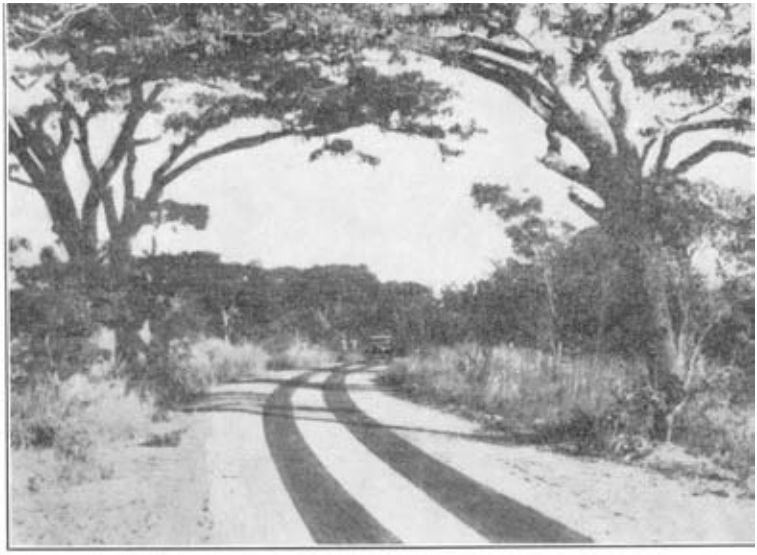


Photo 3.—Asphalt strips, Salisbury-Marandellas Road.

Photo 4.—Concrete strips near Salisbury, S. Rhodesia.

Strip roads in Rhodesia - Photos 3 & 4

A DYNAMITE YARN.

By "LENS."

WHEN the Sapper joined the Egyptian Army about the beginning of this century he was told, for the benefit of his characteristic modesty, many legends. One of these recorded how in the 80's the Suakin garrison was plagued by the Fuzzy Wuzzies, who used to creep at night through numberless sentries and obstacles, right into crowded tents to "scupper" a luckless British soldier. Also how the Royal Engineers, to stop them, laid down buried land-mines charged with dynamite, with contact wires and electric exploders and other fearsome things which were an endless danger to the soldier, but which Fuzzy Wuzzy used to carry off in triumph in the dark, by light of nature. Also how a considerate G.O.C. (K ? ?) could bear it no longer and ordered the R.E.'s to take them all away, which was done, and how a fine young R.E. subaltern lost his life in doing it. The last item was unfortunately true and was probably the reason why the Suakin dynamite was treated with such awed respect. For the land-mines were not destroyed but were put into store in an underground "magazine" in the coral rock of the flat island in Suakin Harbour, which is just across the creek. The hole leading into this excavation was covered over and surrounded by a paling with an alarming notice; and for years everyone walked round another way.

The Sapper's brother officers on the railways enlivened this legend. They said that, later on, considering that dynamite might be disorganized by the Suakin climate, someone had written to the great firm of explosive makers who were believed to have supplied the infernal machines and asked advice. The firm had replied that they could not say what their condition might be; tropical heat might have caused the nitro-glycerine to exude from the dynamite and anyway the stuff was not to be considered safe to touch.

And so the years went on and the dynamite was almost forgotten but for the palings and their alarming notice-board and the ever-growing legend of how many tons of unapproachable dynamite lay below it!

Then there came a time when the Suakin-Berber railway scheme developed towards certainty. The Sudan must have its Red Sea port. Suakin was chosen for the terminus of this railway to the Nile, and developments were obviously needed, for Suakin had become a neglected little garrison town with many men of mixed African races, two or three British officers and some Greek shopkeepers, and little money had been available for such a place.

When information was called for about the state of roads and buildings and other works services, the Assistant Director of Works in the Sudan chanced to be on leave, so our Sapper was ordered to go down from Cairo and report. He always welcomed a cruise and read his orders with great pleasure. They ended with a paragraph to the effect that there was said to be some dynamite stored near the harbour, which would have to be removed and destroyed, and if that could not safely be done it would have to be made safe otherwise. This paragraph did not seem quite so simple as the rest, but it was certainly elastic and so caused no anxiety.

The Sapper's passage to Suakin was not uneventful, though that is really another story. The little Khedivial liner was a stout hearted packet and so were her officers.

But south of the Gulf of Suez the weather was foul and thick and visibility was almost nil. The coral reefs of the western shore of the Red Sea are not to be trifled with; moreover the ship had had no sights for two days.

The officers talked freely to their only passenger as they nosed the ship into the mist, sometimes only to see breakers ahead and to sheer off again. The Sapper found himself joining all hands in the look out for the Sanganeb Beacon, which was on the northern end of the sunken reefs which lie parallel to the Suakin coast-line. At last there was a sudden shout from the bridge and through the mist among the waves appeared a stout mast with ball atop. The ship rounded the beacon and turned south down the channel between the reefs and the shore.

The officers resumed their carefree joviality and spoke clearly and abusively of Suakin, and its outer reefs and the twisting narrow channel which leads into its inner harbour. They could not understand how the Government could neglect Mersa Sheikh Barhud, a sizeable natural harbour north of the Sanganeb with comparatively free approach from the sea. They had heard that this alternative to Suakin had been turned down by the Hydrographer to the Admiralty, and they fairly snorted defiance. The Sapper, thinking of his ancestral admirals and his respect for the Senior Service, was pained and he protested, only to be overwhelmed.

The packet found her way into Suakin and the Sapper reported himself and his business to the Muhafiz, the local civil and political authority, a bright and hospitable young Egyptian Army Officer. He was glad that money was to be spent in his district and delighted to think that his hill station, Erkowit, would be made more accessible, also that his Residency (the Muhafiza) would have some well-deserved repairs. But at the mention of dynamite he clouded over. No doubt it was there, but no one knew anything about it—nor had anyone seen it. Its amount was of course exaggerated, but he hoped

it would not explode, as it was only just across the creek opposite his Muhafiza, which was not too strong.

In the conference next morning the Sailor took a hand. He was responsible for all maritime matters at Suakin and was a stalwart and downright Lieutenant R.N.

When the Sapper made mention of Mersa Sheikh Barhud, he said that if people thought they knew better than the Hydrographer to the Admiralty about exposure to S.E. gales, they had better write in and say so.

Again, overwhelmed by the seafaring man, the Sapper decided to stick steadily to his own business.

The Political, who was also in command of the garrison, was not disposed to provide troops for the questionable job of messing about with dynamite. Neither could local inhabitants be expected to volunteer for it, they had swallowed too many inflated legends about it all. Luckily, he bethought him that a party of Egyptian convicts had just been marched across from Khartoum to Suakin in anticipation of the development works. Surely men of energy and initiative would be found among them. He would order the jailer to call for volunteers.

So the Sapper started out to reconnoitre and the Political wished him *au revoir* somewhat impressively. The covering was taken off the " magazine " and a round hole in the ground was disclosed about the usual diameter of a village well. By peering into this, there could be dimly seen, not far down, a chamber hewn out of the solid coral rock. It was floored with grey coral sand, on which were lying several cases of about the size of a small-arms ammunition box and a few larger cases about the size of a cottage piano. It all looked cool and dry and comfortable. Small stones and then larger stones were thrown down and produced no awful effect.

Next morning a couple of armed warders brought along a party of six convicts, all hefty fellahin of Egypt. One was indeed conspicuous, for his cotton gallabiah was dyed bright red. The Sapper, who had worked some months at Khartoum, looked carefully at him. Could this be the red convict who worked at the mortar mill just outside the gate of the R.E. bungalow at Khartoum ? The man who was such a lurid criminal that he had to be dressed like this ? His history was not known to the British folk up there, but imagination had credited him with unspeakable horrors. The Terror (we must call him something) met the enquiring look with a broad smile. It was indeed the man and he liked being recognized, but prison discipline does not permit polite greetings.

The Sapper enquired about his unusual working party. He was told that they were volunteers for a special job. No information given, no questions asked. He told them that they would have to do exactly what was ordered, without a word. They understood, and

uttered pious ejaculations. He would have liked to have had their fetters taken off, but they were riveted on and presumably their wearers were quite used to them.

The party was ferried across the creek taking with them a ladder, tools, sacking and some rope. The end of the ladder was padded and solemnly lowered into the vault. The Sapper went down barefoot. He had memories of dynamite-headaches due to handling the stuff in hot weather in India, so why not use feet for testing? The test, however, proved negative.

The Terror insisted on going down next and helped to explore, while the warders maintained order above. The smaller boxes were obviously the mechanical mines containing dynamite and presumably in the large battened packing-cases there were a lot more of them.

Touching a batten of one of these larger cases the Sapper was disconcerted to find that it came off. The wood was rotten and the nails had rusted away. It looked as if the whole case was only held together by the obstinacy of inanimate things and might crumble at any moment. The smaller boxes were of teak wood, which was apparently sound, and their nails were copper. But what about their interiors? There must have been safety pins which, until withdrawn, kept the mechanism at safe. And how about those safety pins now? There were no signs of them.

Clearly a thought-out plan was advisable, so work was knocked off for the day.

The Political was glad to hear the report and began to hope for the best. If legend had so magnified the quantity, perhaps the malignant nature of the things themselves might also prove to be exaggerated.

The Sapper's plan was made. The cases would be lifted out by imperceptible movement and they would be taken out to sea and sunk in safe waters. The help of the Sailor could be taken for granted.

One large case was selected for the first experiment. Thin, narrow planks were pushed cunningly through the sand below it until the case, undisturbed, was resting on a sound bottom. Then a new case, exact to size, but with no bottom, was placed over it and screwed down to those new bottom planks. All was now enclosed in sound wood and nothing had been disturbed. Then the convicts shifted the case very delicately below the roof opening, which had been enlarged. A tripod gin had been rigged above the hole and all was ready to lift her out.

The Sapper explained exactly what was to be done and warned his gang to be careful. The Terror broke silence: "Sa'at-el-Bey," said he, using the unknown officer's correct rank and style, "you must go up and stand far off. We understand the job that is to be done and WE will do it." He looked round and the others grunted concurrence. "Bismillah" said one, "it is so." Perhaps there was a

catch in the Sapper's voice when he replied, " Is it your job to give orders or to obey orders ? " Anyway the miscreants grinned and the work went on. Up she went perfectly smoothly and was soon landed on the ground.

The next morning our Sailor had his launch ready in the creek and some scrap iron, chain and wire were brought along to provide sinkers. On the island, the ladder was laid above the case and lashed to it and then for the first time the convicts began to play up. They squabbled among themselves as to their places as bearers along the ladder. The Terror, who seemed to have invested himself with honorary rank as N.C.O., was beginning to rate them soundly, when the warders settled the matter by sternly resuming their responsibilities and the convicts, their brief spell of irregularity ended, moved off with their curious burden towards the creek. From the days of the Pharaohs the fellahin have been experts at shifting heavy weights. The case was placed carefully on the forward deck of the launch, where there was none too much room for it, and the work of attaching sinkers began. A question seemed to arise whether it would be possible to get the case overboard at all if too much iron was attached to it. To give more man-power the Terror was embarked and squatted near the case. When the boat got out through the channel into open waters it was found that there was quite a sea running. The launch tossed her head to it merrily but everyone longed to get rid of that case. Respect for it had been lessened by familiarity, but it was still very unpopular. When deep water was reached it was only with much difficulty that it was got overboard. The Sailor met with an injury to his thumb which was apparently most provoking. The Terror's powers had been overrated, he proved to be a real bad sailor and was only in the way.

But when that case with a long rope attached to it (for gradual lowering) did slide into the water, to the horror of everyone it did not sink, but floated ! The launch was going astern, but that outrageous case, mounting on the crest of an advancing wave, threatened to crash on board of her. The Sailor shouting " Full speed ahead " sprang at the wheel and just swung his boat clear of the oncoming menace. The launch darted forward and the case followed astern towed by its rope. After an impressive silence, the Sailor said, " I do not like that thing out there at all," and the Sapper said, " I like it better out there than ever before." And then the tow rope parted and the case was free, adrift on the waves at the entrance of Suakin Harbour. The Sailor said, in wardroom terms, that it would soon be in the breakers on the shore reef and that he was not going there after it. So the party returned home, while the Sapper meditated on possible methods of destroying mechanical mines ashore. Next day, the Political was to take the Sapper to the hills to see Erkowit and the rocky road to that place ; meanwhile, the carpenter

would prepare the outer casings and bottom planks for the remaining mines.

Baggage went off early and the Sapper looked admiringly at the riding camels squatting in the courtyard of the Muhafiza. They were well-groomed, thoroughbred-looking beasts, almost cream coloured, with light limbs and sleek coats and great eyes almost as full and friendly as the eyes of a Jersey heifer. How different from the growling baggage camel of the Indian Frontier. And then the voice of the Political was heard. "The dynamite has come back all right," he shouted. There in the creek before the Residency was a cranky native fishing-boat and two wild-looking Arabs who were depositing on the quay teak-wood boxes of hateful aspect. The men addressed the Political. "Honoured Pasha, these were washed up on the western reef and we have with great difficulty rescued this valuable Government property. Maybe there are more of them there by now."

They were thanked and rewarded and told to take the boxes over to the island. The camel riders departed for the hills and for three delightful days, dynamite was forgotten.

When the party came back, the Sapper's new plan had been settled. It was based on the fact, well known instructionally, that dynamite, without detonators, burns fiercely without necessarily exploding. The Sapper had verified this for himself in his inquisitive youth. Quite possibly there were no detonators present, they are best stored separately. So the rest of the mines would be brought to surface with the same precautions as before and then carried into the desert east of the island, where a magnificent bonfire would be made up and the whole consignment would be burnt. As the Terror might say, "If Allah willed it, all would be well."

It was a good plan and, as good plans do, it worked uneventfully. The convicts understood it and worked well, still hoping perhaps for the worst. The bonfire was made up with all inflammable things and was drenched with petroleum. It was lit safely—that was the only tricky part—and its smoke rose high to heaven for all the town to see.

It certainly burnt fiercely, though nothing was to be inferred from that, and there was nothing left.

No one can say now what was the actual condition of those land mines, but at any rate Suakin was rid of one of its bugbears.

Incidentally, Port Sudan has been built in the natural harbour formerly called Mersa Sheikh Barhud.

A VILLAGE TOUR IN THE PUNJAB.

By CAPTAIN P. L. KIRWAN, R.E.

THOUGH there are probably many officers who have carried out tours of the villages of the Indian troops, an account of a short tour may be of interest to those who have not, and possibly even to those who have.

I had intended to take about three weeks' leave in the Punjab in March and April, but circumstances prevented my being given more than ten days. This meant that there was not time to spend longer than one night at each place before moving on. Life in an Indian village does not move as quickly as that and I am sure we would have got much better value from staying a day or two at each place.

Every Indian likes to find a job for his "brothers" and the troops in 19 Field Company were no exception, so before they went on leave, I gave them copies of my programme and wondered how many of them would remember when the time came.

THE SIKH COUNTRY.

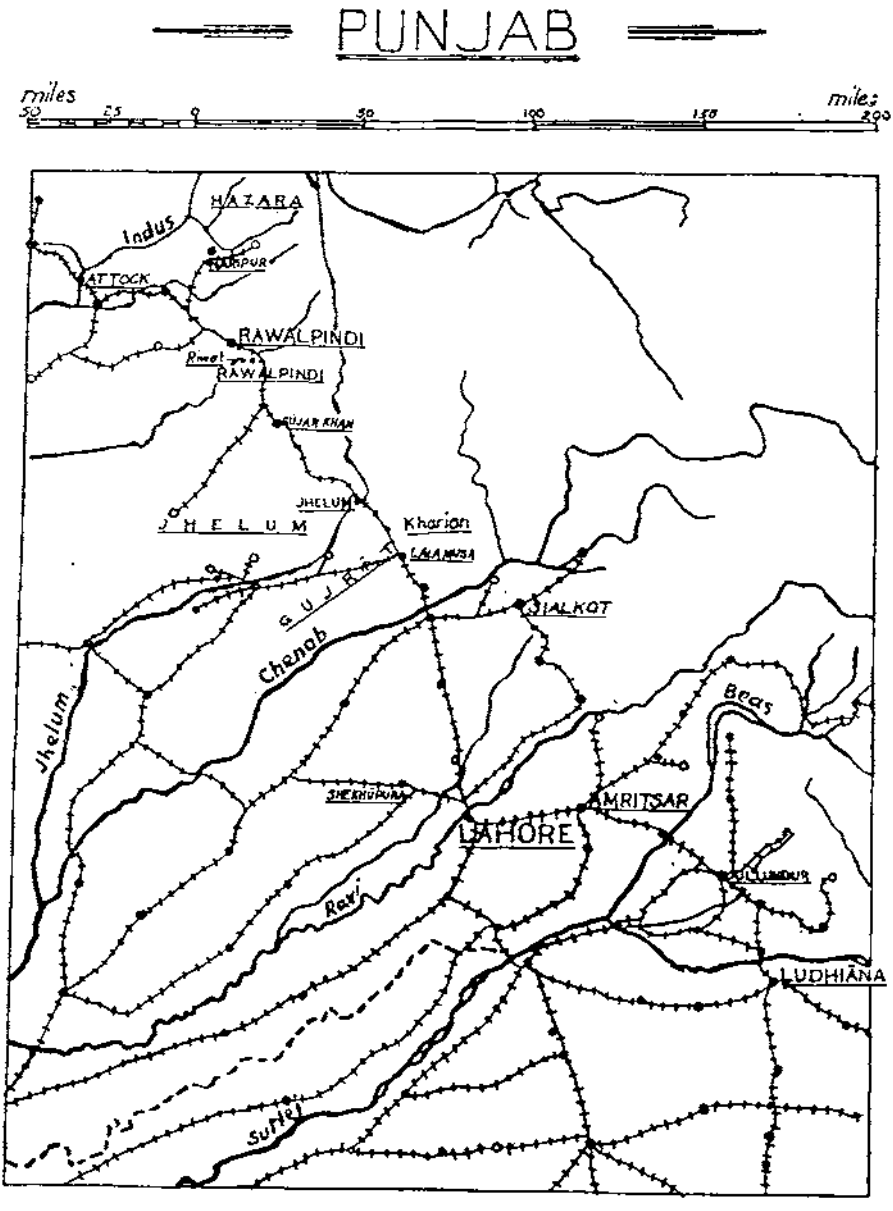
A week later, a chilly dawn saw two figures leave the Punjab Mail at Jullundur. After a welcome bath and breakfast at the M.E.S. rest-house, I thought it would be polite to call on the Recruiting Officer. It was a lovely morning late in March and I enjoyed the walk. The Cantonment was looking marvellous, and the flowers were even better than in Bangalore in May. The Recruiting Officer was delighted. Of course he would enlist any of my friends.

Back at the rest-house, I found Sapper S. Singh and four young hopefuls, so someone at any rate had remembered. I selected one of the four and took his particulars.

The afternoon train took me to Ludhiana, where Subadar Kirpal Singh was waiting at the *dak* bungalow. We had tea and he left soon after with many threats of what would happen in the morning.

While I was having breakfast, I heard ominous noises in the compound, and, when I emerged at 8 a.m., the crowd was big. Ten pensioners, mostly of the Sikh Pioneers, came first and described their war services and experiences, then 30–40 recruits. This measuring of recruits was a new game to me and it took a little time at first. Then came the inevitable tea-party with garlands and speeches, mostly in Punjabi.

Not content with this, they all came to the train to see me off. The train was twenty minutes late and by that time, we had repeated our good-bye speeches till they almost clung to our teeth.



Lahore Cantonment was familiar ground and I slept under a roof I had repaired myself four years before. My host had a date in the Fort in the morning arranging the lighting for the Jubilee Tattoo.

In spite of three years in Lahore, I had never been inside the Fort, so I jumped at the chance. Satisfied about the lighting arrangements, he drove me to my next centre, Sheikhapura, which gave promise of many men and many "brothers." We found the *dak* bungalow deserted. We tried to trace the village where they mostly came from, but to no effect. So we turned our attention to the Emperor Jehangir's shooting-box, built by him and decorated by the Sikhs with pictures of war and sport. It transpired that the troops I meant to see had come in to Lahore to meet me, so we missed. Probably if one had had time to stay even one night, as many would have collected as did at Ludhiana.

Punjabi Mussulmans.

Guest night that night and a rest on Sunday morning completed the week-end and I left by the Frontier Mail for Rawalpindi on Sunday night. The Pindi coach is a good coach. It waits quietly in a siding until you care to get up and dress. Not so my hosts. They were standing outside my coach long before I was presentable. Peeping out, I saw a Havildar and three Sappers. After breakfast at the station we walked to the recruiting office in a procession. . . . Myself, four troops, and seven or eight young hopefuls. The Recruiting Officer was friendly, but the district was large and every unit had different methods. However, to-day was a recruiting day, so if I cared to bring any men there was a chance. To-morrow, they were recruiting at Haripur. This was news. Haripur was on my programme. Better still, the Assistant R.O. would give me a lift there and back. The train journey to Haripur is awkward, so this was most welcome. I watched the A.R.O. recruiting and learnt much. I then went and worked it off on my seven or eight. Seven or eight! I found twenty or thirty, who swelled to forty or fifty when I started measuring. I thinned these down to eight or nine of whom the R.O. passed seven provisionally.

Late lunch at the station was followed soon after by a tea-party with the Sapper Pensioners who had assembled. (Photo No. 1.) Here I was given a pressing invitation to stay the night at Riwat. It was one of those invitations that will not take "no" as an answer!

After a late night writing up notes, it was hard to get up early on a freezing cold morning in a bare station waiting-room. Captain J. and his wife picked me up at 7.30. It poured with rain all the way to Haripur and I sat in the back of their car and froze. A week ago we were complaining of the heat in Kirkee. I had sent my bearer on by train to warn the chaps of my arrival, as I knew there would be little time to waste. On arrival at the *dak* bungalow, the bearer was there, but no Sappers. There was a Pensioner Jemadar of the Bengal Sappers and he was delighted to see me. He was the

Honorary Recruiter and we talked at length about recruiting methods.

Just then the sound of a school bell reminded me of a missionary from Haripur I had met on board. Yes, the mission was here but some little way away. Would I care for a walk ? I would. If anyone says missionaries live in luxury, let them come to Haripur. I found them living in the simplest style. My friend was not there, but they were grateful for the visit. Perhaps I could help them over a small thing—Could I enlist some of their *bhaibands !** Back at the *dak* bungalow, I found a very disconsolate collection of Sappers. I had let them down. I had promised to arrive by train at twelve. There was a band waiting at the station and the equivalent of the Mayor and Corporation, and I had sneaked in quietly by road at 9 a.m. And to add to it, I had been entertained by a Jemadar of another Corps. They were mortified.

When we started to measure recruits, the crowd grew dense, and it looked as though we should get nothing done, but Jemadar P.M.S. was used to this. He had a big stick and he knew how to use it. Before long, I was under the impression that I was inspecting friends of Jemadar P.M.S. and not those of the troops I came to see. This had to be pointed out tactfully, once or twice.

At last we were finished. Jemadar P.M.S. then invited me to lunch at his expense. Tact here was of no avail. It was an invitation like the last one and added to the mortification of Lance-Naik M.D. and Co. After lunch, the A.R.O., who had been on to Abbottabad meanwhile, returned. He passed provisionally five out of the eight I had selected. One was enrolled forthwith and set out for the Training Battalion. He finished his time there as best recruit of his party. But he was one whom the R.O. had picked out before and intended to enrol, so I take no credit for him.

As we drove through Pindi on our return, I recognized the back of a head. There could only be one such. It belonged to a girl friend from Quetta. That meant a drink at the club and an invitation to a dance. The people I met at the club were mystified. No, I could not stay the night. I could not dance. I was spending the night in a village. No, I could not even stay to dinner. I was being picked up by a *tonga* at the station any time now.

Even with a fast pony, ten miles is a long way. It was colder than ever, but we wrapped blankets round ourselves and sat familiar. We arrived at nine to find the village turned out to meet me. The village school was at my disposal. There was a fire, and, *mirabile dictu*, a hot bath, and more wonderful, a complete English dinner. I was ravenous, but as course after course arrived, I remonstrated with my bearer. " I told them you eat nothing," he said, " the last Officer I toured with would have eaten twice this dinner."

* Protégés.

A VILLAGE TOUR IN THE PUNJAB.

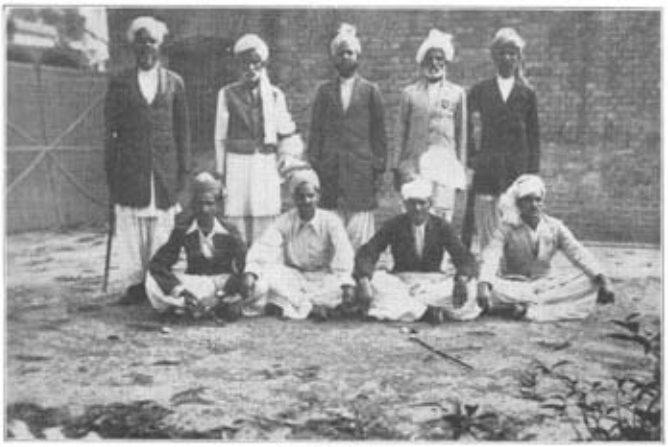


Photo No. 1.

