The Royal Engineers Journal.

VOL. LII. **SEPTEMBER, 1938.**

CHATHAM:
THE INSTITUTION OF ROYAL ENGINEERS,
TELEPHONE: CHATHAM, 2669.
AGENTS AND PRINTERS: MACKAYS LTD.

LONDON:
HUGH REES, LTD., 5, REGENT STREET, S.W.1.

PUBLICATIONS ISSUED BY THE INSTITUTION OF ROYAL ENGINEERS, CHATHAM

THE ROYAL ENGINEERS IN EGYPT AND THE SUDAN

By Lieut.-Colonel E. W. C. Sandes, D.S.O., M.C. With a Foreword by General Sir Reginald Wingate, *Bart.*, etc. Price 18s. (to members of The Institution of Royal Engineers, 6s.).

The Times describes this as "a remarkable book, valuable from the technical point of view but comprehensible to those who are not technicians, pleasantly written and often extremely amusing. It is a real contribution to the history of the British in Egypt."

Sir Reginald Wingate writes: "I can unhesitatingly characterise *The Royal Engineers in Egypt and the Sudan* as quite the best and most comprehensive history of the modern Sudan."

HISTORY OF THE CORPS OF ROYAL ENGINEERS.—Vols. I and II, by Major-General Whitworth Porter, R.E. Vol. III, by Colonel Sir Charles M. Watson, K.C.M.G., C.B., M.A., late R.E. Three Vols. £1 10s. (to members, 7s. 6d.) post free.

AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS, 1914 to 1918. By Major-General Sir M. G. E. Bowman-Manifold, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*, late R.E. Seventh Edition, 1929. With 17 maps and sketches. Price 4s. 6d. post free.

THE MILITARY ENGINEER IN INDIA.—By Lt.-Col. E. W. C. Sandes, D.S.O., M.C. Vol. I 25s. Vol. II 15s. (to members, 6s. each volume), post free.

NOTES FOR OFFICERS PROCEEDING TO INDIA (1930).—Price 3s. 6d. each (to members, 2s. 6d.), post free.

WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914-1919. Comprising:—

BRIDGING.—With 3 maps, 59 photographs and 31 plates. Price 12s. (to members, 3s.).

MILITARY MINING.—With 25 photographs and 62 plates. Price 12s. 6d. (to members, 3s. 6d.).

GEOLOGICAL WORK ON THE WESTERN FRONT.—With 19 plates and 9 photographs. Limited to 500 copies. Price 15s. (to members, 5s.).

SIGNAL SERVICE IN THE EUROPEAN WAR, 1914 to 1918, THE.—(By special arrangement with the Signals Association), R. E. Priestley, M.C., B.A. (late Major, R.E.). With 2 photos and 20 plates. Price 12s. 6d. (to members, 4s.).

SUPPLY OF ENGINEER STORES AND EQUIPMENT.—Price 7s. (to members, 1s. 6d.).

WATER SUPPLY (EGYPT AND PALESTINE).—With 7 maps, 6 photos, 10 plates, and 20 sketches in the text. Price 8s. (to members, 2s. 6d.).

WATER SUPPLY (FRANCE).—With 10 maps, 37 photographs and 41 plates. Price 16s. (to members, 5s.)—*Spectator*.

WORK UNDER THE DIRECTOR OF WORKS (FRANCE).—With 6 maps and 71 plates. Price 21s. (to members, 5s.).

"MISCELLANEOUS," comprising:—(1) The Organisation of the Corps, 1914-1918. (2) Engineer Intelligence. (3) Camouflage. (4) Concrete Defences and Factories. (5) Forward Communications. (6) Machinery, Workshops and Electricity. (7) Inundations. (8) Anti-Aircraft Searchlights. (9) Schools. With 105 plates and photographs. Price 20s. (to members, 5s.).

The whole of the above nine volumes may be purchased by members for 30s. Postage extra in all cases.

THE INSTITUTION OF ROYAL ENGINEERS.

Authors alone are responsible for the statements made and the opinions expressed in their papers.

CONTENTS.

All communications for the Institution should be addressed to:—

The Secretary, The Institution of Royal Engineers, Chatham.

COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS.

(Incorporated by Royal Charter, 27th February, 1923)

Patron:—H.M. THE KING.

President.

Maj.-Gen. *Sir* Charles W. Gwynn, K.C.B., C.M.G., D.S.O. 1938

Vice-Presidents.

Maj.-Gen. D. S. Collins, C.B., D.S.O. (*D.F.W.*). 1936
Maj.-Gen. G. H. Addison, C.B., C.M.G., D.S.O., M.A., M.I.MECH.E. 1938

Elected.

Lt.-Col. R. L. Brown 1936
Brig.-Gen. *Sir* James E. Edmonds, *Kt.*, C.B., C.M.G., D.LITT., *p.s.c.* 1936
Capt. M. C. A. Henniker, M.C. 1936
Col. W. A. FitzG. Kerrich, D.S.O., M.C. 1936
Brigdr. J. C. Wickham, D.S.O., *p.s.c.*, *n.s.* 1936
Lt.-Col. M. Luby, D.S.O., M.C. 1936
Major M. R. Caldwell, *p.s.c.* 1937
Brigdr. E. L. Morris, O.B.E., M.C., *i.d.c.*, *p.s.c.* 1937
Brigdr. A. E. Grasett, D.S.O., M.C., *i.d.c.*, *p.s.c.* 1937
Lt.-Col. B. C. Dening, M.C., *p.s.c.* 1937
Lt.-Col. J. V. Denning, M.C. 1937
Major J. F. D. Steedman, M.B.E., M.C. 1937
Major S. J. Marks 1937
Col. W. Garforth, D.S.O., M.C. 1938
Major W. Porter, *p.s.c.* 1938

Ex-Officio.

Maj.-Gen. L. V. Bond, C.B., *p.s.c.* (*Comdt. S.M.E.*).
Col. H. B. W. Hughes, D.S.O., O.B.E. (*A.A.G., R.E.*).
Col. J. E. Chippindall, C.B.E., M.C. (*A.D.F.W.*).
Col. J. P. S. Greig (*A.D.Tn.*).
Brigdr. A. P. Sayer, D.S.O. (*R.E. & Signals Board*).
Brigdr. G. N. Macready, C.M.G., D.S.O., O.B.E., M.C. (*G.S.*).
Lt. Col. H. E. Moore, D.S.O., M.C., (*C.I.C.*).
Major W. H. Ray, *p.s.c.* (*Staff Captain, S.M.E.*).

Corresponding Members.

Bt. Col. T. R. Williams, C.M.G., D.S.O. (Australian Staff Corps) 28 1 30
Bt. Lt.-Col. C. R. S. Stein, *p.s.c.* (Royal Canadian Engineers) 24 10 33
Captain G. H. Clifton, M.C., *p.s.c.* (N. Zealand Staff Corps) 27 7 37

Secretary: Lieut.-Colonel E. V. Binney, D.S.O. ..... 15th June, 1934.

2,250—1.938.

THE DAY'S WORK ON THE NORTH-WEST FRONTIER.

By MAJOR E. H. T. GAYER, O.B.E., R.E.

"No, my boy, India is not what it was in Smellipore in ninety four."

True; and how very wrong if it were. However, this is not an ethical discourse on evolution, natural or unnatural, but a tale of a few jobs of work in a small corner of to-day's India, in the hope that those who care not for the past may find some interest in the present.

The scene is Waziristan, November, 1936, to October, 1937; the actors a Field Company of Sappers and Miners.

Towards the end of November, for reasons best known to themselves and subsequent writers of military history, the Tori Khel tribe decided to re-open the close season for the shooting of the King-Emperor's troops. As a passing fancy, this form of pleasantry might have been appreciated by both sides, particularly as the Gunners had hardly pulled through their pieces after practice camp. But the rudeness continued for many months and brought in its train work, and more work, for all concerned. So let us see if *Engineer Training, Field Engineering* and all those other tomes, which are the cause of our excess baggage, really are the goods.

To go all theatrical again and for the convenience of chronology, the play is in four acts :—

Act I	November 23—February 7.	In the Khaisora.
Act II	February 8—May 30.	In Razmak.
Act III	May 31—August 2.	Razani.
Act IV	August 3—October 8.	In Razmak again.

ACT I.

November 23, 1936—*February* 7, 1937.

During this period, the principal activities were road-making, except when engaged in active operations with a brigade. The

company worked on practically the whole of the road from Mir Ali to the Sein Gorge at different stages of its construction (see Map).

This road presented little technical difficulty except in the Sein Gorge (see Photo No. 1) where a great deal of blasting was required.

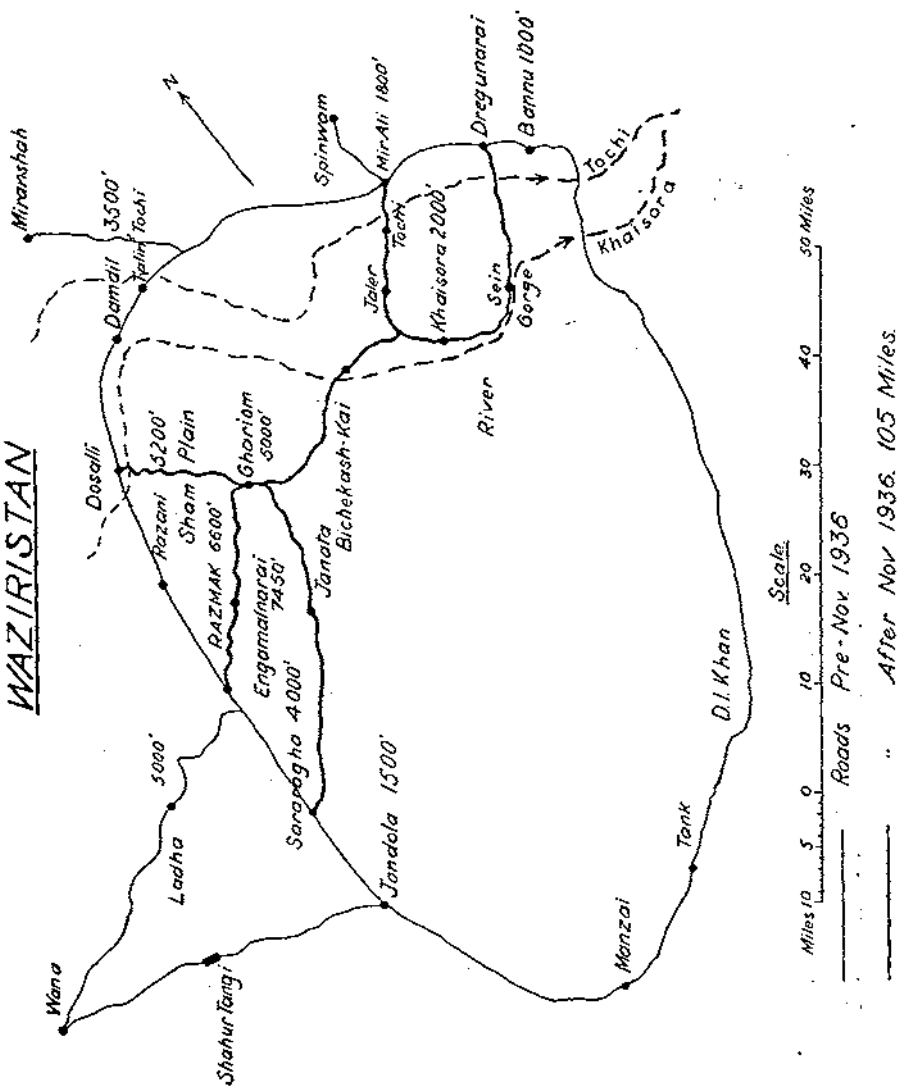
A dirt road was made, varying in width from 20 ft. to 40 ft. according to the terrain, with wide shallow side-drains. After the formation had been shaped, it was shingled, sanded and rolled. Culverts were usually of empty Colas drums with 1 ft. 6 in. to 2 ft. of earth above. Temporarily, these would take heavy traffic, until replaced later by brick or concrete culverts done by contract labour. A moment of stress arose when the Biche Kashkai branch was being made in January (see Map). Speed was essential and it was completed in three days, without shingling. This meant, however, that on the last day, digging, rolling and titivating were going on simultaneously and a ten-ton roller made an ugly dent in a Colas drum culvert, which it had to recross to get home. As the rearguard had already been delayed some time by a ditched light tank, it was unlikely that a roller *in extremis* would add to the popularity of the Sappers. The return trip was interesting, but not disastrous.

The outstanding lesson of this road construction, which in the first place was entirely carried out by troops, was careful organization and ensuring that working parties really understood what was wanted of them. Almost from the start, police are necessary for traffic control.

A typical daily picture is the field company spread over two miles of road, chiefly engaged on culverts, Irish bridges and the like, and probably two battalions as working party, either on formation or shingling. Shingling parties would have twenty or so lorries, all in each other's way and unloading at the same point unless carefully controlled and distributed. Other traffic problems, M.T., mule and camel convoys trying to use the road in either direction, at intervals D.R's, staff cars and the grossly overloaded vehicles of some unit's contractor, add variety to the scene.

In the Sein Gorge blasting was carried out with gunpowder, guncotton and gelignite, and compressors were used extensively. *If* the gunpowder was in good condition, it was cheap, quick, and effective, particularly where large masses of loose rock had to be moved. Guncotton was expensive, slower to use, and not so effective in boreholes as gelignite.

In the various operations that took place, one of the chief jobs was water-supply. 1,500-gallon tanks and horse-troughs were the usual gear, and the chief requirements speed of erection and dismantling, and at least three times as much room for watering that any book allows. All want water and at once ; time-tables take time to prepare and to put into action. 30,000 gallons per day is a reasonable amount for all purposes for a brigade and attached troops, with its attendant transport.


WAZIRISTAN
Miranshah
Damdil 3500'
Spinwam
Mir Ali 1800'
Dreguinarai
Bannu 1000'
Tochi
Khaisora
Dosalli
Razani
Sham Plain 5200'
Ghoriam 5000'
RAZMAK 6600'
Enguinarai 7450'
Janata
Bichakash-Kai
Toler
Tochi
Khaisora 2000'
Sein
Gorge
River
Sarapogha 4000'
Jandola 1500'
Ladha 3000'
Wana
Shahur Tangi
Manzai
Tank
D.I.Khan
Scale
Miles 10 5 0 10 20 30 40 50 Miles
Roads Pre-Nov 1936
After Nov 1936. 105 Miles.

Helping infantry to design, build and wire piquets was a frequent job. In this, there was always a hurry, and getting men, tools and stores to the right place and keeping them in the right place was half the battle.

Village destruction and tower demolition was another favourite pastime. This is a particularly satisfying amusement, especially when personal animosity is felt towards the tower in question. For fear that Sappers might run riot, political officers usually shadowed them closely.

On approaching a cache of towers with a sapper subaltern, the political officer rapidly assumed the role of an elderly duenna sheltering a susceptible virgin from the unmistaken advances of a Don Juan or Casanova. However, a number of towers fell down.

If reliable, gunpowder is much the quickest method. A hole dug in the base, one or two bags with safety fuse, and sandbags on the top—twenty-five minutes was the quickest time, and the result completely successful. The formula for tower destruction given in the Indian *Manual of Fieldworks* usually works out in the neighbourhood of 20–25 lb. The formula usually employed was 25 lb. for a small tower, 50 for a big one, and 100 if it was somebody's birthday. There were no failures. (Photos Nos. 2 and 3.)

Towards the middle of January, the company settled at Khaisora for about three weeks to build a post for three hundred men, and an emergency landing-ground.

The fortified post was of a normal design ; perimeter wall of about 450 yards, parados, two belts of wire, a gravity water-supply feeding sectional iron storage tanks, two 15-ft. towers, and half a dozen small semi-pukka buildings inside. Every trade was needed except engine-drivers and electricians. The most finicky item was the water storage ; a battery of forty 400-gallon sectional tanks, which had to be assembled on the spot with 8,000 bolts and nuts, each with two washers, one felt and one steel packed with grease. This kept several people busy.

The landing-ground, an area of 450,000 square yards in the form of an L, was on comparatively flat ground. The Survey of India with considerable acumen had marked it " Stony Waste." After perspiring infantry had moved most of the stones, its flatness was less marked and two trail-builders and two graders arrived to push hills into valleys.

These machines were viewed with marked unpopularity by the infantry, as more stones arose in their wake. Finally, two ten-ton rollers finished the work, and whitewashed corner and halfway marking flats in broken stone were added. Naturally, all this work needed far more labour than the field company, less a section ; in fact the entire brigade, except those on protective duties, was the working party. This averaged about 1,000 men per day, and the

maximum was 1,800. This was supplemented by over a hundred A.T. carts, 40 or 50 pack mules, a few lorries, road-making machines and rollers.

Act I closed with a week in River camp, spent chiefly in replacing temporary culverts by Hume pipes or Colas drums set in concrete rings, and working parties on catchwater drains.

Act II.

February 8—May 30, 1937.

The company spent this period in Razmak and carried out but little constructive work—two biggish camp piquets, the destruction of a village and minor repairs to the Waziristan circular road. It had, during this time, various detachments scattered round Waziristan, viz :—

(*a*) Twelve men in Miranshah doing water-supply and odd jobs for a brigade there.

(*b*) One section at Tal in Tochi, building two concrete pillboxes on either side of the girders of the bridge. (See Photo No. 4.)

During March, the tribesmen tried to destroy one of the girders and did a certain amount of damage. The method used was an unexploded aeroplane bomb, plus a fire.

The section had an interesting and rather difficult job, which took about six weeks. They lived, more or less cut off from the world, with the Tochi Scouts in Tal Fort, and had to arrange for their own rations, stores and anything else they wanted.

The pillboxes were each designed to hold a section of infantry as a sentry group post. They were of pre-cast concrete blocks made on the site. For tactical reasons they were built on piers of the bridge and not on the abutments. The floor space here was so small that at least half the pillbox had to be cantilevered out on girders and the girders strutted from below. (See Photo No. 4.)

The mathematics of these structures might have defeated even Professor Inglis ; but so far they remain intact. Another factor to be considered was the vibration set up in the main girders of the bridge by heavy traffic. Those girders of the pillbox which were tied to the bridge had to have room to vibrate without shaking the pillbox down.

On completion of this work early in May, the section moved to Dosalli, then the headquarters of 1st Indian-Division during the Sham Plain operations. Two jobs awaited them there ; a 10,000-gallon sectional steel tank on tubular scaffolding and the laying of some victaulic piping. With the exception of sniping piquets, cutting the

pipe-line appeared to be the popular local sport. Several *maliks* were awarded their colours.

(*c*) The third detachment, a sub-section, had a varied career in and around Manzai. They started their activities as the sapper detachment of the Mir Ali-Razmak convoy escort, their duty to remove road blocks; then they moved to the Manzai-Razmak sector and lost their job after a convoy was ambushed in April in the Shahur Tangi. This resulted in the shutting of the roads. Bereft of their convoy duties, they looked after a pumping station, supervised water-supply, improved defences, mended huts and took the wings off a crashed aeroplane.

They were eventually retrieved to Razani about the middle of June.

ACT III.

May 31—August 2. Razani.

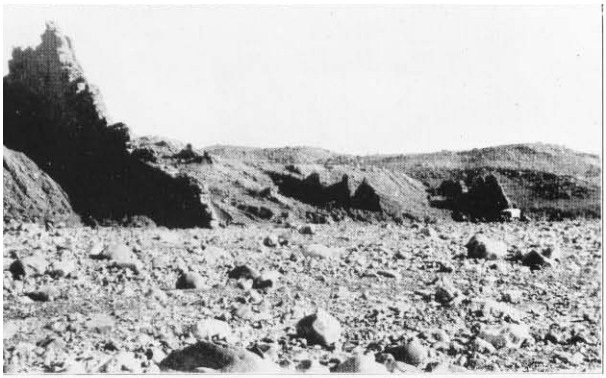
By the end of May it was decided to re-open the Bannu-Razmak road, which had suffered a considerable amount of damage between Razani and Razmak at the hands of tribesmen. A girder bridge on stone piers had been considerably damaged near Razani, and a breach made in the road, aggravated by weather conditions, a mile nearer Razmak. The company moved down on 31st, accompanied by 200 or 300 M.E.S. coolies and a hundred odd donkeys. A somewhat mixed and straggling column for, as a sub-overseer of the M.E.S. remarked, "Sir, our brigade (*sic*) is not accustomed to military march."

One section remained behind for three weeks for operations with the Razmak Brigade, and the detached section at Dosalli moved to Razani on 27th May.

The broken bridge (see Photo No. 5) had to be ready to take a full-dress M.T. convoy on 4th June. Actually, it was ready on 2nd; a diversion suitable for light M.T. was also made in case of accidents.

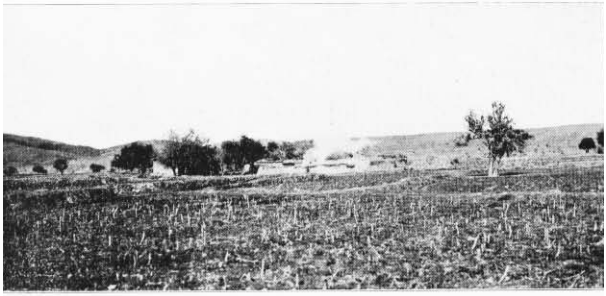
The chief damage was to the central stone pier, which was about two-thirds destroyed; the girders carrying the roadway had sagged but the road had not collapsed. (See Photos Nos. 5, 6 and 7.)

The pier was largely rebuilt in cement bags filled with rapid-hardening cement concrete. Long angle-iron piquets were embodied, vertically and horizontally, to tie the whole together. When the pier was within a few feet of the girders they were jacked up and straightened and actually took a certain amount of traffic in this condition. Finally, the jacks were removed and the pier completed in concrete.



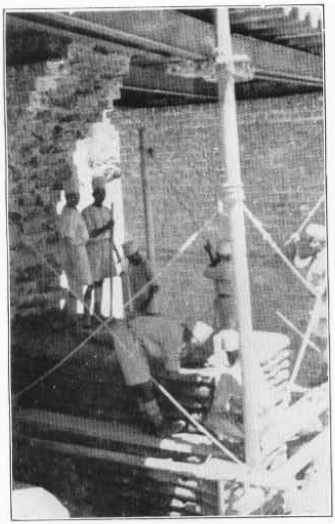
1.—Sein Gorge. The road had to be cut through the rock knife-edge.

2.—Zaranai Tower. Before.

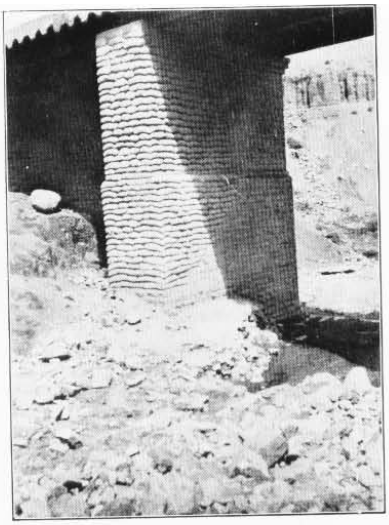


3.—Zaranai Tower. After.

The day's work on the North West frontier 1-3

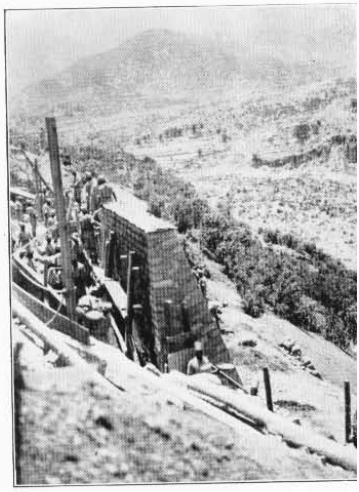


6.—Pariat bridge pier, mending.



7.—Mended

8.—Razani retaining wall. Temporary repair is above.



9.—Razani retaining wall.

The day's work on the North West frontier 6-9

10.—Mahsud road construction battalion.

11.—Gurkhas rock-rolling.

12.—Mile 3·6. Razmak-Ghariom road.

The day's work on the North West frontier 10 - 12

This method of repair was very speedy and saved an immense amount of shuttering. As it will probably be left as a permanent repair, it will be interesting to see how it lasts.

The breach in the road was really the largest engineering job that the company had to carry out. A section and a half was employed for two months, assisted by about 80 coolies and 50 donkeys who provided the raw materials.

The nearest source of water was about 200 feet below the work, and a road down to a filling point for lorries, supplied by a Merryweather pump, had to be made about ¾ mile away.

A temporary repair had first to be made. This consisted of 5,000 earth-filled cement bags in a wall 100 ft. long and about 14 ft. average height. This took four days. The permanent repair was to be built on solid rock to prevent further sliding from above. This retaining wall was made of an external skin of concrete blocks, the centre filled with plum concrete.

The size of this wall when finished was :—

Length, 140 ft.
Maximum depth of Founds., 9 ft. below ground.
Maximum height above ground, 22 ft.
Maximum width of Founds., 9 ft.
Width at top of wall, 2 ft. (See Photos Nos. 8 and 9.)

As some 5,000–6,000 blocks were required, a small block-making factory was established near the Merryweather pump. Altogether about 10,000 blocks were made ; 2,000 or 3,000 were needed for other jobs, a reservoir and two culverts, and, unfortunately, one night a spate removed two thousand which were curing in pools.

The building of the wall itself was fairly straightforward, but the excavation was not so easy.

The line of the wall was about 35 ft. vertically below the road, and was continually menaced by many tons of loose spoil lying at a very steep slope, about 60°. Extensive shoring of sleepers, 2-in. planking, 16-ft. angle irons and forests of ropes, were used, and the excavation carried out in longitudinal sectors each of about 40 ft.

The shoring was strong enough to give ample warning of impending falls, but not to prevent them. Eventually many tons of spoil had to be cleared away before the foundations could be put in.

Another similar wall, 70 yards in length, which was to have been built at the foot of a moving wedge of hillside, had to be abandoned. Trial pits were dug to a depth of 25 or 26 feet without reaching a solid foundation.

Two stone and concrete culverts, each with a waterway of nine square feet, were made through the road. A most useful bridge was provided by the C.R.E. to enable men to work on the whole length of the culvert without dislocating the traffic. This consisted of four

20 ft. 13 in. by 5 in. R.S.J's, sleeper decking, and wooden ramps. This was laid straight on to the road, anchored down, provided with handrails and covered with 3 in. of earth.

Without handrails and the earth, 20 men could erect the bridge in about 1¼ hours, and the road was only blocked to traffic for about ½ hour. Dismantling took only about ¾ hour. Despite the fact that the hours chosen for bridging were during " road closed " hours, an officer of extremely exalted rank twice arrived at the psychological moment when his car was unable to pass. As it was the same officer on each occasion who was delayed, his presence was viewed with apprehension. Fortunately both sides showed no ill-will.

The last job at Razani was a reservoir, 36,000 gallons, to supplement the existing one of 19,000.

The dimensions were 50 ft. by 30 ft. by 6 ft.

Foundations	..	14 in. concrete.
Walls	..	Concrete block skins filled between with plum concrete.
Roof	..	C.G.I. sheets on composite timber trusses and purlins.

The inside was rendered throughout with one inch of cement plaster. Various refinements such as concrete steps down into the reservoir and a measuring gauge painted on the sides were added, but the Razani garrison deplored the omission of a high diving-board.

ACT IV.

August 3—October 8.

One section returned to Razmak about 20th July and the remainder on 2nd August for work on the first six miles of the new Razmak-Ghariom road.

The company was responsible for constructing three sectors, miles 1 to 2, 3½ to 4, and 5 to 5½, and also for cambering and surfacing the greater part of the road from mile 1 to mile 3½.

The general line of the road and the level pegs for the ruling gradient, 1 in 17½, were done by the Field Engineer; practically all other work was left to Sappers and Miners assisted by large working parties.

Of the above-mentioned sectors, except for mile 3½ to 4, the construction of the road was fairly straightforward, though there is a rise of over 1,000 feet in rocky, scrub-covered country between miles 1 and 5½.

One of the major problems was again men, animals and paraphernalia to the right place without undue delay. On a " heavy " day, the company was working on all three sectors at once with working parties of two battalions, a few gunners, some Labour Corps, part of

a Field Ambulance, and a hundred or so Mahsuds from the recently raised Mahsud Road Construction Battalion. The latter were put into a uniform, grey shirt, shorts and *chaplis* and had a number of ex-regular N.C.O's and Indian officers. They worked cheerfully, but rather spasmodically; were mostly very youthful and found the soldiery curious and entertaining. They had one uniform quality, that of a well-hung grouse. As they worked mostly at Prospect Corner (Photo No. 10), at the top of a very steep 600-ft. climb, the order of precedence in the march table was peculiarly important.

The road was an 18-ft. dirt road, with side drains, catchwater drains and scuppers, the surface to be shingled where necessary. Mile 3½ to 4 contained a great deal of rock-cutting and one very hairpin bend; the two arms were at one place only 10 ft. apart. This corner needed incessant checking of levels, etc., by the company's surveyors, a trade that was employed on many occasions not only on road building, but when making the Khaisora Scout Post, the landing-ground, and retaining walls.

The approach to the hairpin bend needed an almost continuous retaining wall about two hundred yards long. This varied in height from 3 ft. to 15 ft., the lower portions in dry stone, the higher in stone in cement.

A compressor working three drills was used daily for 4 or 5 weeks. As the compressor was a thousand feet away and 500 feet below, the victaulic line had to be left out permanently. Fortunately it was not damaged by hostile action, though its peace of mind was frequently disturbed by zealous infantry up above. The infantry battalion on this sector, always the same battalion, were quite capable of moving rocks up to 4 or 5 tons by crowbars and ropes; sapper explosives were reserved for the more monumental rocks. As there were two other arms of the road, vertically below and none above, rock-rolling ceased to be regarded as work. There was an unlimited supply of playthings, so those below were criticized as lacking in a sense of humour, when "rock-closed" hours had to be laid down. (See Photo No. 11.)

Demolitions usually entailed 20 or 30 charges daily; 8–12 oz. of gelignite in 12-in. to 18-in. boreholes was the usual dose. Gunpowder by this stage of the war seemed to have deteriorated, and guncotton was very expensive and frequently unsuitable.

Blasting (see Photo No. 12) also had to be restricted to a certain period, usually the last half-hour of work. In spite of this, sentries, red flags, bugle calls and the most careful liaison with all and sundry, there were many anxious moments when the odd coolie or camel and sometimes officer, always the most difficult to control, wandered into the danger zone.

Two other field companies were usually blasting in two different areas during this time, so the naturally stony path of withdrawing

working parties and protective troops, probably four thousand or more in all, was not so monotonous as it might otherwise have become.

An interesting article of non-standard equipment, the Trewhellion Winch, was used for removed tree roots and not too big rocks. This was anchored on a level piece of ground about 20 yards from the obstacle.

A steel wire rope, usually incorporating a block and tackle, was taken round the obstacle and brought back to the winch. This was provided with a long lever arm working a geared ratchet wheel. Two men could work this and pull the tree or whatnot out.

During these operations, every tradesman, at one time or another, worked extensively at this trade, with the exception of engine-drivers and electricians. Even these had some fun for their money.

During Act II, the electricians were busy wiring and installing electric light and power in the Sapper and Miner workshops. The engine drivers had only a little work with a Merryweather and a small rock-drill called "Warsop." This was a little brother to a compressor and a present from the R.E. Board. He was very temperamental, but did a lot of useful work.

A letter arrived, as such letters do, urging that "Warsop" should be given a thorough trial in the field.

As he had then been 400 or 500 miles on a mule, fallen off into one of Waziristan's stonier nala-beds and successfully dodged a number of bullets, it was felt that, for once, both the spirit and the letter of the law had been faithfully followed.

The Company were also used as infantry, pure and simple, on several occasions. Two or three times during an emergency it was under fire.

As Sappers are not provided with signalling equipment or light automatics, provision of piquets needs a certain amount of training, slightly different from that of the infantry.

Perhaps "Fun on the Frontier" may not be exactly as depicted in *Bengal Lancer*, but at least it is not dull.

NOTES ON THE BRITISH OCCUPATION OF THE CAUCASUS DURING 1919.

By MAJOR-GENERAL A. BROUGH, C.B., C.M.G., C.B.E., D.S.O.

BEFORE attempting any detailed account of the events in the Caucasus during the year 1919, it may be as well if I give some short description of this country and of the general situation towards the close of 1918.

2.—A rough skeleton map appears opposite page 368 of this area; it is to a large extent wild and mountainous, but the tracts near the larger rivers and seas are very fertile.

On the north the main range of the Caucasus forms a fine natural barrier, as it is impassable for troops except for a short distance on the west, near Sochi, on the Black Sea, and similarly on the east, near Derbent, on the Caspian Sea. The road running north and south from Tiflis to Vladikavkaz pierces the range near the famous Mount Kazbek, but even in our time the handful of bandits that infested this area rendered transit precarious.

The spurs running south into the province of Kars, which is also very mountainous, formed a serious obstacle to the construction of the railway from Batum to Tiflis, and it was found necessary to import engineers and labour from Great Britain to complete the long tunnel near Suram.

The construction of the railway to Kars, Erivan and Julfa was a fine feat of engineering, and it may be said that, excepting the railways, the communications in this area are poor, and movement of troops by the bad roads is a serious undertaking.

3.—For many years engineers have been looking for a suitable spot for laying a railway through the mighty range of mountains which guards the western frontier of Persia. I suggest that the most favourable point is some little way south of Erzeroum, where the sources of the rivers Euphrates (here flowing west and south) and the Araxes (flowing east and south) are quite close to one another. This is obviously a low point in this range and the development along these big rivers, through a country full of minerals, is more likely to prove lucrative than the costly construction of narrow-gauge lines through the barren and difficult passes farther south. A glance at the profile of the light railway laid by the Russians from Shakhtakti to Maku should bring this home to any engineer, as the grades and curvature are vastly better than on the routes projected along the Khanikin–

Kermanshah route, and the cost of construction is clearly far less.

4.—Apart from the famous oilfields at Baku, with its pipe-line following the railway fairly closely to Batum, this country has several other oilfields. Manganese was being quarried and shipped from mines in Georgia during our occupation, and copper derived from ore along the Chorok river was being shipped from Batum. There have been explorations demarcating further large copper and coal-mines, and there can be no doubt that this area is extremely rich in minerals, which extend into Persia and Turkey.

Water power is so far undeveloped.

Besides normal crops, tea is grown at Chakva, near Batum, and the vineyards of the country produce both red and white wines of good quality, the most popular of the latter brand being labelled No. 66, the Russian for which soon became " clickety-click " in the parlance of our troops. Most of the country seems to be a gardener's paradise and the autumn and spring climate is wonderful. Timber is also fairly plentiful.

5.—While the Tsar still held sway, this country was administered by a Viceroy, whose headquarters were at Tiflis. On the outbreak of the Russian revolution the three original states, Georgia, Armenia and Azerbaijan, decided to throw off their yoke and declared themselves independent republics, and thereby revived their own latent hostilities.

North of the Caucasus, Bolshevism had made serious strides and the main bulwark of the old régime, General Denikin with his White Guards, and certain missions from Great Britain and France (among others), were striving to oppose the spread of revolution.

His headquarters at the end of 1918 was at Ekaterinodar.

East of the Caspian Sea a British Mission, under General Malleson, which was based on Quetta and Seistan *via* North Persia and Krasnovodsk, was attempting to avert the spread of Bolshevism towards Afghanistan and India. At the end of 1918 its headquarters was at Meshed.

6.—Despite our victories over the Turks in Palestine and Mesopotamia and the fact that peace terms had been signed, the Turkish troops in occupation of the Caucasus at the end of 1918 showed little inclination to withdraw into their own territory, or to carry out the terms laid down for them by their own Government.

In fact they gave it out that they and their German allies had not been defeated, as no victorious enemy troops had appeared in Berlin, and they proceeded to make themselves very much at home.

The firm attitude of the 39th Brigade at Baku, under Major-General W. Thomson, and the arrival of the 27th Division, under Major-General Forestier-Walker, *via* Batum, however, put a stop to

these schemes, which were encouraged not only by the Turkish firebrands but by the German General, Baron Kress von Kressenstein, who was living in Tiflis on terms of considerable friendship with the President of the Georgian Republic.

The official instructions given to our troops were to see that the terms of the peace treaty were carried out. I need hardly say that the fertile imaginations of the local inhabitants, and indeed of some of our allies, assigned to us every conceivable reason for our occupation, and I think they all agreed that we wanted to take over the Baku oilfield permanently!

7.—I had arrived at Basra late in September, 1918, under the impression that I was to take over work on Transportation. My chief arrived shortly after, and we soon discovered that the war was rapidly drawing to a close, and no object was to be gained by a change of régime so late in the day. We were, in consequence, surplus to establishment, and were ordered off at the beginning of December to lend a hand in the Caucasus. My chief pursued a lordly path by sea to Constantinople, while I with a few stalwarts, selected from the Railway Staff in Mesopotamia, was herded off by lorry across Persia to Enzeli and thence by sea to Baku.

8.—We were a party of 17 souls—6 officers and 11 O.R., if I remember rightly—who left Baghdad on the morning of Friday, 13th December, 1918. I had a small Ford car but, by the malevolent wit of some staff officer, the rest of the party was mounted on half-a-dozen 3-ton lorries, than which God never permitted man to design a more ghastly vehicle for desert work.

As a result the whole convoy got hung up at a small irrigation cut a few miles east of Baghdad, and the bulk of our party finished their first short march at 1 a.m. and the superstitious ones were fairly squirming.

However our Guardian Angel came to the fore almost at once and we obtained a change of transport at Khanikin on 15th December, when we transferred to a fleet of Ford vans and even their capabilities were taxed to the utmost next day in climbing up the long ascent in the Paituk pass, and just as we scrambled to the top and reassembled a terrible storm of rain and hail broke on us. Mercifully we had secured a large number of tarpaulins and by anchoring these over our cars with large boulders to hold them down we managed to weather the storms.

I did not know it was possible for one man to sleep in a small Ford car, but two of us shared my car for five successive nights.

There was, at this time, no road ahead, and until the weather improved we were faced by a wet black-cotton plain which was impassable until it dried up a little. I learnt a great deal of the geological formation of these hills in those few days, and I am quite certain that anyone who talks light-heartedly of developing even a

metre-gauge railway through these hills cannot be very sure of his ground.

However, on 21st December, we pushed ourselves and our cars over the next stage to Karind, and on 22nd December we reached Kermanshah just before midnight, after a ghastly drive over the last passes in the dark. We had headlights on only one car out of five, the road was not only very steep and winding but it was obstructed by dead camels and boulders, and a bad shot at steering sent one down a precipice or into a rock wall. Our Guardian Angel was well to the fore again, as we arrived complete and safe.

For the benefit of those who may not know this route, I may say that as one progresses eastward through these hills one is gaining altitude all the time and at night in December it freezes hard. Our Ford cars were wonderful, but they are hard to start on a frosty morning and we had frequently to tow the sulky starters around to warm them up before taking our way across the arid uplands of North Persia.

At Kermanshah we were overtaken by my old friend General W. H. Beach, also bound for Baku, and he cheered us up on many a night during our journey onward.

On 24th December we passed Bitisun, where the great Persian monarch Cyrus had inscribed some account of his victories on the face of the mighty cliffs overhanging the road, and on Christmas Day we had an anxious time of it, as the pass on the main road to Husseinabad was blocked with snow, and we had to follow a deviation. This was merely a track marked by spitlock across country, and it came on to snow hard when we were halfway round. Luckily the snowflakes were small, and they did not obliterate our road marks at once, so that by sending individual cars along at intervals of not more than ten minutes we managed to get the bulk of the cars into an old Persian *serai* for the night.

Two or three cars at the tail of the column stuck and had to put in the night under tarpaulins, and despite the bitter cold the occupants were none the worse next day.

It was a deadly cold night, and, the only firewood obtainable being green and damp, we were decidedly miserable.

However we reached Hamadan next day, and put in the next three days overhauling and repairing cars, several of which were found to be completely done in. All the hills around were capped with snow and it was bitterly cold, so that even at midday in a bright sun the roads only thawed out a little for a couple of hours. The rug market in the covered-in bazaar was a novelty to me, and a still greater surprise was to find a very capable party of amateur dramatists giving a fine performance of " When Knights Were Bold."

On 30th December we left Hamadan and reached a miserable ruined village at Aveh, the road having been cleared of snow. Every

scrap of wood had been looted out of the village, and we had a most uncomfortable night. I shared a hovel the previous occupant of which quite clearly had been a goat.

However we put in New Year's Eve in Kasvin, where General Hugh Champain very kindly put me up in his house, and the rest of our journey to Manjil, Resht and Enzeli was completed without incident, so that we arrived complete at midday on 3rd January, 1919, at Baku, crossing the Caspian Sea from Enzeli in the steamer *Orel*.