Photo No. 2

A village tour in the Punjab Photos 1&2

Photo No. 3.

Photo No. 4.

A village tour in the Punjab Photos 3 & 4

The village is built round the remains of a Moghul fort. I was shown over the fort in the morning at seven, by Havildar Amir Ali, a war-time character—and about ten other ex-soldiers. (Photo No. 2.) After breakfast, we measured recruits till lunch. This, by request, consisted of local food and was excellent. It was followed by many handshakes and garlands, as I left in a *tonga* with two of them for Mandia station, nine miles farther down the road.

The next stop was Gujar Khan and I had promised to spend the night in a village ten miles out with Jemadar Karm Ilahi. He and about six sappers met me and took me to the *dak* bungalow, where they broke the sad news. Gujar Khan is surrounded by rivers and they were all in flood after the heavy rain. They had waded up to their necks to come to me and I could never get through. Perhaps to-morrow, but not to-night. So we sat round the table in the *dak* bungalow and said very solemnly in turn, *Barish bahut hai* (heavy rain).

We set out at eight for the village of our Subadar-Major, Pailwan Khan. He was not there, but his two brothers were, one a sapper and one a pensioner. There were four of us, the two brothers, Karm Ilahi and myself, all mounted on country ponies. Photo 3 shows Karm Ilahi and his pony. One of the rivers is in the background. On arrival we measured recruits. This took a long time, as the village headmen had to bring their own relations first. When we had finished, we had to drink tea. Time was flying, but tea is an institution. We had little over an hour for eight miles, but it would have been cruel to have pushed Karm Ilahi's pony any harder. A mile from Gujar Khan we heard the train. Leaving the Jemadar we galloped down the street and along the platform and caught the train.

At Kharian, the crowd was bigger than ever. I was to stay in the new house which our Driver Havildar had built in the middle of the town. We sat in the courtyard of the house for about an hour, my host and I on chairs, and the others sitting round in a half-circle. When we had exchanged all the news, we started measuring recruits. Poor material physically, compared with what I had. About seven the crowd dispersed and I had some tea. I was just beginning when in walked unannounced an important-looking person. I sat him down and found out he was Capt. M.D. of the Rajputana Rifles. Hospitality was difficult as I had only one cup, so he had some after me. There was a boiled egg lying on the table, but I hesitated to offer him that. Perhaps this was a mistake. He was very honoured that I had come to Kharian, but I had never told him. I must certainly come and have tea with him to-morrow. I explained I had a full programme from 8 a.m. Never mind, I must come at seven-thirty. At half-past eight I was getting hungry, so I took advantage of the custom of the country and excused him. I called

for dinner, but it did not come for another hour. When it came, it was tremendous. It was my first meal since *chota hazri* so I was glad of it. One certainly does not starve on these trips but one has to get used to odd hours.

I ordered *chota hazri* at seven but, as luck would have it, it was late and Capt. M.D. was early. Walking straight in, he found me facing an omelette. This was awkward. Eating before I came to take tea with him ! I pushed it away, I had not ordered it, but of course one must have a cup of tea before stirring out. Of course !

I found the *tahsildar* and his assistant (civil officials) and the paid Recruiter all waiting. One is seldom at one's best at seven-thirty in the morning, so conversation flagged a bit. At eight, I thought the *tahsildar* must have much work to do. This was only too true. When he had gone, we measured recruits. Capt. Mohd. Din, a late Subadar-Major of ours, lives about eight miles away. He was away on pilgrimage to Mecca, but his son came to meet me with ponies at eight-thirty. This time we galloped with speed. I lagged behind till I realized the way to make a *tatt* gallop is not to dig the heels in but to shake the rein and jog his mouth. Capt. Mohd. Din had built himself a new house, decorated inside and out with red, white and blue plaster. It was spotlessly clean and a contrast to other village houses. (Photo 4.) The son and I had tea to start with and then we measured recruits as usual.

When we arrived back at Kharian for lunch, we were met by the father of a sapper in the company, who insisted that I must have tea with him. He showed me a number of photos of his sons in the Corps with great pride.

The Frontier Mail does not stop at Kharian, so after tea we went by *tongas* to Lala Musa, where we met more sappers, had more tea and measured more recruits. This must have brought the number of recruits I had measured up to 500. It is encouraging, however, to know that some were recruited and got on quite well.

The Frontier Mail stopped at Lahore for dinner, which once again was my first meal of the day. I got out at Jhansi to see a Major of ours in hospital. As the train went out, I gathered from the ticket collector that I had made a mistake and the next train did not go through to Bombay but Madras, and there was no train that would get me to Kirkee in time.

I saw the Major and caught a slow passenger to Itarsi. There was no dinner on the train, but I had had lunch, so why worry ? I had to spend the best of the next day in Itarsi. It was not the first time I had waited at that station. One seems doomed to it. I wired to the station-master at Kalyan, the junction for Kirkee, to book me a taxi to drive the odd eighty miles to Kirkee for Rs.40/-. We reached Kalyan at 5 a.m. and I wished I had specified a " good " taxi. The one I had looked tired before we started and it groaned ominously

all the time. The groans grew worse, till finally the universal joint broke and dropped the propeller shaft in the road. Here we really were stranded, miles from the railway and miles from the main road. The next car contained a Mahratta gentleman, squatting in the back seat. I left my bearer to come on with the stuff and sat beside the Mahratta gentleman. I gave him an orange and he took me six miles to the main road. Here I found a bus just starting. I took the front seat and the driver brought me up the *ghat* and fifty miles to Poona in two hours, even driving right up to the bungalow. It seemed only right that an unusual leave should end in an unusual way. I only wished that I had appreciated the humour of the situation at the time and photoed the derelict taxi.

A DEMOLITION SIDELIGHT.

By LIEUTENANT E. S. BARKHAM, R.E.

INFORMATION came through at 1655 hours from Headquarters Wana Bde. that an aeroplane had crashed at Tanai. Orders were received at the same time that all bombs were to be destroyed (because when they fall into the hands of the tribesmen they are used freely to mine roads), and that everything else such as guns, ammunition, etc., that might be of use to the tribesmen, was to be salvaged before nightfall. Tanai is 13 miles of good, but very winding hill road from Wana. At the time, dusk was at about 1900 hours, and it was quite dark by 1920 hours.

The only other instructions received were that two 30-cwt. lorry-loads of infantry would protect the Sapper and Miner party and would be ready to start in half an hour.

It was clear that whatever work could be done would have to be carried out very quickly, but entirely depended on the state of the aeroplane; it was hoped that, after removal of the bombs from their carriers under the wings and possibly doing a little repair work, the aeroplane might be dragged to the South Waziristan Scout's post at Tanai.

Twenty-five Sappers of 20th Fd. Coy., R.B.S. and M., were put into the three 30-cwt. Company lorries, with picks, shovels, hacksaws, hand-saws, sledge-hammers, 20 pounds guncotton, rope, various small stores, and rations for two days.

At 1730 hours, the infantry protection party arrived and the five lorries set off at considerably more than regulation speed, arriving at their destination at about 1810 hours. An hour was therefore available for work, as such a small party working in the open after dark was out of the question.

The infantry party and two platoons of Scouts put out piquets at once, to protect the party working on the machine.

The aeroplane, contrary to expectations, was found to be a total wreck; the front wings were almost untraceable, the engine was mixed up with the forward cockpit, and only aft of the after cockpit did the wreck have any appearance of an aeroplane at all.

A very cautious reconnaissance disclosed that when the machine hit the ground, in a very hard dry nullah-bed full of stones, all the bombs flew out of their carriers and were lying on the ground, anything up to ten yards from the machine. The carriers were more

or less intact and showed that, assuming the machine to have started fully loaded, sixteen bombs were to be accounted for. A careful search produced thirteen, which seemed rather a dismal number, but as none could be found under the wreckage no more time could be wasted with superstitions.

The bombs were 20-pounders with three fins at the back; this was clear as one was found with its tail-piece more or less complete. But what state the fuses were in was quite impossible to discover, as not a single one had its nose intact. One nose was split in two, revealing two small cog-wheels, rather bent; another bomb was completely broken, showing the detonator and explosive, but no fuse or device for setting it off was apparent. All the others were broken in one way or another.

There was not time to lay a slab of guncotton on each bomb as salvage work had to be carried out on the wreckage in the close vicinity. The only course open was to divide the Sappers into two parties, one to remove everything valuable from the machine while the other party removed the bombs and placed them close together to facilitate firing at one time.

This was done. Each bomb was very carefully lifted, hands being placed under the least dangerous-looking parts, and two piles were formed, one of seven bombs, the other of the bits and pieces of the remaining six. Destruction being the only object, four pounds of guncotton were placed on each pile, as near to the nose ends as possible, no tamping or consolidation with mud being considered wise. It was at this juncture that one pile collapsed.

Nerves restored, fuses and primers were placed in position, two time-fuses to each pile to ensure that there should be no misfire.

Meanwhile, the party on the wreckage had retrieved all easily removable instruments, a Lewis gun, ammunition and many more items, the only thing of importance not found being the Vickers gun. This was eventually discovered half under the engine.

It was now getting dusk, so all except four of the party were ordered into the fort, six hundred yards away, piquets on the surrounding hills took even better cover, and the fuses were lit.

The first explosion sounded as if only the four pounds of guncotton on one pile had gone up. But there was no mistake about the second explosion; either six bombs or seven bombs no longer existed. Inspection by torchlight showed that the first explosion was the guncotton on the pile of six, with probably the "slow-burning" of some of the bits and pieces, as only four more or less whole bombs now remained. Of the pile of seven, there was no trace, except a huge blast mark on the ground.

It was considered that protection of the remains by Scouts or the infantry protection party would be unnecessary, so *khassadars* (local Pathans paid to be on our side) were placed near the wreckage,

with a warning intended to prevent them from pilfering, that almost anything they touched would blow up, just as they had heard a few minutes before.

The following wireless message greeted the party on arrival in the fort:

"Do not dismantle aircraft or bombs. Dismantling aircraft loaded bombs highly dangerous. ack. and report action already taken."

The following day the above order was willingly obeyed, the machine and remaining four bombs were left well alone, pending the arrival of R.A.F. representatives. Meanwhile, a careful examination of the area showed what had happened when the machine crashed. Owing to the tribal situation having deteriorated, M.T. convoys were being run from Manzai to Wana and back on alternate days, protected by armoured cars and with one aeroplane co-operating. The convoy had halted at Tanai and the co-operating machine dived low to drop a message; at that spot the telephone line rises from normal level to the top of a hill about 200 feet high, and the machine must have hit the line about 75 feet above ground-level, while doing roughly 100 m.p.h. The wires, besides getting round the propeller and damaging the machine, must have ripped two bombs out of their carriers, as two craters were found about 30 yards short of where the machine crashed. A third crater was later found some way beyond, showing that a bomb had also rocketed from its carrier as the crash occurred. That accounted for the full complement of sixteen.

The R.A.F. personnel arrived at midday and removed all remaining parts worth salvaging; they also explained how the bomb fuses work. When the carriers are loaded before a flight, a cast-iron cap is removed from each bomb, exposing a small three-bladed propeller. In attack, when the bomb is released from the carrier under the wing, the rush of air causes the propeller to revolve; this operates a mechanism within the nose (the cog-wheels of which were exposed on one bomb in this case), and after twenty-five revolutions of the propeller, the slightest impact will explode the bomb. None of the thirteen bombs left after the crash possessed propellers, so just how many of the twenty-five revolutions were completed before they got knocked off is impossible to say.

All unwanted remains of the machine were then burnt. The engine, weighing 950 pounds, was loaded after some difficulty into a 30-cwt. lorry. Here two skids, borrowed off one of the armoured cars protecting the convoy, were invaluable.

The last job was to dispose of the remaining bombs; the R.A.F. armourer made the pile this time and the same charge of four pounds of guncotton was used. It was with great relief that a few minutes later we heard three bombs and two halves detonate as only good bombs can.

GRASS PLANTING AS A MEANS OF TIDAL LAND RECLAMATION.

By MAJOR J. H. R. LE SUEUR, R.E.

IN September, 1928, the late Colonel E. de H. Haig drew the attention of the War Office to the possibility of the use of a hybrid grass known as Spartina Townsendii to prevent coast erosion. A full description of the discovery and subsequent history of this plant is given in *Tidal Lands* by Carey and Oliver, but for the purpose of this article the following brief notes will suffice.

Spartina Townsendii, although observed near Southampton in 1870, first attracted general attention in 1907, when it was reported by Lord Montague of Beaulieu on his property near Lymington, Hampshire, where it had covered thousands of acres of tidal flats and was rapidly building up the ground. A special study of the grass was then made by Dr. Otto Stapf, Keeper of the Herbarium at the Royal Botanic Gardens, Kew, who described it as follows:—"Spartina Townsendii is a vigorous, stout, stiff grass about 2 to 2½ feet high. It grows mainly in the soft ground of mud flats and in the tidal reaches of rivers in Hampshire, Dorset and Sussex. It anchors itself in the mud by long vertically descending roots, whilst another set of roots, short but abundantly divided and interlaced, spreads all round from the base of the stems close to the surface of the mud. It grows in tufts and clumps which, when they unite, form regular meadows with a dense, matted growth. The grass begins to flower in August and September and ripening of the grain usually takes place in October." The grass spreads vigorously into new ground down to 4 to 6 feet below high water mark and converts soft mud flats into hard ground on which cattle can walk.

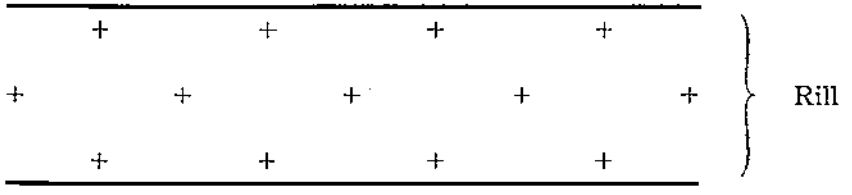
Round the flat lands of Foulness, New England and Havengore, the cost of maintaining the sea walls is heavy and any means of building up the ground round high water mark and so reducing the erosive action of the sea against the wall is of interest. It was accordingly decided to ascertain whether Spartina Townsendii would grow in the district and 300 sods obtained from Hurst Castle were planted on the south side of the dam across Shelford Creek early in November, 1929. It was necessary to plant roots as the grass is difficult to cultivate from seed.

At first the plants made very little progress and at the end of four

months the experiment was about to be written off as a failure. In May, 1930, however, when a few green shoots were noticed, hope revived. By the end of October, 1930—a year after planting—the grass had clearly established itself, had flowered and seeded.

Having discovered that the grass would grow locally, the next step was to transplant from the nursery already established to areas where silting was required and in March, 1931, two new patches were planted out on the north side of the dam. As in the case of the original planting, the transplanted grass again made no progress for some months, but the summer was expected to bring about an improvement. It was not to be; the grass continued to lose ground and in just over a year it had completely vanished. The only explanation that can be given for the great difference in the behaviour of the grass on the two sides of the dam is that on the north side the channel was deeper and here the plants were covered by the tide, which contains much scum. On the south side, the grass was exposed for much longer periods between tides and, as this was clearly a suitable place, a further 500 plants were obtained from Hampshire and added to the original nursery.

During the early summer of 1933, the grass was transplanted and set in the centre of the rills. It was noticed that, after a short time, the plants became smothered before they had been able to establish themselves and, as an experiment, further planting was done along the rills in zig-zag formation, thus :—



This method proved much more satisfactory; all the plants thrived and the rills soon filled up with deposits of mud collected round the clumps of grass. The only other set-back was due to the local winkles. These breed from May to August, during which time, the Spartina Townsendii is also making new growth. The winkles collect in heaps round the plants, climb up the stems and eat away the new shoots. Plants attacked in this way invariably die the same year and no means of combating the winkles has yet been discovered.

Further patches were planted out in the late summer of 1934 and 1935 and have made excellent progress, as is shown by the photographs. Not only has the Spartina itself flourished and built up the level of the creek, but sea horn has made its appearance on the silted areas. The natural growth of this sea horn invariably marks the

commencement of the plant life which goes to constitute the saltings in this district. Sea horn will not grow when subject to constant immersion, but as soon as the Spartina grass has caused sufficient silt to accumulate, the sea horn takes possession and in time will no doubt choke its forerunner out of existence. This process is normal in the formation of saltings. Each plant thrives best at one particular stage, and when that stage is passed, a new plant takes over possession only to die out in its turn when drier conditions weaken its growth and encourage that of its successor.

Photographs are published by kind permission of the Superintendent of Experiments, Shoeburyness.

THE USE OF A.A. SEARCHLIGHTS FOR TATTOOS.

By 2ND LIEUTENANT A. H. S. LEWIS, R.E.(T).

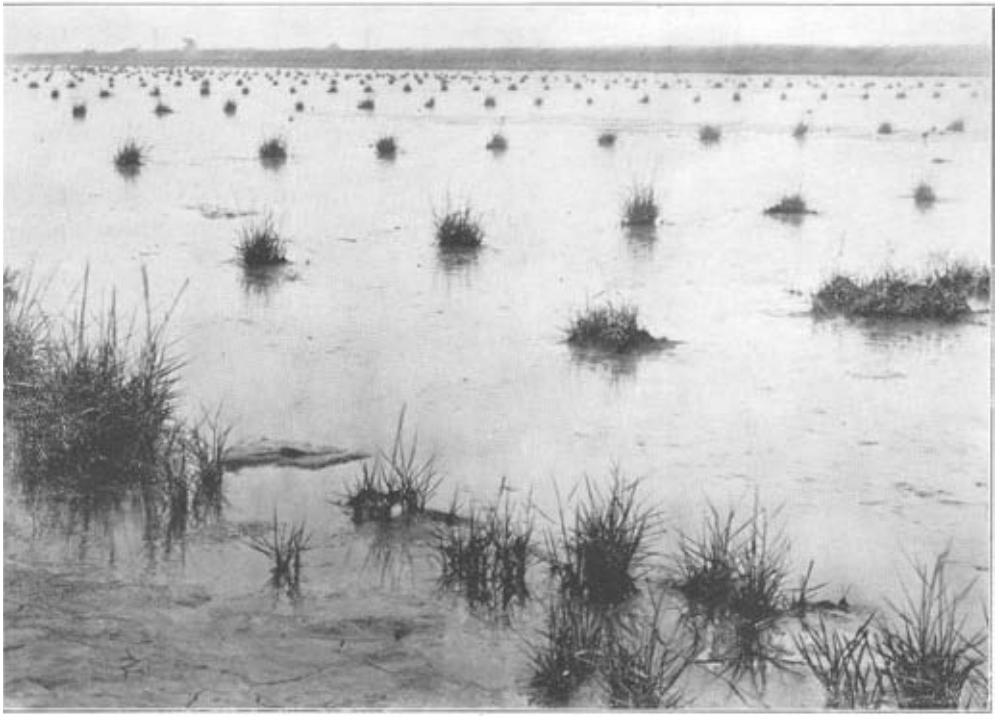
DURING Coronation week, a Tattoo was held in Aberdeen, in the lighting of which the 319th (City of Aberdeen) A.A. Coy. R.E., T.A., was asked to assist. I was put in charge of the work and the purpose of this article is to give the experiences and difficulties, and to suggest improvements so that others who may help at local tattoos and pageants may benefit.

The Aberdeen tattoo was held at the local football field, so a light was erected there to show the lighting effect to the committee. The site chosen for this demonstration was the centre of the grandstand, a very inaccessible spot. Once erected, the light was exposed shining on the centre of the field. Standing in the beam one could not stand the glare with the naked eye, so several screens of different types were tried over the front door and a plain white one gave a good diffused light. For this demonstration the light was 50–75 yards from the centre of the field, but the committee decided that for the actual tattoo they would only require two lights, one at each end of the field, *i.e.*, at 150 yards from the centre of the field.

The tattoo was to take place each evening from the Wednesday to the Saturday of Coronation week, so I decided to erect on the Monday evening, and to take part in the evening's rehearsals. I had inspected the ground and found that all gates had brickwork above them which was not sufficiently high to allow a P.E. lorry to pass under. Being a mobile company, we have no trailer generators which would have got inside readily and made things much easier. As it was, one lorry had to be put in the car park, which was very suitable, but the other had to be kept in the car park and driven out into position on a side road each night before action and taken back afterwards. For the lights, 6 ft. by 8 ft. platforms, firmly fixed in the ground and 6 feet high, were provided by the committee. These proved very satisfactory, giving ample room for the projector and two men, and sufficiently high for the beam to clear the heads of people who might walk in front.

The actual erection on the Monday evening was very simple and amusing. I arrived down at the football ground with two completely equipped detachments at 8 p.m. and went in to find someone who would open the gates at the ends of the field to allow passage for the searchlights. Eventually I found an official and told

GRASS-PLANTING AS A MEANS OF TIDAL LAND RECLAMATION.



1.—Spartina Townsendii.

Grass planting - photo 1

2.—Four years after planting. Note the growth of sea horn on silt built up by the Spartina Townsendii.

Grass planting - photo 2

him what I wanted. "Searchlights," he said, "give them to me and I'll keep them in a cupboard for you till you need them." This, I have found, showed the general public's idea of military searchlights.

The lights were ready for use shortly after 9 p.m., but for some reason we were not asked to take part in the rehearsals. If we had exposed, the inadequacy of the lighting would have been noticed and we would have had time to erect some more lights. Our first and only rehearsal was on the Tuesday evening and the lights diffused by the screens over the front doors and at such a distance from the centre of the field gave a very widespread, but insufficiently powerful light. The committee, however, decided not to accept our offer of more lights.

In the actual tattoo during the week, the searchlights took on a greater importance and did more work each night. Apart from general floodlighting, on the first night we were asked to "spot-light" Britannia. This proved very successful and was continued for all the other performances. The method employed for this was to drop the top half of the screen on each light and to shine the beams directly on to Britannia, who was asked to keep her eyes shut to prevent "arc-eye." In addition to the work of the opening night, beams had to be "sprayed" over a large Union Jack formed of some 2,000 Girl Guides on the second night; again on the third night, the "spot-lighting" of Bruce marching triumphantly into Aberdeen Castle augmented the work and with speeches on the final night, the lights were on over an hour. This meant the lights being on for a short time, changing carbons, and then exposing for the last 50 minutes.

A few difficulties appeared in the work and I have put them here with some suggestions that might benefit others. There should be adequate rehearsals at night so that the correct illumination can be obtained. The screens used in front of the projector were not easily kept on, owing to the sloping rim of the front door. The screens should be of white non-inflammable material for the 90-cm. Mark VI and should have string inside a hem all round the circumference, so that they can be tightened over the front door; also they should be tied to the projector at four points, to the fan-guard, to the two front-door handles and to the out-of-focus device. To uncover the front door, the attachment to the fan-guard should be loosened and the screen merely dropped down. Practice reflectors should be used because the searchlights are usually pointing downwards. Arc should be tested a short time before the lights are actually required, shutters being placed over the front doors. No long arms need be used; just before the lights are required, the stay bars should be removed, and the lamp attendant and another sapper can easily follow any "target" with the beam. Two men should be with each light, one man at each lorry or trailer generator and one runner

for each light for cues or in case the telephone between lorry and light breaks down. If the lights are required for several nights, the lorry-drivers should check the quantity of fuel in the tanks each night after the run and make a report.

Apart from the personnel required for each light, a mechanist (E) and a mechanist (M) should be on the spot in case of breakdowns and an officer to control the working of the lights and to keep in contact with the pageant-master.

The men who were chosen for this job showed very keen interest and they gained much valuable experience during the week. The general public, too, showed great interest in the lights and I am sure that, if we had vacancies in the company, we could have made this a very profitable recruiting "stunt."

A WINTER TOUR IN THE ALPS.

By "SKI HEIL."

OF all forms of locomotion, riding, sailing and ski-ing are among the best. In each form you may choose between the fast and the slow, the exciting and the "go as you please." The writer, being naturally lazy, prefers the open spaces to the race-course, poking about creeks and islands in a stout craft to racing in a shell. Most people derive pleasure at great expense running the same slopes on ski day after day, beating the clock, passing tests and generally engaging in the competitive spirit now rampant in Switzerland. There is another aspect of the sport hardly found in that country, though indulged to a limited extent in Austria. Starting with a rough plan and some maps, moving from place to place, varying the route to suit time, weather and snow conditions, the tourer knows the joy of travelling untracked snow and getting away from the civilized world "where only man is vile." In no other way will he come in contact with the wild life of the mountains above the snow-line; the budding staff officer will find ample opportunity of appreciating the situation and the problem of "time and space."

Such a tour may be done with or without guides. Apart from the expense, which generally rules them out for a small party of slender means, the use of guides rather spoils the fun—like taking a paid skipper on a cruise. As the guide is responsible for the party you must take his advice, whether you agree with it or not, and there is no problem to solve. With a guide you may avoid wasting a day attempting the impossible; this would have been the case on one occasion only in the description that follows. Without a guide you will attempt and often succeed when a guide would refuse to start; this applied on two occasions. There are two important requisites, however, for a guideless tour, namely, good maps and an elementary knowledge of snowcraft. In the case of a party of one or two, great caution is required to avoid the slightest accident; this involves a complete absence of ski-ing pride. Stick-riding, the use of one or both skins downhill, kick-turns, devices anathema to the ordinary skier, should be used wherever they make for speed or safety. Finally, remember that it is not the speed over the plain running that governs the time of arrival, but the expeditious negotiation of the difficult parts.

P. and I were at Leukerbad and decided to tour through Switzerland into Austria, as far as possible on ski. The route lay by Andermatt, Safien Platz, Thusis, Arosa, Davos, St. Anton, the Lechtaler Alpen, the Meiminger and Nordkette Gebirge to Innsbruck. From Innsbruck, if time allowed, we proposed to traverse the Tuxer and Kitzbuheler Alpen. This programme was seriously upset from the start as the result of a telephone call to Oberwald, this being the last station on the Oberalp Railway to which trains run in winter. The proprietor of the Hotel Post there told us that there was much danger of windslab on the Furka and that he did not advise the attempt. As we should have stayed the night at his hotel it was obviously wise to take the advice.

A study of the maps disclosed no feasible alternative except to take train through Italy and enter Switzerland again by the San Bernhardino pass. The excellent Swiss time-tables gave us all the information we wanted and the first train on January 14th took us down to Leuk, where we caught a main line train to Brig. There we dispatched our suitcases to Davos and took a train to Domodossola, arriving about mid-day. Here the route lay up the Val di Vigezzo and down Centovalli to Locarno by a funny little narrow-gauge tramway over the mountains. The run down Centovalli was exciting and picturesque, the line clinging to the steep side of the valley and popping in and out of short tunnels, vines trained on pergolas on almost inaccessible terraces, little hump-backed bridges with shrines in the middle, upstanding women carrying enormous baskets of firewood on their backs.

Arrived at Locarno we decided to stay the night and spend the remaining hours of daylight seeing a place so well advertised by post-war politics. A year earlier, and after another tunnel-popping journey, I had passed Rapallo without stopping ; I felt that I ought not to let the opportunity pass again. The town slept along the untidy bank of the lake, with a dreary and quite empty promenade punctuated by shuttered kiosks. Sprinkled over the slope of the hills at the back were villas, now closed, their gardens unkempt. Drab and dreary under a leaden sky, the whole place reminded us of a concierge in curl-papers hauled out of bed in the middle of the night. Of course the town cheers up in the summer with the sun, blue sky and lake, fashion parade and boats, but at the time we hardly felt that a happy world could be born in such a place. Our depression was not relieved by heavy colds ; we went to bed early with hot toddies and aspirin.

The first train on the broad gauge took us next morning to Bellinzona, whence a narrow-gauge railway runs up the Val Mesolcino leading to the San Bernhardine Pass. The two stations at Bellinzona are nearly a mile apart and we had eight minutes to do it in. A smart double and the sharp eyes of the guard, who held the train up

for us, saved a wasted day and we lunched at Mesocco. A bus was leaving two hours later for San Bernhardino Villaggio, so we walked, intending to get into the bus when it caught us up. The wretched thing defeated us, however, by starting ahead of time and passed us while we were in the middle of a short cut. Walking uphill on an iced road, carrying heavy rucksack and ski, is a wearisome job at the best of times and with our poor training we arrived very tired at the Hotel du Lac, the only guests. The water-supply having frozen up, the house was unheated and unflushed, but we managed to keep warm round the only stove.

Next day, the 17th, saw us started on ski. Our colds being still in the ascendant, we spent a lazy morning and went up to the Hospice at the top of the pass in the afternoon. On the way up we passed through the (so-called) village, a collection of large hotels, all closed. We met a detachment of Italian Alpine troops, recruits with a few instructors, running down to Mesocco. The locality provides excellent ski-ing, both for beginners and day-touring, but does not seem to be patronized in winter. The hospice was one of the coldest places I have spent a night in. There was only one warm spot in the house, a big square stove in the *gastzimmer*, and everyone sat on top of it, including the dog. Happily we were alone and had only the family to share the stove with.

The run down into the Hinter Rhein was necessarily along the road, which zigzags through steep forest. It was a pleasant run, however, and the weather fine. There was plenty of snow on the Viamala. Lunch at Splugen, Andeer about four o'clock. Here we could have stayed the night and skied on to Thusis the next day, but the icy surface of the road and the desire for a hot bath decided us in favour of the bus, which deposited us at the Hotel Post. Here we were received with open arms, bathed, fed and bedded royally. Contrast is the essence of enjoyment. Comfort is not appreciated unless it follows discomfort, while the latter can be cheerfully endured in the thought of the comfort to follow.

The gorge of the Hinter Rhein is the finest in the Alps ; deep and broad above Andeer, equally deep but narrow below. Ice-falls hang hundreds of feet down the cliffs, where the sun never penetrates. The road is frequently roofed to prevent the ice blocking the carriage-way when the falls form in the autumn.

The 18th was a glorious day with almost cloudless sky. A lazy climb to Lenzerheide. Easy slopes to the west right up to the crest of the Stätzerhorn, nursery slopes in the valley ; a perfect beginners' paradise. The broad valley running north and south gets more sun than most places. The village and the big hotels are badly situated, but the Pension Riva, where we stayed, had the sun for eight hours in January. A glazed verandah facing south was very pleasant to sit in in the sun. The next day was spent lazily exploring. A sledge

funicular takes you about 1,000 feet up the west side of the valley for a franc and the runs down from the top are varied and easy. We saw a guide at the ski shop about the route over the Urden Furka to Arosa. This appeared to be easy, but only in fine weather as the top is steep and the line difficult to see in fog. The day closed with snow and we went to bed in pessimistic mood.

The 20th dawned fine out of my window to the south, but a look out to the north showed black clouds piling over the mountains above 6,000 feet. By the time we left at eight it was snowing hard and we were forced to adopt an alternative route worked out the night before. Taking the Chur road to Parpan, we meant to climb east above the tree-line, then north to the Am Joch and east to Tschiertchen. At Parpan we inquired the way from a couple of ski-teachers. These, however, warned us against the route on account of avalanches, saying that our only way was by the road through Chur. We could not understand this from the map, but, being loath to go against local knowledge, continued down the Chur road. (This information subsequently turned out to be quite false and goes to show how guardedly one must take even local " knowledge.") A good run with driving snow in our faces brought us to Churwalden, where inquiry at the Hotel Crone confirmed our original route from Parpan. However, the proprietor of the Crone showed us a way up to join the Parpan track and this we climbed to the Am Joch. Having passed into the cloud, visibility was reduced to 20 yards with occasional glimpses of 100. The track disappeared, the ground flattened out and it became impossible to tell the way by the lie of the land. A course by wrist compass found the pass and, to our amazement, a ski-hut complete with attendant and coffee ! This was a bit of luck, as the track to Tschiertchen would be invisible above the tree-line. In the fog a compass course would find the wood, but whether a search along the edge would reveal a snowed-up path was not so certain. We had already visualized the possibility of having to return to Churwalden, but now the hutman came down with us as far as the wood and put us on our way.

As we descended the wood thinned out, we passed below the clouds, snow was no longer falling and the last run into Tschiertchen was a joy. Apart from a massive hotel, now closed, we found a charming timbered village, all built higgledy-piggledy on the hillside with steep narrow tracks meandering between and under the houses. Through the smithy we saw the Pension Korten, an unassuming and cheerful-looking little chalet. The landlord greeted us in Yankee, which he said he had learnt in London ! Both he and a dear old girl, his wife, gave us warm hospitality. P's birthday was celebrated with a bottle of champagne procured from another hotel. It was obvious that with all this new snow (probably at least a yard above 8,000 feet) neither the Meienfelder nor the Strella passes would now be safe.

We therefore decided to cross the Langweistal at Molinis, climb north to the Hochwang hut, thence *via* the Parsenn Furka or Jenaz to Davos.

Having bade good-bye to our kindly hosts and paid a ridiculously small bill, we ran down to Molinis. The severe thaw of the last fortnight had iced up the lower part of this run and no new snow had lain; we did a good deal of this in a sitting position. We lost the track once, but a kindly peasant went out of his way to put us right. Thence to the Hochwang hut through the little village of St. Peter, a picturesque collection of fine, timbered houses, many of them with pious sayings carved under the eaves. Above the tree-line we climbed in shirtsleeves in the sun, but the snow stuck in masses to skis, whether with or without skins on.

On the 22nd we climbed to the Arflina Furka in sunshine and shirtsleeves. The snow for the run down the Fideriser Heuberg was deep and slow. There we inquired the way at two ski-huts half a mile apart. One hut-keeper advised against the Jenaz route on account of windslab; the other said the route was perfectly safe. We took the Jenaz route—luckily, as it proved perfectly safe and gave us a glorious run in dry powder snow down to the tree-line. From there to Jenaz it got more and more iced, but the line ran through clearings in the forest the whole way, so it was not too bad. We caught the train with two minutes to spare, avoided a long wait and reached Davos Dorf in daylight. There we were welcomed at the Hotel Garni, where I had stayed six years earlier, and there we found our suitcases forwarded from Brig. A bath and clean clothes were very welcome and we decided to wallow in the fleshpots awhile.

The following day was spent in lazy contemplation of the sun, paper and letters. I was anxious to do the Parsenn–Kublis run again and it was P's first visit, so we booked that for the next day. We were warned that the run was iced up and not worth doing and that, being Sunday, we should meet the whole of Zurich and Munich there. We were not put off.

We had hoped to go on to the Arlberg *via* Klosters and the Lanquart to the Silvretta hut, up the Silvretta glacier to the Fuorcla del Confin, down the Vermunt glacier to the Wiesbadener hut, Madeliener Haus and Galtur. Inquiries at the Davos Ski Club showed that the Silvretta hut was not open and that no one had been over the glacier yet that winter. This did not seem quite a safe proposition and we decided to go over the Schlappiner Joch instead. We afterwards heard that all the huts on the Austrian side of the Silvretta were open and we were asked why we did not come over that way. If I had only made the journey before we would have done so in preference to the Schlappiner, which is not an easy pass. The Silvretta route is not difficult, but you want to know where the crevasses are.

Sunday the 24th was another fine day. Scorning the new funicular (8 francs), we went on ski to Wolfgang, up the climbing track and by the Parsenn hut to the Weissflue. I had never seen so many people out before ; the crowd on the Kublis run was so thick that it was unsafe to do a turn without first looking over your shoulder to see that you did not collide with someone. The very conspicuous *rettungstellen* all the way down gave some indication of what the casualities must be under difficult conditions of snow. On this day the surface was ironed out perfectly smooth and, apart from a few bits of rock poking through, running was safe, fast and easy. These conditions lasted to the top of the Conters Meadows when the surface turned to smooth ice. Here one could only skid down on the edges of the skis ; if he lost his feet he would probably sit down the rest of the slope. I had never known these slopes so iced. I do not see how they could improve that season. A light fall would be swept off whilst a heavy fall would avalanche. We stopped for coffee at the new Schwendi hut, a magnificent affair. The old hut, a short way below, would have been quite inadequate to cope with such a crowd. We had to wait an hour and a half at Kublis for the Davos train ; during this time six trains left for Zurich. At a rough guess I should say at least 3,000 people went down the Kublis run that day.

We left next day after lunch and a fond farewell for Klosters Dorfli *via* Laret and the " wood run," whose course was changed since last I knew it ; snow very wet. The *föhn* had come again and the thermometer at the Kurhaus, where we stayed the night, showed 4°C. of thaw. This was a bad start for the pass in the morning. Having gleaned contradictory local " knowledge " from the customs official (whose business it was to patrol the pass) and from our landlord (a guide and ski-teacher), we decided to make an early start, whatever the weather, and judge the best route for ourselves.

It was snowing at 6 a.m. on the 26th, the thermometer showed 2°C. of thaw, there was fairly thick fog in the village and the snow was wringing wet. However we started at 6.30 a.m. after warning our host he would probably see us back in the evening. Between Dorfli and the summer hamlet of Schlappin we passed the steep avalanche gullies we had been warned about ; all had fallen already except one, which was easily avoided by climbing a short way up the opposite side of the valley. Arrived at the hamlet we saw that the route the customs officer had recommended was far too dangerous, whilst the sketch the guide had made was too inaccurate to follow. We could not afford to waste time in reconnaissance and took the only safe route we could see, up a 45° thickly-wooded slope on to the Alp. The climb of 1,000 feet was tough. Emerging on the Alp, fog closed thicker than ever, the temperature was still high and snow wet. However we decided to go on and hope for the best. Choosing

a safe line in the occasional clear intervals, we finally reached the pass at about 1.30. During the last half-hour the clouds had cleared, and now the sun came out. On the north side of the pass we found four inches of dry powder snow lying on crust. The sun was not on the slope nor on the rocks above, and it did not look as though there had been a thaw on this, the northern, side. However, the slope was very steep—about 65°—so we waded down the first part before putting on skis and kept skins on to the bottom. The Gargellental gave us a glorious run of eight miles to St. Gallenkirch.

The next day P. had to leave for home. I walked to Partennen lazily; basked in the sun on a pile of planks at a sawmill by the wayside and admired the peaks of the Silvretta standing up clear-cut against a cloudless sky. Farther on I spent the last half-hour of sun sitting on a milestone, watching a very bored ski-teacher helping helpless women to their feet.

The 28th was not a cheerful day. The first part of the track to Zeinis Joch was steep and iced. Walking up, carrying skis and without crampons, was slow and tedious. Later I branched off for the Heilbronner hut, and above the tree-line found half a gale of wind blowing over the Alp, fortunately at my back. Lunch was an uncomfortable and chilly business, sitting on a soap box in the lee (?) of a small shed. The wind kept whirling the snow into the rucksack, the food and the back of my neck. Not knowing how long the wind had been blowing up here, I had to be careful of windslab and made a considerable uphill détour at one place to avoid traversing a slope of about 35°. The last couple of miles were very tedious as it was impossible to see the surface for drift. The snow being stratified, skis skidded about and would not bite on a side slope. Perched on a hillock in the middle of a broad valley, the hut gets plenty of sun and must be a pleasant place in which to stay in fine weather. The sun set in a glory like slightly-faded tinsel bursting through the black snow-clouds above, while the last rays tinted the eastern peaks flamingo. A streak of sky between showed peacock green. The rising full moon threw gigantic shadows across the valley. I had the hut to myself.

I rose next day to find thick mist, but no wind or snow. The hut-keeper said it was only a six-hour run to St. Anton, so I postponed a start hoping the mist would clear. It showed no signs of doing so and I left at eleven, unable to see the snow at my ski-tips. The wind had built numbers of little snow cliffs a few feet high; all slopes above 30° were suspect for windslab; the surface was all crust and pancakes. Speed was ultra-funereal and I reached the river-fork north of the Grosse Patteriol about one o'clock; lunched sitting on a bridge. Shortly after the track left the bottom of the valley and went up- and downhill through the forest. This was tedious until I put a skin on my uphill ski, a tip I had never tried before and which

proved most successful. You can climb very fairly well with the uphill skin only, the downhill ski being laid across the slope. For running you weight one ski or the other to regulate speed ; in steep places the lower ski, having no skin on, is available for stemming. I do not know that I can claim this as an invention, however, because, when I went to put my skins on, one binding broke, leaving me with only one skin !

In the forest I found tracks of chamois and of a larger antelope ; I do not know what this latter is. He has a fine antler with ten points, rather like a sambur, but smaller, spread about 24 inches. One sees head of both kinds in the inns.

The first inn I came to was the Mooser Kreuz and here I stayed. It had already snowed six inches ; by next morning there were 18 ; had I delayed leaving the Heilbronner I should have been stuck there. The forest track crossed several avalanche gullies which would have been most dangerous to cross in new snow.

My cold, which had been simmering, now broke out afresh and I spent the next couple of days in bed comforted with maps and the *Tiroler Ski Führer.*

On February 2nd I went up the Galzigg, which is the start of the Arlberg Kandahar. There I was enveloped in thick mist and had to find my way down mainly by compass. I afterwards saw this run, though I only ran a part of it, and I consider it most inferior to the Weissflue-Kublis, both for length and variety. There are some fine runs at St. Anton, such as the Valluga and the Kalteberg, but either is a long climb and they are not always safe ; the Galzigg is the only all-weather run available. Also you can do half the climb by bus to St. Christof, at the top of the pass, and I expect this has a good deal to do with the matter. I am afraid the vast majority of ski-ers nowadays are downhill runners.

The next day I explored the Pischelkopf and country west of it. Lunch on a warm rock was very pleasant. Here is good ski-ing ground, but I doubt if the ski-ing at St. Anton is good enough to justify its enormous popularity. Of course there is the Hans Schneider ski-school, but I think it is overrated and one can learn just as well and far cheaper elsewhere. I had intended to do the Valluga and Kalteberg before leaving, but much new snow had fallen and I had to give them a miss.

On February 5th I took train through the tunnel to Langen and went up to the Spuller See, intending to follow the Lechtal from there to Zug, thence to Lech and Warth. The track was much obstructed by fallen trees and obliterated by avalanches ; a very steep and nasty slope at the top had to be negotiated knee deep on foot ; I arrived at the Spuller too late to go on. Having turned back it started to rain, so I lost no time in coming down. I had been told it was quite an easy climb. Nobody had been there in winter and it was not really

passable in reasonable time. At 7,000 feet I put up a bustard at five yards. His explosion out of a dwarf pine was most alarming; he was a very frightened bird. His irridescent plumage looked well against the snow. I had some difficulty in drying my sodden clothes due to the fact that the "chimnist," as mine host called him, had failed to do his sweeping properly.

Next day I went over the Flexen Strasse to Zurs and Lech. This is a fine road, built out from the cliff, passing through frequent tunnels and avalanche-roofed for a good part of its length. At one nasty little gully, however, there is no roof, though a tablet tells of a man who was killed there. I found Lech an uninteresting place in the bottom of a foggy valley, so climbed to the Pension Hohe Welt in Oberlech. The snow had been sticky all day and from Zurs it was blowing a blizzard in my face as well. Oberlech has plenty of easy ski-ing and lots of sun.

I had been warned against going to Warth by the road on account of avalanches, and this was repeated here. Consequently I spent part of the next day reconnoitering a way round by the Saloper Sattel; went down to Lech for food; climbed up to the Mohnanfluk and had a fine run back.

The sun shone all day of the 8th. I went over the Saloper Sattel and down into the Seebach before the snow got soggy, and lunched on a warm rock in the sun. Passed a ski-hut in the valley shortly afterwards. A mile or two farther the valley narrowed to a dangerous "V"; the ski-tracks I was following crossed a footbridge and disappeared. Both sides of the valley were too steep to climb and, puzzled, I crossed the bridge. To my astonishment the tracks disappeared into a hole in the ground which proved to be the mostly snowed-up end of a tunnel. At Warth I found deck chairs ranged in the sun before the only inn; sank thankfully into one and called for coffee. Started at three and followed the sledge track to Steeg, about 10 miles down the Lechtal. It was rather fun running the narrow track, snowed-up well over the handrail, with about three feet between cliff and khud and the river a thousand feet below. Bit by bit the peaks of the Lechtaler Alpen opened up between the steep sides of the narrow, winding valley. A big avalanche I had been warned of near Steeg had already fallen and I climbed over the débris; a big one this, with fair-sized shattered trees mixed up with it.

Next day started walking to Stanzach, but half the distance on the iced road was quite enough and I gratefully took the bus for the rest of the way. At Stanzach I found carnival in full swing. The young men, dressed up, had chased all the women to refuge in the inn, where its modest potations produced amusing results. One of them aired her English on me assisted by the padre. The din was indescribable and drove me to an early bed, but the efforts of the local band still drifted to my room. I hope the low standard of their

efforts was due to good lubrication—a hospitable place the Hotel Crone, and when in peaceful mood is strongly recommended.

The 10th was occupied in an uneventful trudge to Namlos and Berwang. Passed a shrine in the forest with a picture of St. George and the Dragon. A very youthful saint dressed as a peasant wielded a vast two-handed sword in one hand, whilst with the other he held a pair of scales over the head of a harmless-looking creature like a prehistoric bat. It snowed on and off and finally settled down steadily for the night. The next day it was still snowing and I was due for a rest, so took a day off.

On the 12th it was still snowing and a yard and half of new snow on the ground. It was no use staying at Berwang indefinitely, and my plans for ski-ing through the Mieminger and Nordkette Gebirge were now shattered, so I waded to the railway station at Bichlbach. One avalanche had swept the track during the night, and many more would be coming down if the temperature rose a little or the sun came out. The train for Garmisch and Mittenwald was an hour and a half late and the line was reported blocked farther on. However, there was less snow to the eastward and we arrived at Innsbruck three hours late.

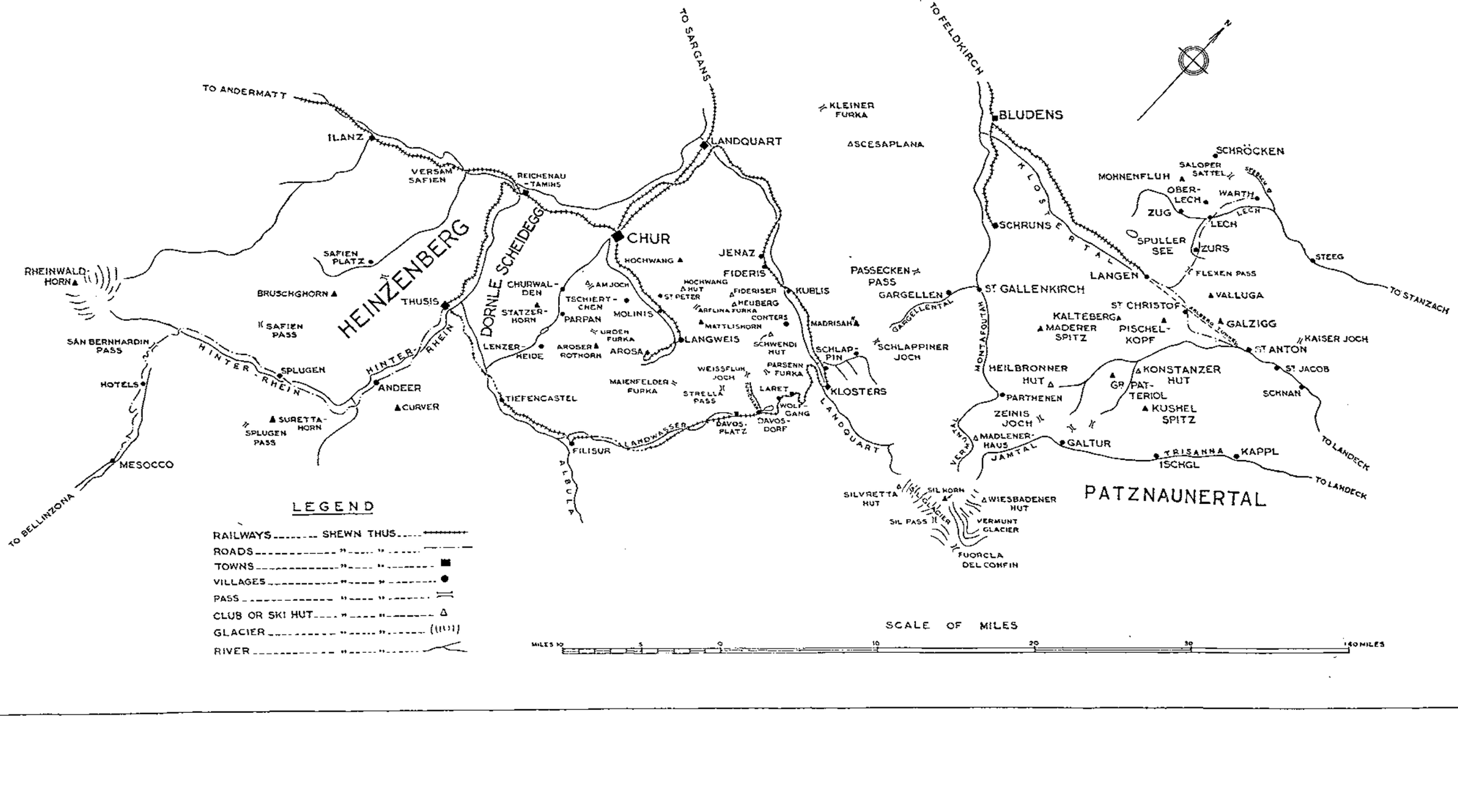
The 13th was spent bathing, changing, reading and writing letters.