I was greatly interested to read in *The R. E. Journal* that this road was out of action in 1919 for about one month owing to bad weather, so I fancy we had some lucky escapes.

9.—Meanwhile the 27th Division was arriving at Batum, a move of which I was in complete ignorance at that time.

The 27th Division Headquarters arrived at Batum on 22nd December, 1918, and landed on 24th December, at an opportune moment to speed the parting of the Turkish troops which were being evacuated from that port.

As a further welcome Colonel Stokes arrived from Baku to report on the general situation, and he brought in word that hostilities were starting between the Georgian and Armenian republics to the S.E. of Tiflis.

To keep the pot a-boiling, on 28th December General Denikin threatened to attack the Georgians on their N.W. frontier on the shores of the Black Sea near Gagri.

On 2nd January the 27th Divisional Commander proceeded to Tiflis, and on 4th January the first troops arrived in Tiflis and the 89th Punjabis were detailed to guard the line at important points between Batum and Tiflis. From 5th to 7th January the Division Commander paid a fleeting visit to Kars to see how the Turkish evacuation was proceeding and to call a halt to the impending Georgian and Armenian hostilities.

The result was that when I arrived in Tiflis on 10th January, I found that a brigade of infantry with artillery and sappers, doctors and supplies were established there, and not one single record had been kept of train movements, nor of special trains for the Divisional Commander, and I had not only to stop this cavalier attitude but to dig out backwards, as far as it was possible, a record of what had happened!

10.—My story must return to Baku, on 3rd January, as I had only been ashore and fixed up in an hotel a short while before I met Major-General W. Thomson, and began to hear what amazing work he had carried out just previously. When he landed the Turks were still around Baku, and they occupied the railway junction at Baladjari, near which the line was damaged; the local government was non-existent, and the banks had been more or less looted by the

sailors of the Caspian fleet. A more distressing situation it is difficult to picture, but in no time he had the Turks out of it, a local Government with a President (Khan Khoisky) functioning, and the banks re-opened and local roubles being printed.

He had even dug out an officer who had once done some locomotive work and given him part of the 72nd Field Company R.E. to begin repairing damaged locomotives in the railway workshops at Baku. But for his cool head and stout heart we should have been in a first-class mess straight away.

11.—It was only a matter of a few days before I realized that the task of restoring railway communications in the Caucasus was going to prove most formidable.

There was no civil rail traffic working, and the few trains that had run materials from the Baku area had been troop trains, run as specials conveying Turkish troops to Batum.

The amount of damage done to rolling-stock in the Baku marshalling yards by the Bolsheviks was appalling. Whole rakes of trucks had been shunted into the sidings at high speed, and any wagons not smashed up had been attacked with heavy sledge-hammers.

The locomotives had been smashed up as well, and it was all one could do to get out one or two locomotives, a few coaches and trucks to begin any form of train service. The first short goods train I saw worked into Baku station had several wagons with the draw gear held in place by bits of packing-cases nailed on with wire nails, and I believed it only arrived as a complete train because there was a strong wind blowing behind it.

There was a limited amount of stock and locomotives along the line up to Batum, which was definitely congested early in January, 1919, with the stock of the Turkish troop trains, and I may say it took several sanitary squads some days to clean up this stock before it could be brought into use for our troop movements. The amount of stock in Armenia was negligible.

It would seem to be an easy matter to treat the whole railway system as one and to work the available rolling-stock and locomotives into suitable positions to meet normal traffic demands, but this idea was quite contrary to the concepts of the local republics. Each republic claimed ownership of such rolling-stock and locomotives as lay within its territory on the day independence was declared and they were firmly determined not to work such stock outside their territories.

For example, when I ran a special train through from Baku to Tiflis on the 9th/10th January to transfer my headquarters to Tiflis, I discovered when we crossed the Georgian border, that not only were we undergoing a Customs examination, but the Georgian railway

carriage staff were busy painting out all the Azerbaijan markings on the rolling-stock and painting on their own markings instead.

Also I had not only to feed our Tartar engine-driver, but to guarantee that he would not be molested at Tiflis, and that he would be allowed to return with his locomotive into Azerbaijan territory.

Batum had been declared a British military province, a Military Governor, General Cooke-Collis, had been appointed, and rather a lion's share of the total rolling-stock on the railway was at this time in his province; and I was most anxious that we should start no ownership claim to this stock, as apart from financial considerations it was most important to get all the available stock pooled at once and get traffic working again, and it would never have done if we had entered into the ownership dog-fight.

As a final example of ignorant cupidity I have to relate that all three republics laid claim to a certain ambulance train, which had been presented to the Russian Government by a wealthy Armenian, Mantasheff. General Denikin also laid claim to this train. I never discovered where this train was, but I suspect it had been broken up and I imagine we were using one or two of the coaches ourselves.

12.—All locomotives on this railway were designed to burn oil fuel, which was normally distributed by rail in oil-tank wagons. Owing to the collapse of the railway service and the damage to rolling-stock, it had been decided to make use of the pipe-line from Baku to Batum to pump crude oil, instead of kerosene oil (for which it was installed) along the line, and so far as I could judge it was being used as both fuel and lubricating oil. The pipe-line followed the railway fairly closely, and rose gradually, the oil being pumped by stages, till it topped the mountain pass west of Suram, after which the oil ran by gravity to Batum. There was a double risk in pumping crude oil, as its freezing point was several degrees higher than kerosene oil, and the flash point was definitely high for a fuel oil. However no accidents occurred from these causes.

No one had inspected the pipe-line, nor paid the staff for months, yet we found all the Russian staff still on duty at the pumping stations, carrying on as usual. They existed by bartering occasional canfuls of oil for food and medicine, and they were most grateful for any help we could give them, and their exemplary patience and loyalty was a very great help to us.

From my point of view the source of fuel oil was at the wrong end of the railway, so I started to try and accumulate some reserves at Batum, so that in emergency we could at least attempt to keep up some service from the Black Sea port.

Most of the first order I gave for oil found its way into the sadly-empty reservoirs in Georgian territory and very little got through to Batum, and this started off a nice little feud between Georgia and Azerbaijan, in which I found myself most uncomfortably implicated.

A repeat order later on did better, but this pumping of oil from Baku was always being delayed by strikes and squabbles.

All oil had to be carried by rail into Armenia and likewise the special fuel oil (Mazoot Engler) required by the Navy at Batum had to be worked through by rail.

13.—Then the problem arose as to how we should pay for our rail traffic. In questions of technical detail your Russian is nothing if he is not thorough, and the passion they develop for forms, statistics and figures is amazing.

For instance, in the pre-war goods tariffs we soon discovered that merchandise had no less than 120 different classifications and each classification at that had from six to ten and even a dozen subdivisions. An occasional genius, or a born fluker, got a classification entirely correct sometimes, and you can well believe it that Tiflis alone held over a dozen lawyers fattening on disputed freight rates.

Moreover, even with military traffic, every possible item of equipment that could be weighed was passed over weighbridges before being loaded on trains. It is true that the insignificant military rates charged probably never paid for such weighment, let alone haulage, but the ritual was always solemnly performed. The breezy British method of boarding a troop train was a cause of positive horror.

Had we not received the assistance of Captain Revillon, who not only was a magnificent Russian scholar but thoroughly acquainted with their business methods, I do not think we could ever have come to terms with these republics over military freight rates.

He finally worked out an average rate of so many roubles per verst (shillings per mile in equivalent) for each truckload of military transport, and this was accepted and all our freight bills were completed and agreed before we vacated.

14.—It must be remembered that each of these republics had installed a complete set of Government officials, so that we had to deal with Ministers for Foreign Affairs, Ministers for Ways and Communications, and so forth, who lorded it heavily over the railway officials, and it was no easy matter to get these newly-hatched and highly-important dignitaries to agree with our wishes, and they were capable of putting up plenty of obstructions and delays if one failed to be patient with them.

15.—By the 19th January, 1919, the headquarters of the 27th Division had been established at Tiflis, where I had succeeded in obtaining a billet and opening an office. The very few officers I had brought with me could only cover the main points on the railway, namely, Baku, Tiflis and Batum, but I was fortunate in getting some very useful officers attached to my staff, and the numbers slowly increased, as our occupation and responsibilities expanded, from the original six to about forty.

I was also fortunate in obtaining a very good Russian interpreter,

a Mr. Mouat (a Scotsman), who had come out to help on the construction of the Suram tunnel, and had subsequently married a Georgian lady and settled down in railway employ at Tiflis. He was over 70 years of age but indefatigable and his patience, fine manners and sagacity were a tremendous help in dealing with local officials.

With his aid I was able to send in my first report on the general railway situation, which was about as bad as it could be, and I prepared to try and persuade the three local republics to pool their railway resources and work to a common end, under my humble direction, to revive communications. Oddly enough, this proposal was one of the very few that these three republics, who disliked and distrusted one another intensely, accepted after their own fashion and after much babbling and delay.

16.—On 20th January, General Sir George Milne arrived in Tiflis on his way eastwards to visit Baku and Krasnovodsk. His view of the situation was most tersely and clearly expressed in a wire sent from G.H.Q. to the War Office, shortly afterwards, in which he stated that a second Division would be required in the Caucasus if we were to produce a proper form of order. He also pointed out that at that time our presence was resented by :—

(1) The three local republics, who wanted to fight one another.
(2) General Denikin, who wanted to fight the local republics.
(3) The Bolshevist agitators, as they obviously detested us.

17.—The Georgian and Armenian Governments had been rapidly persuaded to come to terms, and at our instigation a neutral zone was established along the borders S.E. of Tiflis. To see that the conditions agreed between the Governments were carried out, a British officer superintended the clearing of this neutral zone, and a Captain Douglas was posted at Alaverdi to see that order was maintained.

To try and maintain order farther to the south, between Armenians and Tartars, one company of the D.C.L.I. and a British Military Governor were sent to Nakhichevan, and British officers were posted also to Kars and Akhalkalaki to try and keep order, and all these movements were completed by 28th January.

At this time Captain Poidebard, of the French Military Mission, came in from Erivan, where he had been working for some time, and he gave us a ghastly description of the sufferings of the Armenians from famine and disease.

These few remarks prelude the tragic drama carried out in Armenia during our occupation. America first came to their aid with supplies of flour and medicines, which we unloaded at Batum and railed into Erivan, and I may add that this traffic was frequently impeded by the very people we were helping, as they would hang on to rolling-stock.

The incompetence and apathy of the Armenian Government officials in dealing with such matters as organizing distribution of food and medicines was enough to make angels weep, and on top of this, even when we succeeded in patching up peace between them and their neighbours (Turks, Tartars and Georgians), their mischievous habits and duplicity (for they were swift enough to attack if they thought they could get away with it) invariably fanned the smouldering ashes of hate into flame again.

18.—Evidence of the awful conditions at Erivan came in early in February from General Asser (commanding 27th Divisional Artillery) who paid a visit to Armenia, and on the 6th February we received news that trouble was brewing between General Denikin and Georgia, near Sochi on the Black Sea. On 11th February a party ordered to Kazbek were held up by snow, and from 13th to 27th the line to Kars was blocked with snow.

19.—On 15th February the Georgian Government accepted in principle the idea of British control of railways in the Caucasus. Azerbaijan were rather slower, and not quite so downright in acceptance, but they actually did their share quite willingly and well. For general purposes Armenia hardly counted.

20.—On 23rd February, General Briggs, who was to be head of the British Military Mission with General Denikin, arrived at Ekaterinodar, and General Cowie, who had become Director-General of Transportation at G.H.Q., arrived at Tiflis on a visit to me.

21.—At the end of February the position as regards the supply of fuel oil for the railways was becoming very serious. The authorities at Baku were aware that a good proportion of the fuel oil pumped on my order was being retained in Georgian territory. From my point of view this was not a very serious matter, as by now we owed the Georgian republic a considerable sum of money for the cost of transport of troops and supplies, and this sum would cover any indebtedness for cost of fuel oil taken over by Georgia.

In other words, it was immaterial to me whether I paid any railway freight bill direct to Georgia, or partly to Georgia and partly to Azerbaijan; and moreover, it suited me quite well to have fuel oil in hand at Tiflis and at stations westwards.

Unfortunately this proposal did not suit the Azerbaijan Government, as it prevented them squeezing the Georgians, whom they were trying to get at, and being in doubt they slacked off pumping fuel oil from Baku. It was unlucky for me that my simple financial manipulations were completely misunderstood by the 27th Division Commander, who led G.H.Q. to understand that I had gone surety for five million roubles (about the amount of our freight debt), and I received a quite unmerited snub, for action which I had never taken.

I had, however, to hustle off to Baku, which I found under snow

on 1st March, 1919, and in a state of excitement over naval matters. One of the ships in the harbour at Baku had gone Bolshevist, and in defiance of our Commodore's orders had attempted to proceed to sea and join the rebel fleet on the east side of the Caspian. As a result a motor-boat was sent in chase, and as the rebel refused to accept orders a torpedo was fired at it which fortunately missed the mark, but the results were entirely satisfactory, as the rebel instantly surrendered and returned to port, and apparently honour was satisfied all round.

I say that fortunately no one was killed because the slaying of a few Tartars sends all their kin out on strike for at least one month, and I had only three days' reserve of oil in hand at that moment. The general relief, which followed the tension of the naval battle, enabled me after some grim arguments with the Azerbaijan Ministers to get oil-pumping restarted. I may add that several of these Ministers became very friendly and helped, when they had overcome their original suspicion.

22.—On my return to Tiflis on 6th March, I packed off my deputy to inspect the port of Batum, where it fell to our lot to handle the docks, harbour maintenance, shed accommodation besides the railway yards and pipe-line and oil supply.

Major Herschel of the South African Railways, who had previous experience of this class of work, had taken over this tremendous task early in January, and with the help of the Military Governor had made a capital start, and I was tremendously pleased to get an excellent report on his work. He remained throughout a most painstaking and reliable man, and the handling of the Allied wheat in and out of the port was a fine feat.

23.—On 9th March, General W. Thomson took over command of 27th Division, his predecessor being invalided home, and shortly after General Sir H. Gough, accompanied by General Cory, paid a visit to Baku in connection with some water-supply scheme.

News came in on 16th of trouble brewing near Nakhichevan, and it may be taken that it soon came to a head, and that some form of fighting, looting and murdering continued in this area during the rest of our occupation.

24.—On 14th March I had to send my deputy up to Ekaterinodar, to visit the Head of the British Military Mission there. Poor devil, he had to go by sea from Batum to Novorossisk in a foul ship, which nearly foundered in a terrible gale, and he had a rough passage all round and spent a profitless ten days away, at a time when he was badly wanted at Batum, where labour troubles had arisen in the dock area.

25.—On 20th March another strike broke out at Baku, and the pumping of fuel oil was once more affected, and on 22nd March I sent a telegram to the authorities at Baku to say that all civil rail

traffic from Azerbaijan would be stopped if the pumping of fuel oil again ceased.

I had to go to Baku again at the end of March and I gave a lift to M. Bouin, the French Minister for Teheran, together with his family.

On 1st April the Baku strike fizzled out, but the oil situation was so desperate that I spent a number of hours in very heated argument with most of the Azerbaijan Government officials.

A private interview with the President Khan Khoisky proved more soothing and satisfactory, and I was able to return on 3rd April to Tiflis, in company with Sir John Hewitt, who was returning from Mesopotamia after completing some work for the War Office.

26.—On 6th April I met for the first time the President of the Armenian Republic, M. Khatissian, who proved to be a well-educated and very intelligent man, with a profound sense of humour. He was, in fact, a very great contrast in most ways to the remaining members of his Government, and I fancy he felt their shortcomings very keenly.

He took the greatest pains himself to see that our railway rolling-stock was not held up in Armenia, and he also gave us some very valuable hints as to what some of our Allies were up to.

I find that at this period the Armenians were for various reasons unable to enter into and take over the Kars province, and the railway from Alexandropol to Kars had to be kept going by our troops, for which purpose I had been sent one very weak Railway Company R.E. On arrival this turned out to be a Workshop Company and we had, in a few days, to teach some of them how to handle traffic! Thank God, there was very little traffic on this branch and we had no accidents that mattered, before we handed the line over to the Armenians on 17th April.

27.—I had some long discussions on 11th, 12th and 13th April at Tiflis with the Azerbaijan Minister of Communications, Melik Aslanof, who had come to visit me among others. He became quite reasonable on the questions of oil supply and traffic control, and thereafter he kept his word faithfully. I paid him a return visit at Baku on 17th April, bringing my chief, General Cowie, with me.

We had an opportunity to go over the famous oilfields at Baku on this occasion, and I began to get some glimpse of how the borings were carried out (largely by American methods) and how the crude oil was subsequently broken up and refined; this last industry was practically entirely in the hands of Nobel, who also owned quite a number of oil-tank steamers on the Caspian Sea for traffic on the Volga river.

At this moment a new President, M. Usubekof, was elected as head of the Azerbaijan Government.

28.—On our return to Tiflis on 20th April we found that the Georgian Army was squaring up against General Denikin (whom we

warned) and had crossed the River Bzib, which necessitated the dispatch of a British battalion to Gagri. There was next to no fighting in the end, but the alarms and excursions caused a lot of worry and correspondence.

At Batum the Military Governor had to take over the Civil Administration and appoint his own Civil Governor, as the previous attempts to make local officials pull together had failed. Armenians were now back in the Kars province, but, to balance this, trouble had sprung up in the Azerbaijan district of Karabagh between Armenians and Tartars (I believe these outbreaks started over grazing rights for cattle).

29.—As we had received the most peremptory orders to enter into no financial commitments, and as I was determined not to take over ownership of any locomotives nor rolling-stock on the railways, it became a delicate problem as to how we were to account for the traffic running over the railway lying within our military province of Batum.

After careful consideration I decided that an agreement giving the Georgian Government running rights over our portion of railway would best meet the case, and I still see no simpler solution. It amounted to this, that all trains departing from or entering into Batum would pay their tithe for the privilege of running over our lines.

It is a common commercial practice, and is a purely business deal involving no form of privilege, but no sooner had I got this arrangement working than a howl went up from G.H.Q. I may remark that it was quite impossible to consult G.H.Q. over all such matters, as even the telegraph lines were interrupted for days on end and letters took weeks to answer, and one could not stop all railway traffic while one was making up one's mind or waiting for orders.

I confess that I attached no political nor military significance to a purely commercial agreement, which could be terminated or altered at short notice on either side, but apparently the mere word agreement amidst the turmoil then reigning produced an ill effect, of which I had to bear the brunt.

My chief, General Cowie, had accompanied me to Batum on 22nd April, and we had gone all over the port, docks, sheds and marshalling yards before General Sir George Milne and General Rycroft arrived on the morning of 25th. I was asked to explain my conduct over the agreement I have just described and I received very just treatment from them.

30.—General Sir George Milne came up to Tiflis on 26th April and was joined by General Thomson on a visit to Armenia, where they went as far south as Sarikamish and returned to Tiflis on 1st May, on which date a British officer was murdered in the streets of Tiflis.

At the same time the trouble between the Georgian Army and

General Denikin was sparking up again, and on 5th May a general strike was once more proclaimed at Baku, but fortunately the Azerbaijan Government stamped this out almost at once. A naval raid on 10th May under the Rear-Admiral commanding the Caspian fleet on the Bolshevist base at Astrakhan, which was a brilliant success, did much to restore confidence.

31.—It had been decided by the War Council in Paris in the middle of April that the Italian Government should be asked to take over the occupation of the Caucasus, and on 10th May an Italian Mission, consisting of 15 officers and 50 O.R. under Colonel Gabba, arrived at Batum, and on 12th May they arrived in Tiflis, on which day General Thomson handed over command of 27th Division to General Cory.

I had a young Italian Sapper Major attached to me to discover what I was doing, but we had little language in common, and I do not fancy he was very industrious, as his notes after several weeks of study only covered a sheet or two of paper. Anyhow, I had all my work cut out to deal with my job and I think he found Tiflis in spring-time, outside my office, a very pleasant place. I don't blame him!

32.—Trouble cropped up once more in the Kars province on 17th May, as the Georgians were discovered south of Ardahan, where they had no right to be. So General Cory set out on a long tour right through the whole Armenian area, and he even visited Tabriz in Persia, and during his absence General Briggs from the Denikin mission arrived in Tiflis. I cannot say what the visit of General Briggs was about, but just after he had departed by road for Vladikavkaz General Denikin began to push his way round the east end of the Caucasus Mountains, menacing Derbent and the Azerbaijan frontier, causing the Tartars to line up at once to defend themselves. What General Denikin (aided by allies) had to gain by stirring up these wasps' nests in Georgia and Azerbaijan (occupied by the same allies) under his own tail, it is not easy to see, particularly as a minimum force was required to block aggression from these quarters. At the same time the Military Mission, East of the Caspian, under General Malleson, began to expire. Merv was evacuated and the roads to Khusk and Afghanistan were open to Bolshevist advance.

33.—On 28th May, General Cory returned to Tiflis and we discussed our plans for the evacuation of British troops from the Caucasus. Several postponements took place but the general plan originally adopted was eventually worked to.

34.—The American officers in charge of the supply and distribution of wheat for Armenia, which was working pretty well by now, were most excellent fellows to work with. Under Captain Green they were patient, efficient and helpful, and we were getting delays and

difficulties cut down to a fine point and if the Armenians did not fatten up quickly it was chiefly due to their own turpitude.

I was very sorry to say good-bye to most of this crowd when they were superseded later on, and I may say the traffic never worked better than it did in their time.

35.—Whether the news of our withdrawal or of other allied occupation gained serious ground it is difficult even now to say, but the *tempo* of all troubles appears definitely to increase in the month of June : and each day produces some startling news.

To begin with our own withdrawal is postponed till 15th July.

Georgia and Azerbaijan are almost on the point of attacking Denikin simultaneously, and Georgia refuses to allow ammunition, even under British escort, to go to Askabad.

We begin to remove our Military Mission from Nakhichevan, and our train promptly has a collision with an Armenian armoured train.

The President of the Armenian Republic, with his own population starving, protests against the repatriation of Turkish-Armenians to Kars.

The Bolshevists at Krasnovodsk become such a nuisance we have to send a whole Gurkha Battalion, a Machine-gun Company and a detachment of Sappers (Lieut. Perry and 13 O.R. of 72nd Field Company R.E.) to blow up the railway and establish order.

Just as we demarcate a line between General Denikin and the Azerbaijan Government, the Navy is directed to hand over two ships from the Caspian fleet at Baku to General Denikin.

On 11th, Tartars and Armenians start up a new set of massacres at Shusha in Azerbaijan territory.

Some genius at G.H.Q. suggests all our horsed transport to travel by road (?) to Batum.

The Hebrew National Council protests against Russian Jews being dumped in Constantinople.

Reports say that Italian troops for the Caucasus are leaving Taranto !

Tiflis wireless station is caught out calling up a Bolshevist station !

Luckily nothing much results, and the Georgian Government cool down on the Gagri front ; some ammunition is sent to Denikin *via* Batum, and despite some casualties at Tiflis station (our troops and Georgian Police) we celebrate Peace being signed in truly champion style at Tiflis.

36.—On 26th June a serious affair occurred for me, as the Georgian railways refused to handle flour into Armenia when they were starving themselves. It was awkward as they threatened to off-load the flour, which was American, at Tiflis and acquire it themselves. Luckily our Division Headquarters had a bright boy who remembered we had a surplus of some pretty rough mixture called flour at Batum,

and we railed this up and sold it to the Georgians at a very low price. I obtained, quite undeservedly, full credit.

37.—I may say that it was well known by now that Italy was not going to take over occupation of the Caucasus from us. In fact, after an exchange of marvellous telegrams the Italian Military Mission withdrew, and having shed its more illustrious and noble officers it reappeared, still in uniform, as a commercial mission.

During these times of privation our allies vied with one another in their ambition to provide those requisites without which ladies cannot apparently exist.

38.—To cope with this dreadful oil business I had at last managed to collect an officer who had previous experience of this polluting liquid. He had been trained by the Standard Oil Company, so you may well imagine my horror when a charming American, representing this selfsame Company in its highest setting, arrived in Tiflis armed with a letter from the War Office asking me to give him every assistance! Moreover these two culprits knew one another!! There was another delightful American in the background—just an Admiral at that—and how we escaped without a very severe sentence I do not know. Anyway nothing happened in the oil line, as anyone could have guessed to begin with.

39.—July opens in a more leisurely mood, but the storms are still raging round Armenia. My old friend General Beach was sent off to Tabriz to investigate troubles near Urmiah, and on the way got the credit for making a dreadful pro-Armenian speech, not one word of which he uttered! The Armenians were again making mischief and holding up rolling-stock for their own uses (or personal profit) till dropped on: and finally it reads as if the whole of the southern end of the republic had caved in under joint Tartar and Turkish aggression. It is no business of mine to attempt to disentangle this dreadful web, and all I wish to record is that despite the complete disappearance of some British officers and men they all reappeared safe and sound though they had been, so far as we knew, slaughtered.

40.—On 10th July we received definite orders that the evacuation of the Caucasus would begin on 15th August: and the Azerbaijan Government agreed to work three daily troop trains for us. It may astonish everyone to realize that by now we had built up a traffic equal to five trains daily each way, so this gesture was heroic, and it may give some idea of the paucity and quality of stock to say that the grand passenger-de-luxe dining-car trains from Batum to Baku and *vice versa* (one each way) had not one single coach complete with buffers and identical springs.

41.—Meanwhile these wretched Turkish Armenians keep piling up at the port of Batum under some vain hope they may get somewhere and be fed by somebody, and in themselves might form a study for the American Colonel W. N. Haskell, who arrived at this late hour to

assume the title of Allied High Commissioner for Armenian Relief. He represented Great Britain, the United States, France and Italy, and had a mixture of national flags plastered about his habitat and person, but the precise effect of all this I never discovered.

At this moment the Armenians began to help themselves to Russian ammunition at Kars and rail it south to Nakhichevan in a truly Christian spirit; and at the same time we received orders to withdraw our troops from Tabriz and Nakhichevan.

On 27th July it was reported that the Armenians could hold out no longer at Nakhichevan and the position was hopeless.

On 28th the Russian troops at Krasnovodsk were holding Bolshevist meetings, and apparently the demolitions round Krasnovodsk had not delayed the Bolshevists for any length of time.

42.—On 1st August, General Baratoff, representing General Denikin, arrived at Tiflis and reported to General Cory, and we received the news of the safety of our outlying missions in Armenia. Also a wonderful telegram arrived for the three republics from the Italian Secretary for Foreign Affairs, expressing the highest hopes for combined financial and industrial enterprises! This telegram also definitely stated no Italian troops would arrive, a lapse which was subsequently attributed to *our* not having provided the shipping!

43.—It was now that the three local republics began to suggest that they would be perfectly willing to pay for the occupation of the Caucasus by British troops or by French troops. On 4th August the Georgian Government telegraphed a request for British troops to remain in Georgia, and thanked the British Government for the loyal conduct of the British troops, and a somewhat similar appeal came from Azerbaijan on 8th August. Azerbaijan also protested against our Caspian fleet at Baku being handed over to General Denikin, and reports came in of some Bolshevist ships being out at sea in the Caspian.

44.—On 4th August Krasnovodsk was evacuated, and all our troops arrived safe and sound on 6th August.

We received confirmation that our withdrawal from the Caucasus would begin on 15th August, and some of our outlying detachments were brought in.

At this inopportune moment we received a request from General Sir Percy Cox asking us to arrange a passage for the Shah of Persia through to Batum from Baku. This corpulent young monarch, after being hung up at Enzeli, eventually passed through Tiflis on 17th August and was duly shipped off from Batum in H.M.S. *Ceres*, arriving ultimately in Paris where he died some time afterwards.

45.—On 15th August the evacuation of Baku began, and on that date the Admiralty reported that the Caspian fleet had been handed over to General Denikin and that 300 naval personnel had already landed at Constantinople. By 25th August the evacuation of Baku

was completed, and Generals Shuttleworth and Vaughan were fêted before leaving at an official banquet given by the Azerbaijan Government. The Commodore sailed the same day for Petrovsk.

On 26th August the last train from Baku reached Tiflis, and on 28th the evacuation of our troops in Armenia began.

On 30th August only Lieut. Charles was left as a temporary measure at Erivan, the 39th Infantry Brigade Headquarters was disbanded, and Mr. Wardrop had arrived in Tiflis as Chief British Commissioner.

The evacuation of Georgian territory proceeded according to programme, and on 5th September the 27th Division Headquarters were entertained at a State Dinner given by the Georgian Government. General Cory and staff left on 6th evening for Batum after quite a touching farewell at Tiflis station.

By the 11th September the evacuation of Georgian territory was completed, and I may add that the train movements had been worked with surprising regularity and the average late arrival of all trains at Batum was under two hours, which for this country at this time was very good.

I am sorry to have to narrate that almost at once trouble cropped up on our departure, and two trains were held up on the main line by bandits.

On 19th September the War Office decided to retain the military province of Batum, so that on 24th September, when the 27th Division Headquarters left Batum, General Cooke-Collis took over charge.

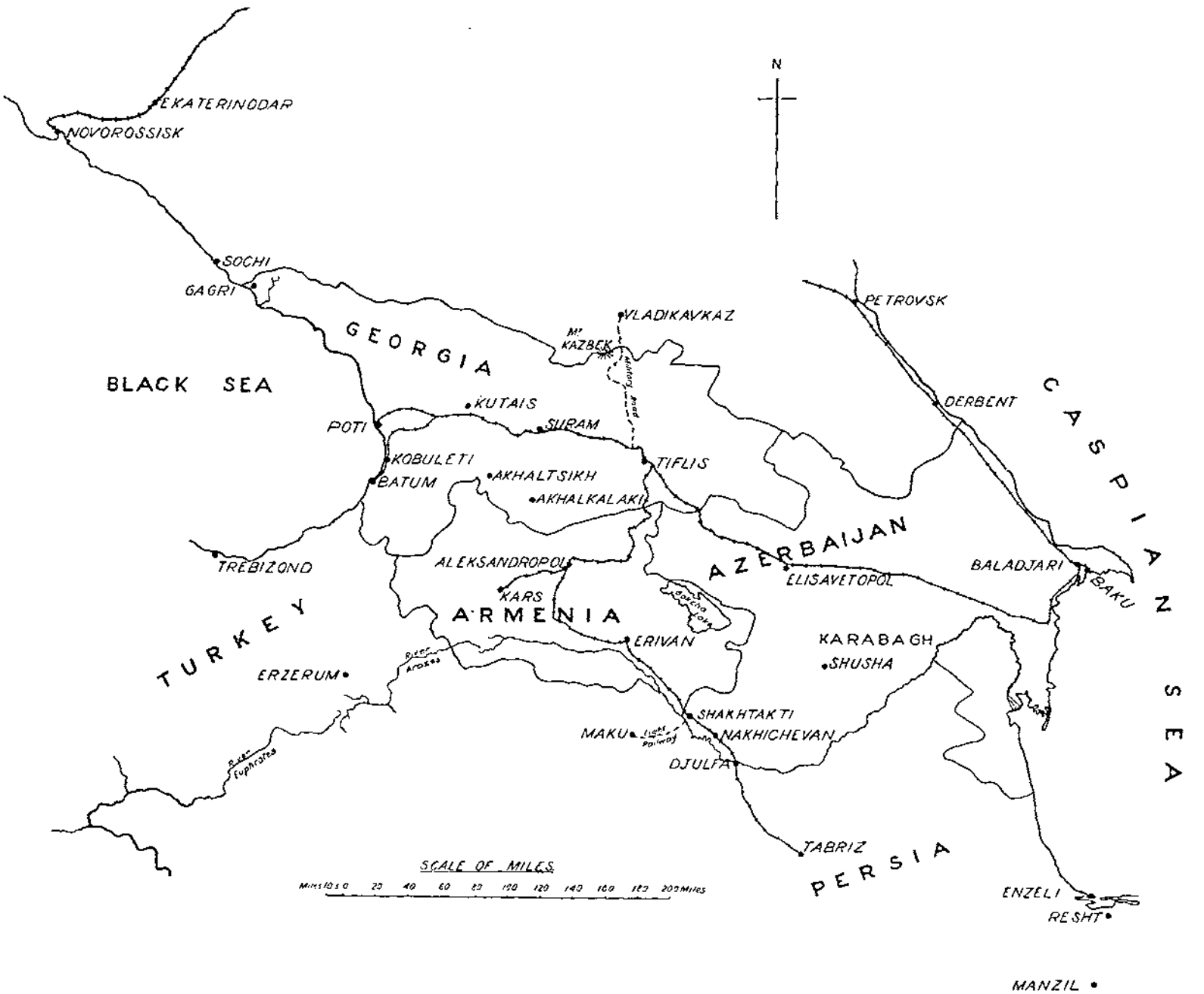
46.—I had to return to Tiflis in October and wind up some affairs, but these matters are of no general interest.

I had a marvellous send-off from the Georgian and Azerbaijan railway officials and reached Constantinople on 6th November, 1919, after winding up all my accounts and leaving a good stock of oil for the Navy at Batum.

So ended a very interesting and educative episode.

47.—I have examined the records of the 27th Division R.E. and the story of their work in the Caucasus is quite easily told. Apart from the routine work of patching up billets, hospitals, M.T. repair shops, supply depots, rest camps, there are only two items of military interest to record. Firstly, the mounting of a 6-in. naval gun at Petrovsk on the Caspian Sea, which was carried out by a Lieut. Piggott and a detachment of 17th Field Company R.E. Secondly, the demolition of the railway line near Krasnovodsk to delay an advance from Askabad, which was carried out by a detachment of 72nd Field Company R.E.

The Field Companies R.E. which accompanied the 27th Division were the 500th, 501st and 17th. The last Company was reduced to cadre and absorbed by 99th Field Company before it left Batum.


N
EKATERINODAR
NOVOROSSISK
SOCHI
GAGRI
GEORGIA
BLACK SEA
VLADIKAVKAZ
Mt. KAZBEK
Georgian Road
PETROVSK
DERBENT
CASPIAN SEA
KUTAIS
POTI
SURAM
KOBULETI
BATUM
AKHALTSIKH
AKHALKALAKI
TIFLIS
TREBIZOND
ALEKSANDROPOL
AZERBAIJAN
ELISAVETOPOL
BALADJARI
BAKU
KARS
ARMENIA
Lake Gokcha
ERIVAN
KARABAGH
SHUSHA
TURKEY
ERZERUM
River Araxes
SHAKHTAKTI
MAKU
Light railway
NAKHICHEVAN
DJULFA
River Euphrates
TABRIZ
PERSIA
ENZELI
RESHT
MANZIL
SCALE OF MILES
Miles 10 5 0 20 40 60 80 100 120 140 160 180 200 Miles

The 72nd Field Company R.E. came into the Caucasus with the 39th Infantry Brigade and remained in Baku most of the time, working partly under me.

Throughout this period these Field Companies, which arrived far below war strength, were steadily being reduced through demobilization, and before June the normal strength of a Field Company was only 70 souls, so that local carpenters and tradesmen had to be freely employed to cope with odd-job work.

48.—It may seem that the foregoing is rather a brief and disjointed general account of our occupation of the Caucasus, and that not much has been said of the part played by Transportation. Perhaps I should have made it clearer that no military movements of more than a few miles were carried out except by rail, so that the incessant shifting of troops (even occasionally to a single platoon at a time) kept us fully occupied, and in all these matters we worked hand-in-hand with the staff of the 27th Division.

I am not suggesting that we had anything but a very rough passage to begin with, because it was a very uphill task to establish any form of confidence among the local Governments and to obtain any form of control—nor could one expect otherwise in a country where graft and turpitude had reigned supreme.

As soon as it was realized that we were quite honest—and I think it came as a shock when we invariably confirmed our verbal agreements at once in writing—and had no tricky ulterior motives, then we began to make headway.

I still wonder if any of those who instigated the original occupation of the country had any idea of the crippled state of the railways or even, later on, of the feeble control we really held over movements.

It may have escaped their notice that in the middle of December, 1918, it took an intelligence officer three days and nights to travel from Baku to Batum.

REINFORCED-CONCRETE PILES.

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

SINCE the beginning of the present century, the problem of foundations for buildings has become increasingly difficult. Not only have the weights to be carried gone up enormously but, for commercial reasons, these vast buildings have often to be erected on constricted sites and on sites where the natural surface foundations are weak. In these circumstances, recourse has been had to the use of reinforced-concrete piles carried to depths at which suitable formations are found which are capable of bearing the loads. Broadly speaking, there are two main types of pile—the driven pile and the excavated pile. In certain cases the two types may be employed together, as will be described later.

DRIVEN PILES.

These exist as complete units on the surface before being driven. The method may be compared with the simple process of driving in a picket with a maul. Although improvements in technique and plant have taken place, the most modern pile-driving plant works on the same principle as the antiquated hand-operated contrivances which most of us have watched driving wooden piles round the small harbours and jetties of England.

Advantages of Driven Piles.

In the writer's opinion driven piles have two great advantages over "excavated" piles, although no doubt protagonists of this latter type will claim that their products are not being justly assessed.

(*a*) The engineer can see the pile before it is driven. He can watch it being cast, check the setting out of the reinforcement and, in fact, be quite certain that the pile, as driven, is a thoroughly well-constructed monolithic structure.

(*b*) The pile can be driven to a definite "set." There are a number of formulæ from which the "set" necessary to carry a certain load can be derived.

Suppose this is calculated to be "x" inches in the last ten blows of the monkey; then driving continues until ten blows result in a penetration not exceeding "x" inches. Even over quite a small site the ground often varies

considerably but, by working to a definite "set," each pile can be driven until it is known that it will carry the designed load.

The alternative to driving to a "set" is to subject a proportion of the piles to a test load. This method, however, is both cumbersome and wasteful of time.

Further, owing to variations in the ground, there is no guarantee that because one pile will take a certain test load, other piles in the vicinity will do the same.

Disadvantages of Driven Piles.

(*a*) Considerable headroom and working space are necessary as the pile driver must be higher than the pile to be driven, and must also be guyed to prevent overturning during the operation of getting the pile into position for driving—"pitching" the pile as it is usually called.

(*b*) The piles must be properly matured before driving and with ordinary Portland cement this process takes at least 28 days. By using rapid-hardening cement the period can be reduced to about 14 days, and if the still more expensive "Ciment Fondu" is employed it is possible to drive a pile 3 days after casting.

No movement of the pile from the position in which it is cast must take place within the time limits just given, so that if piles are cast at a distance from the site of the work, extra time must be allowed for transporting them to the site.

(*c*) The concussion of the heavy monkey causes vibration of the surrounding ground and may do serious damage to other buildings in the vicinity.

(*d*) The plant required is considerable and its transport to the site often presents difficulties, particularly if communications are poor or non-existent. A steam-operated pile driver capable of dealing with piles up to 60 feet in length may weigh up to 25 or 30 tons and even when dismantled the sections require special lorries to move them. The piles themselves are awkward loads for rail or road transport and yet it may not always be possible to obviate this by casting them at the site of the work.

(*e*) It is difficult to gauge the length of pile required. Even when trial piles are driven the results are often misleading and in practice it frequently happens that a pile is found to be too long or too short. The former difficulty can be easily overcome by the simple expedient of cutting off the unwanted

length of pile; but a pile too short leads to delay as even if it is lengthened with "Ciment Fondu," this must be allowed to stand for 3 days before driving is resumed. In the meantime it may not be possible for practical reasons to work the pile driver elsewhere, so that such delays may prove a very real loss of time and money.

EXCAVATED PILES.

Purists may object to the term "excavated" but really there are so many variations in the method of constructing piles that are not driven-piles, that no other sufficiently comprehensive description can be suggested.

In this type of pile the principle is that, by some means or other, a hole is made and lined with a steel tube, inside which a pile is actually built up either from the prime ingredients or from small sections cast on the surface and grouted together after insertion in the hole. The lining tube is withdrawn as the pile is built up.

They are sometimes called "in situ" piles, but this description when used in connection with concrete normally refers to the process of filling a cavity with freshly mixed concrete and this hardly covers some of the methods which will be referred to under the heading of "excavated" piles. The more important are:—

(i) *The "Franki" system*, in which a steel tube with a charge of almost dry concrete at the bottom is driven by a drop hammer working inside the tube.

The hammer blows are taken on the concrete plug, which is forced down dragging the steel casing with it. Extra sections of casing are screwed on at the top as necessary and in this way a completely watertight hole is driven to any desired depth.

When the tube has reached the required depth, it is raised slightly by cables and the concrete plug is driven *almost but not quite* out of the end of the tube. Further charges of concrete are then introduced and successively rammed, the casing being withdrawn before the concrete adheres to it, but not so soon as to allow any water or other matter to get into the tube. The concrete tends to penetrate into the earth which has already been compressed by the driving of the casing. There is, therefore, great skin friction between the concrete pile and the earth.

The process can be adapted for driving inclined piles.

If considered necessary, a cage of reinforcement can be lowered into the casing and the formation of the shaft carried out as before, the hammer operating inside the circular cage of reinforcement.