Took the ropeway up the Patcherkopf in the evening and stayed the night at the clubhouse with a crowd. There had not been nearly so much new snow on this side of the inn and the prospects of continuing the tour looked much rosier. I woke early in an awful fug, opened the window and shut the radiator; great consternation when the others woke but I lay low.

Sunday the 14th broke fine and off we all went to the Glungezer hut (8,750 feet). More people joined us there; the fug and squash for lunch were hectic. All were doing the run down to Hall, so I presumed it must be good. I had intended to stay the night at the Glungezer, and continue along the ridge to the Litzumer hut next day, but was told the route was difficult and untracked. This, coupled with the depressing prospect of spending the rest of the day there alone with nothing to do, and the likelihood of a bad sleep at that height, decided me to do the Hall run as far as the Windeck hut, strike across into the Wattental, and make the Litzumer that way. It might take a day longer but was safer alone.

The run was a difficult one with a mixed bag of deep snow, beaten snow, rocks, steep paths through forest and some ice in the lower part. On one iced side slope I fell and hit my head rather hard. Fortunately this was close to the Windeck, so I stopped the night there. It had not been a pleasant run—rather too difficult for me—but it was an education watching the others; a far higher standard than Davos. The only Englishman I saw was shepherding some girls, rather showing off and seemed likely to break his neck. The

MESOCCO TO LECH



LEGEND

RAILWAYS ..... SHEWN THUS
ROADS ..... " .....
TOWNS ..... " .....
VILLAGES ..... " .....
PASS ..... " .....
CLUB OR SKI HUT ..... " .....
GLACIER ..... " .....
RIVER ..... " .....

SCALE OF MILES

MILES 10 5 0 10 20 30 40 MILES

Austrians were very nice and most solicitous and helpful when I came my crack.

The 15th was a most enjoyable day. I had slept off my headache and reduced my swollen eye enough to see. Crossing the Voldertal, I made my way through the woods of the Vogelsberg along logging tracks. These obviously had not been used that winter and were choked with snow. The air was sharp and clear; the newly-fallen snow on the trees sparkled under a bright sun and cloudless sky; tracks of hares everywhere. The only sounds a shower of snow from an overladen tree-top, the twittering birds, a busy woodpecker, an aeroplane. Descending into the Wattental I followed a track upstream to the Wirtshaus Sage. Here the diminutive landlord was sawing logs at the mill, whilst his hefty wife fed me in the kitchen. A modern turbine had replaced the primitive overshot wheel one commonly sees. A comfortable night in a large room with a roaring stove.

The trudge up to the Litzumer hut was tedious and tiring. A thaw had spoilt the snow effects on the trees and made the air relaxing and oppressive. Arrived at the hut just in time to see a couple of men do a magnificent descent of the Geier Spitz, the two together doing figures of eight down the steep northern face. I spoke to one of them later about my proposed route the next day to Lanersbach and Maierhofen by the Tor Joch. The map showed an impassably steep place; he confirmed this and advised a long détour which would, however, provide some excellent running. From Maierhofen I decided to go by the Gerlos Pass and Salzach Joch to Hopfgarten and home.

Snow started again in the evening, fell all night and the following day. Took an hour's exercise in a mild blizzard and played five games of chess. Next morning it was still snowing; about a yard and a half of new snow had fallen; even if it stopped snowing now no route would be safe for some days; nothing would induce me to play any more chess; the only escape from the hut was the way I had come. The twelve miles' run down to the railway was very pleasant over untracked paths in the woods. Caught a slow train to Innsbruck, collected my suitcase, paper and mail, wired home and caught the evening train for Paris.

And so the tour ended, as it had always been, on a sudden change of plan. I had on the whole followed my general route and had only one of my *Times* weeklies sent to a place I never visited. I had my fair share of good weather; a single fine day wipes out many bad ones. A good deal of optimism is necessary on a tour of this kind; we should never have got over the Schlappiner Pass if we had not started out under adverse conditions and hoped for the best. People say, "You must wait for a fine day." My answer is that if you do that you will not get far and you will be terribly bored waiting.

Better to start out in any weather fully prepared to return ; your luck may turn before the time comes to go back. This happened on several days ; only once did I have to turn back and that was not actually due to the weather, but " time and space."

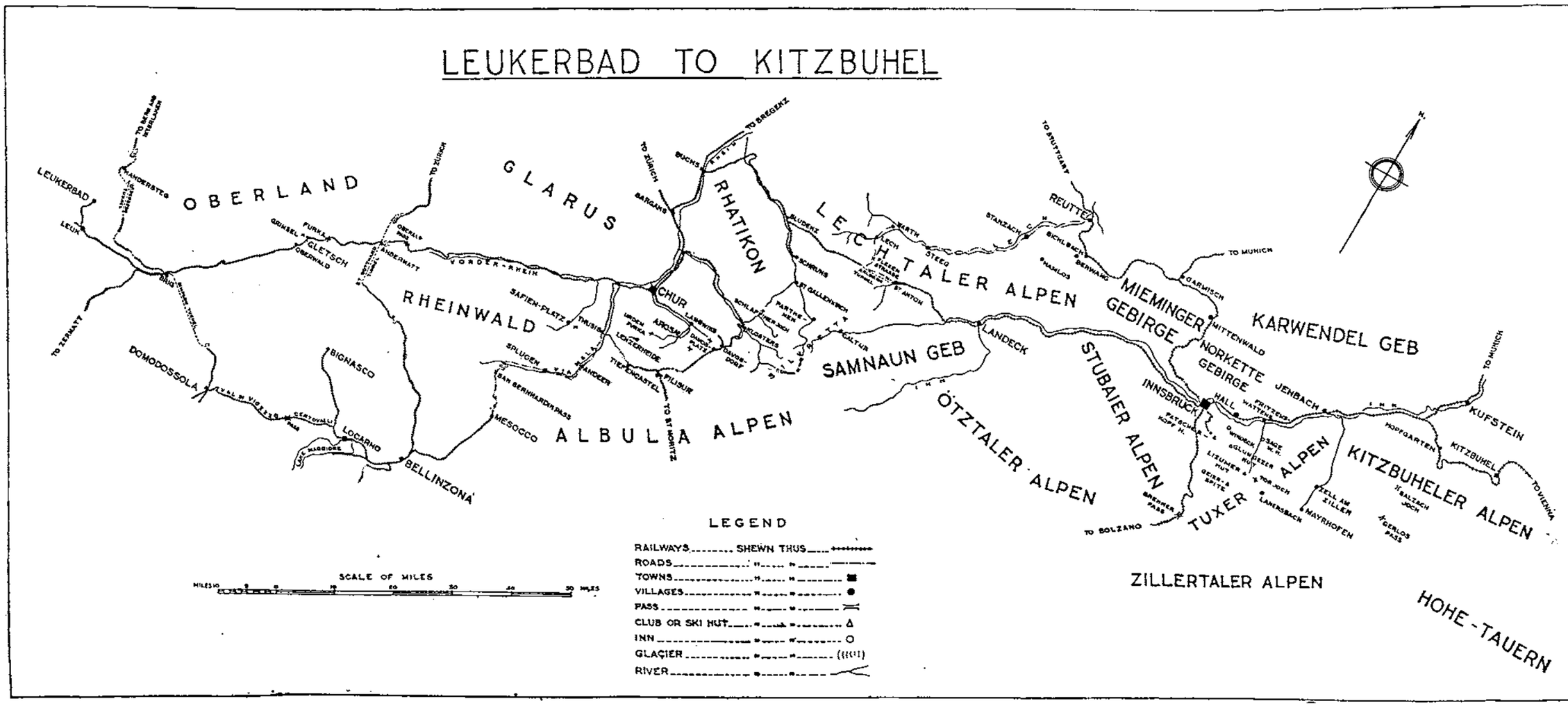
In this account I have included a good deal of rather commonplace incident, but it does not pretend to be other than a commonplace tour. My object is to bring out the kind of difficulties that arise and how they may be overcome. If I have succeeded in interesting a few, I hope they will be persuaded to do likewise and then it will be easier to find touring companions. Given determined caution there is no reason why such a tour should not be done alone, but lone ski-ing is not recommended and is to be avoided if possible.

A few notes about accommodation and cost may not be out of place. Even the roughest inns in Switzerland and Austria are clean. The only time I was upset by, I think, a dirty saucepan was in a middling class hotel. Comfort varies enormously, but is relatively unimportant. By the time you have had a meal, written up the diary and read a chapter of your favourite author, you will be ready for bed. Innkeepers are all most friendly and helpful, the lesser the inn the more helpful.

The cost of dinner, bed and breakfast at an inn or hut averages about 6s. Another 1s. 6d. a day pays for bread, butter, cheese, chocolate, etc., for lunch. It is quite safe to reckon on 10s. a day, which will also cover the odd lunch at an inn and incidental expenses. When going to a hut it pays to take one's own food, ham, eggs, sausages, etc., and have them cooked ; otherwise food in huts comes rather expensive.

Furka, pass, sattel = Pass.
Tal = Valley.
Alp = Meadow above tree-line.
Wirtshaus = Rough inn.
Gastzimmer = Sitting- cum dining-room.
Bach = Stream.
Führer = Guide.
Rettungstelle = First-aid post.
Föhn = Moist south wind.

LEUKERBAD TO KITZBUHEL



SCALE OF MILES

MILES 10 0 10 20 30 40 50 MILES

LEGEND

RAILWAYS	SHEWN THUS
ROADS	" "
TOWNS	" " ■
VILLAGES	" " ●
PASS	" " ⋈
CLUB OR SKI HUT	" " △
INN	" " ○
GLACIER	" " (((((
RIVER	" "

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.)

PROFESSOR DAVID. THE LIFE OF SIR EDGEWORTH DAVID.

By M. E. DAVID.

(Edward Arnold. Price 12s. 6d.)

Professor David—everyone called him "Professor" even when the highest honours came his way—was closely associated with the Corps during the Great War, serving as he did as Geological Adviser on the staff of the Engineer-in-Chief, G.H.Q., France, from October, 1916, until the end. But apart from this his life, written by one of his daughters, should be read by all ranks of the Corps who can get hold of the book, as it is the record of a delightful and knightly personality, an example to the Empire at large.

An officer of the Corps wrote to him when he was sailing for Australia in March, 1919: "You know how all of us who have had the good fortune to come in contact with you feel that they have gained from the association—you have been a pattern to us all in courage, courtesy and tact—and I may add in unremitting hard work, and putting your very best into whatever duty you were given to do." This sums his character up; but Miss David has managed to give a lifelike picture of the man, with sufficient account of his work to show what it was, how he set about it and how he achieved so much. It will be somewhat alarming to fathers to find that daughters know so much about them and are their best biographers, as this book and the "Lives" of Lord Salisbury, Gerald du Maurier and Henry Arthur Jones, to mention recent publications, are evidence.

Tannatt William Edgeworth David—his family always called him Edgeworth, he told me once that his first name brought him many hard knocks at school—was born in 1858, the eldest son of a parson, and was intended for the Church. Educated at Magdalen College School and New College, Oxford, he took a first in "Honour Mods," but then broke down in health. As a boy, his mother's cousin, W. A. E. Ussher of the Geological Survey, had aroused in him an enthusiasm for geology which was never afterwards quenched. Advised to follow an outdoor career after his breakdown, he took up geology as his life-work, and in 1881 was offered the position of Assistant Geological Surveyor to the Government of New South Wales. He very soon did important work in locating tin, coal and gold, in 1891 was appointed Professor of Geology in Sydney University, and in 1897 rose to world scientific fame by successful deep-boring operations under difficult conditions in a coral atoll. This fame was added to when at the age of 50 he was a member of Shackleton's expedition to the South Pole, was one of the first of the party to climb Mount Erebus, and was the leader of the party which reached the South Magnetic Pole and planted the Union Jack there. His selection for such work at 50 is evidence of his great vitality. I happened to ask the Professor whether Shackleton had him medically

examined. "No," he said, "he only looked at my eyes." As a daughter, other than the authoress, wrote to her mother after she had visited the Professor in hospital in 1916, there was always "the same dear twinkle of eternal youth in his blue eyes."

When war broke out in 1914, Professor David devoted his powers of oratory to recruiting; being 57 the authorities could find no other military use for him. But his opportunity came in February, 1916, when the Commonwealth Government, on his representations, decided to raise a three-company battalion of tunnellers, and he got himself accepted as an officer. The colonel said to him, "You cunning old dog! That's why you were so anxious to have the battalion formed."

The battalion reached France in May, 1916. Many of the Professor's adventures and his services were recorded in his memorial notice, written by the late Major-General R. Napier Harvey in this *Journal*, but the book is very much fuller as David wrote home very regularly. It shows, with diagrams, some of the ways in which the geologists rendered good service. In October, 1916, he was transferred to G.H.Q. as geological adviser to the Inspector of Mines, and there remained. The parts of the book which refer to his membership of the Engineer-in-Chief's Mess will be found very entertaining. There was one catastrophe: the two or three officers who drank port (Harvey's port) did so out of claret glasses. The Professor thought they used big glasses from necessity; so the very first time he went on leave he bought and presented to the mess some of normal size. Out of politeness they were taken into use; but the E.-in-C. at least was not pleased.

The war over, the Professor returned to his Chair in Sydney University, retiring from it at the age of 64 after 33 years' tenure, at the end of 1922, on the grounds that first he ought to give place to a younger man, and secondly, that he desired to give all his energies to completing a book on the geology of Australia. But all sorts of current geological work—oil in particular—claimed his attention. In 1932, however, his large geological map of Australia was published with a volume of explanatory notes. Arthritis crippled and troubled his last days, and the three-volumed book was never finished. He died on 28th August, 1934, being 76. Many honours, academic, scientific and military, had been conferred on him, and many kind things were said of him in his lifetime; the University and the tunnellers competed to give him the final honour of a special and a military funeral; but the Commonwealth Government stepped in and ordered a State funeral, and the Senate and House of Representatives voted a motion of regret and condolence, an unusual honour for one who had never been a member of the Federal Parliament. Thus passed away the most learned and most courteous man I have ever met. His poineer work on the geology of Australia will not be forgotten for many a year; his memory is perpetuated by the "David Lectureship" in Sydney University, founded during his lifetime in 1933.

J.E.E.

HALDANE, 1856–1915.

THE LIFE OF VISCOUNT HALDANE OF CLOAN, K.T., O.M.

By Major-General Sir FREDERICK MAURICE, K.C.M.G., C.B.

(Published by Faber and Faber, Ltd., 24, Russell Square, London. Price 18s.)

No soldier who served in the South African and Great Wars can have any doubt of the truth of Earl Haig's dedication that Lord Haldane was "the greatest Secretary of State for War England has ever had." This truth may not, however, be so apparent to the post-war generation, who have no first-hand knowledge of our lack of military preparedness at the beginning of this century, and for these in especial this book is a mine of information. Lord Haldane, doubtless due to his innate modesty, did not emphasize sufficiently in his autobiography the far-reaching results of his

work at the War Office, nor did he deal adequately with his traducers. It is only fitting, therefore, that a soldier of the calibre of Sir Frederick Maurice should have undertaken his vindication.

Lord Haldane had not an impressive personality, nor was he a great orator. He had, however, a powerful intellect, a marvellous memory, colossal industry and a gift for organization. Called to the Bar in 1879, he rose rapidly in his profession; entering Parliament seven years later as a Liberal, he took silk in 1890, at the early age of thirty-four, and when he joined the Cabinet in 1905, he was earning an income of £20,000 a year. As a young man Haldane had studied philosophy at Göttingen University, and as he wrote he "had never been pro-German in any other sense than that he knew and admired German literature and German thought, and the German power of organization." Throughout his career he maintained his interest in Germany and in philosophy, and he visited the Fatherland frequently.

In many ways Haldane was considerably in advance of his times. In the early nineties he advocated not only Women's Suffrage, but also a Ministry of Labour. These did not take shape till some thirty years later. Haldane took a passionate interest in education, and perhaps the most important and far-reaching work of his early days was the prominent part he played in promoting in 1898 the University of London Bill. At the same time he showed his skill as a diplomat by nearly succeeding in passing a University of Ireland Bill. The Conservative Cabinet, however, fearful of religious discord refused to sponsor it. Ten years later his bill was passed by the Liberal Government with little alteration or opposition.

In 1894 Haldane made the acquaintance of the Prince of Wales, who had asked to meet him, as the Prince expected Haldane would be his Chancellor one day. This rapidly ripened into a friendship, which was of vital assistance to Haldane in his work of army reorganization.

When the Liberals came into power in 1905 under Campbell-Bannerman, Haldane hankered after the Woolsack, but C.B. was determined to have Sir Robert Reid as his Chancellor. Refusing the Home Office, Haldane asked for and received the War Office, which as C.B. remarked, "Nobody would touch with a pole." Ever since the end of the S. African War army reorganization, including that of uniform, had been to the fore, and Haldane, imbued with the thoroughness of German organization and of the German General Staff, felt that he was the man best equipped to undertake this task.

It is not often that generals are accused of being angelic, but Haldane in a letter to Gosse written a fortnight after his first appearance at the War Office, states: "The dear generals are angels, no other name is good enough for these simple honourable souls."

The chief monuments to Haldane's work at the War Office are the Expeditionary Force, the Territorial Army, the Special Reserve, the Officers Training Corps, F.S. Regulations, the Imperial General Staff, and last, but by no means least, the organization of the Dominion Forces on the same basis as that of the British Army. This was achieved within five years with the co-operation of Haig, Sir W. G. Nicholson, Cowans, and numerous others, most of whom rose to distinction in the Great War. These improvements were not, however, carried out without considerable obstruction from his fellow Cabinet Ministers and from the Opposition, notably in the House of Lords. That he was able to push them through was a tribute to Haldane's persistence and to his diplomacy, coupled with the powerful backing he received from King Edward VII. As an example of his mental powers, it may be mentioned that one day during this controversy a staff officer took to the House of Lords a sheet of foolscap detailing the General Staff's view on the subject under discussion in the debate on the Army Estimates. Haldane read it through once, returned it to the officer, and then by an admirable speech of over an hour and a half, detailing every point in the paper, he gained a majority in the subsequent division.

Having reorganized the Army, in 1910 Haldane was very anxious to do the same for

the Navy, the first line of defence of the Empire, and which as investigation showed was sadly in need of a naval policy, and of a naval War Staff to expound it. Haldane was, however, raised to the peerage in this year in order to strengthen the Liberal debating power in the House of Lords, and this tipped the balance against him, when Asquith decided to make a change at the Admiralty—the post being given to Winston Churchill.

On the resignation of Lord Loreburn in 1912, Haldane was appointed Lord Chancellor, and thus severed his connection with the Army, much to the regret of the generals and of the War Office staff. Colonel J. Seely was appointed S. of S. for War in his place.

Haldane, as previously stated, had always kept up his connection with Germany, and his knowledge of German and the Germans was of great use to his colleagues in the Cabinet in the mission he undertook to Berlin in 1912, in order to further the cause of peace. Admiral von Tirpitz was, however, too strong for the German Chancellor, Bethmann-Hollweg, and this visit proved abortive. It is, however, interesting to note that Haldane, who knew more about the inner history of the causes of the Great War than most Englishmen, wrote later:—"I hold him (the Kaiser) deeply responsible for the war, for I am satisfied that he could have averted it." One unexpected result of this mission was to provide the Press with material for an attack two years later on the man who had done his utmost to stave off war, and to provide his country with an army larger than ever before known in history, and as scientifically organized as that of the Kaiser.

On the outbreak of the Great War, Haldane to assist the Prime Minister temporarily took over the War Office, but he wrote at once to Asquith, and strongly recommended Lord Kitchener for the post.

This book is a complete refutation of the charges made by the Press and some politicians that Haldane was a pro-German. It is sad to relate that it was the Conservative party, under Bonar Law's leadership, who drove him from office in 1915, on the formation of the Coalition Government. This in spite of the fact that Haldane, though a Liberal, had supported the Conservative Government during the South African War, and had refused to avail himself of the cry of Chinese slavery, utilized with much effect by the Liberals in the general election some years later. Had Kitchener availed himself of Haldane's experience and based his new armies on a territorial foundation, much of the disorganization at the outset of the war could have been avoided. Had the Committee of Imperial Defence functioned as a General Headquarters of the Empire, as Haldane in 1910 intended that it should, many blunders might have been avoided.

This volume, written in General Maurice's usual very readable style, is of absorbing interest not only to the military reader, but also to the general reader, investigating pre-war history.

C.G.F.

THE WAR IN THE AIR. VOL. VI.

By H. A. JONES.

(Oxford University Press. Price 25s. including Appendix.)

This is the last volume of a series which gives us the *Official History of the War in the Air*. Like the preceding volumes, this book leaves the reader with the impression that subjects, some of them highly controversial, have been treated with skill, fairness, and accuracy. At a time like the present, with the problems of air power becoming increasingly important and difficult, the data which this volume in particular supplies is of the utmost value.

The book opens with a chapter on the creation of the Royal Air Force and a separate Air Ministry. This is a problem of the past, but the chapter is instructive in

showing the difficulties of any major re-organization, whether in ministerial or Service circles, in the middle of a great war. No one prior to 1914 foresaw the great expansion of the Air Force. General Smuts' great contribution to the Empire in the Great War as an independent adviser of authority is very apparent in this chapter. It is interesting to be reminded that the separate Air Ministry owed its creation to the effects of the first German daylight bombing of London.

The next portion of the volume contains records of the difficulties met with in the expansion of the Air Force itself, as experienced particularly in 1916 and 1917. The history of these troubles offers lessons which apply equally to any intended large scale war munitions production, be it guns, tanks or bridging material, and as such should be widely read. The familiar problems of indecision as to design, demand ahead of design, multiplicity of types, uncertainty as to scale of production, etc., are all described. The effect of uncontrolled competition of different forms of industry for available labour and materials is well brought out. An acute shortage of skilled labour arose in 1917. Lord Kitchener, we are told, was in favour of allowing skilled men to enlist if they wished. The effects of this on subsequent production are made apparent. This history shows only too plainly how, from the start in any future struggle, our resources in manpower, raw materials, industry and shipping must be controlled and parcelled out to the various Fighting Services and Government Departments. There is in this section an instructive reference to the methods adopted for encouraging munition workers, giving them a chance to see in what way their own efforts were helping to win the war.

In these days men are wondering what the limits to air-power will be. Some of the records in this history bear on this point. In June, 1917, it was decided to expand to 200 service squadrons. By 1918, the total of 340 such units was required, but reduced on account of manpower shortage to 275. At the armistice, in fact, only the equivalent of 189 service squadrons were in action, though 340 were projected for 1919. Sir Douglas Haig's scale of requirements in aircraft as asked for in 1916 were just met by 1918. The principal reason given for this failure to meet military needs, apart from the labour shortage, was the lag of 18 months in the output of engines. France delivered 8,000 engines in 1918, but the U.S.A. were never able to do much for us, though they sent over 15,000 mechanics. The wastage in engines proved to be 100 per cent. per annum. With its reserves, a squadron required 80 engines. To meet the pilot casualties for 106 service squadrons, a scale of 97 training squadrons had to be maintained. To maintain in action the 340 service squadrons aimed at for 1919, on the above figures, the engines required ran into colossal figures. The decision to operate even 200 service squadrons in 1917, we are told, meant an output of 4,500 engines per month, at a cost of £200 million per annum. In air frames, we read that to keep 1,800 aircraft in the field, 1,500 had to be produced each month. Reserves we are told, should be 500 per cent. in excess of first line strength. These various figures give some indication as to the limits that may be placed upon air-power in future. Certain Great Powers to-day are reported to possess 1,500 first-line aircraft. On the above records of the last war, the reserves and continuous output necessary to keep such air-power in action are shown to be prohibitive. When the wasted expenditure, due to the repeated obsolescence of accepted types and the high cost of production are taken into account, it is clear from this history, that even for the wealthiest countries with the largest manufacturing resources, there is an early limit set to the possibilities of air-power.

The next chapters, in discussing the creation and operation of the Independent Air Force, raise most important questions in connection with the proper employment of air-power While the young Air Ministry favoured their own control of the Independent Air Force, and its use against the German morale and industrial output, the French were adamant in their view that this Force should be placed under Foch and used primarily as an adjunct to military operations. Though the French gained their point, much latitude seems to have been given to the Independent Air Force.

This is a question that might so easily arise again, though with the increased range of modern bombers there might be less need to use Allied air bases and less occasion to bow to Allied pressure. The author says "the temptation to dissipate effort will invariably be great." He shows, with examples, how hard it was for the Allied and German High Commands alike to select the correct objectives for air attack. He emphasizes how the correct employment of air-power must vary with every situation. From the experience of the last war, only the highest centre of inter-service control, in fact the War Cabinet, armed with very good information, would be in a position to indicate the proper use of its own air weapon.

The accounts of operations bring out numerous points of importance. The influence of weather on bombing was great. On one occasion, for 18 successive days and nights no operations were possible on account of weather. Generally, the results of attacks on railway systems were disappointing. It is shown how easily attacks aimed at military targets became attacks on a civilian population. It is claimed that attacks of the Independent Air Force turned the scales in the fight for the upkeep of German morale. Certainly the existence of this bombing force of a mere nine squadrons forced Germany to tie up excessive resources in anti-aircraft defence. Thus against one British raid, the Germans fired 16,063 shells and used 173 searchlights. The action of the Independent Force was considered so valuable that in the proposed Air Force for 1919, squadrons were allotted Army 36 per cent., Navy 25.8 per cent., Independent Air Force, 32 per cent. and Home Defence, 6.2 per cent.

As to the material effect of heavy bombing, the most striking example (p. 150) is that of a 1,650 pound bomb, which, landing in the court-yard of a factory, demolished a three-storey building, 100 metres square. The people in the cellars below, with one exception, were unhurt.

Later chapters, of less importance to-day, deal in detail with the part played by air forces in Palestine, Mesopotamia, Italy and Macedonia, and contain a record of operations with the Royal Navy and with the Army in the big battles of 1918 in France.

B.C.D.

OFFICIAL HISTORY OF AUSTRALIA IN THE WAR OF 1914–18.

VOL. V. THE A.I.F. IN FRANCE, 1918.

By C. E. W. BEAN.

(Angus and Robertson, Sydney. Price 21s.)

This portentous volume of 825 pages covers the period December, 1917—May, 1918, but all but two chapters are devoted to the German offensives of March and April, 1918.

Chapter I entitled "The Australian Corps" discusses with considerable frankness, matters political and military concerning the organization, administration and control of the Australian troops in France. In reading it, one gets some further insight into the troubles which faced Lord Haig in driving his Imperial team, quite apart from difficulties with allies, and with the Home Government. The latter in turn had their own difficulties with Dominion and allied Governments besides those encountered on the home front.

It was difficult enough when the Commander-in-Chief had to deal with duly accredited representatives of Dominions, like General Birdwood in the field and the High Commissioner in London, but the situation was further complicated by the intervention of a journalist confidant of the Australian Prime Minister.

Many were the difficulties which arose over the organization, command and staff, and discipline of the Australian forces. Each matter is dealt with frankly and with a marked lack of bias.

Chapter II deals with the winter campaign in Flanders, and then we pass on to the period of the German Offensives.

The Australian Divisions in the March attack were brought up in rear of 3rd and 5th Armies to stem the German tide. While the impression left at the time on the Australian troops was that of disorganized units and formations making their way rapidly to the rear, the author is at pains to show that this was not the true picture. The apparent rabble which the Australians saw was not the true Fifth Army, which was still fighting its way doggedly back, checking the German advance as it could. He makes it clear that it was the Fifth and Third Armies themselves which finally stopped the advance aided, it is true, by the support of Australian and other freshly arrived troops.

Later we find the Australians in the region of the Forest of Nieppe fulfilling a similar role to that which they had just played near Amiens.

The story is told in the same style as in earlier volumes. If anything, the tale has gained by the author's increased experience of his task. Where the account is of such special interest to military students, is that Capt. Bean first tells the story as it appeared to the men on the spot at the time, and then draws back the curtain and lets us see what really happened in a tale culled from official and unofficial documents of both sides. Such a method makes it easier to appreciate why certain actions were taken, and how faults occurred, the only useful method for the student of war.

The description of quite minor actions in the method described above will be a great help to the junior regimental officers, and even N.C.O's, without war experience in appreciating problems such as they themselves may be called upon to solve in the conditions of uncertainty and confusion which are inseparable from war.

Finally, the frank character sketches of officers of all ranks add the final human note to make the pictures complete.

HISTORY OF THE GREAT WAR.

Order of Battle of the Divisions.

Part 2B.—2nd-Line Territorial Force Divisions (57th–69th), Home-Service Divisions (71st–73rd) and 74th and 75th Divisions.

Compiled by Major A. F. Becke, by direction of the Historical Section of the Committee of Imperial Defence.

(H.M. Stationery Office. Price 10s.)

Part 2B follows for each division the same sequence—nominal roll of commanders and principal staff officers, General Notes, Order of Battle, Formation and Narrative—as from the previous parts. The thirteen 2nd-Line Territorial Divisions had their origin in the raising of units to replace Territorial units sent overseas in the early part of the War, and from these, mostly during 1915, divisions were formed and trained under considerable difficulties as to equipment. One of the divisions was broken up in 1917, five remained on Home Service till the end of the War, and the remaining seven (all English), after a period of Home Service, proceeded to various theatres of War. The 71st, 72nd and 73rd Divisions were formed for Home Service late in 1916 and broken up in early 1918. The 74th and 75th Divisions were formed in Egypt from dismounted Yeomanry brigades and served in Palestine and, in the case of the 74th Division, in France.

There are a number of appendices, including a note on the "Central Force."

This volume, like its predecessors, is an invaluable work of reference, and a model of clear and accurate compilation.

E.V.B.

THE HISTORY OF THE ROYAL ARTILLERY. VOL. II (1899–1914).

By Maj.-General Sir JOHN HEADLAM, K.B.E., C.B., D.S.O.

(The Royal Artillery Institution: Woolwich. Price 10s. 6d.)

The period covered by this volume of the *History of the Royal Artillery* was one of the greatest importance, not only to the Regiment itself, but to the Army at large, for it saw the development of a new spirit engendered by the experiences of the South African War; and amidst that revival of serious study of their profession by all ranks of the Army, the progress of the Royal Artillery was marked by achievements and developments which bore much valuable fruit in 1914–1918.

The Royal Artillery had had very little war experience during the long period from the Crimea to the Boer War. Even the introduction of breech-loading and rifled guns had not completely shaken off the enervating effects of the long peace—effects which clung alike to all branches of the Army. When the war in South Africa broke out, the unprecedented demands upon the Army—starved as it was in every department—came upon the Royal Artillery with especial weight, for both guns and gunners were insufficient.

The Regiment's services in the South African War are to be given a separate volume, but the lessons learnt are now described at length. The sudden expansion in the number of batteries required and the necessity of finding and training the additional officers, put a tremendous strain upon the organization at home, which had only recently been affected by the separation of the mounted and dismounted branches. To those who are familiar with the infinitely greater expansion required in 1914–1918 and with the manner in which it was carried out, it may not seem remarkable that 7 additional horse and 56 additional field batteries had to be raised in 1900; but the nation was not then organized for war. The Army at home was denuded of guns and ammunition. The reserves were so depleted that it became necessary to purchase guns abroad, and 108 Ehrhardt field guns, complete with carriages, wagons and ammunition, were secretly shipped over from Hamburg in packing cases, in order to re-equip the Aldershot Army Corps in 1900.

The sudden realization of our lack of any reserves of material worthy of the name and the insistent efforts of General Sir Henry Brackenbury, R.A., who, as Director-General of Ordnance, was tireless in his representations to the Government, gave rise to the appointment of the Mowatt Committee, to whom we owe the "Mowatt Reserves." For the first time, the principle became established that reserves should "be included in all orders for equipment, and that any issue from reserve should be automatically replaced." England has always been fortunate in finding at hand the men to help her out of awkward predicaments, and at the time of the South African War, Sir Henry Brackenbury was one of those men.

The supply of officers was met by opening up a number of sources, notably by shortening the term at the "Shop." Out of 402 commissions to the Royal Artillery granted from the ordinary sources during the period 1st January, 1899, to 30th September, 1901, 323 went to cadets of the R.M.A.; and out of 456 direct commissions granted during the same period, the universities provided 181 and the Militia 120.

It was natural that the influence of the South African War should be prominent when the Army settled down to take stock of its experiences. The unexpectedly long duration of the campaign, the appreciation of the effects of the rifle as a defensive weapon, and the emergence of a number of earnest and capable commanders in the prime of life, combined to lead the Army to determine that it should never again be caught so unprepared. How the Royal Artillery made use of their new opportunities is described by General Headlam in chapters of the greatest interest and clarity.

The South African influence made its appearance in the new edition of *Field Artillery Training* of 1902. Massed artillery and open positions handed down from 1870 were things of the past. Smokeless powder and longer ranges gave power of

concealment; improved rifle fire enforced it. And with the necessity for taking advantage of natural cover came the necessity for new methods of indirect fire. The new manual introduced no revolutionary changes, but it did introduce a new freedom from rigid rules of tactics, and inculcated a general flexibility in the application of principles. These were the first fruits of the South African experiences. The very change in the titles of the manuals of that period indicated the broader view which was now permeating the Army as a whole. The "Drill Books" became "Training Manuals."

General Headlam describes the improved methods which were now practised. Reconnaissance by brigade and battery commanders became a real function. Bringing artillery into action was now a military operation requiring skilful handling and thorough training, and was not the spectacular parade-ground performance which displayed perfection in drill and little else. There were, besides, new methods to be tried out in the technical businesses of laying, ranging, and the observation of fire. The practice camps—now greatly improved by the acquisition of the extensive ranges on Salisbury Plain in 1901—were brought up to date, and the courses became opportunities for keen officers to work out the new theories.

Many are the details given by General Headlam of the all-round improvement which then took place—changes which can be so readily taken for granted now, but those of us whose experience goes back to those days will appreciate what real changes they were.

Two years later, in 1904, a fresh edition of the *Field Artillery Manual* appeared, embodying the progress made in training. The new quick-firing equipment had been issued to horse and field artillery, and now the heavy batteries, manned by the R.G.A., were added to the divisional and corps artillery. For the first time, an expeditionary force was organized, and units and the men who would command them in war were in training together.

Three chapters of the history are devoted to the account of this re-armament and reorganization, and although the details are technical, they are presented to us in a fashion which compels our interest.

Then came the Russo-Japanese War of 1904–5 to introduce fresh experience, and new lessons had to be deduced. Neither Russia nor Japan had quick-firers of the latest type, General Headlam tells us, but too blind a deduction was avoided.

The General Staff produced a new *Artillery Training Manual* in 1906, but it had as short a life as its predecessors, and a further edition in 1908 had to be issued, "to which we must look to find the full effect of the Manchurian influence." The new doctrine recognized the futility of attempting to silence guns in action, the necessity for closer support of the advancing infantry, and the importance of reserving effort for the decisive attack.

Without a perusal of this book, it would be difficult to appreciate the full significance of these varying influences. It seemed that no sooner had one training manual been issued, than its teaching was superseded by another. This rapid succession of manuals was not peculiar to the artillery. The *Combined Training* of 1905 was only the forerunner of a whole series of Field Service Regulations. But each fresh edition marked a stage towards further efficiency. There can be no finality in military education, and it must be remembered that for some years before the war, the Army knew, and appreciated the fact, that Continental war was imminent; every effort to keep up to date was an obvious necessity. The Royal Artillery, at any rate, was not content to stand still.

Meanwhile, the French, considered the best artillerists on the Continent, had re-armed their field artillery with their famous 75's; but these had been kept a close secret, and it was not until 1910 that British artillery experts were invited to watch French artillery practice at close quarters. The French had paid much attention to the study of artillery and infantry on the battlefield. When a nation has gone to the expense of re-arming the whole of its field artillery, it is natural that

its military authorities should be interested in a subsequent re-arming of a Continental neighbour. The *entente* with France, moreover, was bringing about frequent exchanges of visitors interested in these matters; and in a chapter devoted to the "French Influence," General Headlam describes the controversy of 1911, which arose on the French Artillery Regulations. A further edition—but only a provisional one—of our manual appeared in 1912 as a result.

The Balkan wars of 1912–13 furnished no new lessons, but the "changes in the Regulations during the last eighteen months before the Great War are of peculiar value as illustrations of the trend of opinion during the final phase of preparation." A more permanent edition of the training manual was published in 1914, which included sections dealing with the co-operation of aircraft with artillery. The R.F.C. had already taken part in the trials at the practice camps of 1912 and 1913; but anti-aircraft gunnery was still a very vague notion.

In a chapter on the "Final Phase," General Headlam brings us up to the eve of the Great War.

Just as the author deals with the horse and field artillery and shows the successive influences of the South African and Manchurian Campaigns on the training, organization and equipment, so he deals with the siege artillery and with the coast artillery. Space does not permit of similar reference to these chapters, but they are written with the same completeness and methodical development as the others. The auxiliary forces have two chapters, and the volume closes with such family matters as the Institution, the Repository, the Artillery College and the Bands.

This history forms one of the most valuable contributions to the history of the Army as a whole. In reading it, we are made aware of the great revival in military art which fortunately roused the British Army—and the British nation—from its old picturesque habits of war, in time to enable it to prepare for the great ordeal of 1914–18. The creation of the General Staff, the reorganization of every branch of the service, the readiness of all ranks to absorb the lessons of the recent wars, and the creation of the Territorial Force by Lord Haldane, all belong to the period covered by General Headlam's book; and he has given a remarkable account of the part played by the Royal Artillery in this striving after efficiency.

W.H.K.

THE ART OF THE ADMIRAL.

By COMMANDER RUSSELL GRENFELL, R.N.

(Faber & Faber, Ltd. Price 12s. 6d.)

This is an interesting book on the elements of naval strategy, simply and clearly written so that no special technical knowledge is required to follow the writer's argument. Commander Grenfell has been lecturer to the Royal Naval Staff College at Greenwich and, although he does not say so specifically, the reader is given the impression that the chapters of the book are based on a number of lectures; this may account for a tendency to repeat facts and figures and for a certain lack of logical sequence in the development of the writer's ideas. These are, however, minor defects and the book contains so much that must inevitably give the military reader food for thought and gives such an excellent picture of the various problems that the direction of our naval forces entail, that it should be carefully studied by soldiers.

The book opens with a chapter on the nature of strategy, a discussion on limited and unlimited warfare, on the co-operation between the Services, the responsibility of the Government for the conduct of the war, the material and moral elements of strategy and the methods by which naval action can contribute to the attainment of the national object. Early in this chapter, Commander Grenfell challenges a statement made by Sir Frederick Maurice in his book *British Strategy*: General Maurice

expressed the opinion that Bacon's dictum that "He that commandeth the sea is at great liberty and may take as much or as little of the war as he will" is no longer true, in that the advent of modern weapons, the submarine and the long-range gun (he might have added the aeroplane also) makes it inevitable for Great Britain to look beyond the sea as its frontier; "our vitals had thus in process of time extended from our shores on to the continent of Europe, and to defend them we had to expend our utmost efforts." Commander Grenfell considers that few sailors will subscribe to this doctrine; he states that the possession of the Channel Ports by the Germans would not have made it much more difficult to feed London and that we still had, in 1914, the power to take "as much or as little of the war" as we would. One may retort that few soldiers would subscribe to this view: for 4½ years we put forward every effort to prevent the Germans from approaching any closer to the Channel ports, more than once with our "backs to the wall," whilst our offensive strategy was largely based on the necessity of depriving the enemy of such foothold as he had gained on the Belgian coast. It is difficult to believe that our strategy was ill-founded and that our national instincts were wrong. When Earl Baldwin in a memorable speech said that our frontier was now the Rhine, he was expressing in a brief and profound sentence the principle behind Sir F. Maurice's contention and few would be found to disagree with him. It may be added that *British Strategy* may with advantage be read in conjunction with this chapter.

At the end of his chapter on strategy, Commander Grenfell, having stated four main functions of the Navy, concludes that all of them will be fulfilled most conclusively by the destruction of the opposing main battle fleet, a theme which runs like a thread throughout the book. In his later excellent chapters, on the moral factor and attitudes of mind, we have this idea constantly recurring and a pervading feeling that a bolder strategy and a greater readiness to take risks might well have led to the complete destruction of the High Seas Fleet and a shortening of the war. One feels that he does not subscribe willingly to the doctrine that the Grand Fleet did in fact fulfil its task by remaining in being, and keeping the enemy's fleet practically glued to its harbours by the mere threat of its overwhelming offensive power. The chapter on Attitudes of Mind is instructive and much to the point and has a direct connection with morale. The subject is one which has not yet been historically and adequately treated as a study in itself in spite of the fact that it is all important: a study of any campaign will demonstrate the vital influence which the commanders' attitudes of mind exerted on the course of the action. If one analyses the undoubted fascination of Brigadier-General Spear's admirable book *Liaison*, the reason will be found to lie in the vivid and clearly drawn picture of the intensely human factor of the attitudes of mind of the various commanders. Again, a striking example will occur to the mind of the military student in General Bonneau's campaign in Alsace in the early days of August, 1914; General Bonneau, convinced, on quite inadequate grounds, that the enemy were moving through Switzerland against his right flank, throughout his brief forward move to Mulhouse was fearfully looking over his right shoulder for a non-existent danger, an attitude which conveyed itself to his whole force down to the most junior commanders and was a prime cause of his failure to carry out a task which would in any case have tried a much more resolute commander.

Commander Grenfell closes his book with a study of the effect of air action on naval strategy and passes thence to a consideration of the composition of modern fleets and the value of the big battleship in modern war. It is apparent that he considers air action a serious threat to naval ships within the range of shorebased aircraft; it may even be "revolutionary" but war alone can decide how far the defence is now in a position to defeat the attack. This chapter is full of food for thought, but it seems a pity that the whole question of air co-operation and air attack should have been relegated to one chapter at the end of the book; the earlier chapters on various aspects of naval strategy ignoring air action have necessarily a slight atmosphere of unreality.

In discussing the composition of the fleet, one feels that the author would be glad to see the last of the battleship, but regretfully concludes that although these leviathans cannot now move without a mass of attendant defensive small craft, robbing them of the dignity and freedom of an earlier age, we cannot afford to do away with them until other Powers are prepared to do the same, neither on the indeterminate conditions and results of peace manœuvres can we accept that the air has mastered the battleship.

R.L.B.

STORAGE RESERVOIRS.

By GEORGE BRANSBY WILLIAMS, M.INST.C.E.

(Chapman and Hall, Ltd. Price 25s. net.)

Mr. Williams has dealt with the question of storage reservoirs from a very wide point of view.

He starts with a consideration of the distribution and intensity of rainfall in different parts of the world because, as he points out, a reservoir for whatever purpose it is built, must receive an inflow of water sufficient to balance the demand on it, and this inflow can only be obtained from the rainfall.

He next deals with the question of reservoir and spillway sizes; he emphasizes the difficulty of ascertaining the maximum flood intensities in that they bear no relation to the mean rainfall, and touches on the methods of calculating the size of spillways.

His chapters on the design of dams deal with the complete field of gravity, single and multiple arch, reinforced-concrete, earth and hydraulic fill dams—he touches on the principles of calculation. The object of the book is not to teach a student how to design dams—the author merely aims at giving the reader sufficient detail to enable him to understand the general principles and to appreciate the difficulties and intricate calculation involved. His examples of the different types of dam are drawn from all over the world and are clearly illustrated by means of sketches.

After a discussion on methods of outlet and reservoir accessories, he turns to a consideration of works organization and methods of construction; the paragraphs on the subject of waterproofing concrete will well repay study.

He concludes his work with a very general outline of the methods of water purification and an account of a tour round the dams and reservoirs of Great Britain.

The book is not one that will be of practical use to the majority of R.E. officers, as few are likely to find themselves engaged on work of this nature. Dam and reservoir construction is a matter for the expert, and the extent to which even experts disagree as to the best method of obtaining the same results is well illustrated by Mr. Williams' book. Nevertheless the book will repay study by officers who may be called upon to deal with the storage of large quantities of water in any way, whether it be for consumption, irrigation or hydro-electric schemes.

R.G.V.W.

HIGH-SPEED DIESEL ENGINES.

By ARTHUR W. JUDGE, A.R.C.SC., D.I.C., WH.SC., A.M.I.A.E.

Third Edition (Chapman and Hall. Price 18s.)

This is the third and revised edition of Mr. Judge's text-book, first published in 1933, indicating the very rapid development and progress in design of high-speed compression-ignition engines in recent years.

The arrangement of the new edition follows closely that of the last, beginning with a concise account of the theory of, and the actual conditions in, high-speed C.I.

engines, followed by an interesting chapter comparing the C.I. engine with the petrol engine. The methods of fuel injection and combustion which form the bases of design of modern C.I. engines are then discussed, and the bulk of the remainder of the book is devoted to descriptions of the various types of cylinder heads and fuel injection systems now in use. The separate chapters on engines for road transport, aircraft, and stationary purposes contain most useful information on many different engines now on the market, including a number of American and Continental examples. The chapter on care and maintenance which formed part of the second edition, has been omitted; obviously the subject demands greater scope, and is fully covered in the author's *Maintenance of High-Speed Diesel Engines* which forms a companion volume to this. The comprehensive bibliography given in the second edition has also been dropped.

The military engineer will naturally seek information on the development of C.I. engined vehicles. The author shows that the petrol engine is still unquestionably more powerful for its weight, and more flexible over a wider range of speeds, than the C.I. engine. The principal advantage of the C.I. engine, *i.e.*, low fuel costs, has led to its general adoption in heavy commercial vehicles, but in light cars, where fuel costs are not so important, the superiority of the petrol engine in weight, first cost, and acceleration outweigh the C.I. engine's advantages in the matter of simplicity, easy starting and pick-up from the cold, reduced fire risk, and reduced maintenance.

The recent introduction of lighter and smaller C.I. engines, such as the Coventry Victor 10 h.p. opposed twin, the 22·5 h.p. 4-cylinder Gardner type LK., and various Continental engines, has enabled a good deal of practical information on the performance of these engines in motor-car chassis to be collected. From these tests, it is generally agreed that the fuel consumption of the C.I. engine is about one-half that of the petrol engine of similar dimensions. Except when idling or running slowly on load, C.I. engines run practically as smoothly and as quietly as petrol engines. The C.I. engine gives a superior performance in hill-climbing and slow-speed pulling on top gear. As a typical example, a Humber Snipe car fitted with a Gardner 4 LK. engine weighed 98 pounds more than the standard vehicle, the maximum speed on the level was 83 m.p.h. against 80·4 for the petrol-engined car, and the fuel consumption was 44 m.p.g.

For tanks, most people with war experience will agree that the petrol engine has been obsolete since 1918; there is no doubt that it is so now. For heavy vehicles over about 3 tons, the petrol engine is obsolescent, but in lighter vehicles, petrol engines are likely to persist for some years.

Mr. Judge states that in aircraft, since the modern petrol engine using high octane value fuel can invariably be made very appreciably lighter than the C.I. engine of the same output, the petrol engine will always be selected for military purposes. For long-distance commercial aviation, the C.I. engine offers decided advantages and has been adopted in the German trans-Atlantic flying boats.

The book gives an excellent survey of C.I. engine-development and is recommended to anyone who wishes to bring himself up to date in this subject.

F.G.D.

IMPERIAL WAR MUSEUM—19TH REPORT (FOR THE YEARS 1935–6 AND 1936–7)

(H.M. Stationery Office. Price 1s. 6d.)

The period with which this report deals saw the removal of the museum from South Kensington, where it was closed after Armistice Day, 1935, to its permanent home in Lambeth Road, which was opened by the present King (then H.R.H. the Duke of York) on 7th July, 1936. This move is described in detail, and it is interesting

to note that the average daily attendance since reopening has been higher than while the museum was at South Kensington. The report includes records of each section of the museum for these two years, and a list of additions, which is still very large, and it is interesting to learn that 400-500 books a year are still being added to the library.

One or more visits to the museum should be regarded as necessary for the education of all, young or old; and those who have not seen it in its new home should arrange to do so early.

E.V.B.

THE ENGINEER'S WHO'S WHO, 1937.

Compiled and Edited by M. E. DAY.

(The D.M.A. Co., Ltd.: Price 20s.)

This book records the appointments, degrees, careers, publications, etc., of 1,300 engineers, representative it is claimed, of every branch of the engineering profession and associated industries. These 1,300 are those of an original selection of 2,000, about whom it was found possible to obtain full particulars. The selection of these 2,000 must have been no easy task. The book presents in a handy form information which might have to be sought from many sources and should be a useful book of reference.

E.V.B.

BLOODY MURDER.

By S. C. MASON.

(G. Bell & Sons, Ltd. Price 7s. 6d.)

When I picked up *Bloody Murder*, a story of the Irish rebellion by S. C. Mason, I was full of partisan spirit and insular prejudice—I leave you to guess which island the prejudice came from—but I could find in it no injustice to either side to warrant my blood boiling over; though perhaps, this book might give the uninitiated an exaggerated idea of the number of executions carried out by the Military Courts in Ireland.