The nature of the underlying soil is not ascertained by this method. The Patentees are the Franki Compressed Pile Co., Ltd.

(ii) *Bored Piles*, in which a hole is bored and lined with a steel tube in exactly the same way as when well boring. For depths down to about 30 feet the boring can be done by a hand-operated auger, but for greater depths a common boring tool, with a short rise and fall movement operated by a mechanical winch, is used.

At the required depth a concrete plug is placed at the bottom of the tube to seal it against the ingress of mud and the pile is then built up on this plug, a reinforcement cage being lowered on top of the plug. Such piles are always reinforced as, the soil having been bored out, there is no extra strength round the pile. The casing is withdrawn gradually, always making certain that the concrete in the tube is at a higher level than the foot of the casing.

If water enters the tube it must be allowed to stay there, otherwise the pressure outside the tube is so much greater than the pressure inside that the concrete in the tube is actually forced upwards by the static head of water.

(iii) *Pressure Piles.*—A hole is bored as for a bored pile and reinforcement is lowered into the hole. The top of the tube is then fitted with a hopper which has two valves in it.

Firstly, air is blown into the tube in order to blow out all water. Then the pipe is closed, and the hopper filled with concrete which is forced down under air pressure. You can often see air bubble out at the surface round the outside of the steel casing and if too much pressure is applied, cement grout can be noticed. By this system a pile is formed which bulges out into the surrounding soil and gives very good skin friction. Concreting is carried out free from sub-soil water, as this is blown out by the compressed air. The casing is withdrawn as the pile is formed. The system has been patented by the Pressure Piling Co., Ltd.

(iv) *The "Prestcore" Pile.*—A product of the British Steel Piling Co. In this system a hole is bored out and lined with a steel tube. Into this hole is lowered a central steel pipe having a flange at the lower end. On to this flange are placed short pre-cast un-reinforced units with holes to take reinforcement rods equally spaced just inside the circumference. The holes in these pre-cast sections are made to register by means of built-up steel rods, which latter are subsequently replaced by solid reinforcement rods.

When the whole pile has been built up of the small sections inside the steel lining of the bore hole, rich cement grout is forced down the central pipe and escapes through holes in its lower end. This grout expels any sub-soil water, binds together the sections of the pile, grouts-in the reinforcement rods, and forces its way into the surrounding soil, the lining of the bore hole being withdrawn as grouting proceeds.

The most obvious advantage of this system is that it is known for certain that the bore hole is completely filled, because the length of the built-up pile can be accurately determined to correspond with the depth of the bore hole, and the appropriate number of sections inserted.

(v) *Cementation Piles*—a development of the bored pile by the Francois Cementation Company—are identical in the early stages with bored piles.

When the bore hole has been excavated and the steel reinforcement cage inserted, a perforated steel tube is placed centrally in the hole. This tube, which remains permanently in position, is then surrounded by clean screened ballast, inserted a little at a time and lightly tamped with a drop hammer working inside the reinforcement cage. As with other piles of this type, the outer casing is withdrawn as the ballast filling is inserted. When the bore hole is full of ballast, cement grout is forced down the central pipe, permeates the filling and converts it into a solid pile.

Advantages of Excavated Piles.

(*a*) Very much less headroom is needed than is the case when a pile driver is employed. In certain cases piles have been constructed with as little headroom as six feet. Working space required is also small.

(*b*) Vibration is reduced to a minimum and piles of this type can be built close alongside existing structures without danger to their foundations. In fact this type of pile is frequently used to strengthen existing foundations and is ideal for under-pinning work.

(*c*) The plant required is small, light and easy to transport from job to job. It is quickly erected and can be moved about on the site by a few men.

A large pile driver usually requires some form of track on which to move about the site.

(*d*) In those types in which boring is carried out, the engineer can see for himself the soil on which his building is to rest.

(*e*) Whereas the driven pile depends for its bearing capacity on the friction between pile and ground, the excavated pile, in addition to having excellent skin friction with the surrounding soil, also has in most cases an enlarged foot caused by the spreading of the first concrete placed in the hole. This enlarged foot distributes the load over a considerable area and certainly adds to the bearing capacity of the pile.

(*f*) The piles are brought to the site in the form of cement, ballast and reinforcement, all of which are readily handled as compared with the pre-cast pile.

(*g*) Piles can be constructed of any length without waste or necessity for lengthening.

Disadvantages of Excavated Piles.

In spite of the fact that in the majority of cases the nature of the soil is known as a result of boring, one never quite knows what is happening down the bore hole. There is no question of working to a definite set and really it is only possible to ascertain the strength of a pile by test loading, which is an expensive and troublesome procedure. Piles often have to be driven close together and a test load on the first pile may considerably delay progress on the remainder of the work.

Some Practical Experiences of Piling.

During the last twelve months piling of three different types has been carried out at Shoeburyness. The first two jobs gave little or no trouble and went according to plan.

The last undertaking gave considerable trouble and caused much head-scratching before the solution was reached. It was therefore quite the most interesting of the three jobs and the one from which the engineer staff probably learned most. The works will be described in the order in which they were carried out.

Pressure Piling.

Two steel velocity towers, each 140 feet high, were to be built in a very confined space. One of them was to be immediately alongside an armour-plate testing butt. Vibration during erection might have loosened the foundations of the butt and in the first instance it was decided to use steel screw piles. The contractors invited to tender for the work were, however, unable to obtain piles of this type owing to the steel shortage and pressure piling was accepted as the alternative.

One of the towers had to be close up against the sea-wall, where it

was impossible to get much spread on the footing and, under this tower, eight piles were used. The footing of the other tower was wider and in that case four piles were sufficient. All were nominal 15 in. in diameter, reinforced with six $\frac{3}{4}$-in. rods and $\frac{1}{4}$-in. spiral hooping. They were sunk to a depth of about 34 feet below ground level and rested on hard gravel.

The contractors—The Pressure Piling Company—used a W.D. compressor, but the rest of their plant could easily have been carried in two 3-ton lorries.

Driven Piles.

Over a hundred 14-in. pre-cast piles, reinforced with four 1-in. rods and $\frac{1}{4}$-in. hooping at 4-in. pitch, were to be driven over a site of approximately 600 square yards. No piling had previously been carried out on the site nor was any bore hole sunk to ascertain the probable length of pile required, but from information obtained regarding the geological formation it was thought that piles would vary in length from 40 feet to 44 feet. The contract stipulated that three test piles were to be driven. Owing to the urgency of the work, the contractor bought about thirty 45-ft. piles and started driving. He was fortunate enough to find some that were already well matured and had in fact been made twelve months earlier.

The load originally intended was 40 tons per pile, but when work actually started, it was not clear whether this load was " dead " or " vibratory " and to be on the safe side a conversion was made to provide for the worst case, and a " dead " load of 72 tons resulted. Using the formula

$$L = \frac{2 X H}{S\left(1+\frac{W}{X}\right)}$$

where L = safe load on pile in lb. (161,280)
X = weight of hammer in lb. (6,720)
H = height of fall of hammer in feet (4)
W = weight of pile in lb. (8,960)
S = average penetration per blow in inches for the last ten blows
[Figures in brackets are those actually used.]

the set worked out at 1/7th in. per blow, or 1·43 in. for the last ten blows. The first three piles driven attained this set at depths from 40 to 45 feet and the contractor therefore ordered the remainder of the piles 45 feet long.

Even over the small area involved, the piles did not all reach the same depth, due possibly to the compaction of the ground as driving proceeded. About 20 piles had to be cut off, in some cases up to as

much as seven feet, while only three piles had to be lengthened. The latter was carried out in " Ciment Fondu " and although driving was resumed three days after the extra lengths had been added, the new concrete stood up to the 3-ton monkey and showed no signs of failure or disintegration.

The pile driver was capable of dealing with piles up to 60 feet, so was in fact rather larger than actually necessary. It was steam-operated and was moved about the site on a heavy timber platform by means of hand-operated levers and jacks. In all, 117 piles were driven during a period of ten weeks. With the pile driver in position it usually took only about three hours to pitch and drive a pile. The rest of the time was spent in moving the pile driver.

Bored Piles.

Two groups, each of five piles, were required actually in the sea-wall on a site adjoining that at which the pre-cast piles had been driven. Even if it had been practicable to get the pile driver on to the top of the sea-wall, which is only about five feet wide, the vibration of driving would have caused serious damage to the wall; it was therefore decided to make use of bored piles nominal 15-in. diameter, reinforced with five $\frac{5}{8}$-in. rods and $\frac{1}{4}$-in. helical hooping at 6-in. pitch.

Boring was done by a hand-operated auger down to about 30 feet, after which a sludge pump operated by a winch and petrol engine was used.

Owing to the fact that it was known that the sea-wall sinks about six inches a year, it was necessary that the piles should be taken down to something really solid. In addition to carrying the designed structure, which gave a load of 20 tons per pile, the piles had to be strong enough to allow the sea-wall to sink round them rather than press them down with its own sinkage.

The section shows the different types of soil through which the boring was carried, but the word " MUD " conveys a very inadequate description of the trouble caused by that liquid substance. The spoil brought up in the sludge pump appeared to be mostly dirty water and between depths of 30 feet and 57 feet the casing required hardly any driving, so little resistance did the mud offer.

At about 57 feet the casing was definitely checked and was found to have entered fine compact bluish sand, which was considered quite a suitable foundation for the feet of the piles. In order to be certain that the bottom of the casing should be thoroughly sealed against the ingress of any mud, the tubes were driven to a depth of 62 ft. 6 in. and bored out to a depth of 60 ft. 6 in. That left a wad of firm sand about 2 feet thick in the bottom of the bore hole.

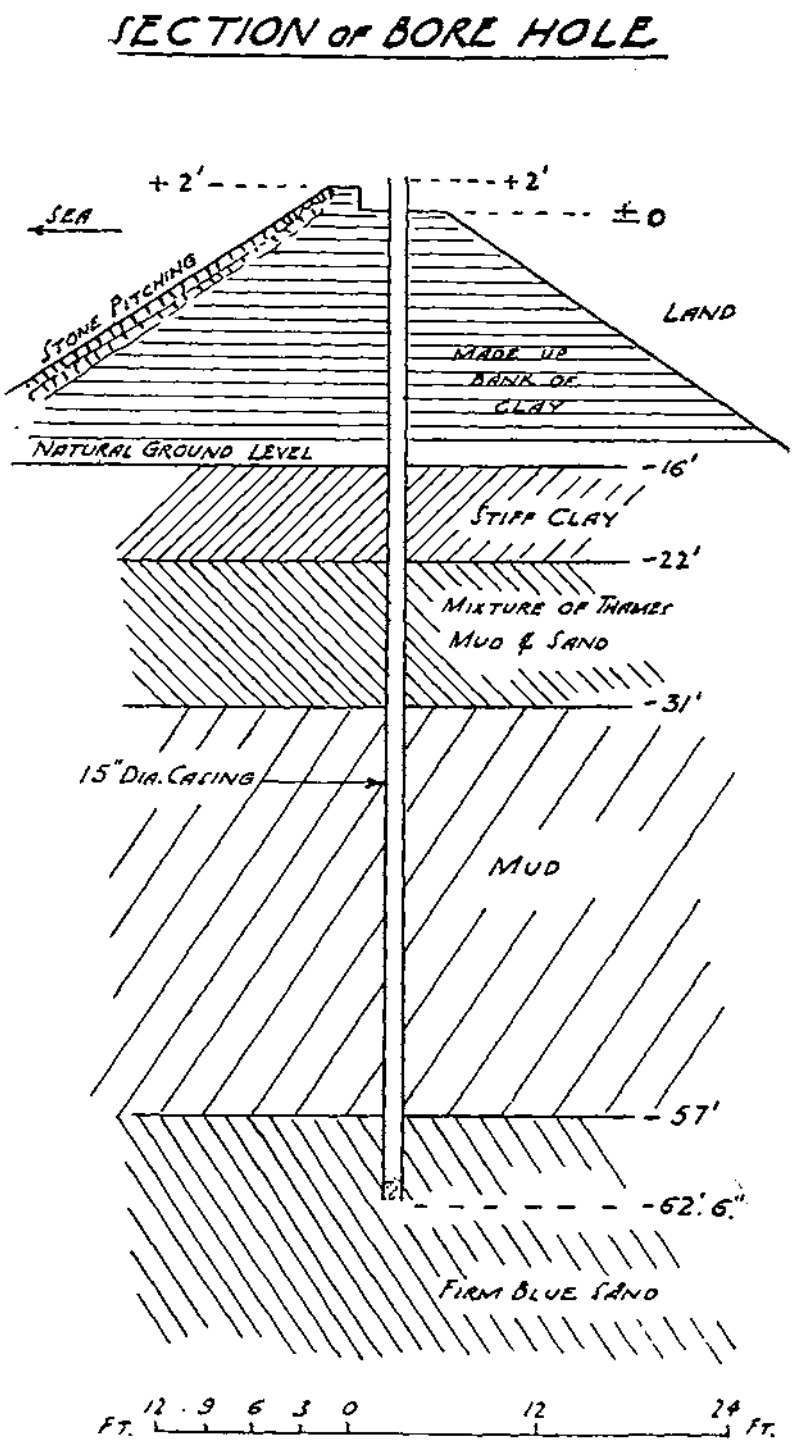
Throughout the work there was of course water in the bore hole, the depth varying with the state of the tide. With the hole well

sludged out to a depth of 60 ft. 6 in., the next step was to place and lightly to tamp a mix of dry concrete at the bottom of the casing, to act as a plug and properly seal the bottom of the pipe. This dry concrete occupied a depth of about 3 feet, so that the depth from ground level to the top of the concrete was some 57 ft. 6 in. After placing this concrete plug, the men knocked off for three-quarters of an hour. When they returned it was found that the sludge pump, instead of dropping under its own weight to a depth of 57 ft. 6 in., was actually stopped at a depth of some 27 feet by what appeared to be a sort of crust as, after being jumped two or three times on the winch, the sludge pump then sank easily to a depth of about 45 feet where it was definitely and finally checked. What was holding it up at this depth when the hole had previously been thoroughly sludged out to a depth of 60 ft. 6 in. ? It must have been silt which had separated out from the water during the time when the bore hole had been left undisturbed.

At this point a definite mistake was made. The water inside the tube was sludged out, so that the static water outside the tube became at once unbalanced to such an extent that its pressure forced the concrete plug up the inside of the bore hole until this plug was only about 40 feet below ground level. It was, of course, impossible to get rid of the concrete plug which had now begun to set and it only remained to draw the casing as quickly as possible, fill in the hole with rough concrete in order not to leave a weak void, and start again in a different place.

The site of the emplacement was moved 2 ft. 6 in. laterally and a start made on a second pile. The foreman was warned on no account to reduce the water level within the bore hole and was in fact told to add water so that the level was, during working hours, permanently maintained at a depth of only 2 or 3 feet below the top of the tube. At times when no work was in progress, the level of the water inside the tube naturally fell until it reached the general subsoil water level, but this did not matter.

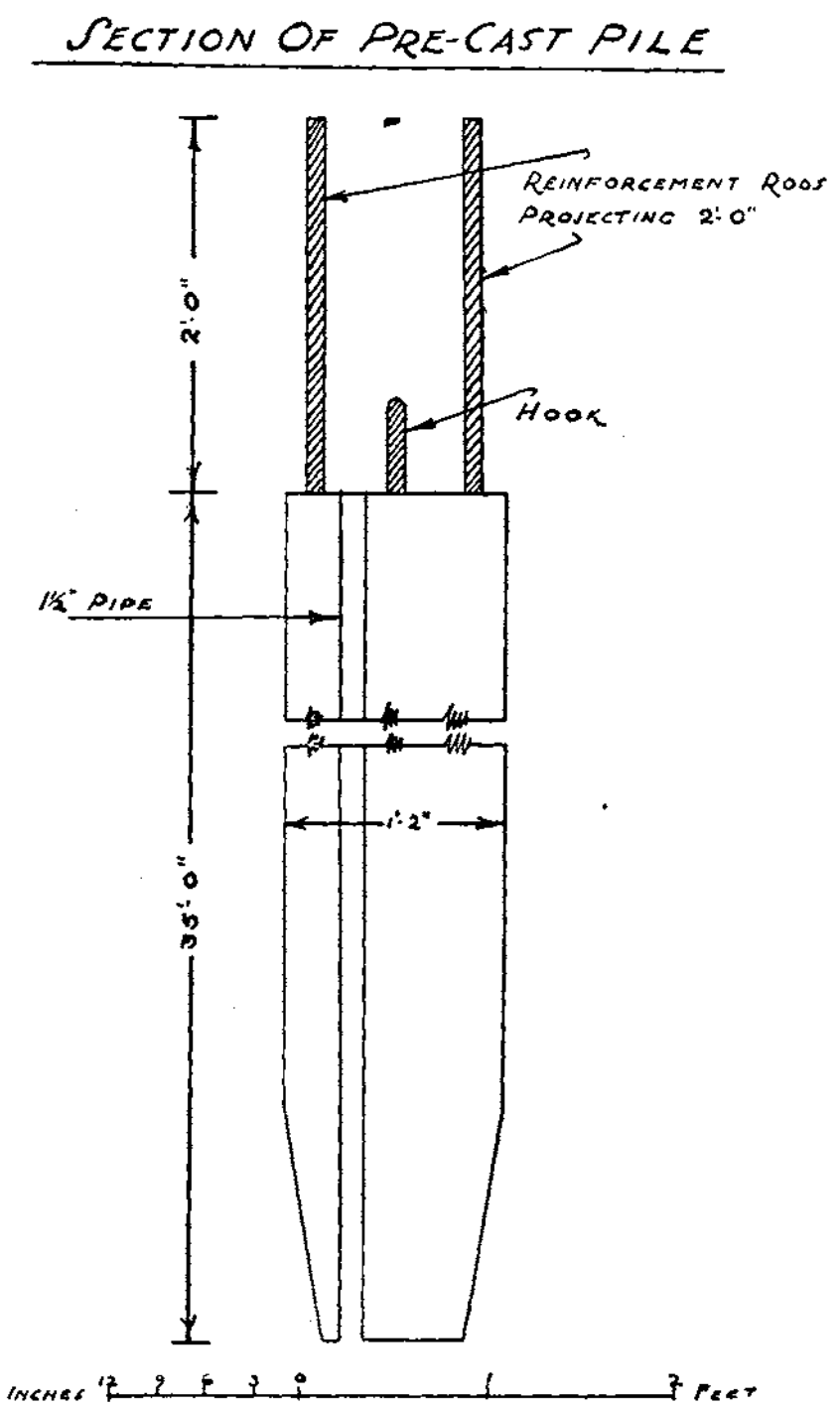
As with the first bore hole, firm blue sand was reached at 57 feet, the casing driven to 62 ft. 6 in. and the hole sludged out to 60 ft. 6 in. A plug of dry concrete was then placed and tamped leaving a clear depth from ground level to the top of the concrete plug of 58 feet. The reinforcement cage was then hoisted on a derrick and lowered into the hole. It stuck fast at 45 feet below ground level. The water in the bore hole had seemed free enough from silt when the concrete plug was put into position, but it was undoubtedly silt which was preventing the reinforcement cage from getting down to the top of the concrete plug. The cage was jumped two or three times, but without effect and then the lashing attached to it broke and, after several unsuccessful attempts to hook on another lashing, it was decided to leave the reinforcement where it was and fill in the hole as before.



1. Section of Bore Hole.

Fortunately the exact siting of the emplacement within 10 feet or so did not matter, so it was possible again to move it laterally and begin work on a third pile. After the first unsuccessful effort, the firm's engineer had visited the site and was of opinion that, provided the water level in the bore hole was maintained, the second pile could be satisfactorily placed. Now, however, it was necessary to think again. It was finally decided that the difficulties of the loose mud, combined with the fine silt in the subsoil water, could only be overcome by using a length of pre-cast pile to bridge the gap between the bottom of the bank and the blue sand. Even if no silt had accumulated and it had been possible to get the reinforcement cage right down on to the top of the concrete plug, the firm were of opinion that when the pile was cast, the concrete would slump away into the mud as the casing was withdrawn. It was therefore decided to cast ten octagonal piles, each 35 feet long, which would just fit inside the 15-in. casing, the reinforcement bars to project 2 feet beyond the top of the pile, in order to give sufficient overlap when the reinforcement cage was subsequently added. Each pile was to have a strong hook at its upper end to facilitate lowering and possible subsequent raising if later found necessary. Further, a 1½-in. pipe was cast in the length of the pile as it was thought that should, owing to silt, any difficulty be met with in lowering the pile, it might be possible to force a jet of water through the pipe, which would clear out the silt and allow the pile to get down to the sand. The inclusion of this 1½-in. pipe was later shown to be of vital importance. In order to save time, the piles were constructed of "Ciment Fondu" and were ready for use four days later.

A third bore hole was accordingly sunk to a depth of 62 feet and the hole thoroughly sludged out. The pre-cast pile was pitched and lowered, which operation took about two hours. As before, silt had accumulated, and tamping of the pile with the drop hammer produced very little effect; the pile would not descend below 45 feet. It was therefore withdrawn, a hose fitted through the 1½-in. pipe extending to the foot of the pile and the latter again lowered into the bore hole, until it rested on the silt. Water was then pumped through the hose and, as had been foreseen, this resulted in the silt being jetted out over the top of the casing so that the pile gradually sank down until its foot was at a depth of 61 feet and therefore resting on the sand. The hose pipe was next withdrawn and the pile tamped with the drop hammer, which was small enough to work within the projecting reinforcement rods. This tamping had no effect and the pile was undoubtedly resting on the compact blue sand. The casing was withdrawn until its lower edge was only some 8 feet below the top of the pre-cast pile, and the reinforcement cage for the upper length of pile was then lowered into position. Throughout the operations, the bore hole was kept full of water. With the reinforcement in position



2. SECTION OF PRE-CAST PILE.

concreting began, each tip being tamped with the drop hammer. Once concreting is begun it must be completed without a break to ensure that the work is monolithic. The casing was gradually withdrawn as the concrete was laid.

No further difficulties were met and the remaining nine piles were constructed in this way without a hitch, each pile taking about two and a half days to complete.

It is believed that the conditions encountered in this particular job were unique. Certainly the piling contractors—The Francois Cementation Company—stated that in all their experience they had never before had to adopt the method which finally proved successful in this instance. A combination of pre-cast and cast-in-situ piles is not uncommon, but the process of " jetting-in " the pre-cast pile is, to say the least, unusual. It goes to show that piling is not altogether the abstruse subject which it is sometimes considered to be, and that common sense is as valuable in overcoming engineering problems as it is in everyday life.

ENGINEER OPERATIONS IN THE SINO-JAPANESE HOSTILITIES AT SHANGHAI.

By CAPTAIN J. V. DAVIDSON-HOUSTON, M.B.E., R.E.

INTRODUCTION.

THE operations in the Shanghai area during the summer and autumn of 1937 were a contest between a modern army and a half-trained force, and as such provided as many examples of how not to do things as of how they should be done. The study of war, however, necessarily consists of so much theoretical discussion and speculation that " an ounce of practice " is well worth examination, from wherever taken. The writer was privileged to observe much of the operations at first-hand, and considers that the following points are of interest to the military engineer.

FIELDWORKS.

The digging of *trenches* was confined almost entirely to the Chinese, and the only Japanese earthworks seen were those hurriedly constructed by their naval landing party while awaiting the arrival of the expeditionary force. The trace of the Chinese fire trench was wavy, with a short branch to a rifle pit every ten yards. There was no fire step, and the trenches were narrower than those of British design. The depth varied with the water-level, which was often four feet from the surface. The trenches were not revetted, and drainage was neglected, so that they filled with water in wet weather. Whether under instructions or not, the local inhabitants sometimes grew vegetables in the parapets, which helped to conceal them.

The *sandbags* used were of various sizes, but approximated to small sacks rather than to the British standard bag. Neither side paid much attention to neat building ; in the case of the breastworks opposite the British lines, the Chinese began to copy our patterns, and gradually improved their posts accordingly.

The Chinese built a number of *concrete machine-gun emplacements*. These were reinforced with iron rods and often as much as three feet thick in walls and roof. Some were well hidden by matting roofs or constructed inside native houses, and escaped serious damage ; others had been sited on exposed rising ground and were penetrated by the explosions of shells and bombs. These " pill-boxes " had iron doors and iron shutters for the loopholes.

Wire obstacles, in the form of "knife-rests," were employed in the street fighting. In the country, where the Chinese were almost consistently on the defensive, they constructed single-apron fences round tactical points; but barbed-wire, being an imported commodity, was hard to obtain and plain wire was often used.

Anti-tank ditches were dug by the Chinese across roads, and their effectiveness was increased by the fact that they readily filled with water, which also disguised their depth. A useful anti-tank obstacle was made by burying rails for half their length in the ground, with the protruding portions sloping towards the enemy. A line of such rails, placed three feet apart, would check any armoured vehicle.

Anti-tank mines, of modern design and weighing about 10 lb., were turned out by the Nanking arsenal. There is no evidence, however, whether they caused any damage to Japanese armoured vehicles.

River Crossings.

The crossing of creeks and waterways, with which the Shanghai country is closely intersected, was one of the most important tasks for the Japanese expeditionary force.

Rafts were improvised from bamboo poles lashed together, to which were attached Kapok floats, or buoys made of *papier-maché*. Squares of canvas, provided with tapes, were also an article of store; these could be wrapped round any buoyant material to make improvised floats.

Assault bridging material consisted of floating piers (9 ft. wide) made of buoyant material in tarpaulin covers, and decking of thin boarding (3 ft. wide) supported by light metal roadbearers which could be locked to the floats. They were launched by engineers.

Folding boats were employed. These were much smaller than the British pattern, and folded quite flat.

Motor craft of various sizes, the largest carrying 90 men, were used both for opposed landings and for navigating the lakes and waterways which are the main traffic routes in Central China. Their employment enabled the Japanese forces to cross an area which the Chinese had regarded as impassable by troops. These boats were all manned by engineers.

Pontoons were of metal, made in three sections, which were fastened together by screw bolts. Each section was carried on a two-wheeled, one-horse, flat cart, and the complete pontoon appeared smaller than the British one. Pontoon parks, as with us, are units of the Transport Corps.

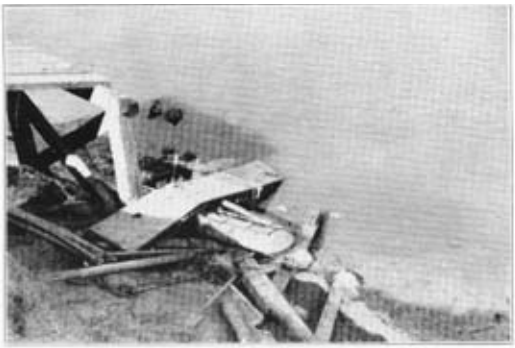
In the rapid *construction and repair of permanent bridges*, the Japanese engineers appear to be equal to any. The Chinese, after four attempts, succeeded in damaging the lower girders of a single-span steel railway bridge over the Soochow Creek, so that the bridge

1.—Chinese "pill-box" concealed in house.

2.—Camouflaged Chinese "pill-box."

3.—Japanese folding-boats in foreground, with assault bridge decking in background.

Engineer operations in the Sino-Japanese hostilities 1-3



4.—Float and decking of Japanese assault bridge.

5.—Effect of shell-fire on North Station building. Anti-tank obstacle in middle of road.

6.—Effect of several weeks' shelling and bombing in Chapei.

Engineer operations in the Sino-Japanese hostilities 4 -6

dipped into a V-shape. The Japanese, using a hand-operated monkey, drove 12 in. x 12 in. piles below the affected part, mounted jacks on the piles, and raised the girders to the horizontal. A crib pier was then erected on the spot, and within a month from the demolition trains were running across the creek. A neighbouring wooden bridge had been destroyed by burning, but in a few days the Japanese had erected a timber trestle bridge on the stumps of the original piers, which was strong enough to take motor traffic. In North China, where details are not yet available, the Japanese army has demonstrated that the destruction of railway bridges 1,000 yards long will not delay its trains more than three or four weeks.

Demolitions.

The incompleteness of every bridge demolition by the Chinese in the Shanghai area illustrates the effect of lack of preparation, lack of training and lack of organization. Chinese engineer officers were issued with books describing various examples of demolition. If the design of the bridge differed from those in the examples, they were unable to work out the problem. The successful destruction of railway bridges in North China and at Hangchow was due to the employment of civilian railway engineers. At arson they were more adept, and many of the villages which they abandoned were successfully burned. The flimsy construction of Chinese houses assisted this operation, and the whole of Chapei (the native quarter north of the Settlement) went up in flames as the Chinese evacuated it. It was found, however, that this method did not appreciably delay the Japanese, since they usually captured a locality by taking it in flank or rear. An operation which caused some anxiety to one of the British posts was the insertion of three dustbins (filled with explosives) in three adjacent manholes, which were connected for electric firing, and which were sited dangerously near the blockhouse. They were ostensibly a precaution against Japanese armoured vehicles breaking through from the neutral area, but remained in position until the Chinese evacuated Chapei, and were never fired.

Searchlights and Sound-Locators.

Although the Chinese had purchased some of these instruments, they did not have any in the Shanghai area. The Japanese cruisers used their lights for air defence, but some were also mounted on high buildings in Yangtzepoo. Several sound-locators were also in use; they were equipped with four horns and resembled the British pattern. The lights were not scientifically used, but appeared to search the sky individually and indiscriminatingly. In the Japanese service, searchlights and sound-locators are manned by the artillery.

EFFECT OF BOMBING AND SHELLING.

There is a widespread impression among people without first-hand experience, that a building subjected to shelling or bombing rapidly collapses. This is largely due to the educative value of the cinematograph, but at Shanghai it was found that shells might penetrate a building, and even burst inside, without more than a local effect. This applied especially to frame buildings, which did not depend for stability upon their walls, but it was generally true of all European-style structures. It would appear that shelling of Great War intensity is required to render modern buildings untenable.

In a similar fashion, even large aerial bombs had a very local effect. The 1,000 lb. missiles, which fell in the streets of the Settlement, killed and wounded many hundreds of people, but did comparatively little damage to the surrounding houses. The Japanese repeatedly bombed certain large buildings occupied by Chinese troops, who took refuge on the lower floors. Practically all these bombs burst in the upper storeys and few casualties were suffered by the troops.

A very curious effect was observed on some of the metalled roads in the vicinity of Shanghai. Heavy bombing in the neighbourhood of a road caused it to assume slight undulations, probably on account of the boggy ground on which the roads were laid.

WALLED CITIES.

It is interesting to observe that city walls played a part in the fighting between Shanghai and Nanking, although modern weapons were in use by the troops of both sides. The Chinese tended to rally in towns, closing the gates and remaining passively within until the last moment, when they would scuttle out through the back door. The walls of Chinese towns are usually earth ramparts faced with brick or stone, which are often 30 ft. high and 15 ft. thick, forming a serious tactical obstacle which required a considerable bombardment before breaches could be made. In fact, Japanese troops frequently resorted to scaling ladders in order to force an entrance. The gates, which are generally few in number, were barricaded and heavily blocked by sandbags. Attacking infantry were subjected to rifle and machine-gun fire from prepared positions on the top of the wall. The Japanese found that an artillery bombardment of the town did not necessarily annihilate its garrison, which could shelter underground or close behind the walls, and still impede the infantry advance. Although the Chinese overestimated the value of walled cities in modern warfare, it was shown that these can still affect tactical operations.

THE ALDERSHOT COMMAND ROAD MOVEMENT EXERCISE.

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

[*It should be understood that this article contains the ideas of an officer taking part in the exercise and is in no sense authorized comment.*]

IN April, 1938, the Aldershot Command ran an exercise known as "The Aldershot Command Road Movement Exercise." The object of this exercise was officially described thus—"to ascertain the best method of moving a division with vehicles at war strength partly by day and partly by night over a distance of about fifty miles in an area protected by our own troops and liable to air attack only."

There was no question of the ground defence of the column; the tactical setting* of the exercise ruled that out, so that the enemy could only interfere by attacking the column with aircraft, in which they had complete superiority. Every aeroplane was an enemy.

The 2nd Division from Aldershot was chosen for the exercise, which divides itself into five phases:—

(*a*) Bringing the Division up to war strength in vehicles.
(*b*) The peace march down to Salisbury Plain where the Division was in (imaginary) concealment when the exercise began.
(*c*) The move of the Division in 36 hours from Salisbury Plain, partly by day and partly by night, to a concentration area near Aldershot.
(*d*) The concealment of the Division in the concentration area.
(*e*) The dispersal after the "Cease Fire."

The higher command was principally concerned with phase (*c*) above, but as units learnt useful lessons in the other phases it is well to mention them briefly.

BRINGING THE DIVISION UP TO WAR STRENGTH.

The vehicles to bring the Division up to war strength came partly from the 1st Division in Aldershot and partly from the other home commands. The result was a motley assembly. The Divisional Engineers alone contained vehicles from thirteen different units as

* The setting is given in Appendix I.

well as some from an Ordnance Depot with civilian drivers. Moreover, for the purposes of the exercise, anything with four wheels or six constituted "a vehicle" so the Divisional Engineers included some strange monsters of types different from what really exist in the Corps. All had to be labelled to show what they did in fact profess to be.

Nevertheless, this does paint a fair picture of what we must expect on mobilization. Units are not kept up to war strength in vehicles or men for many and good reasons. On mobilization there are bound to be unfamiliar vehicles and drivers whom one does not know by name. This difficulty pales into insignificance in comparison with those of the peace-time administration of a composite unit. There is no doubt that the handling of a mixed assembly like this would in many ways be simpler in war-time than in peace-time. And there is some comfort in knowing this.

The vehicles arrived on 25th April (two days before the start of the exercise) and the next day was spent filling up with petrol; for every vehicle had to be self-contained for a drive of 150 miles.

THE MOVE TO SALISBURY PLAIN.

The Division made a peace march down to the Plain on 27th April.* Two routes were used; the Divisional Engineers being amongst the units using the northern route. This was the main Camberley–Whitchurch–Andover–Amesbury road with a detour round Basingstoke, partly on a by-pass and partly on second-class roads.

The headquarters of the Divisional Engineers (10 vehicles and 4 motor-cycles) went with Divisional Headquarters; the three Field Companies and the Field Park Company moved together. They consisted of 150 vehicles and 51 motor-cycles and were allotted one hour of time in the column.

At this stage it should be pointed out that columns of Mechanical Transport are best described in units of time, not length. For instance, on the march down, the column moved at 15 miles in the hour (m.i.h. and not to be confused with m.p.h.) and at a density of 20 vehicles to the mile (v.t.m.). Thus 15 x 20 equals 300 vehicles passing the starting-point in one hour. As the Royal Engineers had only 150 vehicles to fit into the hour allotted to them it was clear that there was ample time to spare for checks, halts or break-downs. To ascertain this fact by calculations of space would lead one into uncharted oceans of arithmetic.

A simple lesson emerges from this which explains all kinds of phenomena whose existence everyone is aware of but which are seldom explained. The lesson is this: The "time length" of a unit

* A time-table of the exercise is in Appendix II.

is the product of its speed (m.i.h.) and its density (v.t.m.), and this must be kept constant.

This is important in moving from bivouac along a side road so as to fit into a space in a column moving on the main road. Suppose that, owing to the narrowness of the side road or a steep hill out of bivouac or cold engines, it is only possible to move along the side roads to the starting-point at half the speed of the column into which one is to fit. Then one must move at *twice* the density of vehicles to the mile or one's " time length " will be too long to fit into the space in the column and the unit behind will be balked. If a commander does not want his vehicles closed up as they move to the starting-point, they must either move at the pace of the column into which they are to fit or else they must be allotted a longer " time length " in the column than they should normally need.

In everyday life this is experienced in getting cars out of a car park into a main road. The cars come out of the car park at a slow pace and tightly bunched. On the main road the pace increases and the cars string out. In either case the product of the speed and the density remains the same.

Everyone knows that when the leader of the ride trots too fast (to change the analogy) the rear files have often to canter to keep up. The same happens in an M.T. column. It happened on the way to Bulford. A young driver of a 3-tonner pulling a trailer said with pride to the C.R.E. when safely arrived in camp : " Aye, surr "(he was a Scot), " she's a fine ve'icle ; she did fifty nee'ly a' the way." This is easily explained. At the top of a hill a heavy vehicle with bad acceleration gets left behind (*i.e.*, the density of the vehicles decreases). To compensate this its speed thereafter must increase or the " time length " of the unit will increase and the tail will get home late. The practical effect of this is that on every hill either the vehicles must close up or the whole move must be done more slowly.

Anyway we got to Bulford without mishap. The Light Aid Detachment R.A.O.C. with the Field Park Company only had to deal with two minor stoppages.

The Move to the Concentration Area.

The move as far as the Divisional Engineers was concerned began at 4.45 p.m. at 15 m.i.h. and 10 v.t.m. Headlights were dimmed by blacking out all but a narrow horizontal strip, $\frac{3}{16}$" wide and three-quarters of the diameter of the lamp. Side lights were dimmed with opaque cardboard having an aperture of $\frac{1}{2}$" in the middle. Tail lights were dimmed in a similar way and painted blue instead of red in some cases.

The move was again on two roads. The R.E. using the northern

of the two. Moreover, progress was hampered by " umpired " road craters from sabotage and aerial attack. The Division overcame this by dividing the road into sectors, each about 15 miles long, with Regulating Posts between sectors. Deviations round defiles were reconnoitred by Gunner subalterns on motor-cycles. Descriptions of the deviations were received in time to be issued down to individual drivers, but it is suggested that this may not always be possible.

The theory is briefly this. When a vehicle is stopped by a road crater caused by an aerial bomb, the nearest officer takes charge. He first sends back a motor-cyclist to stop vehicles behind from closing up. He next decides whether his own men can repair the obstruction there and then or whether there is a local diversion round it. If the obstruction is such that he can neither find a local diversion nor entertain a hope of clearing it himself, he must go back to the nearest previously reconnoitred deviation (of which he should have a list) and send succeeding vehicles down it. He must in any case inform the Regulating Post in rear, who will send up a suitable R.E. detachment to clear the obstruction. The vehicles between the obstruction and the deviation in rear may be halted for some time and units are liable to get mixed up when they proceed.

It also requires of the officer on the spot considerable initiative. He must make many decisions in a short time, and he will probably be " blasted " by someone whatever he does.

In this way a crater adjudged to have been made in the middle of the unit next ahead of the leading Field Company was passed. It naturally makes matters easier if there are plenty of M/C's and road signs to mark the route. Also some care has to be taken to prevent units continuing to use the deviation after the main road has been repaired.

On arrival in the concentration area signs pointed the way to the bivouac area. The advanced party under an officer sent well ahead made this a simple affair, even though it was dark on arrival.

CONCEALMENT IN THE BIVOUAC AREA.

Concealment in a bivouac area is most difficult on first arrival, especially if the area is among trees—as it usually will be. No one knows the way about ; it is difficult to manœuvre amongst the trees and there is a general tendency to light lamps and torches. Lastly, unless other arrangements have been made, the troops have to be fed ; and preparing a meal is liable to involve too much light.

By daylight concealment is easy if the cover is sufficient. But good discipline is required to keep men under cover. Also it must be remembered that aircraft do not only give a vertical view to the observer. Vehicles must be well inside the wood or an oblique view discloses them at once.

The Dispersal after the Cease Fire.

The Cease Fire was sounded at 8 a.m. after the R.E. had had one and a half nights and a day in bivouac. The staff had prepared a dispersal programme which worked admirably. It is interesting to wonder what would have happened had there been no dispersal orders at all beyond a general permission to return to barracks. A division has under 3,000 vehicles, which is nothing compared with a Sandown crowd. It is for consideration whether any march tables are necessary when there is no fear of enemy action, and when everyone knows exactly where he wants to go.

Lessons Learnt.

The lessons learnt were of two categories. The major ones, learnt by the higher command and the directors, and the lesser ones, learnt by units. From the parochial view of the Divisional R.E. it is only possible to suggest some of the former and they are open to contradiction.

1. It is impossible to conceal from the air so large a move as that of a division. It may, however, be possible to mystify him by juggling with ration convoys, etc., at the same time. It is hard to say from the air which are convoys of troops and which of rations.

2. The times when M.T. troop movements are most likely to advertise themselves and get caught by air attack are on moving into or out of a concealed area. The former is likely to produce bunching and so give away the bivouac area. A liberal supply of signs, either illuminated by lamps screened from the air or reflecting "Franco" signs, would be a great help.

3. Any form of dimmed lights—head or side, or even tail—give away to the air M.T. movement by night. And the well-drilled turning them off at a halt and on again before moving is a sure indication of troop movements. The best chance seems to be to drive with no head or side lights—only two very dim shaded tail lights (one red and one blue for preference). Such driving is possible in war, but not in peace-time. Street lamps and on-coming traffic blind the driver of the unlit vehicle.