The author, who must have been intimately connected with the affairs about which he writes, presents an absolutely accurate vignette of life in the British Army in Ireland in 1921. It is so evenly and restrainedly written that the drama of events which actually happened, some of which are portrayed in the story, tends to be lost to sight in that very levelness of description which would not disgrace the best type of "official history." Both sides are fairly treated, each according to its own lights and not according to the lights of its enemies.

The book is written in pleasantly good English, and is not easy to put down until it is finished; but it is then that its art becomes apparent. The reader is left with an unsatisfied feeling, real, but intangible, as of some work begun and left uncompleted without adequate reason. It was, in fact with such feelings, that the British Army left the country when the political surrender came.

I would advise every British Officer to spend the short time necessary to read it. Those who were there, lest they forget; and those who were not, lest they never learn how to deal with, nor what is to be expected from, "irreconcilables" such as they may be called upon to meet in several parts of the world to-day.

HEAR THE BUGLE.

By LEONORA STARR.

(G. Bell and Sons, Ltd. Price 7s. 6d.)

The novel records a pleasant story, but, as in the authoress's previous novel *Colonel's Lady*, the chief interest is perhaps in the background—in this case, army life in England from the point of view of an officer's wife. This is drawn in great detail and with skill and humour. Readers familiar with garrison life will recognize old friends in almost every character and find in most incidents an echo of their own experiences and even thoughts; while to others, the book may be recommended, apart from being an entertaining story, as giving a good description of the life of those ladies who hear the bugle, both in its social aspects and in the unofficial work that they are called on to perform.

Colonel's Lady is probably known to most of our readers: in *Hear the Bugle* one of the principal characters is the wife of a divisional commander; a recent *Gazette* induces speculation as to the sphere in which Miss Starr's next heroine will move.

E. V. B.

A ROVING COMMISSION.

By HENRY NEWMAN.

(G. Bell and Sons, Ltd. Price 7s. 6d.)

This book comprises the recollections of a war correspondent on three campaigns—China, 1900, Tibet and the Third Afghan War, together with chapters on the Mohmand operations of 1916, and the troubles in and near Peshawar in 1927. The word recollections is used advisedly, for the author emphasizes that he has consulted no documents—a fact that is borne out in the case of the Afghan War by somewhat vague chronology and geography. The book must therefore not be read as history, but as what a war correspondent with an Indian force managed to see. He gives vivid descriptions of Pekin after its capture, of the Gurkhas climbing up the cliff to assault Gyangtse Jong and of the "peace conference" at Rawalpindi that brought the 1919 war to a close. It is rather remarkable that in his account of Gyangtse, the sappers are not mentioned apart from some demolitions *after* the fighting!

Many of Mr. Newman's statements seem a little doubtful—were the Wazirs before the War scarcely counted as a fighting tribe? was a certain cavalry general a "well-known thruster"?—But the whole book is well worth reading. The atmosphere of the three campaigns is well reproduced—the largely unco-ordinated international race to Pekin, the confident advance into unknown Tibet, and the ineffectual boredom of the Khyber in 1919. Of the latter, we can only say it is a pity the author saw so little: this was not his fault, but it is distinctly the reader's loss.

E.V.B.

MAGAZINES.

RIVISTA DI ARTIGLIERIA E GENIO.

(*June*, 1937.)—This number is devoted entirely to Engineer matters.

1. *L'Istituto storico e di Cultura dell'Arma del Genio.*

A description of the newly constructed Institution of Engineers in Rome.

2. *L'Arma del Genio negli anni XIII e XIV dell'era fascista e durante la campagna in Africa Orientale.*

This is the second article describing the work of the Engineer arm during 1935 and 1936 in Abyssinia. It deals with road construction between April, 1935, and June, 1936. This time is divided into six periods, and the work carried out during each is described.

During the preparatory period of the campaign a motor road, eight metres wide and 130 kilometres long, was constructed from Massaua to the Abyssinian plateau. Several large bridges were built of reinforced concrete. In October, when the first advance was made in three columns towards Adua and Makalle, the divisional and corps engineers made a track as the troops advanced. This track was improved and made into a motor road by the labour corps which came up behind. The same process was continued until, after the battle of Ashangi, the road reached Quoram. From here the so-called Imperial road led to Addis Ababa. The damage done to this road by the Abyssinians was repaired in thirty hours.

The article is accompanied by several photographs and plans.

3. *Il terreno nelle operazioni militari.*

General Cardona explains the importance of the nature of the ground in all military operations, and shows how it may affect the digging of trenches and of mines, road construction, water-supply, etc. A knowledge of the geology of the country in which military operations are being carried on can be of great value.

4. *Nomogrammi per il calcolo delle cariche occorrenti per la rottura di strutture metalliche, di cemento armato e di legno.*

General Palumbo gives a series of formulæ from which may be calculated the explosive charge required to fracture steel, reinforced-concrete and wooden beams, columns, hollow tubes, etc.

For a reinforced-concrete beam, for instance, the formula is :—

$$C = \alpha \times a \times b,$$

where α is the co-efficient of the power of the explosive,

a the width of the section in centimetres,
b ,, depth ,, ,, ,,
C the explosive charge in grammes.

The value of α is given in a series of tables, and varies between 0·7 and 20, according to (a) the nature of the explosive, viz. (1) blasting gelatine, (2) T.N.T. or dynamite, (b) whether tamped or untamped, (c) the position of the charge, whether external or internal, (d) the material and nature of the beam, plate, or column to be fractured.

Some examples are given, and also two plates from which the results may be obtained by a graphic method.

5. *L'impiego della saldatura per il rinforzo e la riparazione dei ponti metallici.*

Captain Betocchi draws attention to the value of welding for strengthening and repairing steel bridges. In military work, welding may come in useful for increasing

the load that a bridge is capable of carrying, and for repairing a girder damaged by enemy fire.

Some of the advantages of welding are :—

(*a*) Speed and simplicity.

(*b*) Avoiding, within limits, suspension of traffic.

(*c*) A progressive improvement of the stability of the structure.

(*d*) Maintaining its static condition.

(*e*) Increasing its capacity of resistance to dynamic stresses.

Of the various types of welding in ordinary use, the oxy-acetylene process is one that gives good results, but the electric-arc process is better still, as it localizes the heating surface in a very small area.

A portable electric-arc welding set could be made to suit 12 different voltages. The re-actance bobbin would allow of a variation of intensity of current between 10 and 200 amperes, which would admit of welding steel plates up to 15 mm. thick.

The article goes on to describe the methods adopted in practice for strengthening girders, and refers to standard rules for calculating welded joints.

6. *Reticolato speditivo.*

Lieut.-Colonel Betzu describes a form of hasty wire entanglement that has been called after him. It has the advantages of lightness and adaptability, and can be converted into a normal entanglement if desired. It can be put up and taken down rapidly. An entanglement 100 m. × 3 m. requires the following materials: 68 special posts, 80 kilogrammes of barbed wire and 5 kilogrammes of plain wire, and can be erected in 33 minutes by a squad of one N.C.O. and ten men.

The posts are round wooden poles 6 centimetres in diameter and project 1·20 metres above the ground. Each post is fitted at the lower end with a cork-screw attachment made of round iron fixed to a ring which grips the post. A hole is bored through the post, half-way up, to take an iron pin, which provides the necessary leverage for screwing the post into the ground. There are notches near the top, centre, and bottom of each post to take the plain wire binding for each row of barbed wire.

The posts are screwed into the ground at intervals of three paces, in two rows, two paces apart; the posts being staggered. One set of three wires is taken zig-zag fashion between the two rows, other sets are added to form outer and inner fences respectively. The width of the entanglement is then doubled by adding another zig-zag and another straight fence, making the full width three metres. It is claimed that the erection can be carried out silently.

7. *Ricerca delle acque del sottosuolo ai fini militari.*

Captain Mantia shows how a study of the geological formation of the ground and of the surface vegetation may indicate the presence of subsoil water suitable for drinking purposes.

(*July–August*, 1937.) This number is devoted mainly to artillery subjects, but the following articles are of general interest:

L'opera di Marconi nel campo tecnico applicativo militare.

A brief appreciation, by Brig.-General Sacco, of the great scientist's work in the military field.

La stereodiottra "Silvestro."

Captain Silvestro gives a detailed description of a "stereo-diopter," designed by himself, and explains how it can be used for general topographical work, and especially for military purposes. There are 19 illustrations.

Operazioni di sbarco. By B. Bravo.

A study of disembarkations of bodies of troops in hostile countries. For the success of a landing command of the sea is essential, if only local and temporary. Historical instances are quoted of the Russo–Japanese war, the Italo-Turkish war of 1911–12, the German occupation of the Baltic islands in 1917, and the Gallipoli campaign. All, except the last mentioned, had successful results.

The writer considers it of great importance that landing operations should be under a single commander-in-chief. A mistake was made at Gallipoli in entrusting the chief military and the chief naval commands to separate officers. The mistake was not repeated by the Germans in their Baltic operations (where General von Hutier was in supreme command), nor by the Spaniards at Alhucemas on the Riff coast (where General Primo de Rivera was in supreme command). At the same time these landings were far simpler affairs than Gallipoli.

The article deals with a number of points of which only a brief reference can be made. In embarking for a projected landing, troops and stores must be embarked in the order in which they are required, and care should be taken not to have all one's eggs in one basket, or the loss of a single ship may jeopardize the whole campaign. The troopships should be sent in a convoy under proper naval escort.

Further points discussed are the approach to the landing, the methods adopted for getting troops ashore, the action of the naval artillery and that of the army artillery, aerial action, the employment of light tanks, and the establishment of a shore base.

Concetti per lo studio e l'impiego dei mezzi bellici con aggressivi chimici.

Lieut.-Colonel Foà mentions some of the principles of chemical warfare.

Caratteristiche geografico-militari della Sicilia. By General Cardona.

A geographical description of the island of Sicily, from a military point of view, as a suitable training ground for troops.

La neve è un ostacolo insormontabile alla marcia degli autoveicoli ?

Lieut.-Colonel Amione discusses the effect of snow as an obstacle to mechanical transport, particularly in connection with the mountain passes in the Alps, many of which are closed by snow for several months in the year.

Mechanical transport can only travel over a snow surface, without sinking in, if the snow has been converted into ice. In soft snow a vehicle can only move if the clearance under the body is greater than the depth of the snow. With greater depths, runners will have to be fitted to the wheels, or else chain tracks adopted, or a combination of the two. Some success has been obtained with the Citroen-Kegresse car, in which chain drive is adopted in place of the rear wheels, and the front wheels are fitted with skis. But chain drive is not suitable for steep gradients; the limit is soon reached beyond which chains will cease to grip.

The alternative is the adoption of some form of snow plough to clear away the snow and permit the use of wheeled vehicles. Numerous experiments carried out in Italy and elsewhere show that the best kinds of snow plough will clear a track 3 to 4 metres wide, if the snow is not deep and has a low specific gravity. With depths of 40 to 80 cm. tracks between 2 and 3 metres wide can be cleared, and the speed of the snow plough is reduced to less than 1 km. per hour.

Prolonged blizzards are the worst obstacles to progress, but, in the writer's opinion, the problem of clearing Alpine roads of snow is not insuperable.

(*September*, 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.

Details are given, in this article, of the work carried out, during the Abyssinian campaign, by the Signal branch of the Engineers in wire telegraphy and radio telegraphy. The report is divided into two parts: (1) the period of preparation, between December, 1934, and October, 1935, when permanent lines were installed under the direction of Engineer headquarters, (2) the period of active operations, when the higher units arranged their own connections through the signal units attached to them.

Intercettazione radiotelegrafica e radiogoniometria campale.

Major Alessandro explains how, by means of "listening posts," enemy radio messages can be intercepted. The principle of radiogoniometry is that of locating

on the ground the position of enemy radio stations. A field radiogoniometer, *i.e.*, an instrument for determining the direction from which a radio signal emanates, usually consists of a receiver with a disc-shaped aerial rotating round a vertical axis. The disc has a circle graduated to read angles.

With limited capacity, the radiogoniometer gave important results in the World War. Marshal Foch had maps showing the density of enemy radio stations: where there were large numbers an enemy attack might be expected, small numbers indicated a quiet sector. The preparations for an offensive early in 1917 and the intention to retire in June, 1918, were revealed by this method. The German dirigibles on their way to bombard London were located by French radio stations.

Orientamenti dell'ascoltazione aerea. By Major Memmo.

A description of "listening helmets" and other larger and more complicated instruments for discovering and locating aeroplanes in flight by acoustic methods.

Impiego di una sezione fotoelettricisti in difensiva.

Lieut.-Colonel Vanelli describes the duties of a divisional photo-electric section and illustrates his point by a practical example.

Le teleferiche militari con funi ancorate ad entrambe le estremità.

Lieut.-General Bellusci, who was Director of Wire Ropeways during the war, has made a special study of ropeways with two carrying ropes and a hauling rope kept in tension without counterweights. A good deal of information is available from books about the ordinary ropeway that is kept at a constant tension by means of counterweights, but the theory of ropeways anchored at both ends is not so well known.

General Bellusci's study is divided into two parts: Part I deals with the theory of ropeways; Part II gives practical examples. The present number contains the first three chapters of Part I, the remainder will appear in future numbers, and, eventually, the whole treatise will come out in book form.

In the introduction the writer gives a brief history of military ropeways erected in Italy. They were originally introduced to help in the construction of forts in the Alps, and then for the transport of stores to the forts. But even before the World War the possibility of using them in mobile warfare was considered. The following essentials for military ropeways were laid down:—

(1) They must be light in weight, easily taken to pieces, and each individual part must be such that it can be carried by mules or men over country devoid of roads. As far as possible, parts should be inter-changeable.

(2) The terminal stations and trestles should be adaptable to any kind of ground, avoiding excavation of foundations, as far as possible.

(3) Anchorages should be designed so as to avoid the use of anchorage blocks. Cables should be so arranged that they can be easily carried, erected and taken down, and that no soldering or splicing should be done in the field.

(4) The motor mechanism must not be cumbrous and must consist of portable parts.

The first type of portable ropeway was designed by Major Maglietta of the Engineers and was exhibited at Milan in 1906. It was a mono-cable of the to-and-fro type, working over a range of 500 metres. To each branch of the endless rope was fixed a carrier capable of holding 100 to 150 kg. The total weight of the ropeway was 5,000 kg.: the heaviest individual load was the motor, weighing 120 kg. The cable was 14 mm. in diameter and 1,040 metres long, and consisted of sections of 100 to 200 metres joined by special connecting-pieces, which could travel through the pulley rims without difficulty.

The Maglietta ropeway was tried in Italy and gave satisfactory results, both there and subsequently in Libya during the Italo-Turkish war.

But in 1913, the artillery asked for a ropeway capable of carrying heavier loads, and the well-known Milan firm of Ceretti & Tanfani produced a design on the bi-cable

system, carrying heavier loads, and adaptable to longer spans. The same type of anchorage was used, *viz.*, boxes filled with ballast, but a new type of cable, with hemp core, and a new type of trestle, with tubular sections, were adopted. These ropeways were in use during the war.

Other patterns were also in use during the war, such as the B.B.B., the C.T.M.C., and others.

The latest type is known as the B.M.K. In this the trestles consist of two channel-irons, and they have been tested to carry an effective load of 5,000 kg. when extended to their maximum height. The terminal station is of the oscillating type and is provided with a 50-h.p. motor.

In elaborating the theory of the working of the various of types of ropeways, the writer deals with the following subjects: Ch. I. The curve of an unloaded carrying rope. (This works out to be practically a parabola.) Ch. II. The trajectory of the loads according to the system adopted. Ch. III. The hauling rope: the curve it describes, and the determination of its diameter.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*May–June*, 1937.)—*Construction d'un pont Tarrons de 35m à St. Laurent de la Cabrerisse.* By Capt. Choquet. A description of a temporary bridge built in October, 1933, by a detachment of the 2nd Battalion of the 7th Engineer Regiment, to take the place of a masonry bridge over the river Nielle washed away by a sudden flood. The bridge carried a main road, and its rapid repair was therefore urgent. The gap to be spanned was about 90 feet, and the height of the roadway above the bed of the river was 50 feet. There was normally but little water in the river. The temporary structure was to carry a load of 4 tons on one axle.

The type of bridge selected was a sort of bow-string girder, built of spars and steel rope, on the Tarron system, with modifications. The bridge was built on the left bank and launched by means of rectangular sheers erected on both banks. The structure at the time of launching weighed 15 tons.

The work, interrupted by violent winds and heavy rains, occupied 36 working days of 9 hours each, and was carried out by a detachment consisting of 1 officer, 6 N.C.O's and 55 sappers, reduced later to 1 officer, 5 N.C.O's and 44 sappers.

A practical experience of much benefit to the young recruits employed.

Cent Ans de Fortification Allemande. By Lt.-Col. Montigny. The article is concluded in this instalment. After describing the tendencies of fortification in the early 'nineties, the author deals with the "fortified groups" of 1900. The ever-growing circumferences of big cities on the frontiers necessitated continual expansion of the defences, and the ring of fortified groups now became the favourite solution. Separate works for infantry garrisons and artillery batteries came into fashion. The first of these "Feste," or groups of fortifications, was begun in 1893 at Molsheim, and was christened the "Kaiser Wilhelm II."

A section of the article is devoted to the extension of the protective circle round Metz.

The development of the German system during the period dealt with, 1815–1914, ran on parallel lines with that of the French. The race between the artillerymen and the engineers became more intensified during the latter half of the period, when development in guns seemed to outstrip the means of protection until reinforced concrete appeared on the scene.

The articles gives us a clear and concise historical account of the development of German fortification, and is enhanced by comparisons with the French tendencies during contemporary periods.

Nécrologie. Memoirs of two distinguished engineer officers are included in this number. General Curmer (1854–1937), and General Caloni (1859–1937).

L'École de Mézières. By General Dorbeau. Prior to the establishment of the

first school of military engineering at Mézières, young officers of the engineers were selected personally by the head of the service. Vauban, Sauveur and Chevalier all picked their candidates, and the system continued until 1748, when the Minister of War commissioned de Chastillon, then Chief Engineer at Mézières, to establish a school. A small beginning was made with six applicants, for it was in contemplation to establish similar schools in several other fortresses. Even in those early days, it was laid down that engineer officers must have the best possible education, and such a standard of efficiency as would give value to their opinions and make them highly regarded among the other arms.

So successful was the administration of M. de Chastillon, that at the end of a year it was decided to drop the proposal to create other engineering schools, and the establishment at Mézières became the only official foundation. De Chastillon remained as Commandant until his death in 1765, and his successor was M. Ramsault de Raulcourt (1765–1776), himself an engineer of wide and varied experience in the field.

Full details of the courses of instruction and several notes on the members of the instructional staff are given; and the instalment in this number brings the account up to the outbreak of the French Revolution.

(*July–August, 1937.*)—*L'Utilisation des poutres à treillis en bois.* By Lt.-Col. Guet. A well-illustrated article on wooden lattice-girder bridges, based on a few examples of their use during the last few months of the Great War, and, more recently, during the manœuvres of 1936. The development of rapidly moving transport since the war makes the speedy bridging of rivers and canals even more important than before; and some easily assembled, simple types of portable bridges are essential. Lattice girders have many advantages—the chief among them being the simplicity of the materials used in their construction. They can be made up to lengths of 20 to 30 metres; they can be made in rear, and prepared even without previous investigation of the obstacle to be crossed. Their lack of lateral stiffness puts a limitation on their use.

The two examples from the Great War are the bridge over the St. Quentin Canal at Tugny-et-Pont, and the bridge over the Neuvillette at Origny Ste Benoite. Both were built for heavy traffic by the Engineer units of the French XXXI Corps in September and October, 1918.

During the manœuvres of September, 1936, a much larger bridge of this type was constructed at Gréoux, on the Verdon, where the span was about 100 metres. The girders in this case were built in lengths of 16½ metres (say, 50 feet), and were supported on trestle piers. The bed of the river was flat and pebbly, and the depth of water about 2 to 3 feet at the maximum.

Quelques idées Allemandes sur la Modernisation des Unités du Génie. By Lt.-Col. Kuhnmunch. A short article referring to a recent discussion in the *Militär-Wochenblatt* on the subject of the present organization of divisional engineers in the new German Army. The general opinion is that the engineer battalion allowed for a division is insufficient, and that it is not sufficiently elastic for the tasks imposed on it in modern warfare. The battalion consists of a headquarters section, 3 companies (one of which is motorized), each consisting of three sections of three groups. There appears to be flexibility in this sub-division; but the motorization of all the companies instead of only one is felt to be a necessity.

L'École de Mézières. By General Dorbeau. The conclusion of the article.

A period of economy set in in 1790, and the number of pupils fell to less than a dozen. As this was the only recognized school of military engineering, the revolutionary army was not yet alive to the importance of that side of the military profession. The school then fell upon troublous times, and in 1794 it was decided to close it down and transfer the pupils to Metz.

The school had lasted for 44 years, during which time it turned out some 600 engineer officers. W.H.K.

REVUE MILITAIRE GENERALE.

(*July*, 1937.)—*L'Évolution de la Cavalerie.* By General Brécard. Describes the changes in cavalry organization and equipment since the War. Mechanization has made such progress that cavalry officers in the French service can no longer choose to serve only with mounted units; they must be ready to serve either with horses, motorized regiments or motor machine-gun units.

Three mechanized light cavalry divisions are now included in the French Army.

Mer, Terre, Air. By Vice-Admiral Castex. The writer is well known as the author of *Théories Strategiques*, published some ten years ago. He epitomises the chief lessons of modern naval strategy, and gives the principal rôle in the future to the air service, which, he remarks, is the most "reversible" of the three forces; it can reinforce the action of the Navy or the Army, while the converse is not true, at least in a tactical sense.

L'Aviation d'outre-mer. By General Armengaud. As France has about one-fifth of her total air force serving overseas, she must rely on a large proportion of this to reinforce her Home air service, and therefore the air squadrons abroad must be organized and equipped on the same scale and to the same degree.

L'Angleterre dans la Méditerrande Orientale. By M. Reussner. An interesting article on England's present position in the Eastern Mediterranean. The Abyssinian War showed how exposed to air attack our naval base at Malta had become; and the rapid development of Italian air bases in the Ægean Islands and along the North African coasts, has opened up a menace to our maritime communications which cannot be ignored. Once again, we must turn our thoughts to the alternative route round the Cape. But it is not only England's communications that are threatened. France depends very largely on drawing reinforcements from her North African possessions, and she cannot afford to ignore the new situation which has arisen in the Mediterranean.

The Turkish threat to the Suez Canal has given place to an Italian threat; and a menace from the air, much more powerful than the menace from the sea, has appeared to burden the strategical problem for England.

L'Ardenne Française. By Captain Thoumin.

Another of Capt. Thoumin's studies in military geography. He first of all describes the airman's view of the forest area, and then goes into a detailed description of the region, and all its geographical and topographical features.

(*August*, 1937.)—*Le Franchissement de la Save devant Belgrade, par le XXII Corps de Reserve Allemand du 7 au 10 Octobre*, 1915. By General Radenkovitch.

This is an interesting article by the Commandant of the Yugo-Slavian Engineers. The only line by which Germany could send help to Turkey was via Belgrade–Nish–Sofia, and part of this was in Serbian hands, owing to the failure of Austria in 1914, to defeat the Serbians. With their forces fully engaged elsewhere, the Central Powers, in July, 1915, made every effort to persuade Bulgaria to join them. By removing the danger from Russia, they succeeded in inducing Bulgaria to take part in the renewed offensive against Serbia.

Von Mackensen was given the command of a new group of armies consisting of the Third Austro-Hungarian Army (6 divisions), the Eleventh German Army (7 divisions), and the Bulgarian Army (4 divisions). The XXII Reserve Corps was told off to the principal attacking group, and was concentrated on the 27th September in the salient formed by the Save and the Danube at their junction. The Corps consisted of two reserve divisions (43rd and 44th) and the 26th regular division. The presence of German troops was disguised by the wearing of Austrian *képis*, and all movements likely to be observed were carried out after dark.

There was a large island—La Grande Ciganlija—in the River Save, which made the problem somewhat similar to the crossing of the Piave in 1918, when the Grave di Papadopoli had to be negotiated. The Corps had 5 engineer companies and 5 bridging trains (50 pontoons) available; but these were insufficient for the site chosen, and

3 additional bridging units were obtained from Austrian sources. Trench mortars, light, medium and heavy, were brought up close to the bank to bombard the enemy's trenches on the other side. The emplacements of these and of the field and heavy artillery were all prepared without disclosure to the enemy, and by the morning of the 4th October all the artillery was ready to open fire.