4. There must be an adequate Road Control Staff as on a railway. It is suggested that it is uneconomical to use combatant officers for this and that it would be better to take over all roads at the outset and work them like a railway system. The logical outcome of this is to pool all transport (other than that actually required by units to fight with) rather like the rolling-stock on a railway. Troop movements are often made by rail and no one suggests that the units should own the rolling-stock. It appears that it is uneconomical for

a division to have its own M.T. companies in a major war. "Unity of Control" is a watchword of movement (*Manual of Movement*, p. 14). The possession of M.T. by divisions is the reverse; it is a delegation of control to divisions.

LESSONS LEARNT WITHIN THE UNIT.

Some of these were known before but are repeated to give a consecutive statement.

1. Every driver must have :—

(*a*) A map.
(*b*) A clear idea of his destination.
(*c*) A maximum speed, greater than which he must not go—to prevent accidents.
(*d*) A minimum distance from the vehicle in front—to prevent bunching.
(*e*) Some idea of what to do if a bomb falls on the road ahead of him.

(*c*) and (*d*) require careful thought by the unit commander before giving his orders. It is in practice useless to give a driver the density of the column or its speed in miles in the hour.

2. Every commander, down to section commanders of a Field Company, should have a time-table showing the times to pass certain points on the route. By comparing this with his watch the commander can see if he is "up" or "down" on time. The number of watches in the unit is the limiting factor: otherwise it would help if every driver had such a time-table. If the move is done at short notice, only a very sketchy time-table of, say, two or three points is practicable.

3. The maximum safe speeds are :—

(*a*) 3-tonners, *i.e.*, the Field Park Company, 15 m.i.h. by day and 10 m.i.h. by night. The maximum speed will then seldom exceed 30 m.p.h.
(*b*) 30-cwt. lorries, *i.e.*, the Field Companies, 20 m.i.h. by day and 15 m.i.h. by night.

CONCLUSION.

It is a well-known fact that everyone who can comprehend the object of an exercise derives benefit from it by comparing the object with the results achieved. Judged in this light the Road Movement Exercise was a good one, for both object and results could be seen by almost everyone.

APPENDIX I.

Opening Narrative.

Ref. Maps: O.S. ¼" to 1 mile, Sheet 11, 3rd Edition.
1" to 1 mile, "Aldershot Command."

1.—Eastland and Westland are at war. Westland is somewhat the stronger on land, but Eastland is superior in the air.

Starting from a common frontier, Southampton–Winchester–Newbury–Oxford, Westland has invaded Eastland, who has given ground but appears to be standing on the line Woking–Guildford–Godalming–Petworth. Westland is preparing an offensive to break the centre of this line between Guildford and Chiddingfold.

2.—Westland's 2nd Division and attached troops, which so far have been employed on L.-of-C. protection, can now be spared to take part in the offensive. Their order of battle is given in Appendix "A." On 27th April they were concentrated in bivouac at West Down Camp 5069, Fargo Camp 5564 and Tilshead Camp 4768, with orders to march on the night 28th/29th April to the Andover area *en route* for Aldershot.

For scheme purposes it may be assumed that troops in these camps are concealed from air observation in villages, etc.

3.—At 7 p.m., 27th April, a staff officer from Westland G.H.Q. at Salisbury visits G.O.C. 2nd Division, and says :—

> "The date of our big offensive has been advanced and it is essential that your division should be concentrated in the area Blackwater 2979–Aldershot–Fleet 2473 by daylight on 30th April, when you will come under orders of II Corps and may have to move up into action either that day or the following night.
>
> "It is, therefore, obviously preferable that you should be 'harboured' in the Aldershot area by the night 29th/30th April, in time to get a night's rest and carry out maintenance of your vehicles, etc. Whether you can do so or not depends on how you propose to march your division in the face of the enemy's air threat which, as you know, is serious. At the moment he has it very much his own way.
>
> "If you decide to rely mainly on night marching, you have two nights available and can start to-morrow evening. If you prefer to trust to rapidity of movement and dispersion and are prepared to move freely by day, you will presumably march to-morrow morning.
>
> "The point is that other units have to be moved up during the next 48 hours. During any 36 out of the next 48 hours you will be given precedence on the following two roads :—
>
> (*a*) Amesbury U.56–Andover U.86–Basingstoke Q.07–Odiham Q.17.
>
> (*b*) Old Sarum U.55–Lopcombe Corner U.65–Stockbridge U.75–Sutton Scotney U.95–Wheatsheaf Inn–Axford Q.06–Herriard Q.16–Odiham Q.17.

These will, as far as possible, be kept clear for you, though, of

course, there is bound to be a certain amount of traffic (both ways) which cannot be avoided. But we cannot give you a clear run for the whole 48 hours.

"Will you let me know during which period of 36 hours you propose to carry out your march? Of course, if you can do it in 24 so much the better. We are giving you one reserve M.T. Coy. capable of lifting three rifle battalions and the other marching personnel of a brigade group.

"On arrival you will have to hide your Division in harbour and the following area will be placed at your disposal (all exclusive): Blackwater 2979–Cove 2975–Aldershot–Upper Hale 2868–Ewshott 2569–Church Crookham 2571–Fleet 2473–Road Junc. 253783.

"You may now (7.15 p.m., 27th April, 1938) send forward reconnaissance parties to reconnoitre this area.

"The Chief considers that it will probably be impossible to conceal from the enemy's air reconnaissance the fact that a considerable forward movement of troops is taking place and that all you can hope to do is to deceive him as to the size and nature of your formation and to avoid casualties from enemy air action to the maximum extent.

"He is anxious that details of your move should not be given away by the use of wireless. You must maintain wireless silence in your present bivouac area and again at conclusion of your move. He wants to know whether you consider it essential to use wireless to some extent to control the move and, if so, how you propose to minimize the risk of betraying information to the enemy.

"By the way, you may take it that our front is now sufficiently stable for you to be able to neglect any threat by enemy land forces including Armd. Cs."

APPENDIX "A" TO OPENING NARRATIVE.

COMPOSITION OF 2ND (WESTLAND) DIVISION AND ATTACHED TROOPS.

2ND DIVISION :—

Div. H.Q.

Cavalry—

Div. Cav. Regt.

Artillery—

10 Fd. Bde.
13 Fd. Bde.
18 Fd. Bde.

Engineers—

21 Fd. Park Coy. (6 Fd. Park Coy. instead.)
5, 11, 38 Fd. Coys. (23 Fd. Coy. instead of 38 Fd. Coy.)

Signals—

2 Div. Sigs.

Infantry—
1 R.W.F. (M.G. Bn.).
2 Manch. (M.G. Bn.).

Medical—
4, 5, 6 Fd. Ambs.
2 Div. Fd. Hyg. Sec.
2 Div. Provost Coy.
2 Div. Postal Unit.

H.Q., 1st Gds. Bde.—
1 S.G.
1 W.G.
A Bn. to be detailed by 2 Inf. Bde.

H.Q., 5th Inf. Bde.—
2 King's Own.
2 Leicesters.
2 Dorsets.

H.Q., 6th Inf. Bde.—
A Bn. to be detailed by 2 Inf. Bde.
2 D.C.L.I.
2 D.L.I.

ATTACHED TROOPS :—
2 A. Fd. Bde. and Sig. Sec.
2 Med. Bde. and Sig. Sec.
One A.A. Bde., R.A. (imaginary).
4 R. Tanks (" I " Tanks) and Sig. Sec.
One reserve M.T. Coy., R.A.S.C.
One Corps Provost Coy.

Note.—L.A.D's will be represented up to the scale on which they would be available in war.

APPENDIX II.

Mon.,	25th April	... Vehicles arrive to bring the Division up to War Establishment in vehicles.
Wed.,	27th April	... Peace march down to Salisbury Plain.
Thurs.,	28th April	... Move to concentration Area begins.
Fri.,	29th April	... Move continues. Units whose move is complete remain in concealment.
Sat.,	30th April	... Dispersal from Concentration Area back to Barracks.

BALLOONING REMINISCENCES.

By COLONEL F. C. MOLESWORTH.

THE tactics of the old spherical balloon, in use in the British Army up to the advent of the aeroplane, are now only of historical, not to say antiquarian, interest; but such interest is enhanced by the fact that the balloon sections of the R.E., which handled those old balloons, are the lineal ancestors of the Royal Air Force.

The writer was sent to Aldershot on a balloon course in November, 1901, preparatory to proceeding to India. There were there at the time four balloon sections, Nos. 1, 4, 5 and 6. Nos. 1, 5 and 6, which were not, individually, up to establishment, were run as one unit under 2nd-Lieut. T. H. L. Spaight (now Lieut.-Colonel, R.C. of S.). No. 4, which, in its brief life of one and a half years, had already been on active service in the Boxer rebellion of 1900, the only unit to go from the United Kingdom for that purpose, retained its identity under Lieut. T. E. Martin-Leake; this officer was drowned at sea in the balloon *Thresher*, together with Lieut. Caulfeild, in 1907, the only ballooning fatalities in the days when ballooning was an R.E. function. Nos. 2 and 3 sections were, at the time, in South Africa, but they had been converted into field troops when guerrilla war set in.

The Balloon Factory, under Colonel J. F. B. Templer, a militia officer in the K.R.R.C., comprised a block of buildings in Stanhope Lines, north of the R.E. barracks and east of the R.E. recreation grounds. In this exiguous space, all the balloons for the army were manufactured and stored, many accessories such as nets were made, and hydrogen gas was prepared and compressed into tubes. Colonel Templer was assisted by a major in the Guards whose lectures on theory, not by the way a recondite subject, invariably ended after ten minutes with the words "and now let's go into the mess and have a glass of beer."

The balloon envelopes were made of layers of gold-beaters' skin (part of the intestines of cattle) stuck together with a dope, the composition of which was secret. The normal sized balloon, known as the T class, was of 10,000 cu. ft. capacity, or about 27 ft. in diameter; the names of balloons of this class all began with T. There was also a V class, 11,500 cu. ft., and an A class, 13,000 cu. ft., these classes being the result of experiences in South Africa, where the T class was found to give insufficient lift.

The valve of these balloons was a metal-to-metal arrangement, actuated when necessary by a cord which passed through the balloon and its tail. A strong spring kept the plates in place, but in order to prevent accidental leakage, the valve was sealed by a piece of fabric adhering to the underside of the seating. The tail, by means of which the balloon could be filled, was a sleeve about 6 in. in diameter. When empty and folded, the balloon could easily be carried in the car, which was a sort of glorified laundry-basket.

The net, of strong cord in meshes from 6 to 10 in., surrounded the envelope, and was attached at its lower end to a wooden ring from which the car was suspended.

The gas employed was hydrogen, normally made by the action of strong sulphuric acid on granulated zinc. This was compressed at a pressure, I believe, of 120 atmospheres, into steel tubes 10 ft. long, each weighing about 300 lb. and containing 500 cu. ft. of gas. The manufacture of hydrogen by electrolysis of water had been initiated and was resulting in the production of a purer gas, a point of material importance as it resulted in greater lifting power. The tubes were carried in the field on four- or six-horsed wagons. Each balloon section was subdivided into sapper and driver sub-sections, the latter drawing the balloon wagon, store wagon and tube wagons. The drill for inflation was somewhat as follows. A sheltered site was selected and a large ground sheet spread, on which the balloon was placed and carefully unfolded. The net, if not already in place, was put on, and the tail connected with the tubes by a multiplicity of india-rubber pipes, leading into a copper three-way piece just large enough to be inserted into the tail. Circular wheel-valves actuated by a special spanner released the gas, and before long a hissing sound like a nest-full of snakes announced that the filling was in progress. Filling generally proceeded smoothly, and any rents found in the fabric were speedily patched with glue heated up with ignited hydrogen, needless to say at some distance away. Sandbags were hooked on to the net to weigh the balloon down, and as soon as practicable the car was toggled on to the wooden ring, and filled with sandbags which were now removed from the net. The whole process took round about an hour, and the cost of a fill is said to have been about £25.

The weight of sandbags necessary just to prevent the balloon from floating was then taken—this was known as the "lift"; the direction of the wind was taken by letting loose a small pilot balloon, and its force read by an anemometer; temperature and barometric pressure were logged, and the balloon was ready for ascent.

A T-class balloon at or near sea-level took up when fresh two men and several filled sandbags. The lighter the aeronauts the better; the writer owed his selection for a balloon course to the fact

that he was the lightest of his batch. One of the ascenders generally climbed into the net, a rather more comfortable position than that of the other in the basket.

On the balloon wagon was a drum with 2,200 ft. of steel cable, the end of which was then attached to a rope ring in the centre of the ring between envelope and car. The balloon was allowed to ascend gradually, and as it took more and more of the weight of the cable, it was necessary to throw out ballast; as this was in the form of the finest earth procurable, its fall was innocuous, but I remember an incident when an officer, making his first ascent, threw out a whole bag from a considerable height, landing it within a few yards of a group of officers and men. It was seldom possible to reach a greater height, when captive, than about 2,000 ft., owing to the weight of the cable and the deflection caused by wind. As the balloon rose, the gas expanded and found its way out through the tail, and it was the job of the man in the net to see that there was sufficient passageway for it, as a taut balloon ran the risk of blowing out a panel; at the same time he had to prevent as much as possible the ingress of atmospheric air. Hauling down was done quickly by four sappers walking down-wind along the cable with a pole and block.

The function of the balloonists was, of course, observation, and the man in the car, armed with binoculars, looked out for any and every sign of military activity which he could see. Balloons had proved their use under Templer near Suakin in 1885, and also in the earlier stages of the South African War, but in England, owing to the enclosed nature of the country, it was difficult to see much at the range at which the balloon would have to work. In India, they were used successfully at more than one artillery practice camp, as also on various manœuvres, but there the chief difficulty was the presence of dust in the atmosphere, which seemed to hang like a pall over movements of large bodies of troops.

The balloon was in constant movement, and it was hard to keep field-glasses accurately on one spot for long, even in a dead calm. When there was any wind, the motion of the balloon exceeded anything ever experienced at sea; there was a swaying to and fro, more or less sudden rises and falls, an almost constant though slow rotation, and an occasional jerk at the cable, with ever and anon a whiff of hydrogen from the tail. It was thought to be of the effects of these that Tennyson, in *Locksley Hall*, wrote:

> " and there rained a ghastly dew
> From the nations' airy navies, grappling in the central blue."

A wind of 10 m.p.h. was usually regarded as the upper limit. It was estimated that in England, owing to atmospheric causes, two days out of five in winter, and three days out of five in summer only were suitable for balloon ascents.

Photography from balloons had been tried, but was not of much practical importance.

Ascents by night were sometimes made, but often the colder atmosphere rendered them rather difficult. On one occasion on manœuvres, although it was calm on the surface, a strong wind was discovered to be blowing 100 ft. up or so, above which the balloon would not rise, and it was eventually hauled ignominiously back to camp by a host of amateur assistants.

On camping, as sheltered a spot as possible was selected, and the balloon was sandbagged and picketed down. Lieut.-Colonel G. C. B. Loch, late R.E., who commanded the Experimental Balloon Section in India for many years, relates an incident when the wind in a sudden gust caught a balloon tethered in camp, and blew it over the heads of a mass of men, horses, camels and mules, depositing it 300 yards or so away. Marvellous to tell, the pandemonium among the animals resulted in scarcely any casualties and the balloon was hardly damaged at all.

On the march, the balloon could be towed along at the end of its cable by the balloon wagon, or it could be harnessed to a horse by a long manila rope, a rather uncomfortable way, however. The most usual procedure was to work with three squads of five or six men, holding ropes attached to the ring, with the car just high enough to clear trees, etc. This method was easy in open ground, but along roads lined with trees and houses, it was, especially in a wind, very difficult. The crossing of telegraph lines required a good deal of skill in throwing ropes. Diaries record that one balloon was successfully towed from Rai, two stages north of Delhi, through the western suburbs, to camp about 10 miles south of the old city. On another occasion a balloon was towed from Rawalpindi to Gujar Khan, 30 miles, in two days. The great danger was that of sudden gusts of wind driving the balloon on to trees, especially if thorny, and more than one balloon is recorded to have gone west that way. A folding screen was an article of store, but was rather too heavy for use in the field.

As regards communication between car and ground, the human voice, reinforced if necessary by a megaphone, carried up to 1,000 ft. or so, but this method was obviously unsuitable for long or confidential conversations. Flags were difficult to handle in the car, and helios impossible. Telephones were, of course, ideal, and one pattern of cable had an insulated return in the core, but 'phones had not reached their present perfection and interruptions were frequent. Written messages were enclosed in small, weighted bags and slid down the cable.

The transmission of intelligence from balloon wagon to the authorities concerned should have been an easy matter, but was one often overlooked by the staff. In the Section in India, some of the

sappers were eventually taught to signal by flag, helio and lamp, and the difficulty got over that way.

However carefully the tail was manipulated, some infiltration of air was inevitable, and so the lift, in spite of daily freshening with hydrogen, gradually decreased. The record life for a balloon in India was 27 days, on the last of which it was possible for one light specimen only to ascend in the net without the car.

The procedure for deflating and dismantling the balloon was very simple and need not be described. But, in England, it was customary to precede the deflation by a free run. The balloon was equipped with a 100-ft. rope and a grapnel, an aneroid, maps, railway warrants and a Bradshaw. As much ballast as possible was stowed away, and the two passengers seated themselves, one in the car and one in the net, and, with the exhilarating feeling that they had not the least idea where they would strike earth again, gave the word to let go.

One was now at the mercy of the wind, but, blow it hard or soft, there was not the least sensation of it in the balloon. The only sensible motions were rising and falling, if at all sudden and swift, and a very slow rotational movement. Below, the earth seemed spread out like a large-scale map, and, as the balloon travelled much slower than the slowest aeroplane, there was more leisure to observe.

The comparatively small size of army balloons imposed a ceiling of a few thousand feet. I believe the record was held by the late Colonel B. R. Ward of the Corps, who attained an altitude of 7,000 ft. in a T balloon; while another officer held the long distance record for a free run, from Aldershot to Loughborough in Lincolnshire, about 150 miles.

As already mentioned, one was at the mercy of the wind, and it was astonishing how capricious the wind could be. On one occasion, that of an ascent from the R.M.C., Sandhurst, the balloon started off S.W., and finished up going north towards the south side of the Hog's Back. We were becalmed at one time, but by throwing out pages of Bradshaw discovered the existence of a southerly current at a lower level, and let the balloon sink down to it.

Encounters with layers of cold air would bring the balloon rapidly downwards; even the passage of a cloud over the sun was apt to cause a considerable loss of height. What are now known as air pockets were occasionally met with, and my diary records a descent from 1,700 to 300 ft. in five minutes from such a cause. Such sudden falls made inroads on one's precious store of ballast, and as it was desirable to keep a reserve for emergency in descending, one's thoughts were perforce turned earthward once more. It was seldom possible to remain in the air in a T class balloon for more than three or four hours.

When it had been decided to descend, a careful view ahead had to be taken to see that no villages, railway lines or woods lay in the

probable path. Instruments were stowed away, and the rope allowed to trail from the car, the grapnel remaining at its head still attached to the car. The valve cord was then pulled bringing away first the seal, and then opening the valve, and the descent began. By regulating the pull on the valve cord, and by judicious discharge of ballast, it was possible to moderate the speed of descent, but the selection of a favourable spot to land on was by no means easy, and a sudden drop at the last was generally necessary. As soon as the end of the rope touched the ground, the grapnel was slid down, upon which the balloon, relieved of its weight, gave a final leap up, to be checked rather suddenly when the grapnel, which opened automatically on striking, reached earth. Usually it anchored the balloon at once, but memory retains a vivid recollection of an occasion when the ground was hard frozen, and the balloon hopped along dragging at its anchor for what seemed like minutes. Generally, however, landfall was painless ; the semi-deflated envelope descended on car and occupants, who crawled out to meet the crowd who had meanwhile assembled out of nowhere. The more intelligent of the spectators were then enrolled as assistants, the envelope was folded up and packed into the car, a farm cart was requisitioned, and the procession went off to the nearest railway station.

Free runs could, of course, have been of little use in warfare—those from Paris in 1870–71 were for political rather than military objects—but they made very pleasant variations of the daily round.

Already the future cast its shadows before. Santos Dumont had just made his first flight in a dirigible ; on 27th November, 1901, he visited us at Aldershot, and was taken for a free run by Spaight. The writer, and 2nd-Lieut. (now Brigadier) P. W. L. Broke-Smith, who joined in January, 1902, were employed on drawings and calculations for a similar machine, which efforts were filed, and had probably been eaten by mice, before the inception of *Nulli Secundus*.

On landing in India in June, 1902, the writer found himself posted to the newly-raised Experimental Balloon Section of the Bengal Sappers and Miners. It is hoped that some poet will one day sing the epic of those heroes who had to raise new units amid the atmosphere engendered by the twelve volumes of *Army Regulations, India*. Such a task fell to the lot of A. H. B. Hume, W. A. Stokes and G. C. B. Loch, who, the year before, had formed the section from seven B.O.R's of the 4th Balloon Section from China, and about 25 Indian sappers. Initial troubles were, however, over by the hot weather of 1902 ; Loch, who remained with the section from start almost to finish, was then in command.

Rawalpindi had been chosen as the station for the section, both because it was already a Bengal Sapper station, and because there was there a gasworks and gas installation. These gasworks are now the headquarters of the Northern Command, and when the transfer

was made, about 1925, some wag remarked, rather unkindly, that it would take Northern Command a long time to live down the old title.

In the whole ten years of its existence, however, the section possessed no lines of its own. At first it was housed in Misrial redoubt, one of the fortifications round 'Pindi, now abandoned. Generally it spent the cold weather under canvas, and the hot in some empty lines.

Although the gas manufactured at 'Pindi was coal gas, almost useless for ballooning purposes, the gasworks formed a useful place to carry on the manufacture and compression of hydrogen. Help was always forthcoming from the M.W.S. authorities, especially from Mr. C. H. Blackburn, the Superintendent, and Alla Din, the foreman of the works. The career of the latter deserves a mention. When he retired, in 1921, on a special pension, he had to his credit a service of 51 years, without a single day's absence owing to sickness or any other cause. On his jubilee he had been presented with a gold watch. It is related that his father had served the Khalsa army, also as a foreman of workshops.

Much ballooning equipment had to be modified for India; a smaller tube, 6 ft. long and holding 300 cu. ft. of gas, replaced the home service pattern, and lighter mule-carts replaced the horse-drawn wagons. Great difficulty was experienced with the maintenance of balloons, as gold-beater's skin turned very harsh in the heat. Experiments were made with dopes of sorts, and cotton and other fabrics were tried, but without much success. Nevertheless, useful results were at times obtained at manœuvres and artillery practice camps. No occasion presented itself for the employment of the section on service.

The Experimental Balloon Section was abolished in 1911, presumably because the Government of India doubted the usefulness of balloons, now that aeroplanes were becoming a practicable proposition.

THE TRAINING OF THE ANTI-AIRCRAFT SEARCHLIGHT SPOTTER.

By CAPTAIN L. E. C. M. PEROWNE, R.E.

INTRODUCTORY.

TECHNICAL progress in the past few years has been kind to the anti-aircraft searchlight detachment.* No longer are the sledge-hammer, jumping bar and dolly necessary and unhandy accessories to erection. The searchlight operator now strikes his arc by the closing of a switch, and the semi-automatic H.C.D. lamp reduces his labours in maintaining a proper light to a mere fraction of those required of his predecessor who struggled with feed screw and Yorke control. Your engine-driver, too, no longer fiddles caressingly with his throttle control, waiting to nurse his machine through the crisis of arc-striking, for the sudden efficient "clank" of the solenoid governor now relieves him of all anxiety in this connection. The listeners, or at any rate some of them, will shortly repose in comfort on the sprung saddle-seats of the Mark VIII locator and there listen luxuriously to the finer limits of accuracy rendered possible by the paraboloid collectors of this modern instrument. Your ring-sight number, even, is about to be released from the tyranny of the knuckle-joint by that masterpiece of ingenuity, the course-finding sight.

But this tide of technical advancement in anti-aircraft searchlights has passed the spotters by. It has, indeed, in rising, immersed them in some respects farther than before in that sea of difficulties in which they flounder to achieve their objects. For, while the range of the beams has increased, and consequently, the heights at which targets are engaged, the beam itself has grown smaller; so that your spotters are left, clinging manfully to their "Heath Robinson" chairs and clutching their binoculars, to cope as best they can with increased difficulties without any fundamentally improved equipment.

Yet these spotters are, perhaps, those members of the detachment who are required to contribute more than any others to the final act of illuminating the target, which is the principal objective of the whole.

* The searchlight detachment is composed of an N.C.O. and eight men, whose duties are as follows:—Nos. 1 and 3, spotters; No. 2, engine-driver; No. 4, projector controller; No. 5, searchlight operator; No. 6, ring-sight number; Nos. 7 and 8, listeners.

THE SPOTTER'S ROLE.

The inaccuracies inherent in the sound locator* and in the method of its use impose upon the process of picking up a target by sound alone an incertitude which furnishes the chief reason for the spotter's existence in the detachment. Consider a detachment engaging a "heard" target (T, Fig. 1). For the purpose of this investigation we may assume 1st-Class listeners and a fully-trained Sighting Number. Each of the listeners may have an average error of 3 degrees in either direction. At any instant during the engagement, therefore, the target lies at the centre of a "Square of Error" each side of which subtends an angle of 6 degrees. Ignoring ring-sight errors (which may be considerable) we assume the beam brought within this "Square of Error." Taking the beam (B) as of divergence $1\frac{3}{4}$ degrees, the chances are of the order of 15 to 1 against being on target by sound alone. But the spotter, searching in the vicinity of the apparent end of the beam with binoculars, has the whole of the "Square of Error" within the field of his view, and it is probable that the stray light from the beam extends sufficiently far to reduce the chances against him detecting the target to the order of 3 or 4 to 1. Thus with four or five beams searching simultaneously, the odds are on the target being picked up. It is important to understand that this is the reason for detailing one of the spotters to watch his own beam, and that when doing so he should make use of his binoculars.

Approaching targets, however, present to those at the searchlight station (A) (Fig. 2) an aspect so weak as frequently to render impossible of detection by them momentary illuminations by their own beam. But, at a distant or flanking station (B), the same target appears strong in aspect and presents a considerable under-surface from which light is reflected, with the result that the spotter there, charged with the duty of watching neighbouring beams, is enabled to direct his own beam on to the aircraft. Thus we learn the need for the second spotter in the detachment. It is important here to appreciate that, during the actual engagement, this spotter is watching other beams for the target being engaged and not, as is so often supposed, for fresh targets;† and that, as he will have to watch simultaneously up to five beams actively searching for the aircraft, the field to be covered is too wide for binoculars, so that he does so with the naked eye.

Occasions are not infrequent in action when a target, though itself

* Reference is to the sound locator Mk. IIIx.

† This misunderstanding is widespread and probably accounts to a great extent for the number of unobserved "flick-overs" annually reported by the pilots of co-operating aircraft. For while No. 1 (say) studies the vicinity of his own beam in the limited field of his binoculars and is there presented with targets weak in aspect, No. 3 is so often wrongly engaged in watching for fresh targets and is therefore not looking in the direction of the aircraft being engaged, so there is no one to detect the "flick-over."

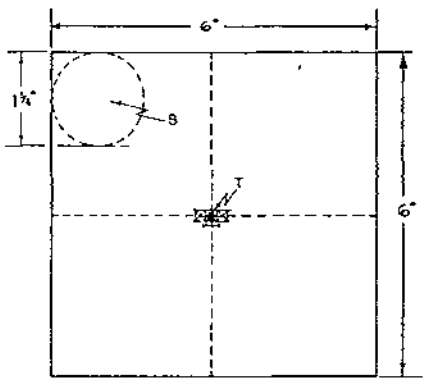


FIG. 1

SQUARE OF ERROR

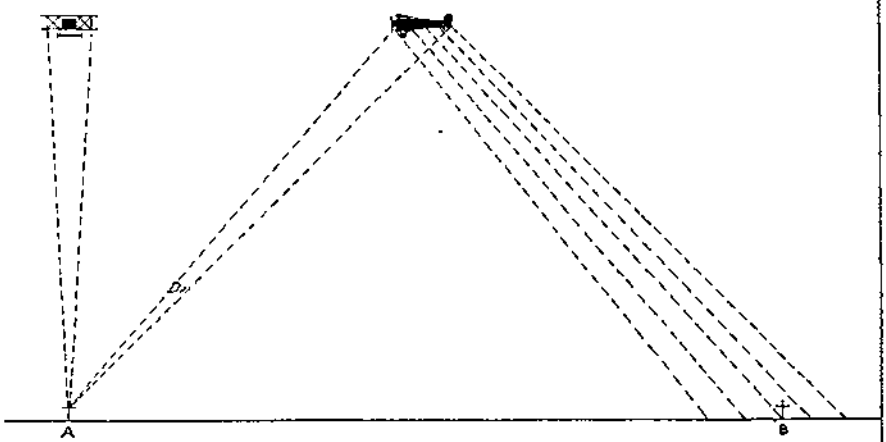


FIG. 2

TARGET ASPECT

R & B
28 4 38

in darkness, appears momentarily in silhouette before a distant searchlight, or in the path of the moon, thus offering to the spotter a further opportunity of illuminating it with his own beam. The experienced spotter will also find opportunities for unaided detection and location, especially when meteorological conditions are favourable and the target appears as a black silhouette against the lighter sky. In the case of gliding attacks, when the aircraft's engines are throttled back, the acute spotter, by the observation of exhaust flashes and other manifestations, furnishes the detachment with its sole chance of illuminating the raider. Finally, in conditions of poor visibility the projector controller may have to rely entirely for his directions in taking over and following an already illuminated target on the spotter, who, being situated farther from the glare of the searchlight, is better placed to see the target and to control the beam.

The duties of the spotters may be summarized approximately as follows :—

(i) *To locate* the target with or without his binoculars either (*a*) in his own beam, (*b*) in other beams, or (*c*) entirely unilluminated.

(ii) *To direct* the beam with the greatest possible speed on to the target as soon as he sees it and to continue giving directions so as to keep the beam on the target until the projector controller sees it.

(iii) *To warn* the detachment commander of the presence of new targets.

It is clearly of the highest importance that the spotters, who are required to work independently from their isolated posts, should be keenly aware of what is expected of each of them at every stage of the engagement.

A more detailed analysis of their duties is, therefore, necessary if the essential co-operation within the detachment is to be assured.

We have already considered their action during the normal engagement of a target by sound. Assume now that the target is actually seen by one of them. He is required to direct the beam on to the target as quickly as possible. This he will do by means of the conventional orders and using his binoculars or not as circumstances dictate. The action of the second spotter is now a matter for consideration. If he has been engaged in watching other beams for the target, there is obviously no object in continuing to do so now that the target has actually been seen by his opposite number. In the case, then, of either spotter seeing the target, he occupies, for the time being, the position of the ring-sight number during the engagement to sound and, following the principle of "backing-up," the second spotter should now take the place of the man watching his

own beam, using binoculars, and striving to detect the target in the stray light when the directing number shall have brought the beam close enough; and ready to take on from him at the first signs of hesitation or faulty direction.

When the beam is finally on the target, and the target is seen by the projector controller, this man accepts responsibility for it by shouting "On target," but the duties of the spotters are not then at an end. One of them (generally he who directed the beam, and in case of doubt No. 1) follows the target with his binoculars, "backing-up" the projector controller, and ready to assist him with directions should the latter show signs of losing the target. The second spotter is now spare and devotes his attention to the possibility of the approach of further targets, with a view to warning the detachment commander of their presence. In doing so he must study the behaviour of other beams in all directions, both with the objects of noting the direction of flight of other targets already illuminated and of observing suspicious concentrations of lights searching to sound. He must also contemplate the presence of targets not at the moment being engaged at all, either by reason of all the lights being already occupied, or on account of the noise of the target in hand masking higher attacks. On account of the wide areas to be observed, the binoculars are not used. This phase in the spotter's performance clearly demands not only a keen intelligence but some knowledge of the tactics of air-raiding.

The roles of each of the spotters in a detachment during the three stages of an engagement are shown diagrammatically in Fig. 3 and should be carefully studied by those responsible for detachment training.

The Selection of Spotters.

It will be seen that the proper working of the detachment in action is very largely dependent upon the efficiency of its spotters, and it will be evident that among the characteristics most required in men selected for these duties are keen intelligence, good hearing and eyesight, instant reaction and the power to command the movements of another at a distance by word of mouth alone. In practice, however, a variety of circumstances frequently combine to fill the spotters' ranks with men exhibiting few, if any, of the desired characteristics.

None with experience will deny the fact that the testing and selection of men as spotters is, both in Regular and Territorial Army units, the exception rather than the rule, with the result that those ultimately allocated to these posts in the detachment tend to find themselves there largely by process of elimination. In much of the preliminary training, nevertheless, it is convenient to group spotters, listeners, and the projector controllers, and it should then be remem-

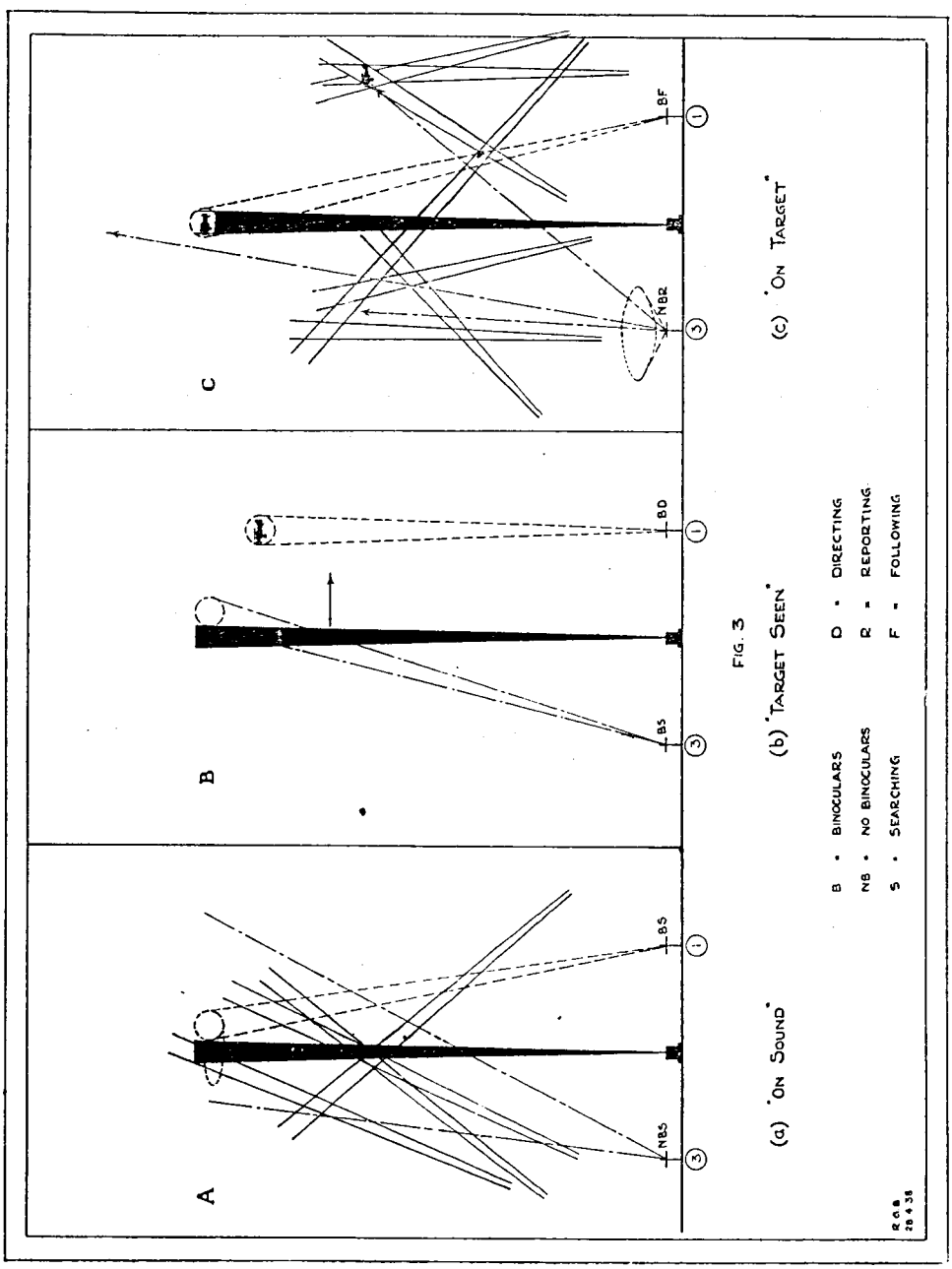

A
B
C
BS
NBS
BD
BF
NBR
(a) 'On Sound'
(b) 'Target Seen'
(c) 'On Target'
B = BINOCULARS
NB = NO BINOCULARS
S = SEARCHING
D = DIRECTING
R = REPORTING
F = FOLLOWING
R.C.S. 28.4.38

FIG. 3

bered that it is more difficult to produce a good spotter than a good listener, and that the projector controller probably requires the least intelligence and training of all. Greater care should therefore be taken to ensure that the final allocation is such that men with inferior qualifications are not employed as spotters when with training they could classify adequately as listeners, or become proficient projector controllers.

If anything, the spotter requires a more acute hearing than the listener because he will have to work with the unaided ear, and, whereas neither spotter nor listener can operate efficiently with unbalanced hearing (*i.e.*, with partial deafness of one ear), the work of the projector controller and sighting number is not affected to the same extent by such an affliction. Perfect eyesight, on the other hand, is of greater importance to the spotter and to the projector controller than to the listener (who could be totally blind, and probably operate more efficiently for it) or sighting number. The spotter, therefore, requires both the most acute hearing and the finest eyesight in the detachment, though certain defects in vision are permissible to him, in the identification of which the assistance of the medical officer must be sought. In the modern conditions of living and working in the cities many people seldom see anything so far distant as 70 yards, with the result that their eyes tend to take up a permanent accommodation for short ranges (*Myopia*—short sight). Among older men especially, a flattening of the eyeballs resulting in long sight (*Presbytism* or *Hypermetropia*) is common. Both short and long sight, however, are subject to perfect rectification by the use of suitable glasses, and binoculars can be used effectively by men suffering from these afflictions without the use of their spectacles, the necessary adjustment being made automatically in the process of focussing. *Astigmatism*, which arises from an unequal curvature of the vertical and horizontal sections of the cornea, may also be rectified, but only by the employment of a cylindrical lens, so that binoculars cannot be employed without the glasses and men with this affection of the eye, as well as those suffering from squint (*Strabismus*), work with the binoculars at the disadvantage of a field of view reduced by approximately one-quarter and should not, if it can be avoided, be employed as spotters.

Certain eye diseases debar a man absolutely from employment as a spotter. Of these, one of the worst eye scourges in this country is oscillating or " trembling " of the eyes (*Nystagmus*) which is very common among miners. Night-blindness, or the lack of the power of " dark adaptation," is also inherent in many people. Double, or even treble, vision (*Diplopy* or *Triplopy*) is present in a few in an insufficient degree to warrant refusal of admission to the Service, but a man suffering this disability is clearly inadmissible as a spotter. Colour-blindness (*Achromotopsy* or *Daltonism*), on the other

hand, renders us incapable of distinguishing tone, or at any rate certain tones, but not contrast, and would not seem therefore to be a very grave handicap to the spotter.

If, then, circumstances generally deny us the selection of spotters with those characteristics we most require, we must at least ensure that no man is allocated to that post with an impediment in his speech or suffering from afflictions of the ear or sight which preclude the possibility of him ever becoming proficient at his duty.

THE TRAINING OF THE SPOTTER.

The training of the spotter falls naturally into two stages, viz. :—

(*a*) Initial training of the recruit spotter.
(*b*) Exercising of the trained spotter.

The initial training of the recruit spotter is arranged with a view to teaching him the care and correct use of his equipment, the development of his natural faculties, and perfection in his drill actions, so that he may be ready instantly and efficiently to carry out his duties in the adverse circumstances prevailing when the A.A. searchlight detachment is called direct from sleep into action. It should, therefore, be carried through with the following aims :—

(i) To acquaint the man with his *role* in the detachment and make him sensible of the difficulties with which he will have to contend.
(ii) By constant practice so to perfect his *drill* that his performance when the detachment is in action is at once stereotyped and spontaneous.
(iii) To teach him the most advantageous use of his *chair* and to orient himself by night so as to be able instantly to face a given direction, or to state what point of the compass he is facing.
(iv) To train him in locating a source of sound with the unaided *ear*.
(v) To quicken the *eye and brain* to react instantly to the sight of a target under varying conditions of atmosphere and illumination.
(vi) To teach him the care and efficient use of his *binoculars*.
(vii) To train him confidently to control the movements of another at a distance, by voice alone, so as to be able to bring a beam on to a target in the shortest possible time. This will involve making him word and tone perfect in the regulation *directional orders* and developing the voice so that he can give them intelligibly over the 50 yards which separate him in action from the projector controller.