All the details of the crossings, the dispositions of the infantry, the difficulties caused by the bad weather, and by the enemy's resistance, are very well described. The criticisms in conclusion are full, and include the remarks of a German authority on the assailant's operations. The author considers that in spite of the exploits of the German engineers and infantry, the crossing would have failed if the Serbians had not committed so many errors. Lack of depth in the defence, lack of local reserves, defective choice of the main line of defence, late arrival of reinforcements and the giving up of the bridge on the Grande Ciganlija without destroying it, are all put down as contributory causes to the German success.

Les Servitudes de la Stratégie. By Vice-Admiral Castex. Deals with the restrictive influences imposed upon strategy, naval, military and aerial. During the Great War, military strategy was affected in many ways:—the initial withdrawal of the French covering forces to 10 kilometres behind their frontier in August, 1914, the expeditions to the Dardenelles and Salonika which were engaged in for political motives; the Germans, in their haste to secure a rapid decision in 1914, overlooked the importance of securing the Channel ports; the British offensive against Passchendaele, which was the army's reply to the insistent call from the Admiralty for the destruction of the enemy's submarine bases on the Belgian coast; the detachment of three army corps for the protection of Paris in August, 1914, at a critical moment for Joffre, etc., etc.

The "servitudes" are the actions and reactions of the different forms of strategy upon each other.

Artillerie de Campagne Allemande. By General Boichut. A general account of the field artillery now being created for the new German Army. The author discusses especially the attributes of the various types of howitzers.

Le Matériel commande la tactique. By Albert Courquin. The author, a civil engineer, describes how the armament of the early war aeroplanes developed, and shows that the tactics of aerial combat—that is, the combat in the air—must depend upon the fighting equipment of the machines.

(*September*, 1937.)—*La Guerre de l'Unite Roumaine* (1916–1918). By General Constandache.

The author was responsible for the formation of the Historical Section of the Roumanian Army and was its first Director. His article is therefore based on correct information. The first instalment takes the account to the close of 1916.

There were three phases of the Roumanian Campaign: the operations in the Carpathians, followed by the invasion of the country; the Battle of Bucharest; and the stand on the Sriet.

For the campaign in the Carpathians, Roumania disposed of three armies amounting to 370,000 men, which were to carry out an offensive into Hungary, in conjunction with the left wing of the Russian forces operating from the Bukovina. Another Roumanian Army of 143,000 men was to act on the defensive along the southern frontier against Bulgaria. In all, Roumania had 20½ infantry divisions, 2 cavalry divisions, and 5 brigades of yeomanry.

The enemy's plan of campaign also consisted of three phases: an Austro-Hungarian Army of 2 divisions and 3 mixed brigades was concentrated on the Carpathian frontier in Moldavia, to delay the Roumanian invasion and to gain time for the concentration of more Austro-German forces; a Bulgarian-German Army in the south was to carry out a strong offensive in the Dobrudja to draw off the Roumanian forces; and then a powerful Austro-German offensive from Transylvania to force the Carpathians and invade Roumanian territory.

The Roumanians opened well, and advanced over the Carpathian passes well into Hungary, but there they were checked, and obliged to detach considerable forces from the north to strengthen the opposition in the south to the Bulgarian threat to Bucharest. The Roumanians had made the mistake of under-estimating the Bulgarian preparedness. The Bulgarians were ready to advance and threaten the Roumanian capital immediately the campaign began. The check in the north gave the Germans time to concentrate their Ninth Army, and by the middle of October the three Roumanian armies were back on the Carpathian frontier.

The subsequent operations by the Roumanian northern armies in the Carpathians during the winter of 1916 are described.

Conceptions Allemandes sur l'organisation défensive du territoire. By Lt.-Colonel Montigny.

In a recent German study of the evolution of the German fortified system from 1870 to 1918 (Major Grabau), the author concluded that the decisive factor in victory to-day was the speed of mechanized units of all kinds; but he considered that good communications, good bases of operations and fortifications on the threatened frontiers were still necessary. He considered that the present French fortifications only favoured a defensive strategy. The German objections to highly fortified systems were that they used up too many effectives, and acted as a drag on the commander-in-chief's initiative.

The fate of the great fortresses in 1914 under the weight of the heavy German artillery certainly shattered belief in the efficacy of permanent fortification. Joffre denuded the remaining fortresses of all their guns and garrisons. But, presently, those who gave study to the question began to realize that the real reason for the downfall of the great forts was that they had not been actively defended in liaison with the field armies. They had been left too much to their own resources. The enemy's big guns had been allowed to take post and batter the forts without molestation.

Lt.-Colonel Montigny refers at length to a recent article on fortification by a German writer, Konrad Metzel. He remarks that Metzel advocates fortification not only for the menaced frontiers, but for the whole of a country; a veritable hedgehog. He concludes by saying that the future will show what path German permanent fortification will take, and whether it will return to the profound ideas of the veteran Froebenius or follow the much more superficial views of Metzel.

Considérations sur l'offensive. By Commandant Krebs. A long article reviewing the development of the offensive from earliest times to the present day, showing how that form of warfare has been affected by the changes in offensive weapons. We must not be surprised, the author says, that tanks and armoured vehicles have not yet brought about great changes in our methods of fighting. Throughout military history, successive developments in weapons of attack have paradoxically strengthened the defence; yet no commander would willingly adopt the defensive if he has the choice, for no decision can be reached thereby.

Trois Coloniaux: Une même pensée. By Captain Demoulin.

A comparison of the colonial work of three great French soldier-administrators, Bugeaud, Gallieni and Lyautey. There was much in the characters and accomplishments of these men that was common to all three. They all disliked war; military measures were a necessary prelude to the ultimate pursuit of a peaceful government. Lyautey's saying "Force must be shown in order to avoid using it" applies almost universally.

There is a link between the three men. Bugeaud acknowledged his indebtedness to General Harispe, one of Napoleon's divisional commanders in Spain; Gallieni studied Bugeaud; Lyautey was a disciple of Gallieni. Bugeaud and Lyautey created the great North African empire for France; Gallieni brought order and contentment into Madagascar.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*July*, 1937.)—*A propos de la défense des canaux en site plat.* By Colonel Bouha.

An interesting article of special significance to Belgian readers, whose country abounds in canals. These waterways are, by their nature, situated in flat country and their long straight reaches are more exposed than the tortuous banks of natural rivers. There are both advantages and disadvantages in canals as defensive obstacles. Their advantages are chiefly that they protect their defenders against sudden surprise, that they are indestructible, and that their defences can be readily organized. Their disadvantages are that they are easily registered by artillery, that their bank, on the enemy's side, forms a dead angle, and that their defence offers no depth. If the defence keeps well back from the canal, the enemy's artillery can play upon the defenders without interfering with his own troops making the crossings. The author discusses these advantages and disadvantages, and then gives a tactical example, involving a cyclist regiment of a cavalry division. He does not touch on any engineering problem.

Notes pratiques d'hygiène militaire. By Captain Fanuel.

Hygiène des troupes en campagne. By Captain Dupont.

Both these articles deal with the ordinary medical problems of a campaign.

Le problème routier en Belgique et la défense nationale. By Lieut. Cumont.

The rapid development of the German "autostrades" and the response now being seriously considered in France, has led the author to study the application of a similar system in Belgium. Germany has built her new military roads wide enough for fast traffic in both directions, but in view of the expense of land purchase in Belgium, the author favours single-direction roads, making use of the existing network as far as possible. These single-direction roads may be paired so that the effect of a two-way system is not lost; and less vulnerability to air attack is obtained.

The Belgian autostrades should stop short of the frontiers for a considerable distance, so as to leave a buffer between the heart of the country and the routes of invasion, in order to slow down the speed of the invader.

Quelques notes sur le rôle social de l'armée belge. By XXX.

Much has been written lately, says the author, on the subject of the social rôle of the officer. With the deeply national character of modern armies, it is time to consider the social rôle of the army itself. The article gives a short account of the circumstances in which the Belgian Army was created, its rôle up to 1914, and then considers its present mission in the national defence. The training in the army has resulted in a general improvement in public education.

(*August*, 1937.)—*L'artillerie contre les chars de combat.* By Major Pottier.

Another article on the subject of anti-tank defence. The author discusses in turn the characteristics of tanks at present in use, the action of artillery and its own defence against a massed attack by tanks, and the defence of artillery in a war of movement. He includes extracts from a report by an English war correspondent on the tanks of different nationalities now being put to the test in Spain. The German tanks of medium weight appear to come out best in these remarks. The heavy Russian tanks failed, and were easily put out of action by anti-tank guns.

Aide-Memoire de l'officier d'artillerie. By Colonel Vermaelen.

A compendium, in very diagrammatic form, of notes on artillery regulations.

Etude d'un cas d'emploi de troupes motorisées et portées. Anon.

An exercise, studying the use of reinforcements sent up by motor transport to support an advanced guard furnished by a cavalry division. The terrain is the country round Louvain, of which a map is added.

Le droit des Gens et la Guerre. By Colonel Voncken.

Written from the military-medical point of view, and urging the collaboration of doctors and jurists to limit the evils of war. The article is in seven chapters, of which four are included in this number. The first is an historical study of the laws of nations.

The humanitarian principles of the Red Cross League date from 1859. Throughout the eighteenth and nineteenth centuries there was a growing resolve to make war more humane, and to respect the hospitals, the wounded and the prisoners. It has remained for the twentieth century to lead us back into the depths of barbarity and inhumanity. The second chapter deals with the basis of International Law; the third with the practical value of the Laws of War. The events of the last five years have given us little faith in the value of any international law. In theory, by signing the Kellogg Pact the nations have foresworn war; but how much do we hear of this international undertaking to-day? The author of this article does not mention it. (*To be continued.*)

(*September*, 1937.)—*Sur les chemins de la délivrance* (*Septembre-Novembre*, 1918). By Major Hanut.

A clear account, in general terms, of the great allied offensives of 1918, with details as to the number of divisions employed. The part played by the Belgian Army is described, and the effect of the continuous blows struck by Foch, in his determination to leave the enemy no time to recover or re-organize, is clearly put. The great attack planned by Foch to take place in Lorraine on November 14th would have gone far to break up the German armies still more, and would have dealt them just the sort of blow that Schlieffen dreamed of.

La Révolution Brabançonne dans le Duché de Limburg (1790–1794). By M. Lecomte.

An historical account of little-known episodes which took place while the French Revolution was working itself out. The author is well known as the Keeper of the Royal Army Museum at Brussels, and his studies are fully documented. He gives us a very detailed account of the doings of the Limburg volunteers, who, after successfully opposing the forces of the Belgian Republic, returned to their homes, only to come out again in 1792, to defend the Duchy against the threat of invasion by the French. Limburg at that time was part of the Austrian Netherlands. This first instalment gives an account of the preliminary hostilities.

Le droit des Gens et la Guerre. By Colonel Voncken.

Completion of the article. It makes interesting reading in these days of broken treaties, violations of solemn covenants and brutal outrage. Most of the international laws and prohibitions discussed by the author are dead letters.

W.H.K.

MILITÄRWISSENSCHAFTLICHE MITTEILUNGEN.

(*June*, 1937).—1. *Benedek and Benedek Legends.*

Colonel Heller concludes his article on Benedek in this instalment, and deals mainly with the commission of enquiry into the defeat at Königgrätz. The opinion expressed in its report was that Benedek's mistakes in generalship were not due to negligence or want of energy, nor to indifference or imprudence. No one could have striven with greater determination to secure victory for the Austrian army, but the political and military relations of the time were such as to require one of those highly gifted and tactful generals, who are all too rare in history, to deal with the situation, and Benedek was certainly not one of them.

The writer closes his articles by summing up Benedek's fine soldierly qualities, his bravery, his loyalty to the Emperior, the care and affection he bestowed on his troops. He failed when it came to making a decision, he paid the penalty for his mistake, and he bore his misfortune like a man.

2. *Changes in the Relationship between strategic, operative and tactical requirements.* By Major-General von Pitreich.

A general study of strategy, operations, and tactics, showing how they have been affected by modern conditions. The introduction of the tank and the aeroplane in the World War altered the order of the three branches of military science: tactics came first, then operations, and finally strategy. But in the air—and the air force

of a nation is now, perhaps, its most important arm—the order is strategy, operations and tactics, as it was before the war.

Land and sea operations will, in future, depend upon air strategy. The first practical example we have had of this has been the conflict between Britain and Italy in the Mediterranean. It is not surprising that the fantastic armaments now being built up by the great military powers have a great preponderance of air force.

3. *Can the Bomber stand up to the Attack of a modern two-seater Fighter?* By Dr. Server.

The great speed of the modern fighter plane places the slower moving bomber at a disadvantage, but the bomber can make use of its greater carrying power by mounting a heavy armament. The writer recommends that a bomber should be armed with two "Oerlikon" heavy machine-guns in the bows and two in the stern.

4. *Limit of Army Motorization.* By Lieut. Krasa.

The circumstances that determine the extent of army motorization are the: (1) capacity of the motor industry, (2) raw materials available, (3) fuel supply, (4) nature of the country, (5) financial considerations. Austria's motor industry is well developed and can supply all the country's war-time requirements, with the exception of tanks. Austria imports practically the whole of her motor fuel; the only fuel available in the country being charcoal. Most of the country is mountainous and only suited to special kinds of motor transport. Her finances do not admit of the expenditure of large sums on motorization.

5. *Supply and Replacement of Artillery Ammunition.* By Major Zuber. (Concluded.)

(*July*, 1937.)—*Attack and Defence on the Western Front in* 1918. *A Retrospect.* By General Horsetzky.

An account, illustrated by plans, of the attack made on the 15th–17th July, 1918, by the German 7th, 1st and 3rd Armies on the French position round Reims, which was followed by a French counter-attack on the 18th–20th July. An account is also given of the British-French tank attack S.E. of Amiens on the 8th August, 1918. The writer concludes with comments on the employment of tanks in future warfare.

An Attack by an Army Corps with the Assistance of Tanks. By Lieut.-Field-Marshal Schäfer.

A detailed review of an article by Colonel Mainié that appeared in the *Revue Militaire Générale.*

Field Fortifications for a Protracted Resistance.

Major-General von Aarenau discusses the influence of tactics and weapons on field fortification in recent times. In the pre-war period the employment of a series of lines of defence was deprecated; great stress was laid on a clear field of fire, and it was considered sufficient to provide shrapnel-proof overhead cover. The experiences gained early in the war (up to the year 1916) led to considerable changes. The first was the continuous fire-trench; the demand for a clear field of fire up to medium ranges was definitely set aside. The long occupation of the trenches during cold weather necessitated the provision of more habitable quarters. It was found necessary to increase the depth of a position. Cover had to be found against high-explosive shells, traverses were provided at closer intervals, and the questions of concealment and camouflage, as well as of drainage, received considerable attention.

In 1917 and 1918 the introduction of tanks and gas warfare necessitated further changes, and the depth of a defensive position increased still more. Observation posts were located in front of the first line of resistance, and the lines were divided up into a series of points and nests, carefully concealed and not easily ranged upon by artillery. The rearmost line of resistance was the strongest. Behind the latter came the artillery positions, and behind those again the second fighting zone. The depth from the front of the foremost fighting zone to the front of the second fighting zone was at least 4 kilometres.

Political Retrospect on the First Half of 1937.

Major-General Paschek discusses four unsolved questions: (1) the western pact, (2) the middle-European zone (*viz.*, the eastern front against the Soviets, the Danubian region, Italian successes in the south-east), (3) the Mediterranean (Britain and France versus Italy, the Spanish civil war), (4) the League of Nations.

"Cellastic" Tyres with Open Air Chambers. (Unpuncturable Rubber Tyres needing no Inflation.)

Dr. Server describes the "Cellastic" tyre, a recent invention that combines the resiliency of the pneumatic tyre with the lasting quality of the solid tyre. The tyre is made up, internally, of a series of rubber cells, inter-connected by air passages, which have an outlet into the outer air through the rim. The air is driven out of the cells as they are subjected to pressure, and is drawn in again as the cells resume their shape. The constant current of air ventilates the tyres and keeps them cool.

"Cellastic" tyres are made in numerous styles and of varying elasticity, and are suitable for motor-cars, lorries, and all sorts of vehicles used for military purposes. They can be fixed on bicycle wheels by hand; for cars a special press is necessary.

A bullet hole through the tyre does not affect it, even a hit by a 20-mm. shell does not put it out of action. It would seem that there is a great future for this type of tyre.

(*August*, 1937.)—*The Battle of Mount Harsány at Siklós on the 12th August*, 1687.

Major Schnagl describes the battle, fought 250 years ago, in which the imperial army, under Duke Charles of Lorraine, defeated a Turkish force of twice its numbers under the Grand Vizier Suliman Pasha. It was in this battle that Prince Eugene of Savoy particularly distinguished himself. As a result of this victory the Trans-Danubian region was permanently freed from Turkish rule, and Hungary became incorporated in the Austrian empire.

The Employment of the Italian Battle Reserves during the Caporetto Break-through. (*24th–27th October*, 1917.) By Major Heydendorff.

After the 11th battle of the Isonzo, the Italian Higher Command made preparations for a fresh attack. But, on the 18th September, Cadorna abandoned the idea of an attack and decided upon a "defence to the very last." The reserves consisted of a number of tired brigades resting in the rear and awaiting completion of their establishment. It is clear from their distribution that Cadorna never contemplated using them in complete units for counter-attacks against an enemy who might have broken through the Italian position.

The attack on the 2nd Army (Capello) was launched on the 24th October, and, during the first three days, 265 out of 271 reserve battalions (Corps, Army and G.H.Q.) had been thrown into the battle. On the 25th Capello realized that his army was threatened with a complete disaster and proposed to Cadorna an immediate retirement behind the Tagliamento. To this Cadorna would not agree.

The writer considers Cadorna's decision to have been correct. Although the 2nd Army did not escape complete disaster, the delay enabled the 3rd Army, to the south, to fall back and establish a strong line on the Piave.

Reflections on Education. By Lieut. Steinitz.

Construction of the Grödner Railway, 1915–16.

Colonel Khu gives an account, accompanied by a plan and ten photographs, of a railway constructed under his orders along the Grödner Valley in the Tyrol. The length of the line was 31 km., the difference in level between the terminal stations, 1,200 metres, necessitating a ruling gradient of 5·1% and minimum curves of 40 metres (in exceptional cases 30 m.) radius. The gauge was 76 c.m. There were numerous high wooden viaducts and several tunnels. The labour employed consisted, mainly, of the 29th Railway company, 800 carpenters, 800 miners, and 5,000 Russian prisoners of war. Work was carried out against time and completed in four months.

Physical Aspects of the Parachute.

Major Gratzy explains, by means of diagrams, the theory of the parachute, which it is advisable that every parachutist should understand. Some interesting conclusions arrived at are the following. It is risky to jump from an aeroplane travelling at a greater speed than 250 km. per hour with a parachute that opens automatically, as the strain is greater than the human body can stand with safety. On the whole, the speed of a falling parachute varies inversely with its bearing surface, but, if the area is excessive, the parachute loses in carrying capacity.

Chemical Fire Extinguishers. By Major Hirsch.

The increasing importance of the air arm and the danger from incendiary bombs makes the value of fire extinguishers worth careful study. Serious damage may be caused to densely populated areas by dropping large quantities of small electron-thermite bombs, which would start fires that are difficult to extinguish. Fires caused by inflammable liquid fuels cannot be extinguished with water, and chemical extinguishers are necessary in dealing with them.

Chemical extinguishers are of three kinds: (1) dry, (2) damp or liquid, (3) in the form of foam. The first two kinds are not effective for thermite and electron-thermite fires, but the foam-forming extinguishers (spumates) are extremely effective. These spumates form a covering over the burning surface that prevents oxygen from reaching it.

The Civil War in Spain.

General Wiesinger continues his account of the events in Spain during the period ending 15th July, 1937. The main operations have taken place on the Basque front, and the Nationalist successes on this front have caused some alarm to the Government, particularly on the Madrid and the Huesca-Saragossa fronts.

(*September*, 1937.)—*Krasnik–Lublin*, 1914. By Major-General von Steinitz.

An account of the operations of the 1st Austro-Hungarian army, under General Dankl, during August and September, 1914, including the battles of Krasnik and Lublin, in the region north of Przemysl. The 1st Army formed the left flank of the Austro-Hungarian forces, and it had opposed to it the 4th Russian Army.

The operations terminated with the Russian break-through in the gap between the 1st and 4th Austro-Hungarian armies. The result might have been different if Dankl had been allowed to press the attack earlier instead of being obliged to conform to the slower moving armies to his right.

The Turudija Battalion in the 6th Battle of the Isonzo. By Colonel von Hubka.

An account of the exploits of the infantry battalion commanded by Lieut.-Colonel Turudija. On the 7th/8th August, 1916, it carried out an attack on the Italian position on Mount Sabotino. After a gallant fight it was surrounded and the survivors were made prisoners.

Air Transport.

Lieut. Hackl gives some instances of the employment of air transport during and after the Great War, but the transport of troops and supplies by air was not undertaken on a large scale until the Italo-Abyssinian war. Here, of course, the Italian command of the air was unquestioned.

Air transport is likely to be used in future for the following purposes:—

(1) To carry troops, who may be landed by the aeroplane itself, or dropped with parachutes.

(2) To carry sick and wounded: in such cases a landing of the aeroplane is necessary.

(3) To carry stores. These can be dropped in various ways.

The Empire Conference. By Captain Sokol.

An account of the British Empire Conference, whose last session was held in London in June, 1937.

Reflections on Food Control in making Preparations for War. By H. R. von Steinitz.

The collapse of the great Austro-Hungarian monarchy in the World War was mainly due to food shortage. The portion of the monarchy that suffered most from hunger was the Austria of to-day, and this in spite of the fact that the productive regions of Hungary, Croatia, Galicia, Poland, Rumania and the Ukraine were in the hands of the Central Powers and could be fully exploited.

The writer considers that the food problem for Austria is not insoluble in the event of future war, provided it is tackled in time. The remedy is the formation of a suitable organization in peace time that will have the confidence of the people and give them a feeling of assurance that their requirements have been fully provided. The writer shows how such a scheme can be organized.

A.S.H.

WEHRTECHNISCHE MONATSHEFTE.

(*July*, 1937.)—*The Use of Bearings in the Location of Foreign Wireless Transmitters.* A description of portable instruments used in locating wireless transmitters.

Relationship between Communications and Industry in Russia. By Captain Ruprecht.

At the outbreak of the World War, Russia, with an area 40 times as great as Germany, had a railway system of 78,000 km. as compared with 64,000 km. in Germany. In the first five-year plan the budget allotment for improvement of communications was only about a third of that for industries. In the second five-year plan (1933–1937) a much larger proportion was allotted for communications. The proposals consist of 11,000 km. of new railway construction, and the electrification of 8,600 km. of line.

In spite of Russia's vast mineral wealth, the country is severely handicapped in the event of war by the inaccessibility of its mines and oil-fields. Transport is likely to be completely inadequate for many years to come, both as regards railways and roads. The main river waterways run north and south, the direction of traffic is east and west. Water transport will have to be supplemented by a canal system connecting the main tributaries.

Two of the main reasons for the collapse of Russia in the World War were lack of communications and dearth of skilled labour.

Technics of Brown Coal in Armament Industry and War.

After a temporary set-back in 1914, the output of brown coal in Germany increased month by month throughout the war. Owing to the extensive use of machinery, the mining of brown coal is less susceptible to shortage of labour than that of bituminous coal.

Brown coal now forms the largest source of energy in Germany: the percentages in 1932 being: Brown coal 39·0 per cent., bituminous coal, 36·6 per cent., water power, 17·1 per cent. gas motors, 4·85 per cent. The production of petrol and other fuels from brown coal has become a matter of great importance, and has reduced the dependence of the country on foreign sources of supply.

Non-liquid Fuels for Mechanical Vehicles. By P. Wiesenthal.

Gas and electric power as propelling agents have proved their practical value and are well beyond the experimental stage. Some of the gases used are propane, butane, methane, and others of similar nature. They can be compressed, in a liquid form, in steel cylinders, and are economical in weight.

Ordinary coal gas, though deficient in heating power, can be used, but no means of liquefying it have been discovered.

Wood, coal and coke can also be used for the production of gas. Electric storage batteries furnish a useful source of supply, but their range is limited.

Steam Engine or Diesel Motor.

Recent improvements in design have led to the extensive use of Diesel engines

for the propulsion both of lorries and railway locomotives. The latest Diesel engines for lorries are of 600 h.p. The German state railways have an 8-cylinder Diesel motor with an output of 920 to 1,400 h.p.

In spite of the superior efficiency of Diesel engines in many respects, the steam engine holds its own when heavy loads have to be dealt with, and it has the advantage of being independent of foreign fuel supplies.

Concrete and Reinforced Concrete Shields against High Explosive Shells. By Dr. Heidinger.

This article is concluded in the current number. The writer gives a number of equations and tables for determining the penetration of German shells and bombs of different weights into concrete.