(viii) To develop in the spotter a high degree of mental alertness and a standard of physical fitness sufficient to ensure that he does not reach his post in action out of breath and unable to use his binoculars steadily.

This initial course includes a number of lessons which, once learnt, need never be repeated. It involves also the learning of a number of quite independent processes, physical and mental, which pursue each other in natural sequence as the spotter carries out his role during the engagement. Thus our first requirement is to face roughly in the right direction, then to locate the source of sound, predicting the position of the target to within the required limits. When this has been done we have the process of detecting the target itself in the momentary or partial illumination of a beam. If using binoculars, this involves the mechanical process of focussing, the physical action of scrutinizing the field of view, and the mental processes of perceiving that an object is under observation and of appreciating whether or not this object is the aircraft. Finally, we must direct the beam on to the target.

Training subsequent to the initial recruits' course will consist principally in the exercising of the trained spotter in these processes to ensure the maintenance of the required standards. For this purpose they may be conveniently grouped as follows :—

Group I	..	Orientation.
Group II	..	Location and Detection.
Group III	..	Focus and Scrutiny.
Group IV	..	Directing.
Group V	..	Mental and Physical.

These groups will now be examined in detail with a view to defining the requirements in training called for by each of them. The additional matter included in the syllabus for the initial training of the recruit spotter, where this is not common knowledge, is to be found in the appropriate sections of the manuals or has been referred to above.

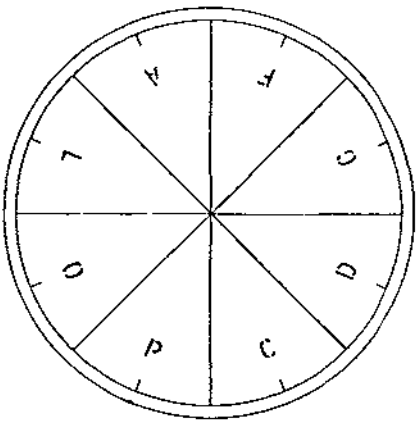
Orientation.

There are two independent operations under this heading, viz.: Reporting and Orienting. It is not necessary to emphasize the importance of a spotter detecting the presence of a target being able to report instantly and accurately its direction to the detachment commander. The spotters must also (in common with the remainder of the detachment) be able to orient themselves accurately and instantly in the direction detailed by the detachment commander in his order to engage. The accuracy demanded in both these operations is not great and is defined by the drill as to half-cardinal

(quadrantal) points. Orientation by night is easily lost, more especially after rotation once or twice in the spotter's chair in the course of an engagement, so reference marks are necessary on which the spotter can check his orientation. These consist of (*a*) one leg of the chair painted white; (*b*) conspicuous trees, houses, etc., or the projector itself; and (*c*) the Pole Star. Speed is an important element in all anti-aircraft work and is as important in orientation as in any other duty in action. The spotter, therefore, will be required to be able to recognize the Pole Star, to know his points of the compass, and to report a direction in which he may find himself facing, as well as to face a direction ordered in the minimum of time, using any of a variety of reference marks as a guide. Let the spotter be placed in a spotting chair, centred over a disc marked off with the points of the compass in such a manner that they can be seen by the instructor and not by the man. Let a reference mark be detailed, and its supposed direction. Indoors this mark may be the door, window, or fireplace of the class-room. Out of doors, trees, houses, or, if by night, the Pole Star. Let the chair now be given a slight push by the instructor so that the spotter is swung through an unknown angle of bearing. When the chair comes to rest the spotter is given (say) three seconds to report to the nearest half-cardinal point the direction he is facing. Then let the instructor order an imaginary engagement in any direction at random. The spotter now orients himself and his chair in the new direction and declares "on" within (say) five seconds of the order being given. The instructor checks the direction by reference to the disc beneath the chair. In this manner a class of eight or ten men can be exercised in the two processes of orientation in about five minutes. A different reference mark and bearing should be used for each man in the class, thus keeping the men's brains active, since none will know his orientation until he is actually seated in the chair. For this purpose it will be convenient not to have the points of the compass actually lettered on the floor-disc, or to have them lettered at random, the instructor being provided with a key previously related to the various reference marks. (See Fig. 4.)

LOCATION AND DETECTION.

The spotter works under the disadvantage common to all elements of air defence in that the only probable manifestation of an aircraft's presence by night lies in its sound. When explaining the sound-locator we habitually refer to man's directional sense of hearing as being liable to errors of the order of five degrees, and we are at pains to show that such errors are sufficient to negative any attempt to direct by unaided hearing a beam of only $1\frac{3}{4}$ degrees divergence on to a target. But these errors are well within the field of view of all

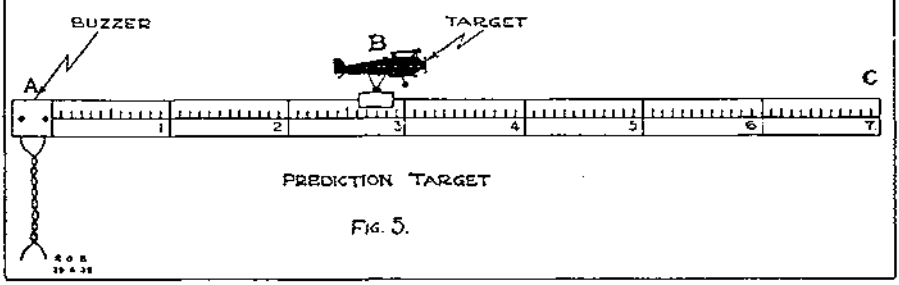


ORIENTATION
DISK, SHEWING ARRANGEMENT
OF LETTERS

N	NE	E	SE	S	SW	W	NW
A	F	G	D	C	P	O	L
F	G	D	C	P	O	L	A
G	D	C	P	O	L	A	F
D	C	P	O	L	A	F	G
C	P	O	L	A	F	G	D
P	O	L	A	F	G	D	C
O	L	A	F	G	D	C	P
L	A	F	G	D	C	P	O

INSTRUCTORS KEY

FIG. 4.



PREDICTION TARGET

FIG. 5.

the Service binoculars (the smallest of which is 7 degrees) and, of course, amply embraced by man's normal unrestricted field of vision, so that the first requirement of the spotter, whether carrying out an independent search with the binoculars, or watching with the naked eye for a "flick-over," is to direct his gaze as accurately as possible by sound. In all this work it is important to regard the spotter and his chair as a single unit where movements in azimuth are concerned, so that, with the man looking straight to his front, his line of sight, line of sound, and the longer axis of the chair are coincident. With the spotter's chair centred over a circle marked in degrees,* and used as an azimuth locator in conjunction with a buzzer, the man should be taught to appreciate the "crossing-point" and thence advanced by the normal sequence of the Listeners' Course, Part I Instructional Practices, until he can carry out his "Three Swings Rapid" (Practice D) in the standard ten seconds and to an accuracy of 5 degrees.

It is now necessary to consider a method of dealing with a moving source of sound. The problem lies in making allowance for the lag of sound and predicting the future position of an aircraft to within the limits imposed by the field of view of the binoculars. The spotter has no means of doing this other than his own experience and judgment. His training in this process, therefore, must consist of providing this experience, and of developing his judgment of the amount of lead required in various circumstances. The best method of achieving this end is probably to present the man with a visual impression which he can subsequently be taught to convert into an angular movement of the chair. For this purpose it is convenient to make use of the prediction apparatus shown in Fig. 5.

AC is a light lath of wood at one end of which is fixed a small buzzer A. B is a clothes-peg or spring paper-clip carrying a small model aircraft. The lath is marked off in inches. A simple calculation serves to show that at a range of 10 ft. the offset representative of a target crossing at 100 m.p.h. is approximately 16 in. Let the man be placed in his chair facing the buzzer at a range of 10 ft. Then let him observe the displacement of the target, swing the chair until he is facing the target, and note the angular movement of the chair necessary. This can then be repeated with targets on varying courses and with the lath at different ranges with the offset adjusted proportionately. In this way the man acquires experience of the relation between the angle of approach of the target and angular movement of his chair necessary to give his line of sight the correct offset. Now let the binoculars be blanked off by capping the object glasses, and allow the man to combine the two processes of location and prediction by making three swings to fix the direction of the

* It will be convenient to have this circle of degrees marked on the reverse of the disc used for the orientation practices.

buzzer and then laying off his chair by the correct amount according to the direction of flight of the target, which will have been communicated to him before the exercise commenced. It will be found that with constant practice the spotter becomes adept at this operation and the experience can then be extended by varying the supposed speed of the target as well as its course. The instructor checks the work by looking over the A.A. sights affixed to the binoculars.*

So far, however, we have dealt only in location and prediction in bearing. In the case of the spotter watching for the momentary illumination this is sufficient, since the vertical component is supplied by the beam itself, but in the independent search something further is required. Unfortunately, man's directional sense of hearing is not of great assistance in the vertical plane, so that we have now to resort to a purely mechanical process known as the "upward search." We must here define the fundamental "*Law of Searching*," whether with a beam or by eye, according to which *any object must remain under observation for at least one second to be perceived by the average observer.*† From this law it follows that no movement of the binoculars should be made at a rate exceeding one field of view per second. Assuming the spotter has accurately predicted the bearing of the target, it remains for him to detect its whereabouts in the vertical arc between the horizon and the zenith. For all practical purposes we may disregard targets at elevations below 30 degrees. The "upward search" must then be made through an arc of 60 degrees, from elevation 30 degrees to the zenith at a speed not exceeding 7 degrees per second. It is convenient to allow 10 seconds for this process, and the man should first be schooled to estimate the elevation at which to commence (30 degrees) and timed in the search from that elevation upwards until his line of sight reaches a mark on the ceiling vertically above the chair. When he is proficient in this the three processes of location, prediction and searching may be combined, the prediction apparatus being raised to give varying degrees of elevation. The spotter is now ready to carry out this same practice with a moving buzzer suspended from the buzzer masts, or with actual aircraft targets by day. By constant exercise in these processes with aircraft the man acquires the necessary experience to enable him to bring the target within the field of view of his binoculars by sound alone.

We will now contemplate the factors affecting the action of the second spotter engaged in the detection of momentary illuminations ("Flick-overs") in the beams of other searchlights. He is required

* The errors can be read off on the inch scale. One inch at ten feet represents approximately one-half a degree. Tolerance in this practice is one-half the field of view of the binoculars in use.

† The period of illumination necessary for detection at extreme range is given by Spearman as 1 second; by McDougall as 2 seconds. It is possibly less.

to watch some four or five beams operating over an arc of perhaps 30 degrees. (See Fig. 3 (a).) By the processes of location and prediction just described he is able to narrow the useful field of search to a horizontal arc of 10 degrees. He is now required to study those portions of (say) five beams as they pass and repass this arc in the process of their own searching. Any other beams which may happen to be exposed at the same time, but which do not enter this arc, can be disregarded, since they are obviously either searching for a different target, or are grossly wrong, while, in any case, five is probably the maximum number of beams which can be properly studied simultaneously by one man. Now in the normal course of events the spotter is not in the habit of watching more than one object at a time, so that this simultaneous study of five beams is a process demanding special training of the eye and brain. Let an arc of 30 degrees be set out on the floor of the room, or on the parade ground, or elsewhere convenient (Fig. 6). Let the spotter under training be placed at the apex of the angle and five objects distributed over the chord of the arc. It will be convenient for these five objects to be men, and, since it is uneconomical to employ five men to train one, let five pupils be spaced out in line with the apex and parallel with the line of assistants. The angle subtended by the chord at the eye of each man is approximately the same. Let each of the assistants be provided with six small pieces of paper. Among the total of 30 pieces of paper, one shall have a black dot on it, and the remainder be perfectly blank. The assistants turn over the pieces of paper slowly or quickly according to their individual taste, and the spotters watch the five assistants for the appearance of the piece of paper bearing the dot. When a spotter sees the dot he shouts "Target seen" and commences immediately to give orders to the assistant facing him so as to bring him covering off the man exposing the dot. Each spotter in turn on seeing the dot proceeds likewise and the practice terminates with all the assistants covering off the man with the dot. The papers are now transferred to the men who have been spotting and the exercise is repeated for the benefit of those who were the assistants. In this way we exercise each man in the process of watching simultaneously five moving beams, detecting the momentary appearance of a target in one of them, and in commencing instantly to direct a beam on to it. The object of continuing the practice until all the men shall have directed their opposite numbers on to the target is to prevent the weaker or idler spotters from trading on the efforts of the efficient performer by shouting "Target seen" immediately they hear the first man do so, without themselves having seen it; since they cannot start directing until they know where the target is. The introduction of the directing practice into this exercise also keeps the assistants alive, since they have to be ready instantly to respond to the orders of their own director the

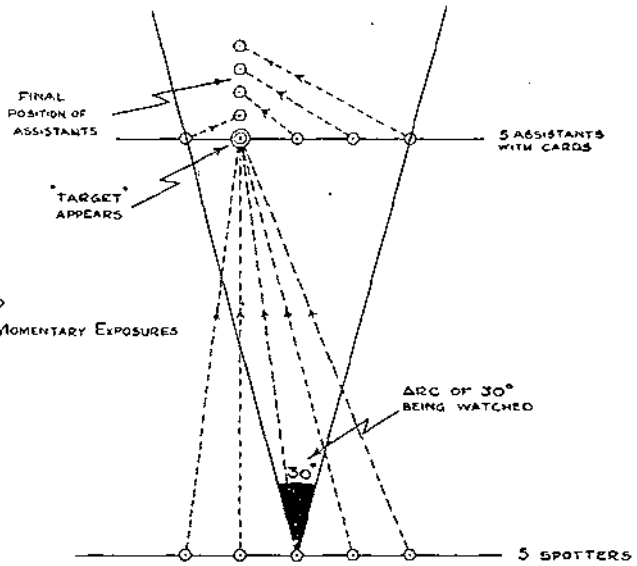


FIG. 6

DETECTION OF MOMENTARY EXPOSURES

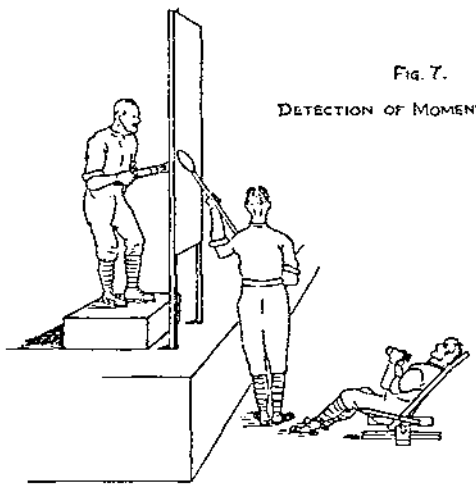


FIG. 7.

DETECTION OF MOMENTARY EXPOSURES.

moment he sees the dot. A spotter seeing the target appear immediately in front of him shouts, "Target seen. On target." The exercise can be made progressively more difficult by the use of playing cards in lieu of the blank papers, a given card being the target, or by the use of aircraft silhouettes, the target required being a given type of machine.

There remain, however, two other processes in this function of the spotter in which this exercise affords no training and for which a further exercise is necessary. In actual practice with searchlight beams by night, neither the beam nor the target remain stationary in the positions at which the "flick-over" was detected. The spotter has, therefore, not only to observe the "flick-over," but to *memorize* the point in the sky at which it occurred, and to take note of the direction of movement of the target. The following is a simple exercise affording practice in the three processes at once, and in directing. Let a screen of dark translucent material be set up facing a spotter's chair and of such dimensions and at such a distance that it covers a horizontal arc of 30 degrees from the spotter's eye, and extends from an elevation of 30 degrees at the foot to (say) 75 or 80 degrees elevation at the top (Fig. 7). This screen then represents, roughly, the segment of the heavens which the spotter is required to watch. An assistant stationed behind the screen flashes an electric torch at any point on the screen, making an exposure of one second. The spotter observes this flash and notes its position on the screen, shouting "Target seen" and proceeding at once to direct a man with a spotting disc so as to bring the disc on to the point at which he imagines the flash appeared. When he reaches the point required he will say "On," whereupon the assistant once more exposes the torch in the same spot and the spotter is enabled to check his power of memorizing the point of illumination. When this stage has been successfully reached by all the class, the exercise is repeated, but the torch is then moved throughout the practice. The spotter thus detects a moving flash, memorizes the point of illumination, notes the direction of flight of the target, and brings the beam on to a future position which he predicts from these observations. When "on," the torch is again exposed (still moving) and the errors are checked.

This concludes the group of practices in Location and Detection designed to afford exercise in the several processes of :—

Location by sound ;
Prediction for moving source ;
The upward search ;
Detection of momentary illuminations ;
Memorizing the point of illumination ;
Observation of direction of flight ;

—and to develop the link between eye, brain and voice, which is necessary to ensure that directing commences the instant the target is seen.

Focus and Scrutiny.

In the practices which have already been considered, we have assumed that our spotter will have seen the target if it is there to be seen, but this assumption is clearly inadmissible since the conditions under which the work is carried out in actual practice are so disadvantageous as to render the visual processes required of the man in some respects the most difficult of all. When the recruit appears before the medical officer on enlistment, he is subjected to a test of eyesight involving the reading of quadrangular black print on white paper. This combined operation of eye and brain we term *perception*. In such normal use the eye sees principally what the brain expects it to see (*i.e.*, the print upon the page of a book) and no great effort in perception is required. When unusual or unexpected sights meet the eye, the casual observer fails often to perceive at the first glance the essentially unusual characteristics in what he sees and, if interested, proceeds to look again and more closely. The subsequent mental process of analysing what is perceived and of converting it into (say) a lingual description we may call *appreciation*. This sequence of perception and appreciation becomes very highly developed in certain occupations, especially among those who habitually make use of the microscope or telescope,* but with the untrained man takes time which cannot be spared in the anti-aircraft engagement. The process of perception and appreciation is naturally aggravated by elements of *confusion* which, in the practical work of the spotter, are contributed by weak aspect of the target, very low contrast between the aircraft and its background,† glare, stars, insects in the beams, etc., and by the unaccustomed appearance of distant objects magnified several diameters. For these reasons it is important that the spotter be trained to avoid careless observation and to perceive and appreciate readily the presence of a target in the worst possible conditions of confusion. This training will depend for its success upon the extent to which the brain of the pupil can be enlisted on the side of the instructor.

For this purpose we must have recourse to special *tinted sight-cards* and to *confusion cards* in which the pupil learns to strive to detect objects not at first sight apparent. Figures 8 and 9 suggest

* An expert has stated that it would require two years to make a man really proficient with the binoculars, but that he could not guarantee to raise a pupil to the standard of proficiency attained by the Highland ghillie with the telescope in a life-time.

† In action the spotter is required to detect targets in conditions of very slight contrast, the aircraft forming a jet black silhouette before a background of sky having the appearance of the darkest blue velvet or, at best, a silver object upon a beam of electric blue.

arrangements for each of these types. The latter appears to the careless observer as a capital letter "T," and only the skilled eye and brain detects immediately the component elements. Infinite variations are possible in this practice, the important point being to keep the pupil's eye and brain alert and to foster the characteristic of inquisitiveness and the determination of the spotter at all costs to outwit the ingenuity of the instructor in designing the cards. Combinations of tinted and confusion cards are obviously an advanced stage of this part of the training and the period of exposure and scale of illumination should also be progressively reduced, or the element of *glare vision* added by placing the source of light unshielded between the observer and the target. By constant practice the spotter should become able to satisfy the normal tests of standard eyesight even in the worst conditions of confusion, contrast and illumination in the minimum of time.*

Although these exercises should at first be carried out with the naked eye, they obviously form an important part also of the training of the spotter with his binoculars. Before they can be undertaken with glasses, however, it is necessary for the man to be initiated into the method of using this instrument. In assuming that any man can naturally use the binoculars we make one of the commonest mistakes in this branch of training, and it is safe to aver that only one man in a hundred of the type from which our spotters are drawn has ever even seen such an instrument outside the windows of a pawnshop, or has the slightest idea of what constitutes clear focus. The practical details of the purely mechanical process of *focussing* are perhaps sufficiently well understood to call for no description here, but there are two fundamentals which must not be omitted. The first of these relates to the distance at which focus can be ascertained.

From any point 65 metres distant (70 yards) a pencil of light may be regarded as consisting of parallel rays and this point will be seen by the normal (emmetropic) eye without any effort of accommodation. This point, either at this distance, or in infinity, is called the "*punctum remotum*," or the most distant point seen without accommodation. It follows that *for long-range focussing of the binoculars (as required for anti-aircraft work) a minimum distance of 70 yards is required.* In the preliminary training of the Territorial Army especially, this range will seldom be obtainable and it will often be necessary for exercises with the binoculars to be carried out at shorter ranges. It should, however, never be less than 20 yards and it must be remembered that the focus settings ascertained in these circumstances will not be precisely the same as those required by the spotters in action. If this limitation be clearly understood

* Where apparatus for snapshooting targets is installed in miniature ranges this will be found particularly suitable for this type of exercise. Alternatively, a box may be constructed containing an electric light and some form of card holder, or the cards may simply be exposed by hand.

FOLLOWING DOCUMENTS

UNSUITABLE

FOR SCANNING

Micro Imaging Services Limited

Fig. 8.

Training of the AA searchlight spotter

the spotter may be trained in all the processes of telescopic vision in the drill-hall.

The second fundamental affects the design of the sight cards to be used both with and without the binoculars. The standard eye (according to Snellen) identifies quadrangular letters subtending a visual angle of 5 minutes. At a range of 10 ft. this implies lettering $\frac{3}{16}$ in. high; at 20 ft.—$\frac{3}{8}$ in. Through binoculars the same eye should recognize letters subtending a visual angle of $\frac{5}{M}$ minutes, where M is the magnification of the instrument.* Thus with an instrument offering a magnification of 4 diameters, the lettering on a target for use at 20 yards should be $\frac{9}{32}$ in. high; at 70 yards—1 in. high. These figures clearly govern the standard eye and focus tests, and *there is no satisfactory method of checking that a man has his glasses correctly focussed and adjusted other than by the use of sight cards with lettering of the correct size used at the correct range.* All the exercises mentioned will, therefore, consist in ascertaining the maximum range at which the spotter can read the standard print clearly, or, alternatively, the smallest print which he can conveniently read at a given range. Since when viewing a distant object through binoculars with the eyes in the required state of rest, the image will only appear distinct when each eye-piece has been separately and correctly focussed and the distance apart of the eye-pieces correctly adjusted to suit the inter-ocular distance of the user, the spotter will be required to practise with each eye independently as well as with both eyes.

The process of accommodation, being a muscular process, if prolonged produces fatigue and gives rise to eye-strain and headaches. It follows that, when using an optical instrument such as the binoculars, the eye should be relieved of all strain possible by allowing it to rest in the normal state for distant vision, and the necessary adjustments made in the lenses of the instrument itself. The observer about to use binoculars will, therefore, fix his eyes on the distant object and endeavour to bring the instrument into position before his eyes without altering their accommodation. The observer must never try and look *into* the glasses with the intention of seeing an image *inside* them, but will look *through* them, as if they were not there, at the distant object. This is comparatively simple so long as the distant object is visible. By night, when the binoculars are to be used for conducting a search of the dark sky, there will be no means other than the experience of the observer of ensuring that the eyes are maintained in the normal long-range condition. If they are not,

* The characteristics of the Service binoculars concerned are as follows:—

No. 4.	Magnification	X6.	Field,	11 degrees.
No. 5.	,,	X7.	,, 7	,,
No. 6.	,,	X4.	,, 12	,,

clearly the focus settings ascertained by day will no longer apply. This is one of the principal objects of constant daylight practice with the binoculars. Even if the proper use of the instrument be mastered, telescopic vision induces a marked fatigue in the observer and for this reason continuous observation should never exceed two minutes.

In daylight, visual acuity is sharpest at the Point of Fixation of the eye (*i.e.*, that at which the eye is directed), the image of which falls on the highly-sensitive macular region in the centre of the retina. Thus, if we fix the eye on the centre of a line of print, it is seen distinctly and in sharp focus, but the words towards each end of the line are vaguely defined. If we wish to see each word distinctly we "run the eye" along the line. When using the binoculars in normal daylight conditions, with the eyes in a state of light adaptation, the observer automatically keeps the object in the centre of the field of view, thereby preserving the visual impression at its sharpest. When conducting a search of the dark sky, however, the target is liable to lie at any point in the field of view and only on the rarest occasions at its centre. It follows that, when using the binoculars for these purposes, the eye must not be permitted to dwell on a particular Point of Fixation within the glasses, but must travel over the whole of the Field of View. This travel is known as *Scrutiny of the Field* and is an essential process of the spotter's work. An alternative to a scrutiny of the field would seem to be the swinging of the binoculars around the determined point, but this is not appropriate for the following reason, which also dictates the manner in which the scrutiny should be carried out. Whereas under ordinary illumination stimulation of the central part of the retina gives rise to by far the most acute visual impressions, the reverse is the case under dim illumination when the eye is in the condition known as dark adaptation. The macular region then becomes the least sensitive part of the retina and is, indeed, "night blind." This fact was discovered very early by astronomers, who observed that stars appeared unmistakably brighter if looked at slightly eccentrically.

When searching for a target with the binoculars the danger is that, although the spotter may have directed his instrument with sufficient accuracy for the target actually to lie within the field of view, it may leave the field of view before he perceives it to be there. The most dangerous point will then be the "leading point" on the periphery of the field of view, and, in order to counteract the effect of the night blindness of the macular region of the retina, the eye should in theory be directed first at the diametrically opposite point. It is not, however, practicable to make use of the "leading point" of a target under such conditions and it is, therefore, necessary to employ a standard *system of scrutiny* of the field which takes account of as many as possible of the factors without becoming too confusing to the

spotter himself. The majority of targets will be approaching rather than receding, and the danger-point will therefore in most cases lie in the upper semicircle of the field of view. The scrutiny accordingly always commences at 6 o'clock, thus ensuring that objects at and around 12 o'clock are viewed eccentrically and therefore under the most favourable conditions for perception. If the target is proceeding right-handed the next most dangerous area lies in the right-hand semicircle, and the eye must accordingly travel into the left-hand semicircle, or clockwise. If a left-handed target, counter-clockwise. The scrutiny continues around the periphery of the field of view until the target is perceived, or until the eye returns to 6 o'clock, when the binoculars must be shifted to a new point of fixation and the process repeated.

The training of the spotter in this process is progressive from the exercises in perception and appreciation and consists of practice with cards arranged approximately on the periphery of the field of view. At 20 yards a field of view of 7 degrees is represented approximately by a circle 7 ft. in diameter—12 degrees, 12 ft., etc. At greater ranges part of the field of view lies on the horizontal foreground, but this can easily be calculated and set out by means of pegs. The centre of the field of view or point of fixation must be defined, and it is here that we expose to view, in characters of suitable size for the range employed, the instructions as to the direction of flight of the supposed target, *i.e.*, right or left. The man aligns his binoculars first on the point of fixation (as in the process of location) and there ascertains the direction of flight, from which he deduces the direction of rotation of the scrutiny. This sequence follows the sequence of thought in the actual engagement. Around the periphery are arranged cards bearing letters which the spotter is required to read out in turn. Later they may be arranged to spell a word, or consist of words arranged to make an intelligible sentence, if read in the correct sequence (Fig. 10). In either case the sequence starts at 6 o'clock, so that the man forms a habit of glancing immediately to the bottom of his field of view.* The word or sentence need not occupy the whole periphery of the field of view, but may end at any point, the remaining cards being marked at random. The man checks at the break in the sequence as if on target. When he is proficient at these simple reading tests, the cards may be replaced by aircraft silhouettes, the point of fixation as before defining in words the direction of flight, and a notice at 6 o'clock indicating the particular aircraft nominated as target. The man then continues his scrutiny identifying each aircraft in turn until the one required is reached. Or the targets may consist of blank or coloured cards on

* Note that, as these exercises will be carried out in conditions of light adaptation, the man actually sees most clearly that arc of the periphery at which he directs his gaze, and learns only subconsciously the process of removing the night blind region from the area required to be seen most distinctly in circumstances of dark adaptation.

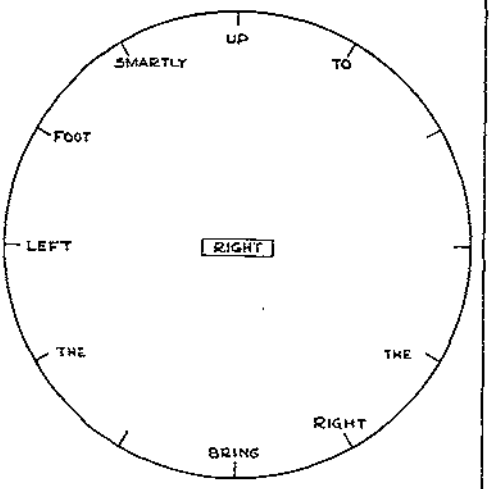


FIG. 10.
SCRUTINY TARGET

70'/8 3/4".

O A Q
N
V

FIG. 9.
CONFUSION CARD

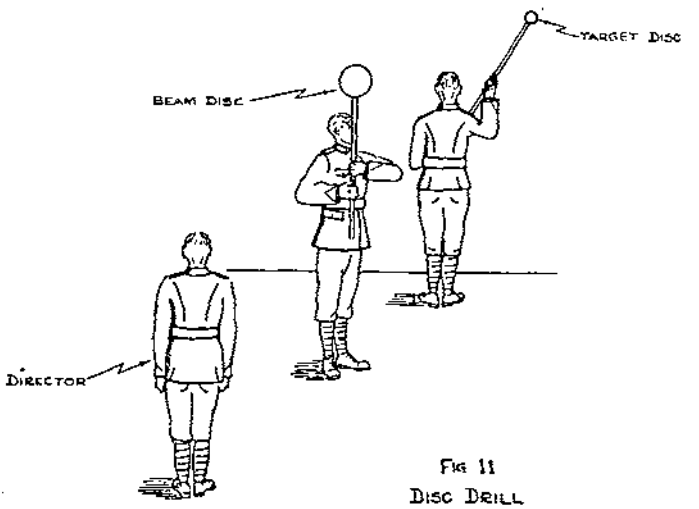


FIG 11
DISC DRILL

R.O.S.
30.4.36.

one only of which is a dot or word representing the target, the man being required to declare at what o'clock the target is, and being timed in the process. Each hour representing 30 degrees, it is then possible to check whether the scrutiny is being carried out at the speed demanded by the Law of Searching. In time, elements of confusion can also be introduced and the training will culminate in combination exercises involving, perhaps, several contiguous fields of view, in which the processes of :—

Focussing ;
Perception ;
Appreciation ; and
Scrutiny ;

—will have been performed under all conditions of confusion, contrast and illumination against time.

Directing.

We may now assume that the spotter has correctly oriented himself, accurately located the position of his target, and actually seen the aircraft either with the naked eye or with his binoculars. It remains for him immediately and efficiently to direct the beam on to it. This function of the spotter is fully dealt with in the appropriate passages of the manual and is generally well understood. There is little that can usefully be added here except to emphasize that the basis of all training in directing must be the practice (Fig. 11) in which the spotter under instruction endeavours to direct a man carrying a wooden disc to cover off a second disc held stationary or moved by a third man. In the normal way the spotter is probably not in the habit of ordering anyone to do anything, and almost invariably experiences the greatest difficulty and displays considerable lack of confidence in giving his orders. He will be seen at first to endeavour to support his orders with movements of the hands and arms, these members being most probably his normal medium of operation. In disc practice he is not only obliged to rely on his voice alone (because the man he is directing is not facing him and cannot therefore see his movements), but has to raise his voice to be heard above the other members of the class and in this way not only learns the correct tones and words of command, but gains confidence and develops the voice as well. We do not mind at this stage at what speeds the beam and target discs move, since our object is to teach the man to control the movements of another at a distance. The speeds can be corrected when we enter the dark room for following practice with a miniature beam and target, but the time element must be introduced early, and consequently the reduction to a minimum of the orders given to bring a beam on target. For this

purpose it will be found convenient to make use of the well-known exercise with the squared blackboard, and then to practise directing a disc on to the bull of a normal musketry target in a given time, points being deducted for wrong or unnecessary orders.

MENTAL AND PHYSICAL.

It will be conceded that the various processes required of the spotter in the execution of his role in the anti-aircraft searchlight detachment call for very highly-developed links between eye, brain and voice, and to some extent also between brain and muscle. To develop this necessarily high degree of alertness it is desirable that the spotters' class should be conducted on the principles adopted in the Daily Lesson in *Physical Training*. The class should invariably move at the " free " double and, whenever the instructor desires to address them as a whole, fall in in double time in the P.T. style. For any one period of instruction, exercises should be selected from each group of practices and in sufficient numbers to avoid any one of them becoming tedious. As far as possible, also, each individual man should be set a different problem in each practice. The order of practices should also be varied and short periods of manning drill, or foot drill without arms (in which multiple orders and other enlivening elements can be introduced), interpolated. In these ways the spotters are kept continuously " on their toes " mentally and physically and form the required habits of mental alertness, quickness and activity.

CONCLUSION.

Unlike the training of engine-drivers and searchlight-operators, we are faced in the training of spotters and listeners with making men proficient in a subject which has no counterpart in civil life. We have here the problem of developing the senses, but, whereas the sound locator provides in itself a ready means of demonstration, checking progress and registering the results of the listeners' work, the functions of the spotter furnish us at present with no such opportunities. Telescopic vision, moreover, is an art practised by few among those from which our potential spotters are drawn. Authorities contend that it is among the most difficult arts to acquire, demanding long periods of constant practice to achieve perfection. By its very nature there is no opportunity for demonstration, and the degree of perfection attained must remain for ever known only to the pupil. The training of the spotter is therefore the more difficult by reason of its intangibility, and it is this very intangibility which creates the impression that the spotter's role has little or

nothing to it. This impression, in turn, is the principal cause of the marked unpopularity of this particular duty in the detachment.*

One of the principal objects of the system of training outlined above is, therefore, to furnish a scientific framework upon which to build, and to provide a basis for a series of tests to which both instructor and pupil can relate their progress. The difficulties which have been enumerated, combined with the necessity for accepting often the poorer material in the ranks of the spotters, demand the closest attention to their training, and call for the greatest care in the selection and qualifications of their instructors.

* Intending recruits to units of the Territorial Army have been known to offer their services only on the understanding that they are not to be employed as spotters! In this connection it is important that the expression "Games" and "Gadgets," so loosely used in relation to the methods of training the spotter, be omitted entirely if the true importance of their work is to be impressed upon the class, and the more appropriate terms "Practice" (or "Exercise") and "Apparatus" (or "Appliance") substituted.

THE ENGINEERS OF THE GERMAN ARMY.

By CAPTAIN D. E. HOLBROOK, R.E.

INTRODUCTORY.

A LITTLE while ago I was attached for six weeks during the summer to the 9th Pioneer Battalion of the German Army, stationed at Münden in Hanover. I came back to England full of admiration for the German Army and with a much clearer understanding of the German outlook. I found amongst officers a strong desire for peace and for friendship with Great Britain. The morale of all ranks is good and they seem confident of their ability to give a good account of themselves on active service. In my opinion their confidence is justified.

THE PIONEER CORPS.

The engineers of the German Army are known as the Pioneer Corps. The Corps consists of four main branches :—

(*a*) Divisional Pioneers (partially mechanized).
(*b*) Corps Pioneers (fully mechanized).
(*c*) Pioneers of the Armoured Divisions (fully mechanized).
(*d*) Pioneers of the Mountain Brigade.

Broadly speaking, the duties of the Pioneers are the same as those of our Field and Army Troops Companies. The Corps has no responsibility for heavy bridging (except pontoon heavy bridging), A.A. defence, railway work, survey or works services. In war, heavy bridging would probably be undertaken by civilians engaged in that type of work in peace time. A.A. defence is entirely the duty of the Air Force. No railway units exist at all, but since the German railways are State owned and all the personnel are reservists, arrangements for operating military railways have doubtless been made. Special staffs of civilians are responsible for survey and works services.

Divisional Pioneers.

In every Infantry Division there is one Pioneer Battalion which is at the disposal of the Divisional Commander. The Battalion is commanded by a Lieut.-Colonel, who is in exactly the same position as a C.R.E. He has under him a signal section, three companies, a

bridging column and stores units, some fully and some partially mechanized. The signal section is used for communication within the Battalion; the three companies correspond to our Field Companies and the remaining units to our Field Park Company.

Each Company is organized into three Sub-Sections and each Sub-Section into a rifle and an L.M.G. group. Thus there is an L.M.G. in every Sub-Section, or a total of nine L.M.Gs. in a Company. These guns are intended for ground firing as well as for A.A. defence.

The battalion to which I was attached held and used in peace time practically the whole of its war equipment, which in general is designed on the same lines as ours. A most noticeable point is that a considerable quantity of pontoon equipment is carried in the battalion, which is quite contrary to our policy. There is no equivalent of our small box-girder, and in the place of folding boats the battalion has inflatable rubber boats.

The Other Branches of the Pioneer Corps.

The establishment of every Corps possibly includes a Corps Pioneer Battalion, an entirely mechanized unit, organized on the same lines as the Divisional Pioneer Battalion.

Each Armoured Division also probably has its own Pioneer Battalion, a completely mechanized and highly mobile unit. In addition, a number of the other units of the Armoured Division have their own special Pioneer Section. In the training of all Pioneers in the Armoured Division, particular attention is paid to the rapid crossing of dry and wet gaps and to the erection and removal of obstacles.

The Pioneers of the Mountain Brigade are intended for warfare in the Alps, and their training is carried out in southern Bavaria. The men are skilled mountaineers and good skiers. Their life is strenuous, particularly when the mountains are under snow, but they enjoy it and an excellent spirit exists amongst them.

The Training of Divisional Pioneers.

The whole training of a Pioneer Company is intended to produce a unit which has rehearsed in peace any situation it may meet in war, so the training is essentially practical. The training year starts on 1st November and the first six months are spent in breaking in the new recruits. After that follow Section, Company and Battalion exercises, until the unit goes on manœuvres; it is, of course, not possible for every unit to go on manœuvres each year.

The Pioneers do considerably more infantry training than the Royal Engineers and are familiar with the methods. They are keen on small schemes, which are valuable in giving junior leaders the chance to lead their units, and in training the Company to work as a

team. Visual signals are considered important. I saw a scheme in which an enemy armoured-car suddenly appeared and fired on the two leading scouts of the advanced guard; by means of visual signals the whole Company, which was spread out over ¾-mile, was off the road in 30 seconds. This emphasis on infantry training, and the large number of L.M.Gs. in a Company, may indicate that Pioneers will be used as infantry quite early in a battle.

The men carry blank ammunition on every scheme, which adds considerably to the realism of the training. The blank has a thin wooden pellet to enable it to be fired from an L.M.G.; when fired from the rifle the pellet flies about 20 yards, so can be dangerous, and my Company Commander had in fact been hit in the neck by one and nearly killed.

The steel helmet is invariably worn on schemes; it is an olive-green colour and is easily seen, even when a man is lying down, so the troops always cover it with leaves and branches.

Companies occasionally go for a practice route march in marching order. Quite a normal distance is 20 miles. One company came back from a 12-mile march, went straight on to the parade ground and did half an hour's drill in marching order, because the singing on the march was bad. On schemes the men often march in single file on both sides of the road; this helps to conceal them from the air and gives each man as much fresh air as possible. Little effort is made to keep in step when marching in this formation. When marching as a body the troops march in three's.

Each year a company is supposed to do four or five days of field firing. The whole company goes away for this period to a suitable area chosen by the Company Commander.

Assault bridging schemes with rubber boats are carried out now and then. A company has smoke candles to mask its assault crossings; they produce a good smoke cloud, which goes straight up in the air unless there is a little wind. Pontoon bridging is carried out by day and night, and the men are trained in handling and loading the vehicles; this needs considerable practice. Improvised timber bridges are considered important; every company has available a liberal supply of timber, and can practise these bridges quite often. There are no restrictions about cutting the timber, so the men are familiar with the methods and good bridges are built without any trouble.

The men are well trained in demolitions and obstacles, and considerable importance is at present being attached to these subjects. When practice charges are laid, a number of smoke charges are always included in the circuit and are eventually fired. This is a good system, since the men have a genuine circuit to test, and they feel they really are working up to something. Companies carry out private demolition jobs for firms whenever possible; the firms pay

for the job and the whole of the money goes into the Company funds.

Road block exercises are carried out frequently; the blocks may consist of anti-tank mines, concertina wire, trees, improvised mines or farm carts. The laying of minefields is also practised. In war the Divisional Commander may order the laying of a minefield; the Battalion Commander may not do so of his own initiative, but, if told to create obstacles in a certain area, he can put down a minefield if he thinks it necessary.

From time to time Pioneer units are visited by the Inspector of Pioneers, who is a Major-General; during my attachment he visited the Battalion for the third time that year. He was a most competent inspector and officers told me he could not be satisfied with a rehearsed demonstration. Nevertheless, at the very moment they told me this, they were rehearsing a demonstration to show him on the next day.

Points about Field Engineering Methods.

The German pontoon equipment is heavy but good. The pontoons themselves are made of sheet metal and they are not decked; this makes them difficult to row and is unsatisfactory in other ways. However, they are gunwale-loading, a system which has the great advantage that bridges can be built on the same principle as our folding boat bridges. The normal method of bridging is by rafting; the motor-boat tows a string of rafts upstream, they drop off one by one and manœuvre into their position in bridge. In bridge the rafts are fastened together with rigid connectors, so the roadway is practically rigid throughout; this distributes the load, and a bridge to carry heavy loads can be built with fewer pontoons than we use.

The motor-boats are very powerful and are extensively used: the 9th Battalion had six of them. The boat is made of thin metal sheeting and draws about 1 ft. of water; it has a 40-h.p. engine which drives a 3-ft. screw. A special 1-*in.* S.W.R. rein is provided for towing rafts and I saw one boat tow five medium rafts and their crews at 3 knots against a 3½-knot current.

At each end of a pontoon bridge there is an excellent sliding bay which makes it possible to build a bridge from both ends at once; the final gap in the middle is closed by sliding out the two halves of the bridge.

No life-jackets are worn during pontooning, so one motor-boat is permanently on duty below the bridging site to rescue anyone who may fall in. In spite of this, men are drowned from time to time.

As regards obstacles, great importance is laid on tree blocks, which can be made at the rate of about 5 yards a minute with motor-saws. Small charges are laid amongst these blocks, which explode when the trees are moved, so killing or demoralizing the party which is trying

to clear them away. Trip wires are hidden on either side of the blocks, and they also let off small charges. The method taught for dismantling such blocks is to make fast a cable to each tree in turn and the party then pulls from 50 yards away.

Concertina wire blocks consist of six coils; the coils are about five yards apart and each one is pulled straight across the road. It has been found on manœuvres that reconnoitring A.Cs. work in pairs, a large one and a small one together. They remove a concertina wire block by throwing out a grapnel and pulling the wire away; or they throw out smoke candles and under cover of these a man jumps out of the small A.C. and removes the wire, while the large car drives slowly backwards and forwards, shooting with its machine-gun at every sign of movement. To counter the first method, the concertinas are now lightly fastened down and when pulled away tend to spring into the wheels of the A.C. To defeat the second method, the Pioneers cover a concertina wire block with the fire of a whole Sub-Section, the L.M.G. being so placed that it can fire accurately on the block even when it is hidden by smoke.

Anti-tank mines and improvised mines are largely used, and are always very carefully hidden. Mines are to be expected in the road between concertina wire coils, and also anywhere where it looks possible to drive round a road block. The improvised mine usually consists of a charge and a wire; when a vehicle or a body of troops touches the wire an electric circuit may be completed or a pin removed, the mine then going off under foot, dropping from overhead, swinging out from behind a tree-trunk or doing something else equally unpleasant. I even heard rumours of a mine which jumps out of the ground and hurls itself against the bottom of a vehicle!

The principles of demolitions proper are much the same as our own, except that no cratering methods are taught. The lead-cased instantaneous fuze has been abandoned and the present fuze has a glossy covering similar to our safety fuze. Electric leads are now issued with both leads contained in one covering; the great advantage of this is that the possibility of a tangle on the drum of leads is reduced. The only apparatus carried for testing leads is an ohm-meter and a dry cell, both contained in one small case; leads can thus be tested very quickly and simply. There is no equivalent of our pricker test; a Company carries plenty of leads, and if one length is found to be faulty it is thrown away and a new one used.

Now, what of the individuals who teach and apply these methods?

The Pioneer and his Training.

The Treaty of Versailles fixed the size of Germany's Army at 100,000 men and so for many years military service in Germany was voluntary. In 1935, Hitler announced that he intended to have a stronger army; compulsory military service was introduced and

now every male on attaining approximately 20 years of age has to serve for two years with the colours.

Before joining the army a boy is usually a member of the Hitler Youth for five or six years; during this time he is physically developed and the correct patriotic spirit and political ideas are instilled into him. He then serves for six months in the Labour Service, where he learns the elements of drill and discipline, and finally he joins the colours. The German recruit is thus fairly well broken in before he comes into the hands of his military instructors; he is not, however, up to the standard of our ex-boy.

During the summer of each year, men who are due to come up for compulsory service in November of the following year are examined at certain centres by a medical officer and are then told to what branch of the army they will be posted. Tradesmen and men who are strongly built or well educated are picked out for the Pioneer Corps. The trades which are particularly desired are carpenter, fitter and waterman.

The Pioneer's training is intensive and strenuous. The daily working hours are 6 a.m. to 6 p.m.; sometimes he has to work part of Saturday afternoon and he does a night exercise about every three weeks. There is no time for games or for education. His training can be divided up under four main headings :—

(*a*) General military training.
(*b*) Physical development.
(*c*) Infantry training.
(*d*) Field engineering.

All these subjects are taught concurrently throughout the year. The object of this is to train a man to turn quickly from one to the other, to teach him not to regard his subjects as separate from one another, and to maintain his interest through variety in his training.

General military training includes lectures on the correct behaviour of a soldier, comradeship, military law, other branches of the army, German heroes, national and political questions.

Physical development is achieved chiefly by means of P.T. in the winter. In the summer men are instructed out of doors in swimming, athletics (including throwing dummy hand-grenades), handball and obstacle course. The obstacle course is a very severe test indeed, and is usually run in uniform.

Drill is performed chiefly in small squads for long periods up to two hours. Rifle exercises have been cut down to the " Slope " and " Present."

Men start their musketry by firing on the 50 yards miniature range. On the open range they fire standing, kneeling and lying; the normal practice is standing at 100 yards. The only time during

the year that the Pioneer fires at long ranges is during the annual field firing.

Small realistic infantry exercises are carried out frequently as already mentioned. The men have an excellent understanding of minor tactics ; they put their whole heart into these exercises and I was struck by the intelligent way they discussed the situation amongst themselves.

The field engineering training is run on much the same lines as our own ; training is greatly facilitated by the fact that each unit holds nearly all its own war equipment for use in peace-time. A high standard of watermanship is demanded ; every Pioneer is expected to punt a pontoon single-handed across a fast-flowing river 100 ft. wide, and can do it, too.

In exchange for all this hard work the Pioneer is paid 6d. a day. His uniform and kit are entirely free and are replaced without charge when damaged by fair wear and tear. At the end of his service he has to hand back every article of kit issued to him. The colour of the uniform is field grey ; the jacket is high-necked, the trousers are ordinary slacks and are tucked into loose pull-on boots, which come rather more than halfway up the calf. Equipment and belt are of leather ; the pack is made of the hide of a foal and has the hair still on it. The respirator is carried in a tin. There are no brass fittings on the uniform at all ; in fact, every effort has been made to reduce the daily cleaning to a minimum.

Taken all round, the Pioneer is hard-working, intelligent and quietly efficient. He shows no great enthusiasm over his military career, which is hardly surprising, seeing that his life is practically all work and no play.

The N.C.O.

Service in the army beyond two years is voluntary. The N.C.Os. are promoted from amongst the volunteers, after passing a practical and written examination. Hard work and a high standard of knowledge and intelligence are expected and obtained. If any N.C.O. makes a mistake, he is at once "ticked off" by his officer in front of all the men.

N.C.Os. are encouraged to use their own initiative and to develop their powers of leadership. They handle their small bodies of men with confidence in the frequent exercises they carry out, and the senior N.C.Os. are mostly capable of leading a section.

Corps of Officers.

The sudden expansion of the army from 100,000 men to a strength of 36 Divisions and 3 Armoured Divisions caused a shortage of officers ; this was further aggravated by the formation of an Air Force, to which 1,400 army officers were transferred. To overcome

the shortage a number of police officers were drafted into the army, and retired officers who had served in the Great War were encouraged to return to the colours; they were all given ranks suitable to their ages, and were placed on an equal footing with the officers already serving, although their military knowledge was somewhat smaller. It is likely to be some time before these three types of officers shake down together.

A candidate for a commission in the Pioneer Corps first serves for one year in the ranks of his unit as a Cadet. During this time he lives with the men in the barrack rooms, wears the Pioneer's uniform and does the same work as the conscript recruit, except that during the last few months he is given special training. After the first two months he eats his midday and evening meal in the officers' mess.

At the end of this year's service in the ranks the Cadet is promoted to Ensign and transferred to a military academy for a further year of training. During this time he receives a broad military education, similar to the education at "The Shop."

On leaving the Academy he is promoted to First-Class Ensign and goes to a Pioneer School for a five months' course in engineering. Here he is taught chiefly field engineering and also touches very lightly on the other subjects which the R.E. young officer learns, with the exception of searchlight work. This finishes the period of training, and he returns to his unit as a First-Class Ensign; he holds this rank until the next promotion day, when he becomes a Second-Lieutenant. An officer in the Pioneer Corps has thus $2\frac{1}{2}$ years' service before he finally gets his commission.

All Pioneer officers can drive a car, but only a few have a car of their own. They drive very fast and hope that Providence is on their side. In quiet country villages we sometimes left battered or tail-less chickens in the road, but never stopped; I asked about this, and was told that, since a chicken could move fast enough to get out of the way, they could be run over free of charge, but there would be trouble if we ran over a goose. To give officers practice in driving they are permitted to use their official cars for their own amusement within reason.

In large garrisons some units have officers' messes as we know them, but in the 9th Pioneer Battalion the system was different. The junior subaltern of each Company had his quarters in the company barrack block, the mess secretary lived in the mess and all other officers had to find their own lodgings in the town. There were no married quarters.

All officers had breakfast in their own rooms—sometimes rather a rushed meal for the subalterns, who always went on the 6 a.m. first parade; we assembled in the mess for lunch, which was a parade meal. There was no tea in the afternoon—work only finished at 6 p.m.—and there was supper in the mess twice a week, at which

mufti could be worn; on other days there was no evening meal in the mess.

The mess was small and comfortable, furnished rather like a private house. The mess secretary was a subaltern, but he had a Lance-Corporal as a clerk, who kept the key of the safe, made out the mess bills and signed the receipts.

The officers' uniform is field grey. It consists of a high-necked tunic, breeches and black polo boots. Evening uniform is the same colour, but the material is finer and trousers are worn. Uniform is worn a great deal more than with us; there are no occasions when an officer may wear mufti on duty and when going out while off duty, one of the first questions that always arose was whether we would go in uniform or mufti.

The local populace were very interested in the British uniform, and on one occasion, when I unwisely walked to the mess in blue patrol, most of the small boys of the town came too. The officers also were interested in our uniform; my field boots which I wore most days, as I was getting a good deal of riding, made no impression on them, but when I turned out one day in boots and leggings I was surrounded in the mess and all the officers were full of admiration for this novel and practical form of leg wear.

My general impression of the officers was that they were very capable. The keenness and efficiency which they displayed was all the more noteworthy in view of the strain imposed on them by the long hours of work and their few opportunities for recreation. They were extremely hospitable and spared themselves no trouble to show me everything of interest and entertain me. At the end of my attachment it was with very real regret that I left the Battalion, whose officers had been such good friends to me and had shown me such unceasing kindness.

THE VALUE OF WORKS SERVICE AS ENGINEER TRAINING.

By COLONEL E. H. CLARKE, M.C.

THE award of a prize to an essay in the June number of *The R.E. Journal* may give to views expressed in that essay a weight which it is strongly felt they should not possess.

" Works service cannot be classed as training for war. . . . Work of this nature is the antithesis of military engineering."

The author does not " condemn all works service out of hand," but a large number of our unfortunate 130 captains and subalterns employed on works are, in his opinion, holding " sterile appointments."

2. A large factor in determining the value of the help we can give to the army is the opinion the other arms have of us.

Has anyone ever heard of a barrack or a quarter being handed over to the works service or even to the Garrison Engineer? Is it not always " to the R.E. " ?

Every soldier in the army is directly dependent on us for the comfort, the appearance and the efficiency of what is, during his colour service, his " home " and he judges us very naturally by the conditions we produce.

The M.F.W's are the best N.C.O's we can turn out, and unless we fill the officer ranks of the works service with the best type of officer we shall get an unbalanced organization and shall lose that good opinion upon which the value of the work we do for the army largely depends.

3. As regards the value of works service as training for war, the author of the essay does not make sweeping generalizations but states categorically the points in which it fails.

Economy, so unfortunately necessary in the works service, has, according to *F.S.R. II*, Section 11, its part in war.

Speed may not often be of vital importance when erecting a building to last 100 years, but an officer's confidential report, vital enough to himself, will generally depend on his power to get things done.

Improvisation, in the sense of substituting a material for a more desirable one, often arises.

Opportunities for independent thought and for initiative do really frequently occur. Though buildings may be to standard designs, their

appearance in every case depends to a great extent on the local choice of bricks and tiles. These and the externals, such as paths, grass, bushes, etc., are always left to the officer on the spot.

Moreover, even though designs originate in the War Office they are not like the laws of the Medes and Persians. They should always be carefully studied in the light of local requirements and deviations are often advisable.

Sometimes, if he is lucky, the works officer may meet on the coasts of England problems of coast erosion.

And there are many engineering problems to which no one has yet found the best answer.

But every officer in works service will have scope for independent thought in providing for the comfort and well-being of the troops in his area.

4. Section 6 of *Field Service Regulations*, Volume II, suggests several tasks which the engineer may have to perform in war. For many of those in the forward area, *e.g.*, construction of heavily protected emplacements, water-supply and roads, and for all of those in rear areas, works experience will be most useful.

5. The necessity is stressed of getting contact with civilian engineering work. It is doubtful if such contact will have much value unless it is in connection with some problem one has met practically or theoretically.

Building is not an exact science. Works experience will soon bring one up against problems and in search for the solution, especially when the conditions are due to the locality, the Garrison Engineer may often get in touch with the local borough surveyor or other engineers faced with similar problems.

The construction and even the maintenance of roads are far from the point where no independent thought is required. Anyone who motors in more than one county will notice more than one method employed in the upkeep of roads. The officer on works service will find the road engineers at Harmondsworth very ready to help.

When contact with civilian engineering has been obtained it is very easily extended.

6. The officer employed on works service has two great individual advantages.

(*a*) Even the most junior has a clear-cut job, on the results of which he can claim to be judged. This produces the most favourable condition for the growth of self-confidence.

(*b*) By meeting and studying the needs of all ranks, from generals to privates, in the area under his charge he has a fine chance of acquiring a knowledge of human nature.

7. But there is another aspect. Education does not finish when one leaves school nor training for war when one gets away from office.

Section 16 of *Training Regulations* states very truly that " the most important part of their individual training is the work they do by themselves," and goes on to describe a programme of training which can only be carried out in one's spare time, whatever appointment one may hold.

" Concentration "—another of those principles for tactical (and other) success—" implies always a concentration of will-power, of enthusiasm and of effort of all kinds towards the object in hand."

The officer in a works appointment with an elasticity of mind acquired in " the trivial round, the common task " and a character formed by attention to the welfare of others, will surely be well placed to gain the maximum benefit from such study of war.

NOTE.—One has argued above theoretically but with the Great War so recent (to us older ones) it would surely be justifiable to reinforce one's arguments, if there were need, with experience.

GRAVEL FOR ROADS?

By LIEUT.-COLONEL K. B. S. CRAWFORD, R.E.

FATE having bestowed upon us a gravel pit, with one set of machinery for washing, sorting and crushing the gravel, and another for mixing it with tar or bitumen, it has been necessary on grounds of economy to use the gravel rather than limestone or granite for the greater part of our work of road construction and repair. This has not been entirely successful, as the science of premixing gravel for surfacing roads is even now scarcely past its infancy, and until a year or so ago the use of gravel in surface-dressing was hardly anywhere unaccompanied by the evils known as Stripping* and Bleeding. Research work is going on rapidly and it is appropriate to review, in addition to our own work, results obtained by some county and borough surveyors, and also to mention methods hitherto only tried out in experimental fashion by the Road Research Institute or the Ministry of Transport. It is impossible to feel sure that the use of a new gravel mix is successful until it has borne the wear and tear of traffic for at least three years, and unfortunately the few that have proved themselves successful are proprietary, so that details of their manufacture are not all available.

Considering for a moment the repair of civil roads generally, it seems that the practice of surface-dressing has been slowly going out of fashion, partly because it is difficult with this method, whether using gravel, granite or any other kind of stone, to prevent the tar or bitumen from coming to the surface under traffic. This unfortunate tendency of the binder causes the road to lose both its colour and its texture, and necessitates frequent dressing which is almost as tiresome for the engineer as for the public. Surface dressing perpetuates the unevennesses in a road. Main roads, excepting concrete roads, are now usually re-surfaced therefore with unsealed carpets of premixed materials, which method has generally been successful in keeping the binder in its place, corrects inequalities in the surface and is very much more lasting and convenient.

Finance must be the principal factor in deciding between these two methods. In the attempt to prove the newer practice to be more economical, carpets were laid thinner and thinner. There were even half-inch carpets. But a thickness of one inch after consolidation is now generally admitted to be the practical minimum.

* See Appendix A—Definitions.

Roads other than main roads fall into two classes—urban and rural. Where they have to bear much traffic, urban roads are usually re-surfaced with premixed materials. Many of the rural roads are treated in the same way, but owing to the higher initial cost of this method it will be some years before surface-dressing is abandoned altogether.

The Materials.

The four constituents of premixed road material are the aggregate, sand, the filler and the binder. As regards affinity for the ordinary binders, gravel has always had a poor reputation, possibly because stocks of gravel are generally moister than stocks of other aggregate, and gravel therefore needs to be more carefully dried. The 1936 Report of the Road Research Institute states that dry gravel has as good " wetting " properties as any other stone.

As regards the filler, some authorities recognize no filler but Portland cement, and there is something to be said for this view, but it is generally considered that any stone dust passing the 200-mesh sieve is good. The price of stone varies of course in different localities but limestone dust is generally the cheapest filler.

Tar and bitumen are both used as binders in premixed gravel. Straight bitumens seem to give better results than Cut-backs and, although hard and soft bitumens are used with equally good results, the softer binders (200–300 penetration) have the advantage that they set more slowly, which facilitates transport and laying, and they are mixed at a lower temperature. Similarly with tar, a soft aromatic tar is preferred.

The Machinery.

Gravel may be excavated by means of a dragline bucket, suspended from a crane, which claws the side of the pit in an upward direction and deposits the spoil in a trolley in which it is carried to the plant. After a preliminary crushing which reduces the bigger stones to a maximum gauge of (say) $2\frac{1}{2}$ inches, the whole of the spoil passes along a conveyer into the washer, which is a rotating cylindrical drum into which water is introduced, and the clay and sand are washed out through a small mesh screen. The gravel is passed out into trolleys through other screens whose mesh varies from (say) $1\frac{1}{2}$ inches to $\frac{3}{8}$ inch, and is stored in heaps. The sand and clay are drained away into a sand washer, where the sand is deposited and the clay and water pumped out to a basin to dry.

So far the process has produced round, that is to say (mostly) uncrushed gravel. The material which will not pass the largest size screen at the washer is conveyed to a second crusher where

it is reduced and screened again, and so we get a series of crushed gravels.

Gravel in heaps remains very wet, and even after several days of fine weather only the stones on the surface of a heap are commonly dry.

Premixing plant consists essentially of machinery for drying and heating the aggregate and sand, for storing and heating the binder and for mixing these constituents at the correct temperatures and in measured proportions. The drier is a large rotating cylinder, heated by an oil flame which is forced into the interior, or sometimes by a fire underneath, and the materials to be dried are introduced by means of a short elevator from a hopper where they are shovelled in by hand. The dried aggregate is carried on by another elevator to the mixing chamber. Sand and gravel should not go through the drier together as they dry at different rates; either the sand would come out moist or the gravel too brittle. Also the sand must not be added to the mix until after the aggregate has been coated. They must therefore be passed through alternately or—better—through separate driers. Both are weighed into the mixing chamber, where they are thoroughly stirred up with the hot binder by revolving paddles. The binder is heated in a kind of boiler and pumped up to the mixing chamber, where it is measured by means of a special hopper. The filler is added (cold) by hand during the mixing of the other materials.

From the mixing chamber the hot mix is dropped into a collecting chamber, and from there it is dropped again as required into lorries or trailers. It is usually necessary to cover the mix with a tarpaulin while in the lorry so that it may arrive at the other end of its journey soft enough to be properly laid and rolled.

THE PROPORTIONS.

In Appendix "B" will be found details of the proportions in which the various constituents should be mixed for the manufacture of a gravel base-coat, surface coats for roads, a path surface mix and a parade ground surface mix. Proportions are also given of a special granite mix for the surfaces of parade grounds for tracked vehicles and surrounds of tank hangers.

Road Research experts are now increasing the proportion of sand in gravel surface-coats and their "road machine"—a kind of bench test—shows that these close texture carpets are more durable than those of open texture which have been lately in vogue. Manufacturers, however, are not following this lead and we hope to avoid having to use carpets of very close texture, as they cost more to produce and are apt to be very black. With aggregates such as granite, quartzite and limestone it appears probable that the open-

texture mix, which has now had time to prove itself, will remain in favour. Apart from the cost, roads are often reconstructed or otherwise altered and it seems a pity to forgo the lighter colour and superior non-skid quality of the open-texture carpet in favour of a material which may last longer than is really necessary. If the scientists are to be believed, good gravel which is dry has unsurpassed wetting properties, and it is to be hoped that gravel carpets of fairly open texture, which show a pleasant and useful colour after a few months' wear, may soon be proved to last long enough to justify their moderate cost. Opinions differ as to the temperatures at which premixed gravel should be manufactured, and it seems certain that these temperatures vary according to the exact nature of the materials used and the atmospheric conditions. A process of trial and error is usually adopted. The following is a rough guide :— aggregate at 150° to 200° F ; binder at 250° to 300° F.

It is best to determine the proper proportion of binder in premixed material by making up and laying several trial mixes. The greater number of experiments soon prove themselves failures under traffic and after a few weeks' use the condition of the various surfaces will probably differ considerably. One or more mixes may then be chosen for a more extended trial. Each may be laid in three lengths—one containing the same proportion of binder as before, one containing three quarters of a gallon more binder per ton of material and the third containing three quarters of a gallon less per ton. After a year's trial one or more of these specifications can be selected and used for normal repair work—and at last a positive result may be obtained.

Methods of Repair.

1. *Re-surfacing.*

From the strictly financial point of view, if a gravel carpet one inch thick is to be preferred to surface-dressing it should last about ten years but, making allowance for greater evenness of surface and texture and for less frequent disturbance of the flow of traffic, a carpet that lasts seven years should be considered satisfactory.

When a road is merely to be re-surfaced with premixed material it is not necessary to scarify it unless it is so uneven that a very thick new layer would be required. It is not even always necessary to put down a priming coat of tar or bitumen before laying the new carpet. Roads are less uneven than they were, and good results may often be obtained by first levelling up the old surface with patches of premixed fines and then laying a 1-inch carpet over all. The edges of the patches will be very thin and for this reason a priming coat is required over the parts which are to be patched. The engineer should take great care in every case that the old surface,

whether scarified or not, is levelled before laying, and also that a straightedge, camber-board and level are used again over the new layer during rolling. Long practice is required in order to be able to spread premixed material properly and quickly.

Base-coats should be rolled with a 12-ton roller, surface-coats with a 6- or 8-ton roller.

2. *Surface-Dressing.*

The problem of surface-dressing with gravel consists chiefly of bringing the gravel as dry as possible to the work and finding the right quantity of the right binder to hold stone of the gauge selected. Gravel seems to be almost hygroscopic, and is seldom really dry when used for surface-dressing. It is difficult to decide upon a gauge which is big enough to avoid bleeding and yet small enough to stick to the sprayed road surface under the wear and tear of modern traffic. On the whole the best results have been obtained so far with round gravel of $\frac{1}{2}$-inch or $\frac{5}{8}$-inch gauge. Though the binder may come to the surface along the traffic lines, the colour and texture should remain sufficiently good for 2 or 3 years under a fair amount of traffic. Tar is cheap and much used on the less important country roads, but it is always liable to bleed in hot weather and takes up to three or even four days to set, according to the weather. Round gravel seems to adhere to the ordinary binders quite as well as crushed, and does less damage to rubber tyres.

Gravel dressings on roads are laid with the hot process, and the work is therefore done during the summer months. Using cold emulsion, they should be laid only on parades and paths, or where the stress of traffic is small.

Gravel in a surface-dry condition, treated with oil such as fluxing oil, has been found to adhere to a good binder even in the presence of water; and this process is useful for small areas where the extra cost of producing such material is justified. The simplest way to dry and oil the gravel is to put it through a premixing plant.

THE CALCIUM CHLORIDE PROCESS FOR UNMETALLED TRACKS.

A gravel process for unmetalled tracks has recently been adopted in North America. Briefly, the top four inches of the surface of the track are mixed with calcium chloride after being corrected, by making the necessary additions, approximately to the following mixture:—

Gravel 1 inch to $\frac{1}{4}$ inch	..	..	30% by volume
Gravel $\frac{1}{4}$ inch to $\frac{1}{8}$ inch	..	..	30% ,, ,,
Sand $\frac{1}{8}$ inch down ..	..	..	28% ,, ,,
Clay 1/200 inch down	..	..	12% ,, ,,

The general idea is that the gravel and sand form a voidless mix, held together by the clay. The sole function of the calcium chloride is to keep the clay damp in dry weather.

The first part of the process is of course to drain thoroughly the site of the work.

The constituents to be added to the natural soil may be laid direct from a lorry with a moving floor; and the whole of the scarifying, mixing and shaping are best done with a blade grader and spring-toothed harrow. Unless the weather is very wet the track should be watered before laying the constituents upon it, and again before mixing is begun. After the final shaping the road should be rolled with a medium (say an 8-ton) roller. From one-half to one pound of calcium chloride (in the flake form) per superficial yard should be put down before mixing, and an equal quantity spread over the surface after the rest of the work has been finished.

A surface prepared this way is said to take a limited amount of medium weight fast traffic and the cost varies between 6d. and 1s. per square yard according to the quantity and cost of the material to be added. These figures include 1¼d. for the calcium chloride. Our experimental Calcium Track has not been tried out very long but it looks promising.

As regards subsequent maintenance, the road is shaped as necessary in wet conditions and an annual addition of calcium chloride up to 1 lb. per square yard may be required.

The Emulsion Process for Improving Old Gravel Roads.

A process for improving old gravel roads has given good results on rural roads in Devonshire.

The surface is scarified to a depth of 4 inches and then harrowed with a weighted agricultural spike-harrow, preferably horse-drawn, to break up the surface. During the harrowing the road is re-shaped, and if the aggregate is particularly dry it is watered.

The loose surface is then sprayed with a diluted bituminous emulsion of high stability at ½-gallon per square yard and the harrow is passed once over the surface. A second application of the emulsion at the same rate and another brief harrowing are sufficient to incorporate the emulsion in the aggregate. The second application must be made before the first has time to dry out, otherwise mixing will be difficult.

The surface is then lightly rolled, and after half an hour or so, when it has begun to harden, ½-inch chippings are spread at about 120 square yards to the ton and thoroughly rolled in. Finally a surface-dressing of emulsion (62% bitumen) at 4 square yards to the gallon blinded with ⅜-inch chippings is given.

The equipment required is of a simple nature and, as all the

aggregate is already *in situ*, transport charges are reduced to a minimum. We have laid down 300 yards of this track at 1s. $2\frac{1}{2}$d. per square yard and it appears to be doing well. The "break" of the high stability emulsion is so controlled that an intimate mixture with dust or ashes is possible without premature coagulation.

This process may be adapted for use with any kind of aggregate except one containing a considerable proportion of clay, and provides a road which is unaffected by the weather and will bear a reasonable amount of lorry and horse-drawn traffic.

APPENDIX "A"

DEFINITIONS

Binder is a term applied to tar, bitumen or a mixture used to bind broken stone or gravel. A fluxed binder, which is one that has been diluted with oil, is often called a *Cut-back*. Bitumen that is not fluxed is usually known as straight bitumen.

Bleeding. Sooner or later the binder used in surface-dressing generally comes to the surface. This is called bleeding; the surface is blackened and may become slippery in wet weather.

Colour of a road. Light colours are generally preferred; the colour of gravel is one of the best. A road is said to lose its colour when it becomes black.

Cut-back. See above under *Binder*.

Cut gravel. See below under *Round gravel*.

Filler. The scientist applies this term only to Portland cement and to stone dust which will pass the 200-mesh sieve. Some manufacturers use the term loosely to include sand.

Round gravel, Cut gravel. These terms signify respectively uncrushed and crushed gravel.

Sealed. When a new road surface is surface-dressed it is usually said to be sealed.

Stripping is a term used when the grit or chippings applied in surface-dressing come away from the coat of tar or bitumen underneath, leaving black patches.

Surface-dry. Gravel is said to be surface-dry when each pebble appears to the eye to be dry.

Wetting property is the quality in stone which causes it to adhere to a binder.

APPENDIX "B"

PROPORTIONS FOR PREMIXED MATERIAL.

Note:—The correct proportion of tar or bitumen varies considerably according to the exact nature of the materials used and other conditions.

The proportion of binder in each of the following cases should be taken as a guide only.

The filler should be stone dust passing the 200-mesh sieve, or Portland cement. The bitumen may be fluxed with oil in cold weather.

Gravel Base-Coat.

Gravel, uncrushed, size, 2½ in. to 1½ in.	100 %
Straight bitumen	7½ gallons per ton

Gravel Surface-Coat.—Isle of Wight mix.

Gravel, round, ¾ in. to ⅜ in.	2 parts by volume
Gravel, cut, ⅜ in. down	5 ,, ,, ,,
Sand, medium	1 ,, ,, ,,
Filler...	35 lb. per ton
Straight bitumen	14 gallons per ton

Gravel Surface-Coat.—Harmondsworth "B" mix.

Gravel, round, ¾ in. to ⅜ in.	7 parts by volume
Gravel, cut, ⅜ in. down	3 ,, ,, ,,
Sand, medium	1 ,, ,, ,,
Filler...	50 lb. per ton
Straight bitumen	12 gallons per ton

Gravel Footpath Surface-Coat.

Gravel, cut, ⅜ in. down	4 parts by volume
Sand, medium	1 ,, ,, ,,
Filler...	112 lb. per ton
Straight bitumen	15 gallons per ton

Parade Surface-Coat.

Gravel, round, ¾ in. to ⅜ in.	5 parts by volume
Gravel, cut, ⅜ in. down	5 ,, ,, ,,
Sand, medium	1 ,, ,, ,,
Filler...	45 lb. per ton
Straight bitumen	12 gallons per ton

Granite Surface-Coat for tracked vehicles' parade.—Waterloo mix.

Granite, ¾ in. to ½ in.	3 parts by volume
Granite, ¼ in. down	1 ,, ,, ,,
Filler, cement	50 lb. per ton
Straight bitumen	14 gallons per ton

CONSTRUCTION OF LANDING GROUND AT MIRALI, WAZIRISTAN.

By MAJOR W. E. C. PETTMAN, R.E.

1. *Origin.*

During the 1937 Waziristan Operations, Mirali became an important point on the L. of C. forward from Bannu, the railhead.

A landing ground was soon needed, and the work was given to the Military Engineering Services.

2. *Site.*

Some cultivated land was chosen adjoining the road near the camp.

This was fairly level except for about 400 ft. square in its northern corner, where it sloped up towards some high ground, and was hard and covered with boulders. The rest of the surface was good, though rough on top and dotted with small bushes. The greatest slope anywhere was 1 in 70.

The site was crossed by an irrigation channel 2½ feet wide and 2 feet deep and by two rain-water nullahs, of which the larger was 14 feet wide and 4 feet deep.

3. *Preliminaries.*

The usual "L" shape was set out, with arms 600 yards long and 300 yards across.

Diversions were planned for the water courses. These were led to land hitherto barren, whose value was thereby enhanced, thus reducing the compensation to be paid for taking over the landing ground. Until the Political Agent had settled this compensation, no soil was broken on any of the land.

Meanwhile, road-machinery, men, tools and donkeys were collected.

4. *Organization of work.*

(*a*) Work to be done.

(i) Filling up the water courses and digging their diversions so as to provide a catch drain.

(ii) Grading the steep northern corner.

(iii) Removing boulders and bushes, and smoothing the surface.

(iv) Making a short approach track.

(*b*) *Labour.*

Obtained locally.

Paid As. -/10/- instead of the usual As. -/8/-, as the crops were being gathered. The men also knew that they were urgently needed.

Man-days worked were :—

Mates, 100.
Coolies, 2,500.
Donkeys, 740.

Average, 100 coolies and 30 donkeys per day for 25 days.

Most of this was used in digging the diversions and catch drain. A small party also accompanied the machinery and removed boulders and bushes.

(*c*) *Road-machinery.*

The following were used :—

1.	Autopatrol	23 days
2.	Roadbuilder	23 ,,
3.	MacCormick-Dearing Tractor with grader	39 ,,
4.	Caterpillar tractor with grader	10 ,,
5.	P.W.D. Caterpillar tractor with grader and planer ..	6 ,,
6.	2 10-ton steam rollers, each	33 ,,

The processes were in the order given, but overlapped, as the work proceeded in different parts of the ground.

The use of the machinery was liable to interruptions to meet the needs of Wazirforce, advancing farther forward towards Razmak.

Mechanical breakdowns included :—

(i) Broken caterpillar track links. Spares were taken from the other caterpillar, which therefore only worked for 6 days.

(ii) A worn out blade of a grader. A spare was available in Bannu, 24 miles away.

(iii) Minor engine troubles.

5. *Maintenance of grounds.*

After completion, a gang of about 4 men has been constantly employed in :—

(*a*) Filling holes made by sand lizards.
(*b*) Keeping down the growth of bushes.
(*c*) Ramming soft parts after rain.

The last item involved extra men each time. A steam roller was also used to consolidate certain portions, notably those where the water courses had been filled up.

6. *Miscellaneous details and notes.*

(*a*) *The outline* was altered slightly as the work proceeded, to avoid the worst ground and to include other good ground instead.

Thus, the angle between the arms of the L was partly filled in by smoothing a triangular portion. One corner, at the end of one of the arms, was omitted.

(*b*) *After rain* there are short periods when aircraft would not be able to land. The worst area is where the nullah was not completely rammed, owing to the machinery being suddenly required elsewhere. This state of affairs will gradually improve after frequent consolidation when wet. Reports are sent out immediately the ground becomes unfit for use, and again when it becomes fit. The R.A.F. have said this is the best landing ground in the area.

(*c*) *The approach road* was at first only a rough track, especially where it crossed the new nullah at the edge of the ground. When the landing ground was used for evacuation of wounded, a smooth road was essential, and the track was then graded, shingled, and rolled.

(*d*) *The wind vane* was supplied and sited by R.A.F. M.E.S. supplied and fixed the pole, which is 25 feet high and far enough from buildings or hills to show the true wind.

A circle of 20 feet radius round the post was covered with ashes to enable the vane to be seen clearly from the air. Experience here and elsewhere has shown that at least 30 feet radius is necessary to show up the vane from all likely angles, and that ashes, even treated with crude oil, are not dark enough ; tarring was found satisfactory.

(*e*) *No ruling gradient* was laid down. The ground was levelled until the result appeared satisfactory. Improvements could have been added later, but none was necessary in this respect.

(*f*) *The time taken* was 63 days from the order to start. Work was actually commenced on the ground on the 12th day ; *i.e.*, after the preliminary arrangements, including purchase of land, had been completed.

Area of ground actually made good, after deducting bad patches :— 61·4 acres.

Cost, Rs 23,000/-. Details are appended separately in paragraph 7, below.

(*g*) *Road-machinery* enabled the levelling and filling to be finished reasonably quickly, considering the nature of the ground. If this part of the work had been done by manual labour instead of by machinery, not only would the time required have been prohibitive, but it was reckoned that this cost would have been doubled.

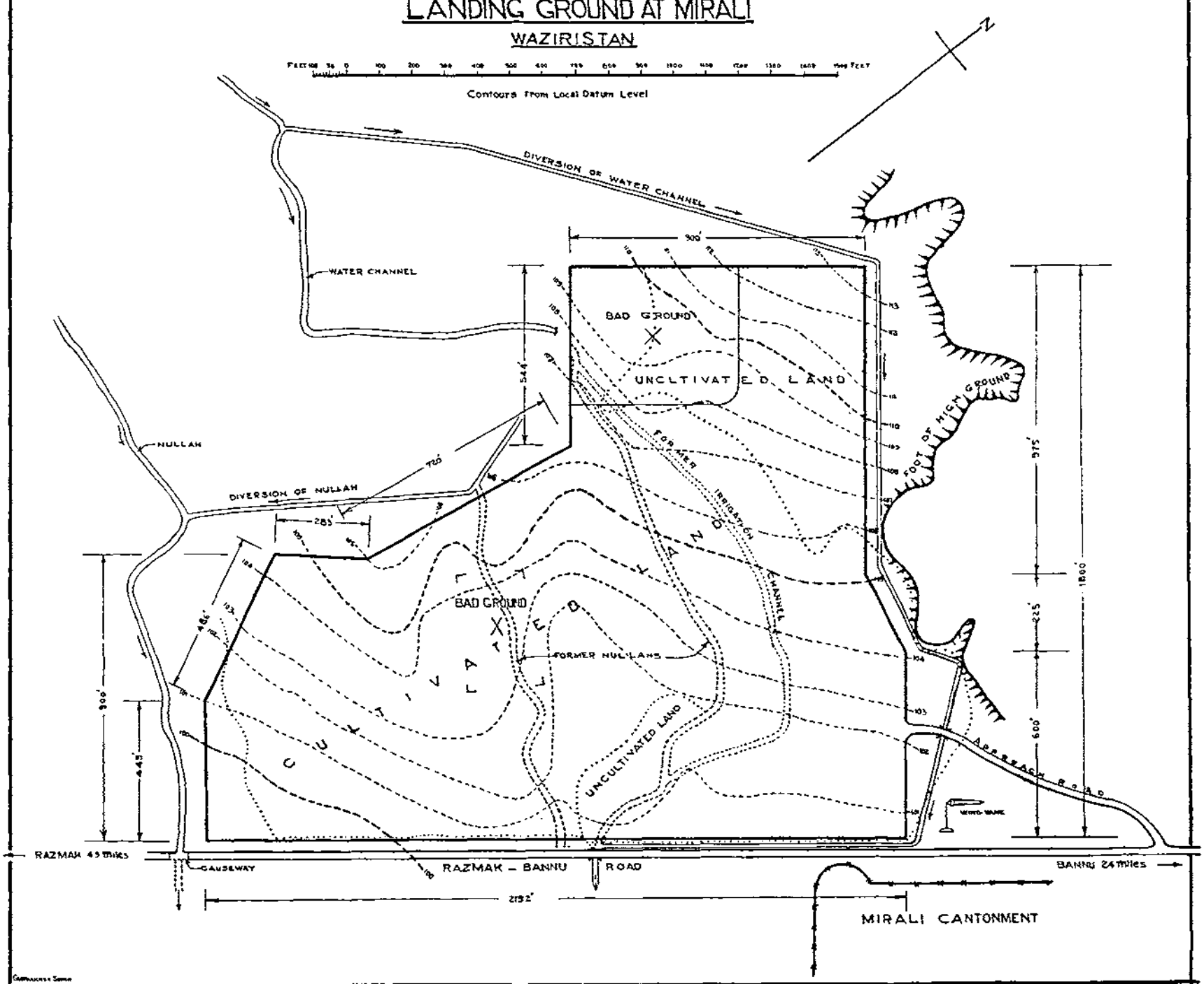
It was subsequently observed that, although the machinery can work on very hard or rough ground, the wear and tear involved may cause more damage than would be realized at the time, and the machine may even be completely out of action for later stages of the work, or for subsequent work elsewhere.

The lesson seems to be that machines must be fairly used, and not strained. They should be overhauled beforehand, properly attended to during the work, and examined afterwards. This is a platitude

PLAN OF

LANDING GROUND AT MIRALI

WAZIRISTAN



but, like many other platitudes, apt to be ignored in the heat of the moment.

The cost of running these machines is given in paragraph 8, below, showing the quantities of fuel used.

7. *Cost of Work.*

	Rs*
1. Acquiring land 64 acres, *i.e.* average Rs 250/- per acre	16,500/-
2. Dressing and grading by machinery, average depth 6 inches	5,300/-
i.e. Rs 4/- per 1,000 cu. ft.	
,, ,, 2/- per 1,000 sq. ft.	
3. Labour and donkeys for excavation and filling of water channels	1,100/-
4. Approach Road	100/-
Rs ..	23,000/-
Area actually made good	61·4 acres.
Average cost per acre	Rs 370/-
,, ,, per 1,000 sq. ft.	Rs 8/8/-

8. *Details of machinery used.*

(*a*) *Machinery used*—as in 4 (*c*).