A typical cross-section is given, showing the steel reinforcement of a concrete shield. Very heavy reinforcement is given in the lower half of the slab, but steel rods of moderate dimensions are recommended. 10 to 14 mm. (0·4 to 0·56 inch) is recommended as a suitable diameter for most of the rods; the two bottom layers should not exceed 18 mm. (0·72 inch). There should be no connection at all between the upper and lower reinforcements.

(*August*, 1937).—*Development and present state of Television.* By Colonel von Dufais.

Production of Liquid Fuel from Coal and Oil Consumption in War-Time. By Captain Ruprecht.

It has been calculated that the consumption of liquid fuel in time of war will be five times that in time of peace. Only two countries: the U.S.A. and Russia, will be able to maintain their requirements from their own supplies. All other countries will have to rely upon imports. Certain countries will be able to supplement their imported oil by synthetic petrol and substitute fuels such as alcohol, benzole, gas, etc., in the following proportion to their total requirements:—Great Britain, 6·6 per cent., France, 13·2 per cent., Germany, 44·3 per cent., Italy, 3·2 per cent., Czechoslovakia, 21·7 per cent.

The writer goes on to describe the state of the liquid fuel supply in all leading countries. In Europe, Italy is worst off of any of the great powers. Japan is doing her utmost to develop her internal supplies, especially that of petrol obtained from coal.

Supply of Munitions to the German Army in the World War. By Major Engel.

A short account of the work carried out by the Fireworks (now Ordnance) personnel during the war. The Ordnance Department consisted mainly of retired officers who were recalled to duty on the outbreak of war, and many of whom had become rusty after long years of civil life. They were called upon to mobilize industry from ordinary peace conditions to war conditions exceeding anything ever dreamt of before.

At the outbreak of war, nearly all shells were made of pressed steel. It was impossible to maintain the supply of steel, and cast iron was resorted to in the manufacture of a large proportion of shells. There was a shortage of chromium, nickel, manganese and copper, and alternative metals and alloys had to be used to keep up the munition supply.

Freedom in Food Supply. By Dr. Meier.

Before the outbreak of the World War, the possibility that a war might last for several years had never been seriously considered by the German government, and no special arrangements had been made for food supply in time of war. Some time elapsed after the war had begun before food was rationed, and rationing was only introduced in instalments.

Figures are given in this article showing how the production of rye, wheat and potatoes declined as the war went on, and how there was a corresponding fall in the areas under cultivation.

Under the Versailles treaty, one-sixth of the agricultural area of the country has been ceded, mainly to Poland, thus reducing the potential food supply in time of

war. Strenuous efforts have, however, been made to increase the productivity of the country, and it is now, economically, better prepared and organized that it ever was before.

Defence Policy in South-East Europe. By S. H. Kocab.

An account of the defence policy of Rumania and Yugo-slavia.

(*September*, 1937).—*The Land Fortification of Belgium.*

The pre-war fortifications of Belgium consisted of the fortresses of Liége and Namur, with the antiquated fort of Huy between them, the " Réduit National " of Antwerp in combination with the obsolete fortress of Termonde, and the coast defences of Ostende. The main reason for the complete collapse of the Belgian fortifications in the World War was that the Belgian command failed to use them—as their designer, General Brialmont, intended them to be used—as " points d'appui " for the field army, not as places of refuge for the latter.

The Belgian post-war defences were based on the Franco-Belgian military pact of September, 1920, and faced east along the eastern Belgian frontier, in continuation of the Maginot line in France. In 1936, however, a change of policy was announced, by which Belgium refused to remain a bastion of France. It remains to be seen what action Belgium will take now that the French have been compelled to continue the Maginot line along the west frontier of Belgium.

Organization of Industry and Modern Conduct of War. By Captain Ruprecht.

The organization of industry and the strength of the armed forces of a country go hand in hand. It was the neglect of this principle that led to the breakdown of the " Russian steam-roller " in the World War. Most countries have learned the lesson and have organized their skilled labour so that it may be available at the outbreak of war. The repair of the damage that may be done by a hostile air force immediately on the outbreak of war will require the services of a large number of skilled workmen.

German Losses in the World War. By Dr. Jungblut.

A criticism of an article by Dr. Fischer in the March number.

The " Cellastic " Tyre. A modern Solution of the Tyre Question. By Major Kolshorn.

This new tyre, which is proof against punctures and at the same time nearly as resilient as a pneumatic tyre, was described in the July number of *Militärwissenschaftliche Mitteilungen* (reviewed in the current number of *The R.E. Journal*).

It should be a guarantee of its excellence and reliability that the " Cellastic " tyre has been adopted in military vehicles by such well-known firms as the Citroën-Kegresse, Bofors, Hotchkiss, Madsen and Oerlikon.

Railway or Motor Vehicle. A comparison of these two methods of transport in war time. One of the main difficulties in connection with railways is the sudden change from peace conditions to war conditions of traffic on the outbreak of war. In a future war, railways will doubtless take first place in the carriage of war stores. As an example, during the World War, 215 trains were required to bring up stores of all kinds during a single week in January, 1916, on the western front.

But mechanical transport, which proved its value everywhere in the last war, is likely to be used to a far greater extent in a future war. It is clear that all nations have realized this from the energy and expenditure laid out in the development of their roads.

A.S.H.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*August*, 1937.)—*Engineers in Higher Formations.* By Colonel Dittmar.

The strength of engineers in a division, corps, or army must necessarily be a compromise between what is required for normal tasks and what may be required in exceptional cases.

At the outbreak of the World War the proportion of engineers was one company

per division. Besides the divisional engineers, there were one or two regiments of engineers attached to each army, primarily intended for siege purposes. In the reorganization of January, 1917, the scale was increased to a battalion of two companies per infantry division. Subsequently a large addition was made to the army troops, consisting of a number of battalions, single companies and special formations. Still later all bridging trains were combined as army troops.

A comparison is made with foreign armies, and two extreme cases are taken. France has one engineer battalion of two companies per division plus a weak engineer-park company; the United States have a whole regiment of six companies in a similar formation. A French division has no bridging material of its own beyond foot-bridges.

In the writer's opinion the correct organization is based on "decentralization for normal cases, stronger units in reserve for special difficult tasks." Most of these reserve units should be with the army. It is suggested that an army of three corps should have at least two motorized engineer battalions and a *Landwehr* engineer battalion at war strength as army troops. These battalions might with advantage be combined to form a regiment. It is further proposed that G.H.Q. should have at their disposal one engineer regiment of two battalions for each army.

Engineers in Attack.

Major Ahlfen discusses the employment of engineers in attack when the question of river crossings does not arise. The regulations lay down as a guide that (1) in attack, engineers support the attacking infantry by removing barricades, surmounting obstacles, and in the capture of fortified points, (2) in village fighting they can give valuable assistance with explosives and flame-throwers, (3) in wood fighting they clear the way for infantry through barricades and obstacles and make roads for horsed transport.

These points are elaborated and examples are given.

Tasks for Engineer Leaders and Troops.

Lieut.-General von Mertens, a distinguished engineer officer of the old army, propounds a number of problems that engineers may be confronted with in practice. They are sub-divided into (A) Road Construction, (B) Field Fortification and Obstacles, (C) Employment of Engineers in Attack, (D) River Crossings.

Two examples of the problems, out of a large number given, read as follows:—

How would you enable attacking infantry to cross an unfordable river, 20 metres wide, by means of two ropes stretched tightly across?

How would you cross a river packed with moving ice floes?

Lay-Out of Anti-Tank Positions.

General Burstyn, a former Austrian engineer officer, who, 25 years ago, worked out a design for a tank, has made a special study of anti-tank defence.

The 20-mm. self-loader, weighing about 40 kg., is an excellent weapon for the infantry. The main weapon for anti-tank defence is, however, the anti-tank gun, with calibres from 37 to 47 mm. in the various armies, and limited to 300 kg. in weight.

A tank is far more vulnerable from the flank than from the front. The flank offers a larger surface as a target, the flank armour is often thinner than that in front, and is vertical to the line of fire. Hence every effort should be made to get enemy tanks to expose their flanks.

To avoid the risk of a side-slip, a tank will endeavour to cross a trench at right angles. An anti-tank defence line should therefore be designed with a zig-zag trench with each straight length running at an angle of 45° with the general line of defence. Illustrations are given showing two type plans. Anti-tank guns and self-loaders are so arranged that each enfilades a line of trench. To economize excavation the trench need not be very broad or deep, the idea being to encourage enemy tanks to attempt to cross it. Moreover the trench can be so laid out that a tank that has been put out of action will not provide cover for the tanks beyond it.

The writer points out that his proposals are merely intended as general suggestions, and that they would not be effective against the very heaviest tanks weighing from 70 to 90 tons.

Equipment of the Fortifications of the Fortress of Metz in 1914.

Colonel Heye gives an account of the work carried out during the first few weeks of the World War in bringing the Metz forts up to war standard, and he throws some interesting side-lights on the difficulties encountered.

General Schroeter, the Inspector of Engineers, and his staff, had at their disposal for equipping the Metz forts a number of engineer units, some *Landsturm* infantry battalions and 12,000 civil labourers. Difficulties assailed them from the very start. Reservists had been taken at a moment's notice from their civil occupations and were poorly clad and shod. No greatcoats were available. There was a good deal of sickness and there were no proper medical or sanitary arrangements. The *Landsturm* troops were men getting on in years, many had been in sedentary occupations and were quite unfitted for strenuous manual labour. Ill feeling arose from the fact that civil labourers received 4 to 6 marks a day, while reservists, doing the same work, received only their military pay.

The work consisted largely of the erection of wire entanglements and of concrete construction. Arrangements for water supply were insufficient. The supply of gravel for concrete ran short. Transport, both horsed and mechanical, was inadequate. Roads were bad, and impassable in wet weather. Large stocks of cement arrived at the railway station, but could not be moved for lack of transport.

Owing to nervousness on the part of the garrisons of the forts, many acres of forest land all round them were cleared of timber, to provide a clear field of fire. The result was that the forts showed up clearly, and the work of screening them that had taken years of careful forethought was thrown away. Moreover, contractors' sheds and other buildings that would have proved invaluable were all pulled down. A large stock of explosives was accidentally detonated with serious loss of life.

In spite of all difficulties, reasonable progress had been made in seven weeks towards making the forts defensible. By a piece of good fortune the French did not make an attack, although they might well have done so.

The writer's comment is that all this will not happen in a future war, although the danger from a hostile air force is infinitely greater. The country is better organized.

Bavarian Mountain Engineers blow up a guarded Enemy Bridge. By P. Griesbacher.

An account of the demolition of a French pontoon bridge over the Somme near Falvy on the 30th August, 1918. Advancing under cover of darkness, the demolition party made a rush for the first pontoon, placed and fired the charge (150 lbs. of dynamite) before the French guard on the further bank was fully aware of what had happened. The bridge was wrecked.

A.S.H.

REVUE MILITAIRE SUISSE.

(July, 1937.)—*Quelques considérations sur le combat défensif.* By Col. Lecomte.

A reply to Colonel Montfort's article in the January number of the *Revue*. Colonel Lecomte thinks that the latter was written before the publication of the new *Instruction Provisoire pour la construction de barrages anti-tanks*. "Barrages," in this sense, means of course a disposition of artificial obstacles to tanks; and the instruction describes the different types of obstacles, and two sorts of anti-tank mines. Colonel Lecomte does not think that the tank is nearly so dangerous an enemy as the aeroplane. He considers that so much of the Swiss territory is unfavourable to

tank attacks, that more attention will as a rule be paid to the choice of a position than to its organization and defence.

Qui exercera le Commandement Unique ? By Lt.-Col. E. Mayer. A short contribution to the vexed question which confronts all democratic countries to-day. Colonel Mayer is strongly of opinion that the choice of the supreme commander cannot be made until the last moment; and he gives his reasons.

Répercussions possibles de notre nouvelle organisation sur l'emploi de l'artillerie. By Major Gonard. The conclusion of last month's article.

(*August*, 1937.)—*La Garde Civique Finlandaise.* By General Clément-Grandcourt. An interesting account of the force raised in Finland after that country had thrown off the Russian yoke. The Finnish Civic Guard is a somewhat unusual institution. It has many points of resemblance with the Swiss *Militia*, but it exists alongside of the regular army. It is a sort of National Guard, whose functions in time of peace are "to develop the defensive strength of the nation and its moral and physical qualities by giving it a military aspect," and, of course, to defend the constitutional régime.

It has a strength of some 100,000 men, aged from 17 to 60 years, who serve voluntarily and without pay. In time of war it would form part of the armed forces of the Republic. Training grounds, rifle ranges, schools and gymnasia are to be found everywhere; these are all the property of the Civic Guard.

The account is to be continued.

La défense de la Suisse à travers les Âges. By Col. Lecomte. A rapid review of the defence of Switzerland against foreign invasion, from the famous battle of Morgarten (1315), at which the ill-armed peasants overthrew the armoured knights of Austria, to the year 1856.

In 1476, the Bernese troops, aided by their Austrian and Zurich allies, smote the Duke of Burgundy's forces—considered the best equipped in Europe at that time. The campaign of 1799, fought on Swiss territory between French and Austrians, is full of instruction, and Colonel Lecomte summarizes its chief lessons. "From 1800 to 1813 Switzerland was under French protection, but most of the Swiss people sympathized with the enemies of France." In 1813, the Austrians demanded free passage for their troops through Switzerland, and although some preparations for resistance were made they were tardy and ill-executed, and the Austrians passed through into France.

Invasion was again threatened in 1838, when the French Government demanded the expulsion of Prince Louis Napoleon (afterwards Napoleon III) who was living in Switzerland; and in 1856, when Prussia attempted to regain her control over the Canton of Neuchatel. On both these occasions, the readiness of the Swiss to mobilize and prepare their defence made the would-be invader desist.

L'Automatisme à la Guerre. By Lt.-Col. E. Mayer. A further discussion of an article which appeared in the March number of the *Revue d'Artillerie* on the "Mentality of the Officer." The writer of that article was in favour of an "automatism," judiciously developed, which would lead to the execution of orders in the minimum of time, and abolish confusion, fear and panic. Colonel Mayer, who dealt with this article in the June number of this *Revue*, is of opinion that such a doctrine might be injurious. The best soldier is he who has been so well trained that in the hour of action he uses his weapon or executes his duty with mechanical precision yet preserves a steady head. Too much automatism abolishes individualism. Colonel Mayer tells the story of rifles picked up on battlefields in the American Civil War which were found to have been re-loaded several times but not fired; the barrels were full of separate charges. The soldiers had acted mechanically, but had lost their heads.

Préparation Morale. By Lt. Grosjean. A short syllabus of precepts for the young

officer about to start a refresher course. The author describes it as a résumé of some notes made recently in a French military school.

(*September*, 1937.)—*Les Prodromes de l'attaque de Verdun*. By General Rouquerol. The author attributes to von Falkenhayn the determination to strike a decisive blow at the fortress of Verdun from the very outset of his appointment to the Supreme Command of the German Armies in September, 1914. The race to the sea, and the Allied attacks following the battle of the Marne delayed the development of his plan; and it was not until February, 1916, that he was in a position to launch his scheme. Its failure proved his downfall. The German attempts in September, 1914, to cut the communications of Verdun first by attacking between the Meuse and the Aisne (Crown Prince's Army), and then in the pocket of St. Mihiel (von Strantz' Group), both failed to obtain any useful result, as did also von Mudra's efforts in 1915. But von Falkenhayn persisted, and when his resources in men and materials had sufficiently accumulated, he opened his tremendous attack of 21st February, 1916.

La Garde Civique Finlandaise. By Gen. Clément-Grandcourt. Conclusion of the article. It describes the economical way in which Finland maintains her Civic Guard. The annual training in camp lasts about three weeks, and is well attended. As the men receive no pay, every effort is made to raise funds locally, and a continual propaganda by film, by concert and through the Press is maintained. The local units of the Guard mix with all the sporting activities of their neighbourhood, and in Finland sport is practically universal.

The author concludes with a description of a personal visit to one of the summer camps and to a training school.

Le Meeting Aéronautique international de Zurich. By Capt. Schlegel. Describes the recent International Aeronautical meeting held from 23rd July to 1st August.

Le Défilé de la 1re Division. By V. A brief account of a march past by the 1st Division of the Swiss Army before a large crowd of spectators on the 9th September, at Mont-Les Etavez.

W.H.K.

THE INDIAN FORESTER.

(*July*, 1937.) The number begins with a broadcast talk by the Inspector-General of Forests on "A career in the Forestry Department," every sentence of which is of interest. It is addressed primarily to Indian candidates for the Service, and, while pointing out the intense fascination of the subject, points out that life in the department is no bed of roses. "Most of your life" he tells them, "will be lived in the remote places of the earth, you will see little of towns or the amenities which are offered by the towns. . . . You will be living surrounded by nature, very often your only companions will be the wild elephant."

The subject of the influence of forests on rainfall crops up, and it is interesting to note the dictum of the Empire Forestry Conference in South Africa in 1935, as follows:—"After careful review of the data available, we are of opinion that at various times and in different countries, altogether too much credence has been placed in the supposed influence of forests on the total rainfall of a country. We can find no reliable evidence to this effect and would point out that the topographical features of a country exercise a far greater influence upon precipitation than can be exerted by forests alone, however vast. On the other hand, there is evidence to show that forests have some influence upon the local distribution of rainfall by lowering the temperature of moisture-laden winds and in other ways." It would be interesting to know what is the evidence for the converse, *i.e.*, does disforestation leave the total rainfall of a country practically unaffected?

(*August*, 1937.) This question is to some extent answered in another broadcast talk by Sir Gerald Trevor, Inspector-General, on Forests and Climate. While the effects of disforestation are sudden and calamitous, it is very long before afforestation can restore the *status quo*, if ever. The appalling effects of disforestation have been seen in the recent floods in U.S.A. Sir Gerald warns his hearers to profit by the lessons already given by the erosion consequent on the destruction of forests in the Punjab and Orissa.

A letter to the Editor is accompanied by a photo of a bridge over the river Khapri in the Guzarat States Agency, 394 feet long, designed and supervised by the Bombay Forestry Engineering Department.

A summary of a German paper treats of the use of aerial photos in estimating the volume of standing timber—a very long process if done by ground methods. It is claimed that an estimate can be made within 7·4 % for single trees and within ·4 % for masses.

It is astonishing to read that the root system of a single wild oat plant, grown free from competition over a period of 80 days, measures 54 miles!

Mr. Kamesam supplies an article on Cheap Power Production, treating of the use India can make of timber products for this purpose. An Italian motorist claims to have travelled 4,000 miles in a producer-gas-driven car, using only 10 cwt. of charcoal.

(*September*, 1937.) Sir Gerald Trevor again supplies an article, this time on the proper selection of seed for forest trees; it is a matter of greater importance than a layman would think to select the right parents among trees, and the matter may ultimately become nearly as important as the breeding of race-horses.

Exhaustive experiments have recently been carried on at the Forest Research Institute at Dehra Dun on the comparative strengths of hardwood and sapwood. Samples of a good number of trees used for structural purposes—*shisham*, *kail*, *chir*, *sal* and *teak* among them—were tested, and the results show that as regards modulus of rupture, compressive strength, and hardness, there is little if any difference. Specimens were green, except in two instances, *teak* and *sal*, where they were air-dried.

A large *sal* felled in the Ramnagar forest division of the United Provinces gave 264·3 cubic feet of scantlings, ranging from 15 ft. by 11 in. by 4 in. to 4 ft. by 4 in. by 4 in.

F.C.M.

CORRESPONDENCE.

THE ORIGIN OF CHANGI CANTONMENT.

To the Editor of *The Royal Engineers Journal.*

SIR,

In the article "Changi Cantonment, 1933–1937," in the September number of *The R.E. Journal*, the author states that "the conception of Changi as a military station dates from the visit to Malaya of the Gilman Commission." This is incorrect; the origin of Changi dates from June, 1926, a year before the Gilman Commission arrived in Malaya.

The preliminary plans and reconnaissances were all made in 1926 and the negotiations for the purchase of the first portions of the land, held up until the necessary allotment of funds had been made, were well advanced by the time the Commission landed; so much so, that the first land came into possession of the War Department six weeks after its arrival. The Colonial law required that the intention to purchase land must be published in the local *Government Gazette* six months before the purchase could be completed.

The site for the pier, and the necessary soundings for it, the site of the *padang* or recreation grounds, the alignment of the railway, and the general distribution of the principal buildings were all selected and reported upon in 1926, and have now been incorporated in the work. The reports are in the War Office.

The Gilman Commission only stayed about six weeks in Malaya; it came to report and advise the War Office on the whole scheme—so far as it then went—for the defence of the Singapore Base, and, as regards the Changi project, it took over and adopted a ready-made scheme.

There had been a tentative scheme for a very small cantonment prior to 1926, but this was to have been on the east coast of the island of Singapore. It was very exposed and on too flat a site for drainage, etc.

Yours faithfully,

W. HYDE KELLY,

Lieut.-Colonel (retired).

27th September, 1937.

THE PROBLEM OF THE ENCOUNTER BATTLE. A QUERY.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

Brigadier Montgomery's article in the September number of *The R.E. Journal* has come at a most opportune moment to those of us who have been scratching our heads as to how to make infantry on their feet keep up with mechanized Divisional Cavalry, and how to ensure that the latter will comb the ground ahead of a column sufficiently closely to give security.

I think that Brigadier Montgomery's suggestions come nearer to solving the problem than anything I have yet heard advanced, but I should be very glad if he would clear up two points.

During the tactical approach, four sections of the Reserve M.T. Company will have to lift not only the dismounted personnel of nine rifle battalions, but also the Divisional Engineers (less one Field Company with the forward troops, to which will have to be allotted the C.R.E.'s pool of M.T.). As the Divisional Engineers will be moving in bounds in company with the balance of the Divisional Artillery and one M.G. Battalion (units which are completely mechanized) and may be required forward at short notice, whatever transport is allotted to them to carry personnel will be " tied up " for the whole day. This will leave not much more than three sections of the Reserve M.T. Company available for the nine rifle battalions.

Assuming an advance of 40 miles in the day, which seems not unreasonable, it can be worked out that, even if each Infantry battalion does a fair share of footslogging, each section of the Reserve M.T. Company will have to average about 180 miles in the 24 hours, this work being spread over very long hours.

I do not think that any M.T. will stand up to this—80 miles used to be considered a fair day's work for second and third line M.T.

The requirements of the Divisional Engineers will be the same during the contact battle, but the total advance during the day will undoubtedly be less.

Is the solution to mechanize completely the Divisional Engineers and at the same time increase the allotment of transport for the Infantry, or is it to restrict the day's advance ?

The second point is at what stage should a commander decide to alter the composition of the forward troops ? Admittedly in the earlier stages of the advance forward troops organized as in Brigadier Montgomery's Diagram " A " will serve the purpose. But no tank unit in the world can help overlooking little nests of machine gunners, if the latter will only emulate Brer Rabbit and "lie low and say nuffin." I fear that the first intimation that the Divisional Commander will receive that it is time to " stiffen up " his forward troops

with an Infantry Brigade will be a sudden burst of machine-gun fire. The result will be—to use a favourite phrase of Brigadier Montgomery—" a scene of intense military confusion."

Yours truly,

ENDYMION.

The following reply has been received from Brigadier B. L. Montgomery, D.S.O. :—

REPLY TO " ENDYMION."

1.—Under existing arrangements there is in the Field Park Company a pool of lorries which can be allotted at the discretion of the C.R.E. This is the pool of M.T. referred to by " Endymion " ; it may be required for stores, in which case the personnel of all Field Companies would have to march. The pool of lorries is sufficient to carry the personnel of one Field Company.

In 1936, the Finlayson Committee was assembled to consider the war organization of the Royal Engineers. This committee recommended the complete mechanization of the Divisional Engineers. If this recommendation is accepted, the Divisional Engineers will presumably be mounted in trucks or light lorries, or in a combination of both types of vehicle. The resulting addition to the establishment of a Field Company, in terms of vehicles, would be approximately 25.

It is obvious that, in any form of mobile warfare, the Divisional Engineers require a mobility as great as that of the mobile units of the Division. The mechanization of the Army has given increased mobility to all units ; to leave the Divisional Engineers to march would not be in keeping with the present tendency in this age of progress. I have assumed throughout that the recommendations of the Finlayson Committee regarding the complete mechanization of the Divisional Engineers will be accepted. I am sorry that this was not made clear in the article itself.

2.—The answer to the second point raised by " Endymion " is contained in paragraph 19 of the article. If, having read this carefully, " Endymion " will then refer back to paragraph 10, he will see that " a commander must decide *before* contact is gained how he will fight the battle."

Certain risks always have to be taken in war. It is quite impossible to provide the soldier with complete immunity against bullets, or gas, etc. Commanders in their several grades are trained to take all necessary precautions against surprise at all times, whether their units are in touch with the enemy or in reserve.

B.L.M.