(*b*) *Volume of work* .. .. 1,346,000 cu. ft.
(Average depth, 6 inches.)

(*c*) *Costs.*

	Rs
Hire of machine and accessories	3,358/-
Labour charges, working with machines	800/-
Petrol, 808 gallons @ -/10/-	505/-
Kerosene oil, 1st quality, 108 gallons @ -/11/-	74/-
Kerosene oil, 2nd quality, 190 gallons @ -/8/-	95/-
Diesel oil, 2/1/0/6 tons @ 52/4/-	108/-
Cylinder oil, 118 gallons @ -/14/-	103/-
Mobiloil, 154 gallons @ -/15/-	144/-
Steam coal, 8 tons @ 19/-	152/-
Lime slaked, 4 mds.† @ 2/-	8/-
Firewood, 5 mds. @ -/10/-	3/-
Cotton waste, 60 lb. @ -/2/-	8/-
Total	5,358/-

(*d*) Cost of machinery = Rs 4/- per 1,000 cu. ft.

* Rupee (16 annas) = 1s. 6d.
1 anna = 1d.
† 1 maund = 82 lb.

THE ENGINEERS IN GRANT'S CAMPAIGNS OF 1864–5.

LITTLE has been written about the engineer work in the Civil War of 1861–5. Much entrenching and building of log-breastworks was practised, but the infantry and cavalry constructed the battlefield works, attended to their own hutting and water-supply (there were plenty of rivers), and even carried out the mining—the Petersburg Mine was tunnelled and loaded by the 48th Pennsylvania Infantry, composed principally of miners. The engineers were almost entirely employed on bridging and road-making, of which, in a half-settled country, there was plenty to keep them fully employed.

As the 1864–5 campaigns have been set for examination, some account of the engineer organization and work during those years may be of interest.* On the Confederate side, there were no field engineer units, work on communications being carried out by negro working parties under engineer officers. On the Northern side, the regular battalion of United States Engineers, under Captain Mendell, and two engineer regiments, the 15th and 50th New York Volunteer Engineers, brigaded under General Benham, are shown on the strength of the Army of the Potomac on the 1st May, 1864. The regular battalion consisted of five officers and 350 other ranks. The 15th New York Volunteers did not accompany the Army into the field. The 50th contained twelve companies, one of which, however, remained as depot company at Washington.

The other eleven companies, 40 officers and 1,500 men in all, were formed into four battalions :

Three battalions of three companies each.
One reserve battalion of two companies.

The first three battalions had each a bridging train of 15 wooden pontoons, trestles, and a Corps entrenching tool park. One battalion was assigned to each of the three Army Corps.

The reserve battalion had two bridging trains, each of 12 canvas pontoons and two trestles, and was utilized as required, sometimes assisting the other battalions, sometimes being lent to the Cavalry Corps. The canvas pontoon was a vessel of untarred duck canvas made fast by tags to a stout wooden framework ; for travelling, the canvas was taken off the frame.

For the passage of the Rapidan on the 4th May, the canvas pontoons were carried at dawn about 300 yards down to the river at Ely's and Germanna Fords, where the river was 150 feet and 220

* The notes for this paper were made just thirty years ago and taken from various sources, including : *Report of Lieut.-Colonel Spaulding, 50th New York Engineers*, and reports of General Benham, the Chief Engineer of the Army of the Potomac, and Captain Mendell, commanding the U.S. Engineer Battalion, in the Official Records; Humphrey's *The Virginia Campaign of '64 and '65* and a number of magazine articles.

feet wide respectively, and laid in about one and a half hours. As soon as a few infantry had got across—the cavalry appears to have used the fords—the wooden pontoon material was brought up and laid. The bridge of this pattern at Ely's took 3¼ hours to construct; when completed, the canvas equipage was removed and sent on to Chancellorsville with the II Corps. The other canvas bridge was left standing till 6 p.m.; two wooden pontoon bridges were laid alongside it, but one was taken up at 5 p.m. and moved to Culpeper Mine Ford for the use of the train. The two wooden bridges at Ely's and Culpeper were dismantled on the 5th, but that at Germanna was left until the 7th.

On the 6th May, the second day of the Battle of the Wilderness, the whole of the Engineers, with the Foot Artillery, were collected as an infantry reserve; but they were not actually engaged and lost only two men, wounded. They constructed some new rear lines of entrenchment and strengthened some old ones for the II Corps. At 11 p.m. two companies were sent back to dismantle the last bridge, and the remainder set to work to corduroy and repair roads; they continued this latter work during the movement to Spottsylvania.

On the 10th May, General Grant gave orders for the construction of a bridge over the Rappahannock at Fredericksburg, in rear of the Army, in order to improve his communications, and a second bridge was thrown on the 18th. These two bridges were 420 and 440 feet long respectively. One was dismantled on the 20th and the other shortly after. By this time, the chesses had been cut through by constant use, and some old buildings were pulled down to furnish planks as substitutes.

On the march from Spottsylvania to the North Anna River, one canvas bridge train was overlooked in orders and left behind; it was nearly captured, but being required at the head of the column it was rescued in the nick of time and hurried up at speed, passing a column four miles long in a distance of six and a half miles.

On the North Anna, the engineers had very heavy work, as the rapid rise of the river made the bridges dangerous. It was vital to keep them serviceable, as the outer wings of the Army were across, but the centre still on the north bank, so a number of crib piers were put in. The skill of the volunteers appears to have increased, as bridges 160 feet long were made in about one hour.

A third canvas equipment now became available and two of the three equipments were lent to General Sheridan when he was sent forward with the cavalry to Hanover Town.

During the early part of May, the second regiment, the 15th New York Volunteers, had remained at the engineer depot preparing pontoons and bridging material. While the Army was at Spottsylvania, it was sent to construct more bridges over the Rappahannock at Fredericksburg in rear of the Army, and then to

build piers and improve roads at Belle Plain near Fredericksburg, which formed a temporary base. It repeated the same work at Port Royal, lower down the Potomac, when the troops moved forward.

While the Army was at Cold Harbour, part of the regiment took a number of wooden pontoons to Fortress Monroe, whence they were towed up the James river for the construction of the great bridge, which will be referred to later, by which Grant transferred his whole Army across the James from the Yorktown Peninsula to the south of Richmond.

During the march of the Army from Cold Harbour to the James, the U.S. Engineer Battalion and the 50th Volunteers had specially arduous work in bridging the numerous streams and making roadways over the marshes. One bridge over the Chickahominy was 1,240 feet long and had corduroy approaches 450 feet long; it took from 8 a.m. one day to 3 a.m. next day to construct. All the transport, 2,800 head of cattle and a division, passed over it. It was then dismantled and the pontoons were towed round to the James.

The bridge over the James river was formed by the 50th Volunteers and a detachment of the 15th working from both ends. There were marshes on both sides varying from 50 to 1,000 yards wide. Where the marshes were widest the river was narrowest—it varied from 1,250 to 1,992 feet at the sites reconnoitred, so the widest waterway was selected as demanding least work, but it required a 2,100-foot bridge. The approaches prepared by working parties from General Butler's Army (in Bermuda Hundred), took 36 hours to construct, but were ready by 10 a.m. on the 15th June. The pontoons had not appeared, so a dispatch boat was sent down river and found the pontoons moored and the captain of the tugs fast asleep.

At the site the current was strong, the rise and fall 4 feet, and depth in the centre of the channel 12 to 15 fathoms. Work was commenced at 4 p.m. and completed by 11 p.m., 101 pontoons being used and moored in succession, either singly or in rafts. A cut of 100 feet was arranged. Three schooners were moored above and below to steady the bridge. To guard it, five schooners were sunk up-stream and connected by booms. A bridgehead of redoubts was laid out by the U.S. Engineer Battalion to cover the Peninsula end of the bridge from pursuers. The whole Army passed safely; there was no interruption except when one of the moored schooners dragged anchor and carried away part of the bridge.

During the nine months' trench warfare, June, 1864, to March, 1865, in the Petersburg lines, the Engineers were employed in building redoubts to form a second and a third line of defence.

In 1918 each American division had an engineer regiment with an establishment of 1,712 of all ranks and an engineer train with 84 all ranks.

HISTORIES OF THE INFANTRY BATTALIONS, TERRITORIAL ARMY,

Which have become Anti-Aircraft Battalions, Royal Engineers.

[Continued.]

31ST (CITY OF LONDON RIFLES) ANTI-AIRCRAFT BATTALION, R.E. (T.A.).

THE formation of the Volunteer movement in 1859 saw the beginning of the " City of London Rifles."

First known as the 24th Battalion, The Surrey Regiment, it had its headquarters in Newington Causeway, and was commanded by the artist Cruikshank, with General Havelock as its Honorary Colonel. In 1862 the Battalion was re-named the 48th Battalion, The Middlesex Regiment.

The conditions of service in those days demanded many sacrifices from those who decided to serve. Each member had to pay an annual subscription, buy his own uniform, and provide his own arms. Ammunition for musketry training was supplied free by the Government, but such was the variety of firearms in existence that it was found to be impossible to supply rounds suitable for all the different makes in use, and the Snider rifle was then officially issued.

Ten years later (1872) another change in name came, this time to the 2nd London Rifle Volunteers (10th Battalion King's Royal Rifle Corps). At this time a large number of the members were drawn from the printing house of Messrs. Eyre and Spottiswoode, and the unit became known as " The Printers' Battalion." The Headquarters were now in Carey Street, and Lieut.-Colonel C. B. Vickers, the Commanding Officer of the 48th Middlesex, still in command of the new unit.

The year 1878 found the Battalion quartered in a private house in Bartletts Buildings, Holborn, but in 1888 it moved in to its present home in Farringdon Road, which was opened by Field-Marshal H.R.H. the Duke of Cambridge.

During the South African War the Regiment sent a special service company to the King's Royal Rifle Corps and a contingent to the City Imperial Volunteers, and so earned its first Battle Honour, " South Africa, 1900–1902."

When the Territorial Force was formed in 1908, a new title of " 6th Battalion, The London Regiment (City of London Rifles) "

was assumed. The reorganization at this time caused much disappointment among the old Volunteers, most of whom hated compulsion of any kind, and there were many resignations. The Press now came to the rescue with a great recruiting campaign, and the City of London Rifles was soon well over its authorized establishment. Already known as "The Printers' Battalion," it was now strengthened by companies provided by the great Harmsworth organization, under the leadership of the late Lord Northcliffe, which controlled the Amalgamated Press, the *Daily Mail*, the *Evening News* and the *Sunday Dispatch*. It became the popular thing for large firms to sponsor a company, and in many cases to find the officers. The present Hon. Colonel, Brig.-General W. F. Mildren, C.B., C.M.G., D.S.O., T.D., commanded the Harmsworth company. Among other large firms who helped in this way were Messrs. Waterlow and Sons, Gamages, and the South Metropolitan Gas Company.

In addition, many City companies contributed handsomely to the funds. So right on to 1914 the unit flourished and was maintained at full strength.

On August 1st, 1914, after many camps at military centres, such as Salisbury Plain, Aldershot, and Shorncliffe, the Battalion went to Eastbourne for a fortnight by the sea.

Visions of a real holiday camp were very rudely shattered when, on arrival on the camping ground, the order was given for immediate return to London, and in three days the fateful order for mobilization was issued. At last the great testing time had arrived, and the City of London Rifles answered the call loyally, 90 per cent. of them undertaking foreign service obligations immediately. After seven months of strenuous training, the 1st Battalion sailed from Southampton on March 17th, 1915, for France.

It is interesting to record that the ship which carried the unit to France was the old pleasure paddle-boat, *La Marguerite*, which in more peaceful times had carried many riflemen down the Thames to Ramsgate and Margate. This was her first journey as a Government transport. In 1927, when she was broken up, Commodore Sir R. Williams-Bulkeley, *Bart.*, K.C.B., director of the steamship company which owned her, formally presented her bell to the Regiment. This bell has been mounted and incorporated into the life of the Regiment, and is one of its most treasured possessions. During Annual Training ship's time is struck, and at all social functions the bell takes the place of the chairman's gavel.

After being involved in the fighting at Cuinchy, Givenchy and Festubert, the Battalion was moved to the Loos district in preparation for the battle of September 25th, 1915. Here these Londoners had their first real attack. With their comrades of the 7th London, they formed the hinge upon which the whole British

attack swung. In an hour and a half they had penetrated to the third German line and, living up to their nickname of the " Cast-Iron Sixth," held their objectives for five days until relieved. After the battle, nearly one hundred dead were collected and buried in one great grave by the Padre (Rev. A. E. Wilkinson, O.B.E., M.C., T.D.), and a rugged wooden cross erected. This cross stood untouched throughout the war, and was afterwards placed in St. James' Church, Croydon, where the Padre was the vicar. On Armistice Sunday in each year a large party of Old Comrades attends a service in this church as a mark of respect to the fallen.

On February 20th, 1917, the City of London Rifles executed a raid to the south of Hill 60, in which 118 prisoners were taken. The number of prisoners broke all existing records, and was never equalled in a raid by a single battalion during the whole of the war.

The 2nd Battalion, formed at the end of August, 1914, to provide reinforcements for the Battalion overseas, was in its turn sent to France in January, 1917, where it took part in much severe fighting, particularly on the Somme.

A 3rd Battalion was raised in March, 1915, which remained in England as a draft-finding unit.

In the Headquarters in Farringdon Road is a splendid memorial, on which are inscribed the names of the 1,200 who died. Among these is Field-Marshal Earl Roberts (a prominent Freemason), who became the Honorary Colonel in 1895, and held the appointment until his death while on a visit to the troops at the front.

As a more permanent memorial, a bed (The Mildren), named after the present Honorary Colonel, has been endowed in St. Bartholomew's Hospital, which, while paying tribute to those who made the great sacrifice, is a service to the living, and no member of the City of London Rifles is ever refused a bed in this great hospital.

In December, 1935, the Battalion, after 80 years' existence as Light Infantry, was converted into the 31st (City of London Rifles) A.A. Battalion, R.E.

The Battle Honours of the Regiment are:—" South Africa, 1900–02." " Festubert, 1915." **" Loos."** **" Somme, 1916, 1918."** " Flers-Courcelette." **"Le Transloy."** **"Messines, 1917."** **"Ypres, 1917."** " Menin Road." " Polygon Wood." **" Passchendaele."** **" Cambrai, 1917."** **" St. Quentin."** " Avre." **" Amiens."** " Albert, 1918." " Bapaume, 1918." **" Hindenburg Line."** " Epehy." " Pursuit to Mons." " France and Flanders, 1915–18."

34TH (THE QUEEN'S OWN ROYAL WEST KENT) ANTI-AIRCRAFT BATTALION, R.E. (T.A.).

The Regiment of to-day, formerly the 20th London Regiment (The Queen's Own), bears a new title, but it can trace its ancestry through nearly four centuries; from time to time, and for varying periods, units have been raised and maintained in Blackheath, Deptford, Greenwich, Lee and Woolwich.

As early as 1543, a Volunteer unit was formed around Greenwich Palace at the instigation of Henry VIII. In 1585 the "Trained Bands and Auxiliary Forces of London" were re-organized under the threat of Spanish aggression, and were inspected by Queen Elizabeth in what is now Greenwich Park. Citizen soldiers played a large part in the Civil War, and in 1643 the Greenwich unit was among those that marched to the relief of Gloucester, and among other engagements took part in the Battle of Newbury on September 20th. The year 1659 saw the formation of a Volunteer Company at Deptford, recruited from "the well-affected workmen of the Dockyard" and known as "Captain Packwood's Foot Company of Volunteers."

The Napoleonic wars led to a revival of the Volunteer forces and among the units raised at this time were :—

The Blackheath Cavalry (1798), whose original Standard now hangs over the staircase of the officers' mess.

The Loyal Greenwich Water Fencibles (1803). The Drums of this unit (known as the Nelson Drums) now rest in the officers' mess and are carried on ceremonial parades. These same drums were piled around the coffin of Lord Nelson in the Painted Hall at Greenwich, and were beaten during the procession to London and at the State Funeral.

The Deptford Volunteers (1805), who mounted a special guard when Lord Nelson's funeral procession passed through Deptford.

The Loyal Greenwich Volunteer Infantry (1808), which took part in the expedition to Copenhagen in 1808 and lost some of their number at the taking of the Island of Walcheren.

In June, 1814, the bulk of the Volunteer forces was disbanded. The Greenwich Volunteer Infantry and the Deptford Volunteers were, however, among the few units retained.

In 1859 came another revival of the Volunteer Movement and companies were raised at Blackheath, Bromley, Charlton, Deptford, Greenwich, Lee, St. John's and Woolwich, and these were known as the West Kent Rifle Volunteers.

In 1882, there was a change of title, and some of the Companies were grouped to form the 2nd Volunteer Battalion, The Queen's Own (Royal West Kent Regiment), with Headquarters at Blackheath, while others formed the 3rd Battalion at Woolwich.

During the South African War these battalions raised a Composite Company, which saw extensive service at the front.

In 1908, when the Territorial Force came into being, the two battalions were amalgamated and the title of the new unit thus formed became the "20th (County of London) Battalion, The London Regiment (Blackheath and Woolwich)" with Headquarters at Blackheath.

Within a few hours of the declaration of war on August 4th, 1914, the battalion relieved a battalion of Coldstream Guards stationed on Plumstead Marshes, and assumed the duties of guarding the magazines there. Subsequently it was moved to Hatfield in Hertfordshire, and, after being brought up to full strength, and completing its training, the battalion proceeded to France on March 9th, 1915. The battalion remained in France and Flanders throughout the entire war and took part in a great number of engagements.

In the meantime a Second Battalion had been formed, and this embarked for France in June, 1916, and at the end of the year was transferred to the Macedonian front. Later, the 2nd Battalion was moved to Palestine, when it took part in the capture of Jerusalem (the keys of the city are now in the officers' mess) before returning to France in July, 1918.

Both battalions took a prominent part in the great battles which ended the war, and the 2nd Battalion led its Division in the ceremonial march across the frontier into Germany and formed part of the Army of Occupation for some months. During the war a 3rd Battalion was maintained in England and supplied the drafts of men required by the two battalions abroad.

Early in 1920 the Territorial Army was re-constituted, and in recognition of its fine war service the new battalion was given the title of "20th London Regiment (The Queen's Own)."

On April 10th, 1920, H.R.H. Prince Albert (now H.M. King George VI) visited the Headquarters and unveiled the Regimental Memorial Cross to the 1,067 of all ranks who gave their lives during the Great War. On the same occasion His Royal Highness presented a King's Colour to representatives of the 2nd Battalion, and this was later deposited in St. Mary's Church, Lewisham.

In the troubles of 1921 the battalion provided, on a voluntary basis, the 20th London Defence Regiment which remained mobilized for three months, chiefly in Kensington Gardens. Again in the general strike of 1926, the battalion formed a unit of the Civil Constabulary Reserve at its headquarters.

On December 15th, 1935, the Regiment ceased to be an Infantry Battalion, and became an Anti-Aircraft Searchlight Battalion of the Royal Engineers.

The battalion has once again undergone a change of title, and is now known as 34th (The Queen's Own Royal West Kent) Anti-

Aircraft Battalion, Royal Engineers. The Army Council has permitted the battalion to retain its colours, cap badge and buttons, and, while it now forms part of the Corps of the Royal Engineers, it remains affiliated to the Queen's Own Royal West Kent Regiment.

47TH (THE DURHAM LIGHT INFANTRY) ANTI-AIRCRAFT BATTALION, ROYAL ENGINEERS, T.A.

Records show that in 1794 there was formed in Sunderland a Volunteer Corps known as "The Loyal Sunderland Volunteers" and, although it is not quite clear whether this corps was purely an Infantry Corps or whether it was composed partly of infantry and artillery, it is believed that it was the first of a series of voluntary corps in Sunderland, of which the 7th Battalion, The Durham Light Infantry, was the infantry representative immediately prior to conversion on December 10th, 1936.

"The Loyal Sunderland Volunteers" was formed in 1794 by "several young gentlemen of Sunderland who, with a spirit becoming that true loyalty so amiable in every British subject, had engaged a regular serjeant to teach them the use of arms."

In 1803, upon the recommencement of hostilities between England and France, the "Sunderland Volunteer Infantry" was formed under the command of Sir Ralph Milbank, *Bt., M.P.*, of Seaham Hall. The list of officers of this corps shows that several of the officers of the old "Loyal Sunderland Volunteers" joined the corps, whereas the list of officers of the "Sunderland Volunteer Artillery," an artillery corps formed at the same time, contains none of the names of the old corps officers, thus suggesting that the first corps was more of an infantry unit than an artillery unit.

The Sunderland Volunteer Infantry consisted of 30 officers and 600 men and was divided into eight companies. A subscription list was opened in August, 1803, to provide clothing for the corps and this list at its close in December of that year amounted to upwards of £1,600.

In consequence of the Peace of Paris in 1814, the corps was disembodied on June 24th of that year.

There is no record of any volunteer activity in Sunderland from 1814 to 1859. In 1860, when the national volunteer movement was started, the old Infantry Corps was reformed in Sunderland under the official title of the "3rd Durham Rifle Volunteers." They were also known as "The Sunderland Rifle Volunteer Corps." The establishment of this corps (as confirmed by a War Office letter dated August 29th, 1860) was 500 men of all ranks divided into 5 companies, 1 major commandant, 5 captains, 5 lieutenants,

5 ensigns, 1 adjutant, and 1 surgeon. On July 31st, 1860, Lord Adolphus Vane-Tempest was appointed Commandant. On August 7th, 1860, the corps took part in the review of volunteers at Edinburgh by Queen Victoria. In 1881, the title of the corps was changed to the 3rd Volunteer Battalion, The Durham Light Infantry. The Battalion sent a detachment of 2 officers and 83 other ranks to the South African War. On April 1st, 1908, on the creation of the Territorial Force, the 3rd Volunteer Battalion became the 7th Battalion, The Durham Light Infantry, T.F.

On June 19th, 1909, the present colours were presented by King Edward VII at Windsor. The Battalion furnished the following detail for duty in London at the Coronation ceremonies. June 21st to 23rd, 1911: 1 officer, 4 serjeants, 1 lance-serjeant, 1 corporal, 1 lance-corporal, 18 men.

In August, 1914, the Battalion was at camp at Conway with the remainder of the 151st Brigade and after declaration of war went with the remainder of the 151st Brigade to Ravensworth and subsequently to Gateshead. On April 19th, 1915, the Battalion embarked for France under the command of Col. E. Vaux, D.S.O., V.D., with the 50th Division.

On November 16th, 1915, the Battalion was appointed Pioneer Battalion for the 50th Division and continued as such until May 28th, 1918, when 90 per cent. of the unit became casualties. Only 71 officers and other ranks were left and these were amalgamated with the 22nd Battalion D.L.I., and attached to the 8th Division with which they remained until after the Armistice. In March, 1920, recruiting began for the reconstituted Battalion, the command of which was vested in Lt.-Col. A. H. Birchall, M.C., who was appointed as C.O. on May 27th, 1920. The whole Battalion was recruited from and situated at Sunderland.

On March 25th, 1936, the Battalion was "invited" by the War Office to convert into an A.A. Searchlight Battalion and this invitation was accepted by all ranks.

SPAGHETTI.

By LT.-COLONEL W. E. BRITTEN, O.B.E.

SPAGHETTI: Wheaten flour ground into paste, and squeezed through a die into long vermiform tubes. The staple food of the peasantry of Italy. (Extract from *Encycl. Brit.*)

PACKETTY: A nasty, dirty feed only fit for organ-grinders. (Excerpt from the sayings of Carter the Coxswain.)

"WHAT about lunch to-morrow?" said the Mate, his eye roving round the grocer's shop. He had, I noticed, lost interest in giant olives, and I was wondering what new line of country he might have reconnoitred since our last cruise together. I suggested cold tongue, but he murmured something uncomplimentary about tinned foods. Then his eye lit on an innocuous-looking packet, clearly marked "Spaghetti." In retrospect, I seem to remember a far-away look in his eye, as if in speculation, not untinged with sardonic humour.

"Yes," he said. "We'll have spaghetti. One packet, please."

I was on deck at midday the next day, and I heard a certain amount of talk going on below, the voices being those of the Mate and Carter. I put it down to an argument on the merits of different brands of old ale, of which the Mate has an extensive and peculiar knowledge, and I thought no more about it. But I noticed that we lunched on cold beef.

The following day—a beautiful September morning, with hardly a cloud in the sky, and the sea like a mill-pond—I remembered the spaghetti, and thought that probably the same midday argument I could hear below concerned the method of cooking it, especially as this time the controversy sounded considerably more lively.

I was rather surprised when I found we were to lunch off bread and cheese.

The third day out the Mate had got his sea-legs, or whatever it is that fills him with an unholy desire to pull Carter's leg at all costs.

"To-day," said the Mate, taking care not to look directly at Carter—"we will have spaghetti."

I saw Carter cock his eye, and then busy himself with some gear on deck which needed no attention.

But the Mate's blood was roused.

"Carter!" he shouted. "Can you cook spaghetti?"

"No, sir!" replied Carter firmly. "Good plain English cooking

is my line. I'll do that with any man—but that packetty—I don't 'old with it, sir."

" Right ! " said the Mate, in that still small voice which I have learned to tremble at. " I'll show you."

Then the balloon went up. Quite a big one. Whilst I busied myself quite unnecessarily with the chart, the guest (aged 15) found it necessary to stuff the larger part of a rather dirty handkerchief into his mouth.

Carter started quietly by outlining his services in the Royal Navy, his subsequent career in *Ilex*, touched lightly on his trials and tribulations during several ocean races, made a passing allusion to the officers of the Royal Engineers, who, it appeared to him, were never happy unless attempting to sail *Ilex* with an angle of heel which he described somewhat unnautically as " Arse uppards," and finally announced his unconquerable aversion to the sight of anybody but himself amongst his precious pots and pans forrard.

From time to time the Mate added an interjection, harmless-sounding enough, but evidently based on a shrewd knowledge of the joints in the Coxswain's armour. At any rate they had the effect of stimulating him to fresh flights of rhetoric, all the most lurid being centred round " that nasty, dirty packetty."

We did *not* have spaghetti for lunch, but a desultory warfare around it continued all the afternoon. About sunset, for a reason believed to have some connection with a bottle of gin, Carter capitulated, but it was more a retreat to a different field of battle than a surrender.

Fragments of the conversation reached our ears from forrard.

" What ! Another saucepan ? 'Ow many blinkin' saucepans are you going to mess up, and 'ow am I going to clean off that nasty, dirty. . . ."

Then from the Mate :

" Now a tin of milk, Carter."

" Are those eggs boiled yet, Carter ? "

" Where's the Parmesan cheese ? "

" Now a tin of tomato soup, Carter."

" Now I want that bottle of tomato ketchup."

The last demand drew a broadside from Carter.

" Law lumme ! "—pause—" Now look 'ere, sir ! Tomato soup's one ——— thing, and tomato ketchup's another. If you go and mix 'em together, they'll ——— each other up ! "

However, there is ample evidence that both ingredients went into that saucepan, and ten minutes later we sat down to a dish whose richness would have put the Rothschilds to shame.

Not so the Coxswain. His supper was a piece of cheese and the driest-looking crust he could find. The Carter family, we gathered,

had never eaten spaghetti, did not eat spaghetti, and, God helping them, would never eat spaghetti.

* * * * * *

About three hours later, although we were lying peacefully in Burnham river, a tug and a tow of barges passed slowly across my chest, to be followed by even heavier craft at intervals until dawn, when the *Queen Mary* dropped anchor on my midriff and woke me to take certain drastic action about that spaghetti.

I have every reason to believe that Carter's forecast of the mutual reactions of tomato soup and tomato ketchup was entirely accurate, although it might have been differently expressed.

At any rate, my sympathies since have been entirely with Carter.

CORRESPONDENCE.

CRAWL TRENCHES.

Monmouth,

July 6th, 1938.

To the Editor, *The Royal Engineers Journal.*

SIR,

Buried as we are, here, in the depths of the country, it naturally takes some time for information of the latest developments of field engineering to reach us.

We have, however, recently heard rumours (which we are loath to credit) that the Fieldworks School at the S.M.E. states that it has borrowed from the Germans the method of connecting Rifle Pits by means of Crawl Trenches.

Jealous for the reputation of British powers of invention, we were immediately driven to get out and study our manuals, and in our *Text Book of Fortification and Military Engineering*, Part II, dated 1886, we have found as we expected the following paragraph to restore our sense of national pride :

> "Rifle Pits. 420. The advanced sentries when posted in the open are sheltered in small trenches and pits capable of holding from one man to a section of a company, as may be thought desirable. Communication may, if necessay, be established between any of the pits or trenches by means of any of the deeper forms of shelter trench, given in Chapter II, along which men may creep or crawl on hands and knees."

I trust, Sir, that, having read this letter, the Fieldworks School will cease to belittle the ingenuity of the Corps by giving credit for this "invention" to a foreign power, but will look more carefully into its manuals and in future justly attribute this idea to our forebears who anticipated the foreigner by over fifty years.

We remain, Sir, your humble servants,

The Royal Monmouthshire Royal Engineers
(Militia) S.R.

CONCRETE SURVEY PILLARS.

Fort Southwick,
Farcham, Hants.
20th July, 1938.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

A note from *The Empire Survey Review*, June, 1938, No. 27, Vol. IV, "A Winter Survey," may interest sappers. Talking of setting up concrete survey pillars, " . . . Portland cement with which was mixed a certain amount of calcium chloride to produce quick setting and offset the difficulties of using cement in weather below freezing-point."

Yours truly,
A. S. T. GODFREY, *Lieut. R.E.*

SOIL STABILIZATION AT LYDD.

Norman House,
105–109, Strand, W.C.2.
29th June, 1938.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

I have been interested by the article entitled " Soil Stabilization at Lydd " occurring in your issue for March. The work described is unusual and in many respects instructive, but I am of the opinion that there are too many omissions of detail to render it of maximum value.

Readers of *The R.E. Journal* look to the articles for instruction and advice regarding methods which may be adopted for the tackling of new problems. The work described in the article to which I am referring certainly comes under the latter heading, but I am afraid that the information given is hardly sufficient to enable one to get an adequate idea of what was done. The actual processes adopted have been very clearly described, but no idea can be obtained of the composition of the aggregate employed, nor that of the ultimate bituminous mixture.

It is stated that it was necessary to incorporate clay with the material which was found on the site but, while the grading of the

latter is given, no indication of the amount of clay which was added nor of the ultimate grading is provided.

It is well known that, when mixing aggregates of soil type with stable emulsion, incorporation of the bitumen is most uniformly and most readily obtained if the emulsion is diluted with water prior to mixing. Dilution ratios are given, but I would point out that they do not agree (see pages 118–120). Further, in spite of the fact that the emulsion was diluted, it was also found necessary to dampen the prepared road surface prior to mixing with such a quantity of water that the ultimate dilution ratio, water to emulsion, became approximately 7 : 1. The amount of liquid was about 20 gallons per square yard for a depth of stabilization of 6 in. This represents about 20 per cent. by weight in the mix. While fluid mixes are most satisfactory, I feel that general experience indicates that a mix as sloppy as this would be, particularly taking account of the fact that the aggregate contains a relatively large proportion of stone, is not desirable. It is to be noted from page 121 that drying-out of the road was relatively slow, while owing to heavy rain the seal coat was applied prematurely, the result being that the road has not stood up as well as was anticipated. I feel that this difficulty would not have occurred if the dilution ratio had been less.

The article is entitled " Soil Stabilization," but the grading of the initial aggregate shows that 7 per cent. was retained on a 1-in. sieve and 73 per cent. on a ¼-in. sieve. The work is, therefore, much more akin to the preparation, *in situ*, of a cold bituminous macadam, the binding medium being a slurry of clay and bitumen.

The general interest in work of this nature is rapidly increasing and we cannot be provided with too much detail regarding jobs of the type described. I should, however, like to suggest that Lieut.-Colonel Behrens should supplement the information he has already given us by a further article giving details of the ultimate composition of the aggregate prior to mixing and of the bituminous mixture after incorporation of the emulsion.

Yours faithfully,

E. G. WACE,

Brig.-Gen. (retired).

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.)

OFFICIAL HISTORY OF THE CANADIAN FORCES IN THE GREAT WAR. GENERAL SERIES, VOL. 1. AUGUST, 1914–SEPTEMBER, 1915.

By COLONEL A. FORTESCUE DUGUID.

Published by authority of the MINISTER OF NATIONAL DEFENCE (The King's Printer, Ottawa).

Price, $2.00. With a separate volume of Appendices and Maps, Price, $1.50.

This volume covers the period up to the entry of the 2nd Canadian Division into the war and the consequent formation of the Canadian Corps. It deals therefore with the operations in which only the 1st Canadian Division, under the command of General Alderson, took part, though it was reinforced before the Festubert offensive, owing to the heavy casualties suffered in the second Battle of Ypres, by the Canadian Cavalry Brigade, dismounted.

Those operations, which include Neuve Chapelle, second Ypres, Festubert and Givenchy, have of course been fully described in the British *Official History*. General Edmonds admits, however, in the preface to his 1915 volume, published in 1927, that, owing to distance, he had not been in direct contact with the officers of the 1st Canadian Division except its commander and G.S.O.1., and acknowledges his indebtedness for material Colonel Duguid had collected. One cannot therefore expect to find essential difference in the account given of the battles in the present volume, but rather an amplification of the story as we know it. Speaking broadly, one might say that General Edmonds deals with the story from the standpoint of the higher formations and Colonel Duguid from that of brigades, subordinate commanders and the troops. Naturally the Ypres battle, in which for the first time the Canadians were heavily engaged, and which was such a high test of their quality, occupies a large part of the book. It was a battle in which the higher command could exercise little control beyond ordering counter-attacks and pouring in reinforcements, while leaving it to the brigadiers and junior commanders to deal with the changes in the situation as it developed. It is specially interesting to follow how the two Canadian brigades in line reacted when the first gas attack swept away the French front and exposed their left flank to a depth of some three miles with only local reserves to fill the gap. Fortunately the troops had, in the main, escaped the gas cloud, but, even with that and the prompt assistance rendered by the British divisions in line on the right, it is evident that the enemy lost a great opportunity of exploiting the original success, whether because his plans were too rigid or because the bold front showed by the Canadian and British troops deceived him. Whatever the reason, we learn from one side the necessity of always being on the watch for an opportunity and having plans flexible enough to allow it to be seized; from the other, that the moral effect of stubborn resistance may far exceed its physical results. As regards the other battles

described, Neuve Chapelle did not give the Canadian Division much practical experience for, though assigned a part in the hoped-for stage of exploitation, that stage was never reached. At Festubert it learned something, and at Givenchy still more, about the meticulous preparations required in a set-piece trench-to-trench attack. In common with others, it had to pay a heavy price for the lesson, but it was well learnt.

Colonel Duguid must have in some ways been handicapped by the fact that the British *Official History* preceded his own. Perhaps it is because he does not wish to repeat what General Edmonds has written, that he confines himself in the main to narrative and makes few comments, leaving the reader to make his own deductions. His story is commendably clear and interesting and one welcomes an entire absence of carping criticism. It might, however, have helped the reader if the narrative had occasionally been interrupted by explanation of the implications of succeeding situations. The historian, I suggest, keeps himself too modestly in the background.

Perhaps the opening chapters, dealing with the raising and training of the first contingent, form the most valuable part of the book for British readers. The difficulties encountered, and the mistakes made and corrected as further contingents were raised, are instructive. As in the case of the other dominions, except in some respects New Zealand, the contingent was a voluntary, *ad hoc* effort, unconnected with the existing military organization in the country. All Canadians of military age were liable for service in the Militia for the defence of Canada, but this obligation was held not to apply to service overseas. The Militia organization was, therefore, not employed as a basis for the expeditionary force, though of course its equipment was used. Equipment, however, proved to be the source of trouble and revealed the absolute necessity of standardizing the military equipment of the constituent members of the Empire. The Ross rifle, an admirable target weapon, proved defective not only for active service conditions, but because slight alterations had been made in the size of the chamber irrespective of the specification laid down for gauging British ammunition. As a service weapon, the rifle was a failure, costly in lives and money and a source of friction between the Canadian Minister of Militia and British authorities. The Minister convinced himself that objections to the rifle were due to British jealousy and not until the troops took the matter into their own hands was his consent to re-arming obtained. Somewhat the same situation arose over the Canadian substitute for web equipment and entrenching tools. For all his enthusiasm, energy and drive, we gather that the Minister was hardly the ideal man for the occasion.

Colonel Duguid is evidently one of those to whom footnotes are anathema, for he makes no use of them but has elected instead to give us a volume containing 855 appendices. For the general reader this presents certain difficulties. For example, the order of battle at the time of the Ypres battle is given in Appendix 842, and is consequently not easy to find. Many of the appendices are, however, of great interest as, for instance, the history of the Ross rifle, but some are merely references to authorities.

The six sketch maps in the text are sufficient to illustrate the narrative and the appendix volume contains fourteen larger scale maps, those of the Ypres salient giving a good representation of the ground by well-executed stump shading.

C.W.G.

CHEMICALS IN WAR.

A Treatise on Chemical Warfare.

By Augustin M. Prentiss, ph.d., Lieut.-Colonel, Chemical Warfare Service, United States Army.

(McGraw-Hill Book Company, Inc., New York and London, 1937. Price 45s.)

This is the most important work on the subject of chemical warfare that has been published in the English language. Very few books on this subject have been

published at all; *Chemical Warfare*, by Brigadier-General A. A. Fries and Dr. C. J. West, is mainly a narrative account of the work of the Chemical Warfare Services of the American Army during the World War; *"Gas!" The Story of the Special Brigade*, by Brigadier-General C. H. Foulkes, is a narrative account of the activities of the formation which carried out the gas attack operations of the British Army during the same period. Neither aims at being a treatise on gas warfare in all its aspects, nor is there any other published work which does so. The work under review is, as it claims to be, a treatise on the whole subject.

There is probably no branch of the art of war that is so misunderstood and so misrepresented as chemical warfare. This is partly due to the circumstances of its first surprise introduction by the Germans in violation of the spirit of the Hague Agreement, which forbade the use of projectiles having the sole object of disseminating poisonous or asphyxiating gases; the disgust and hatred engendered by this treacherous act were reflected on to the mode of warfare itself. It was also partly due to ignorance of the nature of gas warfare and fear of its effects, and also to the conservatism and dislike of anything new which is prevalent among those who have been brought up in a profession in which tradition has a very powerful effect. One of the lamentable effects of this ignorance of the subject is the aptitude of the public to be swayed by the lurid pictures, drawn by sensational writers, about whole populations being liable to be wiped out in one night by gas bombs from aircraft. Any book which sets itself to dispel this ignorance is of value.

Colonel Prentiss's book does much more than that. It traces the development of chemical warfare from its beginning in the World War to the present day. It deals exhaustively with the scientific chemical and physiological aspects of the subject, giving in great detail descriptions of all the chemical substances which have been tried up to date. It deals with the technical methods by which chemical substances can be used as weapons of offence; with the tactical value of this weapon in military operations and how to obtain tactical results from it; with the means of protection, both individual and collective, of troops and of civil populations against gas; and with the military organizations built up during the war for the operations of gas warfare. In all these matters it describes the practice of each of the principal combatants in the World War. In short, it is a complete textbook on the subject.

Like other textbooks it is not a book for general reading. One cannot hope to sit down and read it through consecutively. It presents the subject in an orderly and scientific form, authoritative, impartial and accurate. Its great value is as a work of reference which should be in every R.E. library, now that the Royal Engineers have been entrusted with the duty of undertaking all chemical warfare operations, defensive and offensive, in the event of the Government deciding to make use of the latter in a future war. In fact any R.E. officer employed with a chemical warfare unit or establishment will find it indispensable for his education in the subject.

H.F.T.

AUSTRO-HUNGARY'S LAST WAR.

VOL. VII.

Edited by the AUSTRIAN MINISTRY OF NATIONAL DEFENCE AND THE WAR ARCHIVES. Vienna, 1938.

(Published by the *Militaerwissenschaftliche Mitteilungen.*)

The sixth volume of this work brought the history of the war up to the end of 1917: the present volume describes the final stages and the break-up of the Austro-Hungarian Empire. Thirty-nine maps and tables, contained in a separate volume, illustrate the operations on the different fronts.

The book opens with a picture of the world situation at the beginning of 1918. War weariness was beginning to show itself everywhere, but especially in the non-German portions of the Habsburg Empire. Bulgaria had hoped, in 1915, that a short

campaign, with Germany's support, would make her mistress of the Balkans. A long indecisive war left her disillusioned. Turkey had suffered heavily in the wars in Gallipoli, the Caucasus, Mesopotamia and Syria, and was on the verge of breaking up. A great shortage of food, clothing, and other necessaries was felt by all the Central Powers. Nor was a spirit of pacifism and defeatism entirely absent in the Entente Powers, and statesmen had to do their utmost to fight against it.

The Central Powers, and especially Germany, were anxious to get rid of their commitments on the eastern front. The " bread peace " of Brest-Litovsk with the Ukraine was signed on the 9th February, 1918, and the treaty of Bucharest, concluding peace with Rumania, was signed on the 7th May.

The policy of the Central Powers, at the beginning of 1918, was to deliver early and vigorous attacks on the west and south-west fronts and to compel their opponents to sue for peace.

The Bulgarian Army, which had been in the field, to all intents and purposes since 1912, was too exhausted to do more than stand on the defensive. The Turks, though relieved from Russian pressure, had to meet risings in Transcaucasia, as well as the British advance in Palestine and Mesopotamia. They were at the end of their tether as regards war material and hospital arrangements.

Even Germany, with 253 divisions, all told, at the end of 1917, had suffered very heavily from 3½ years of war. Her units were losing their mobility: there was a shortage of tanks and of oil fuel. Time was on the side of the Entente, and a purely defensive attitude meant defeat.

The employment of the Austro-Hungarian Army was a bone of contention between Austria and Germany. The Emperor Carl strongly opposed the sending of Austro-Hungarian troops to the western front to support the German Army. Eventually it was decided to make a vigorous attack on the Italian front.

The prospects of the Austro-Hungarian Army at the beginning of 1918 were anything but bright. Out of nearly 8½ million men called to the colours since the beginning of the war, 4 millions were no longer available. (Of these, 1,600,000 were prisoners of war.) The supply of reserves was practically exhausted. Prisoners of war, returned from Russia, were of little value for fighting. Food was desperately short, both for the army in the field and for the civil population. The supply of horses presented a serious problem: it was impossible to find fodder for them in the country. Lack of horses made many artillery batteries immobile.

After describing the Austro-German operations in the Ukraine in the early part of 1918, the main object of which was to obtain food supplies, the authors turn their attention to the Italian front, where the last great attack of the Austro-Hungarian Army had been planned.

Since the Caporetto disaster of the previous autumn, the opposing armies had faced each other on the Piave, the line continuing across the Asiago plateau to the north end of Lake Garda, and then northwards to the Swiss frontier. The Austro-Hungarian forces were divided into two army groups, the northern army group in the Tyrol under Field-Marshal Conrad, consisting of the 10th and 11th armies; the southern one consisting of the 6th and Isonzo armies, under Field-Marshal Boroevic. The date fixed for the attack was the 15th June: the ultimate object being a break through the Italian position at least as far as the Brenta, and, if possible, as far as the Adige. The attack was launched in the early morning of the 15th along the whole line. For a time it was successful; the Austrians succeeded in crossing the Piave and establishing themselves on the right bank. But the position, with the river behind them, and the bridges over it only maintained with the greatest difficulty, could not be held in face of strong Italian counter-attacks. The Austrian retirement began on the 22nd and was completed on the 25th. Some of the heaviest fighting of the war took place during the battle, and the casualties on both sides were very heavy. Between the 14th and 25th June, the Austrians lost 142,550 officers and men: far more than in the 11th Isonzo battle (110,000), which lasted twice as long.

The causes of the failure are attributed to various reasons, *e.g.*, disagreement between the army-group commanders, which led to an unsatisfactory compromise; heavy rain which brought floods down the Piave and played havoc with the bridges, and failure of the Austrian gas shells to do much damage. The behaviour of the troops was beyond praise.

The account next takes us to the operations in Albania during the spring and summer, and then to the Macedonian theatre of war in the summer of 1918. The Allies' plan of attack was awaiting the approval of the supreme war council.

On the French front, after the great March offensive had been held up, the Germans had not made much progress. Their losses between March and June amounted to 460,000 men. Two Austrian divisions, the 1st and the 35th, were sent in July to reinforce the Germans. Later on, in September, the 37th and the 106th followed. On the 15th July, the German Crown Prince's army-group began a big attack in Champagne, which was met by a counter-attack by the Entente armies between the 18th July and the 14th August. The 18th July was the turning-point of the war, and, with the Americans coming over in increasing numbers, the dice were heavily loaded against the Central Powers.

Turning again to the Balkans, General Franchet d'Esperey's attack on the Bulgar positions opened on the 14th September along the whole line. The Serbs, supported by the French, succeeded in breaking through at Dobropolje, and, in the course of the next few days, the whole Bulgar Army was in retreat, pursued by the victorious allies. Before the end of the month, Bulgaria had sued for peace, and the Austrians were driven out of Albania.

The collapse of Bulgaria was followed within a few days by that of Turkey. Driven out of Palestine by Allenby's Army, the Turks realized, with the occupation of Damascus by the British on the 30th September, that the game was up. They asked for an armistice, which was agreed to, under severe conditions, on the 30th October.

Next, we come to the final attack, from the 24th to the 28th October, made by the Italians, with the assistance of the British XIVth Corps and the French XIIth Corps, on the Austro-Hungarian front. The force under General Diaz's command consisted of 57 divisions with 7,000 guns. The force detailed for the "break through" comprised 22 divisions, formed into four armies: the 4th and 8th, and two new armies, the 10th under Lord Cavan and the 12th under the French General Graziani. The attack was launched on the Piave on the 27th. The Austrian front-line troops put up a gallant resistance, but the non-German troops of the Monarchy were infected with Bolshevik ideas and some were openly mutinous. The allies succeeded in crossing the Piave; by the 29th, the Austrian forces on that river were cut in half. On the 30th, the bulk of the Italian attacking forces were across the river, and the Austrians were in full retreat.

The Austrian High Command was unable to check the spread of mutiny amongst the troops. Many of the Hungarian, Czech, Slovene and Croat troops refused to fight, and marched back, plundering as they went. The Navy, too, was in an open state of mutiny. The Emperor Carl's only hope was to ask for an armistice and to accept any terms that the allies were prepared to offer. Several days elapsed before the necessary arrangements could be effected.

The armistice negotiations were begun on the 1st November at Villa Giusti; Lieut.-General Badoglio being at the head of the Italian delegation, and General Weber at the head of the Austrians. The clause on which the allies insisted, that Entente troops were to be allowed free access into Austria for operations against Germany, led to the Emperor Carl resigning the command of the army and handing it over to Field-Marshal Koevess. Hostilities ceased at 3 p.m. on the 4th November, a week before the armistice with Germany was signed.

The authors conclude the work with a brief retrospect of the whole war. In 1914, the Central Powers were faced with a hostile combination of countries greatly superior to them in numbers on land, vastly superior to them in sea power, and having

at their disposal the huge industrial resources of the United States. This superiority increased with the passage of time. On the other hand, the Central Powers had the advantage of interior lines. As regards unity of command, there was a good deal of friction between Falkenhayn and Conrad. After Falkenhayn's fall, and with the introduction of a supreme command, there was a better understanding between the Austrians and the Hindenburg-Ludendorff combination.

The suggestion has been made that the Central Powers would have done better if they had directed their main attack against Russia in the first instance instead of making France their main objective. The authors of the last chapter are opposed to this view. In order to inflict an overwhelming defeat, it is necessary either to encircle the enemy's whole force, or to drive it against the sea or a neutral frontier. In the case of Russia, such a procedure was impossible, although several complete victories were won over large Russian forces. Even after Russia had dropped out of the war, the Central Powers were obliged to retain a large force in the Ukraine.

It is considered that Falkenhayn made a mistake in December, 1915, in not allowing the Bulgars to cross the Greek frontier and pursue the retiring allied divisions to Salonika. Had they done so, it is possible that Rumania would not have entered the war on the side of the allies. The presence of the Salonika force remained a permanent threat to the Austrians in their campaign in North Albania.

One cannot close the book without a feeling of sympathy for the Austro-Hungarian empire and its brave army in its struggle against overwhelming odds, and its final disintegration.

A.S.H.

WEHRGEOLOGIE.

By Dr. KURD VON BÜLOW, Professor and Chief of the Mecklenburg Geological Survey, with the assistance of Major Dr. WALTER KRANZ of the Württemberg Geological Survey, Major and Civil Engineer ERICH SONNE, and Professors Dr. OTTO BURRE and Dr. WILHELM DIENEMANN of the Prussian District Geological Survey.

(Quelle & Mayor, Leipsig. Price 5.10 Reichmarks.)

There is no book of this kind in English. One of the volumes of *Work of R.E. in the European War*, 1914–19, entitled "Geological Work on the Western Front," by the "War Geologists," the late Lieut.-Colonel Sir Edgeworth David and Captain King, gives in 69 pages, with a large number of maps and diagrams, an account of the geological work done. The book under review, of 170 pages and many coloured diagrams in a pocket, aims at telling geologists what is required of them in war, and instructing soldiers in the elements of geology and telling them what geologists can do to assist in the operations of war. Among other things it has a chapter on "Rocks and Building Material," showing what rocks, etc., are most useful, how they are obtained and prepared for use. There is even advice as to the best soil for cemeteries. It is a book every engineer officer should read.

J.E.E.

A SHORT GUIDE TO THE IMPERIAL WAR MUSEUM, LAMBETH ROAD, S.E.1.

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

The Imperial War Museum was moved to its present site in July, 1936. This *Short Guide*, recently published, is not a catalogue, but contains a short description of the principal contents of each of the galleries in its present building. It is illustrated with photographs of a few typical exhibits. It is a useful *vade mecum* for any visitor, and an encouragement—were such necessary—to all to visit it.

E.V.B.

MAGAZINES.

CIVIL ENGINEERING MAGAZINES.

The following articles which have recently appeared are recommended as being of special interest to Royal Engineers.

(1) *Fire Precautions in Electrical Power Stations.*

"Journal of the Institution of Civil Engineers," June, 1938.
"Journal of the Institution of Electrical Engineers," September, 1937.

This subject is important from an A.R.P. point of view owing to the large quantities of oil used for insulation and lubrication.

The authors discuss the relative merits of inert gases, saponine foam and plain water jets and sprays.

(2) *Ventilation with air-conditioning in Modern Buildings.*

"Proceedings of the Institution of Mechanical Engineers," Vol. 135, May, 1937, p. 171.

The author describes the mechanical means employed with calculations and illustrated examples of typical installations.

An excellent paper.

(3) *Modern Developments in Tractor-Drawn Excavator Equipment.*

"Proceedings of the Institution of Mechanical Engineers," Vol. 137, December, 1937, p. 345.

Various types are briefly described, with ten illustrations.

(4) *Diesel Traction on Railways.*

"Proceedings of the Institution of Mechanical Engineers," Vol. 137, December, 1937, p. 125.

An analysis of operating characteristics is given, and steam and diesel traction compared.

(5) *Lamps and Eyes.* "The Engineer," July 15th, 1938, p. 77.

This article indicates the modern tendency towards higher standards of artificial lighting, and illustrates the importance of ensuring that the scales laid down in the *Barrack Synopsis* are fully maintained.

T.C.W.B.

RASSEGNA DI CULTURA MILITARE.

(*March*, 1938.)—*La difesa anticarro negli eserciti francese e tedesco.*

In this article a comparison is made between anti-tank measures (both active and passive) adopted in France and Germany.

The German Army has special units detailed for anti-tank defence, and in that respect has the advantage over the French in being able to carry out anti-tank measures more rapidly.

As regards armament, the Germans have a 37 mm. anti-tank gun firing an explosive shell, while the French have adopted a 25 mm. armour-piercing non-explosive shell. The French have twenty 25 mm. anti-tank guns per regiment; the number of guns is approximately equal in a French and German division. The question arises whether it is better to have the more powerful 37 mm. gun or the more mobile 25 mm. gun.

NOTE.—This article would appear to have been written before the re-armament of the French infantry with the 37 mm. gun had been taken in hand.

La guerra cino-giapponese.

Colonel Oxilia continues his account of the Sino-Japanese War, dealing with the period from July to October, 1937. The Japanese made considerable progress everywhere on the northern front, in spite of the Chinese resistance, and added to their previous conquests interior Mongolia, Suyuan and almost the whole of Shansi.

On the Shanghai front the Chinese put up a stubborn resistance, and the operations assumed the aspect of position warfare.

Strade e motori: mentalità della motorizzazione.

Lieut.-Colonel Di Marco concludes his article on motor roads with a eulogy of the new "autostrade," and he describes a system of traffic control that will enable them to be used to the best advantage for military purposes.

La valorizzazione dell'impero.

Captain Lucca concludes his article on the economic development of the Italian Empire in East Africa.

On the occupation of Abyssinia by the Italians a vast amount of building work was necessary to make up for the destruction done during the war. Addis Ababa, for instance, had to be almost entirely rebuilt. A large number of labourers—masons and others—were enlisted in the militia and sent out to Abyssinia for employment on road and building construction. Staple industries, such as cotton, flax, gum, sugar and tobacco are being developed by the natives under Italian control. Investigations are being made into hydro-electric power and the mineral products of the country. Slavery has been abolished, sanitation is being developed, schools have been started both for Italian and native children.

Sulle possibilità attuali dei radiocollegamenti campali.

Major-General Sacco discusses the relative value of long and short waves for radio communication in the field. The general conclusions that he comes to are that micro-waves and ultra-short waves, together with photophony, will probably be extensively used in radio communications in advanced positions. For strategic purposes either short or very long waves will be mainly used, whilst in colonial work short waves will be found most suitable.

Le teleferiche militari con funi ancorate ad entrambe le estremità. By Lieut.-General Bellusci.

Chapter VI gives a summary of all the formulæ worked out in previous chapters relating to ropeways anchored at both terminals.

(*April*, 1938.)—*Cino e Giappone.*

Marshal Caviglia gives an account of the rise of Japan as a great power, and of the Russo-Japanese war of 1904, which he followed in the capacity of a military observer accredited to the Japanese Army.

Studi di strategia sulla guerra mondiale.

General Ago describes the Schlieffen plan for the invasion of France, and shows how the conditions for its success failed to materialize in 1914. These were a feeble resistance on the part of Belgium, and a very slow Russian advance, neither of which worked out as expected. The failure of Italy to co-operate in the Triple Alliance greatly handicapped the Central Powers.

According to General Ludendorff, the correct strategy would have been for Germany to have directed the first attack on Russia. If their country had not been invaded, the

French would not have fought whole-heartedly to relieve the armies of the Czar. Although only a small country, the opposition of Belgium would not have had to be counted with, and there would—for a time at any rate—have been no British intervention. A big success against Russia would have kept Rumania out of the war. Even after the battle of the Marne it would not have been too late to direct the main attack against Russia.

La conquista delle regione dei laghi equatoriali. By Lieut.-Colonel Terragni.

The first instalment of a description of the Italian operations in the region of the equatorial lakes in the Galla country north of Kenya.

In January, 1936, the Italian force, based on Mogadiscio, had occupied Neghelli, over 900 km. inland. The occupation of Neghelli was a direct threat to Addis Ababa (lying to the north of it), and the Abyssinians collected a large force to oppose the Italian advance.

To prevent the Abyssinians from breaking away to the south into Kenya, Brig.-General Geloso, in command of the 1st special division, decided to move south-west to Mega before advancing northwards, although this involved a detour of some 700 km. in an almost unknown country.

The problem that faced the Italian commander was to arrange for supplies, munitions and stores, for a force of 12,000 men, with artillery, for 45 days. At the same time, fuel had to be provided for 750 lorries. The requirements in petrol were estimated at 250 tons, but 500 tons were indented for, of which 300 were to be sent to Neghelli, and the balance to Dolo on the Juba river.

It was found economical to use naphtha-burning American caterpillars with trailers, to save petrol, but these vehicles were too slow to take part in a general advance. (*To be continued.*)

Sulle possibilità attuali dei radiocollegamenti campali.

In this instalment Major-General Sacco deals with the disturbances that may affect a radio service: atmospheric disturbances and interference by the enemy or by other means. He also deals with cipher messages and describes cryptographic machines.

Marshal Badoglio, in his book, points out the necessity for lightening the work of the wireless service, so as to leave more initiative and liberty of action to commanding officers. The radio service should be reserved for urgent and important instructions only.

Brevi note in materia di carte topografiche. By General d'Espinosa.

A note on recent developments in map making for military purposes.

Le teleferiche militari con funi ancorate ad entrambe le estremità. Part II. By General Bellusci.

This article gives examples relating to ropeways, worked out by means of the formulæ given in part I.

(*May*, 1938.)—*Cino e Giappone.*

Marshal Caviglia concludes his article on China and Japan. He gives a detail of the encroachments made by Japan in China since 1931, and of the benefits that Manchuria has received under Japanese control. The only powers, other than Japan, that could have introduced law and order into China were Great Britain and Russia. Japan can carry on a war in China at a fraction of the cost that other nations would have to incur, since the Japanese can live entirely on the country.

The movement that brought on the downfall of the Chinese dynasty in 1912 started in South China. It was encouraged by American missionaries and by Chinese students educated in the States. The government that existed, to some extent, under the Manchu dynasty, disappeared completely, and the only power that could rescue China from anarchy was Japan.

The writer foresees, in the future, a huge empire of 500 million inhabitants, uniting China, Manchuria, Mongolia, Eastern Turkestan and Tibet. Its influence will raise a serious problem for the white races, and especially for Australia and Oceania.

Una cronaca portoghese sulla spedizione di Don Cristoforo da Gama in Abissinia.

Professor Naldoni-Centenari concludes his account in this number. The three main events of the story are: (1) Don Cristoforo's victories over the Moors, (2) the Portuguese defeat and the murder of Don Cristoforo in August, 1542, (3) the battle of Lake Tana and the return of the Portuguese to India.

La difesa controaerea degli eserciti moderni.

In discussing anti-aircraft defence, Lieut.-Colonel Camera confines his article to anti-aircraft artillery. An army corps has allotted to it three batteries of A.A. guns: a motorized division has one or two 20 mm. A.A. machine-guns. Three batteries would be quite insufficient to protect an army corps on the march along several roads, but, theoretically, they would cover the ceiling, at a height of 4,000 metres, of an army corps in attack or defence.

Various points mentioned are the following: a modern anti-aircraft gun must necessarily be heavy, to stand the strain of a charge large enough to give an initial velocity of 800 to 900 metres per second. The length of the gun must be from 45 to 50 calibres, and the gun will require freq uent relining. Guns mounted on mechanically propelled vehicles are of little use; they must fire from a pedestal mounting with a cross-shaped base, in order to obtain a horizontal sector of 360 degrees and a vertical sector of 90 degrees. The distance up to which an aeroplane can be seen, even with the aid of optical instruments, is not more than 6 km. (roughly 4 miles).

La conquista della regione dei laghi equatoriali.

Lieut.-Colonel Terragni continues his account of the conquest of the region of the equatorial lakes. He describes the concentration of the expeditionary force at Neghelli in May and June, 1936, and the advance into the Borana country. The conquest of Moiale, where the road from Addis Ababa enters the British colony of Kenya, gave the Italians control over the Borana country.

La marina militare della Francia.

Lieut.-Colonel Varanini, quoting from some articles in *La France Militaire*, considers that the French Navy is behind the Italian Navy as regards rapidity of construction. The 25,000-ton battleships *Dunquerque* and *Strasbourg* are taking five years to build, and the 35,000-ton ships *Richelieu* and *Jean Bart* will not be ready till 1939.

Great Britain and Germany are both well ahead of France in rapidity of construction: the projected increase of the British fleet allows of an additional expansion of the German fleet, which is limited by treaty to 35 per cent. of the British.

France has dropped from second to fourth place in the navies of Europe.

Difesa controaerea territoriale.

Lieut.-General Guidotti describes some recent improvements in anti-aircraft gunnery.

Cenni descrittivi e dati di calcolo relativi a una torre per addestramento paracadutisti.

Lieut.-Colonel Calligaris gives a full description of a tower designed for training parachutists.

The tower is a steel framework, square in plan, and tapering from 4 m. × 4 m. at the base to 2 m. × 2 m. at the top. The full height from the ground to the spring-board at the top is 55 metres; the height of the main framework is 51 metres. The latter is made up of 17 sections, each 3 metres in height, and suitably cross-braced. The whole structure can be taken to pieces in a relatively short time.

A description, with sketches, is given of the joints between uprights, horizontals, and diagonals. There is an electric lift running to the top of the building, as well as a light ladder connecting each section with the one above it.

Stability is ensured by means of an inverted bracket, loaded with sandbags, running all round and rigidly fixed to the base.

The methods used in calculating the strength of the structure are indicated. A wind pressure of 200 kg. per square metre has been allowed for, and a factor of safety of 3 has been taken into account.

Brevi note in materia di carte topografiche.

General d'Espinosa concludes his article on maps and their requirements from a gunner's point of view.

Le teleferiche militari con funi ancorate ad entrambe le estremità.

General Bellusci gives further examples of cableways anchored down at both ends.

(*June*, 1938.)—*Gli agressivi chimici ed i mezzi di difesa contro di essi.*

Sig. Parravano traces the development of chemical warfare from its introduction by the Germans in April, 1915, to the present day, and of the means of countering its effects and the improvements made in the design of gas masks.

Precisazioni sulla guerra di Spagna.

The writer criticizes certain statements made by French and Belgian writers on events that have taken place in Spain. It was stated that in the battle of Guadalajara in March, 1937, a motorized column of Nationalists was attacked by low-flying Russian aeroplanes, as a result of which vehicles and guns were abandoned and troops fled in a panic. This is completely denied.

The writer also considers that the use of tanks has not been on a sufficiently large scale to give any reliable conclusions as to their use in future warfare.

Come combatte la Honvéd. By Colonel Mattioli.

A review of the new Hungarian tactical regulations, in which the general principle is that of utilizing the national characteristic for attacking the enemy, even if in superior force.

La conquista della regione dei laghi equatoriali.

Lieut.-Colonel Terragni continues his article. After the conquest of Mega and Moiale, the next objective of the Italian force operating in Somaliland was Irgalem, to the north along the so-called imperial road—which proved to be an indifferent mule-track. In order to reach Irgalem it was necessary to follow the shortest route, to economize both food and petrol. This involved certain risks: the country was broken and mountainous, thickly wooded in parts, and the strength and dispositions of the enemy were unknown. On the 26th July, the Italian force occupied Agheremariam, in the enemy's zone of defence. On the 16th August, a reconnoitring force sent out from Agheremariam came into contact with an Abyssinian force at Giabassire and was obliged to fall back, but it caused some heavy losses amongst the enemy.

I proiettori nella difesa antiaerea.

Major Martinez shows the great advantage to be gained by the use of searchlights in anti-aircraft defence. It is true that searchlights may, to some extent, give away the position of a vulnerable point, but nowadays an airman will know his approximate position with relation to his objective in any case.

The intensity of light of a beam has increased steadily in recent years. At the beginning of the World War a normal searchlight was one of 90 cm. with a 100-ampère arc, giving a beam of 60 million candle-power. The latest type of searchlight is one of 120 cm. with a beam of over 500 million candle-power, its range being about three times that of war-time stations.

The cost of one of the latest types may vary from 300 to 500 thousand francs, according as a sound-ranging apparatus is included or not. The cost of operating it is trifling compared with that of the ammunition expended in an air raid. In fact, the economy resulting from more accurate shooting would in time cover the original cost of a searchlight installation. An airman coming into the beam is, moreover, completely dazzled and can see nothing of his target.

Le inclusioni estranee quali agenti di decomposizione delle polveri infumi. By Dr. Tonegutti.

The spontaneous explosion of ballistite that occurred on the Italian battleship *Marco Polo* in the Bay of Chemulpo in 1904 led to a series of experiments being made

to ascertain what extraneous substances in nitro cellulose powders caused the deterioration of the latter.

Dr. Tonegutti describes the experiments made with various substances, and the conclusions arrived at are that pyrites are the most dangerous impurities that can be introduced into smokeless powders. Zinc is also harmful; as regards iron and aluminium the findings are not very definite.

Attività stradale del genio militare in A.O. (Eritrea).

Captain Balzac gives an account of the road construction carried out by the engineers in Eritrea during the Abyssinian campaign. The main road ran in a southerly direction from Asmara towards Quoram and Dessie, another road ran in a westerly direction towards Lake Tana, and a third road formed a cross connection between the other two. The labour available for the work consisted of battalions of engineers, civil labour units, and labour furnished by contractors. The specification worked to was as follows: width of metalled portion not less than 6 metres, widened at curves; maximum gradient 7 per cent.; minimum radius of curves 20 metres, with gradual super-elevation. Bridges were designed to carry loads of 15 tons and the weight of a crowd (500 kg. per sq. metre) on the footpaths. The road surface was treated twice with bitumen.

As regards out-turn of work, it was found that, owing to climatic reasons, Italian labourers could only do 40 per cent. of the work that they could turn out in Italy. Native labourers had only a quarter of the efficiency of Italian workmen.

The writer describes the country through which the main road passes, the difficulties that had to be overcome both in survey and in construction, the shortage of supplies, the intense heat and the trying climate.

The cost of the roads varied between 500 and 900 lire per metre run (£10,000 to £18,000 per mile), all materials such as iron and steel, timber, bitumen and cement having to be imported, and having to pay sea freight, Suez Canal dues, and cost of transport up country.

Le teleferiche militari con funi ancorate ad entrambe le estremità.

Lieut.-General Bellusci works out two examples of military ropeways, taken from actual practice on the Italian front.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*March–April*, 1938.)—*Étude expérimentale des ouvrages voûtés en beton armé.* By Lieut.-Colonel Kilian. A study based on an investigation into the causes of certain defects found in the arched concrete roofs of some hangars built at Rheims in 1932. Cracks appeared in these roofs about a year after their completion, and an enquiry was ordered. The spans were large—56 metres—and the arches were thin. It was found that they were extremely sensitive to small variations of temperature.

The author gives a careful analysis of the factors which affect such structures.

Les explosifs employés dans l'industrie. By R. Forquin. A rapid review of the explosives available to-day for military use in the field.

Dunkerque: Œuvre de Vauban. By J. Duvivier. A short account of the growth of Dunkerque as a fortified town. It fell into Spanish hands by conquest in 1652, and into English hands in exchange for naval assistance in 1658. The financial embarrassments of Charles II caused him to sell the town back again to Louis XIV in 1662. Vauban was then charged with overhauling the fortifications and enlarging them into a fortress of the strongest type. Louis XIV took a great interest in this development.

In the Great War, Dunkerque was an important base for the British Naval Air Force, as well as a key-point in the water defences of Northern France.

Transport du matériel d'équipage de ponts dans l'armée Américaine. An analysis of an article in the *American Military Engineer* for September–October, 1937. It describes, with photographs, a two-wheeled trailer adopted by the American Army for the transport of pontoons and trestles. It is adaptable for carrying pontoons or trestles or super-structure; the draw-bar being telescopic to allow for the longer loads. The trailer itself weighs about half a ton, and its load weighs from 1½ tons (for pontoons) to 1¾ tons (for super-structure).

(*May–June*, 1938.)— *Àpropos de la locomotive "Garrat double Pacific" des chemins de fer Algériens.* By Captain Tricaud. The description of a new type of double locomotive built for the Algerian railways and recently exhibited at the Gare du Nord, Paris. The author takes the opportunity of giving an historical summary of locomotive history from the earliest days. The monster engine is specially designed for the steep gradients and sharp curves of the Algerian system, and can haul a load of 540 tons at 60 miles an hour on the level, or at 15 miles an hour on a gradient of 1 in 50. It runs in either direction and dispenses with turn-tables. Its military uses for heavy troop movements, etc., have been borne in mind, and many different units complete with their equipment can be dealt with.

Pont suspendu de 4 tonnes à Entremont-le-Vieux. By Captain Corbieres. A suspension bridge, built by a detachment of the 4th Regiment of Engineers at Entremont-le-Vieux over the little river Cozon. The distance between abutments was about 150 feet, and the roadway some 90 feet above the river bed. There was nothing very notable about the work, but all the material was prepared locally, and the weather conditions were bad. The working party consisted of 6 officers and 112 other ranks, divided into two shifts, working from 6 a.m. to noon, and from noon to 6 p.m.

Suggestion au sujet des accès de l'abri-caverne. By Colonel Dubois. A proposal for the better protection of the entrances to mined dug-outs, and a wider spacing apart of these entrances, so as to minimise the damage to both by one explosion. Briefly, the suggestion is to make the entrances in the bottom of a false communication trench, and provide them with a burster-layer around the orifice. The author does not explain how he proposes to fix the gas-proof protection to these horizontal openings; presumably these would have to be lower down.

La fortification en Autriche. By Lieut.-Colonel Montigny. Based on articles by Generals von Steinitz and von Aarenau, which appeared in recent numbers of the *Militarwissenschaftliche Mitteilungen* (and already noticed in *The R.E. Journal* in March and June, 1937). A short account is given of the Austrian fortifications before the war, and the part they played in 1914–18. Conrad von Hotzendorf placed greater faith in a forward offensive against Russia than in costly fortifications, for which Austrian budgets could make little provision. The Italian frontier was furnished with more up-to-date works than the other Austrian frontiers, and some of these were subjected to very heavy bombardment. On the whole, fortresses were looked upon by the Austrian High Command as traps for shells and too expensive in garrisons and armament. Yet they played their part in absorbing much of the energies of their enemies; more so than in any other country.

W.H.K.

REVUE MILITAIRE GÊNÉRALE.

(*April*, 1938.)—*France-Brésil.* By General Gamelin. An address given at a recent Franco-Brazilian reunion.

La Guerre de l'unité nationale roumaine. By General Constandaché. The second part of this outline of the Rumanian campaign of 1916, describing the battle of Bucharest, "the culminating point of the first phase of the war of liberation conducted by Rumania against the Central Empires." The fighting covered the period 23rd November–3rd December, 1916. The Rumanians were nearly everywhere

outnumbered by the superior concentration of the Germans, Austrians and Bulgarians; their Russian allies disappointed them. Von Mackensen's Danube Army, supported by Bulgarian and Turkish divisions, was threatening the Rumanian left flank, very weakly held, while von Falkenhayn with his Ninth Army was concentrating for a drive eastwards. Mackensen crossed the Danube with ease, and the Rumanians hurriedly collected a "mass of manœuvre" (of no great strength), which was intended to strike at von Mackensen while the other Rumanian armies held off the Austro-Germans in the north and west. There was the opportunity to strike an effective blow at the scattered German forces, and the Rumanian Command tried to seize the chance, but it lacked the means, and its operation began too late. The unfortunate capture of two Rumanian staff officers with an order from the First Army gave away the whole plan.

Transport difficulties were immense; the "mass of manœuvre" was itself defeated in detail. The Russian assistance was half-hearted and ill-directed. The defeat laid Bucharest open; it was evacuated and left for the Germans to enter on 6th December. The Rumanian armies retreated into Moldavia.

La Guerre d'Espagne: Technique et tactique des forces de l'air. By General Armengaud. There have been many articles of this nature in the military reviews, all drawing attention to the new employment of air forces as instruments of terrorism. What we have to realize is that in Spain we are witnessing the practical training of German and Italian air units at the expense of the unfortunate Spanish population. Complete units of German and Italian airmen are employed on General Franco's side; their whole equipment and staffs and reserves are of those nationalities. New types of machines are sent to Spain to be tried out. The units are regularly relieved, in order that a large number of war-experienced officers and men may be passed through their respective air forces.

General Armengaud is a well-known expert, and this account of what he has seen in Spain is of wide interest. On the Spanish Government side, the air forces are manned almost entirely by Spaniards; there are very few individual volunteers of other nationalities. The machines are chiefly Russian with American engines. The pilots are very young and are animated with the strongest enthusiasm for their cause; but it is difficult for them to contend with the continually refreshed units which support General Franco.

Les Écoles de perfectionnement des sous-officiers de réserve. By General Niessel. The signing of pacts, agreements and treaties having proved to be of no avail to-day, General Niessel reaffirms the possession of force as the sole means of obtaining peace and the respect for rights. With her system of one-year service, France's mobilized army will be an army of reservists, and its value will be that of the reservists. In order to improve the quality, schools of training, founded at first in Paris in 1928 by some keen reservist officers, were formed for the purpose of educating the reservist N.C.O's, and these rapidly spread all over France, until their number reached 3,484 last year, with 93,400 members and 45,000 regular attendants. These numbers are but a small proportion of the total number of reservist N.C.O's required for mobilization, and the author, who was himself responsible, as Inspector-General of the training schools for officers of the reserve, for much of the success of these junior schools, urges further expansion.

L'Autarcie. By M. Camille Rougeron. An article on the economic disadvantages which are incurred by the policies of the totalitarian States. Self-sufficiency and the multiplication of synthetic products are not good substitutes for purchase in the open markets. The writer quotes Switzerland, Denmark, Norway and Sweden as examples of countries which have happily overcome their lack of certain raw materials by seeking them elsewhere, at prices far less than those of the synthetically forced substitutes of the dictator-ridden States.

L'Armée Japonaise et le théâtre d'opérations Chinois. By Captain Sereau. A short

discussion of the question whether the Japanese are likely to penetrate farther into the heart of China, or whether they will content themselves with the possession of Nankin, Hankow, Shanghai and Canton. The parallel of 1812 and to-day is not very apparent, and the Japanese are level-headed people. The commercial control of those parts of China which can be readily developed will possibly limit the Japanese advance, but other forces and the chain of events may prove stronger than the Japanese expect.

(*May*, 1938.)—*Pour relever notre aviation.* By General Armengaud. A plea for a much stronger French air force. The writer points out that Germany has about three times as many aeroplanes as France, and the disparity is growing. Events in Spain and China have shown that destruction of the civil populations by air will be the principal feature of future warfare—in spite of official denials that any but military targets are aimed at—and that retaliation will be the only effective deterrent. General Armengaud urges that the air forces should be immediately expanded, even at the cost of the Army and Navy. The misuse of the petrol engine has indeed brought about a vicious circle.

La crise de la Marne. By Lieut.-Colonel Malcor. A study of the Marne and the criticisms on it according to the German official accounts. This is a sequel to the same author's article on the genesis of the Marne in the October number.

The events are well known. The operations got beyond the control of the Higher Command which had deviated from the settled plan of invasion, and which remained too far behind to keep in touch with the rapidly moving armies. Lieut.-Colonel Hentsch, the scapegoat of the disaster, on his mission to the Armies, was "morally shaken" by what he saw, and in endeavouring to make up for the uncertainty and absence of control, he performed the functions of the Higher Command.

The account of the confusion into which Moltke's headquarters were plunged is clear, and since the narrative is based on the official German history it should convince any reader that Germany was defeated on the Marne, if there are any still in doubt. It was a triumph for Joffre that, after a fortnight's retreat, he was able to muster an army of manœuvre to strike against the German right flank, and take immediate advantage of the error into which Moltke had fallen. Had the Allied troops been less exhausted by the marching, the German right wing might have been smashed instead of driven back.

La politique mondiale du pétrole. By Captain Grandclément. An interesting article on the distribution of petrol sources throughout the world, and the manner in which certain nations, themselves deficient in natural supplies, are making up for these deficiencies Three-quarters of the world's supply comes from the two Americas. The bulk of the remainder is controlled by Great Britain, Holland, Rumania and France. (In this there is much food for thought. With such a control over the petrol supply, it ought to be possible for the peace-loving nations, if they were so minded, to put a stop to all aggressors.)

Germany is making headway with her synthetic productions, but the author does not think she can do more than supply her peace-time needs; she must rely on outside sources in time of war. Japan is almost totally dependent on outside sources.

Details are given of the distribution and output of the French refineries.

Les forêts de l'Ile de France. By Captain Thoumin. The name Ile de France applies to the region between the Marne and the Oise, bounded on the west by the Seine, and with no defined boundary on the east. The author describes the topography of the district, and especially its woods and forests, from the point of view of the military geographer. He refers to the military value of the woods as masks and obstacles.

(*June*, 1938.)—*La Direction de l'arrière pendant la guerre de* 1914–18. By General Raguenau. The recently published Volume XI of the official history of the French

Armies during the Great War, dealing with the services of supply, transport and communication, is the basis of this article. An outline of the vast organization of these rearward services is given, and details of the large number of officers and men absorbed in their maintenance. The French service is more economical in the staffing of such departments than other armies; as an example, the author remarks that the *Direction de l'arrière* was represented at G.Q.G. by 29 officers at the beginning of the war, afterwards increased to 61, while similar services on the British staff required 300 officers. This disparity was always noticeable between the French and British armies, and a study of the organisation and staffing of departments would be well repaid if more economy in staffs could be achieved.

But beyond the economical aspect of this subject, there lies a valuable field of study in the vulnerability of lines of communication. When the Allied offensives forced the German armies back in 1918, the enemy's lines of communication, both axial and lateral, became so restricted and congested that the Germans could not have maintained themselves many days longer when the Armistice saved them.

Commandement unique et ministère unique de Défense nationale. By J. Le Clère. Another article on this much discussed topic. Some solution of the problem of unified command in time of war must certainly be found, and the sooner such command is established, the sooner will much duplication, even triplication, of effort and expenditure be avoided.

The author urges the economical view.

La Guerre avec les Abyssins. By General Rouquerol. The memoirs of a Russian ex-officer, Colonel Konovaleff, who was employed in the Public Works Department at Addis Ababa for several years, and who was the only European permitted to accompany the Abyssinian forces in the field, provide an interesting view of the late campaign from the Abyssinian side. The chief difficulty of the Abyssinians was the lack of cohesion among the twelve Ras, some of whom were fiercely proud, and unwilling to accept orders from the Emperor; others were ignorant and refused to believe that their primitive forces would not fall upon the Italians and slaughter them like sheep. Their pathetic efforts to fortify their frontier were ludicrous; they lacked the spirit to defend position after position. Their mountainous country could have furnished plenty of opportunity for guerrilla warfare, which, if it could not have prevented the Italian conquest, would have made it costly in the extreme. But Abyssinia placed much reliance on the assistance of the League of Nations. Had she not justification in expecting protection?

Notes sur l'infanterie. By Lieut.-Colonel Lançon. The author has ideas of his own on the kind of infantry required for modern war, which do not altogether follow the present regulations. Much of the article is devoted to idealistic principles, and nothing very definite in conclusion is arrived at. Elasticity of movement, lighter equipment, less rigidity in manœuvre and intelligent use of fire-power are points which receive elaboration.

Moyens d'Europe en terre d'Afrique. By Captain Grimaux. A short discussion of the problem of warfare on European lines carried on in Africa. A campaign on the southern shores of the Mediterranean is envisaged, but only in the merest outline, and with reference to no particular countries.

Végèce et l'Instruction des cadres et de la troupe dans l'armée romaine. By Captain Reyniers. It is refreshing to turn from the congested study of modern systems to the works of the remote past, and compare the methods adopted long centuries ago. Vegetius is known only by his writing, but he was evidently a soldier of experience. His work on the training of the Roman army at the end of the fourth century was largely based on that of earlier writers—a singular fact in view of the scarcely-developed state of reading and writing.

Captain Reyniers gives us an insight into the simple, practical system of training

the young Roman soldiers; many of their methods have persisted to this day. A simple way of getting across rivers which were otherwise unfordable appeared to be the cutting away of the banks and "bleeding" the river until it became fordable. Such methods could only have been applicable in the wide plains.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*April*, 1938.)—*Pages d'histoire de l'Armée Belge. Dixmude, 17 Oct.–10 Nov., 1914.* By Major Wanty. The fourth instalment of this vivid account of the defence of Dixmude. There were plenty of exciting episodes in those early days, and the narrative does justice to them all. Sudden appearances of enemy patrols behind the outposts were frequent; and the encounters afforded occasion for many a smart action. Prisoners were taken and lost again on both sides. The lack of reserves and the critical state of the vast battle now going on in Flanders made it almost impossible to maintain the daily supplies, and many of the Belgian troops had no food for two days or more.

The credit of the defence of Dixmude belongs largely to Admiral Ronarc'h and his marines, but the Belgian troops bore no less a share than their French comrades in the confused fighting for the bridgehead.

The narrative covers the events of October 25th to November 6th, 1914.

Renseignements sur l'ennemi et obéissance passive. By Captain Jacques. A valuable study of the problem of military obedience to orders; that is to say, the carrying out of the commander's will. "Among those who receive an order," says the author, "there are those who simply have to translate it into action, into movements, or into commands; others have to disseminate it, translate it into fresh orders, distributing to different executants the part which they have to play." To-day, the latter category has greatly increased in number.

"In the transmission of an order, three factors come into play: (i) the will, or plan of the authority who gives the order; (ii) the personal part of the individual who distributes it; (iii) the doctrine which is the link between the two."

Intelligence, on the other hand, reaches the higher authorities through diverse lower channels. Each chief therefore receives intelligence coming from his subordinates and orders coming from his superiors.

This time-honoured problem is well set out by the author, and his chapters—for the article is a long one—are full of historical allusions selected from the war of 1870, and then from the Great War. The Prussian Corps commanders of 1870, who provided the famous examples of disregarding orders from above and acted on their own initiative, were proved to be justified beyond a doubt. The blind obedience required in the days of galloping generals in the midst of their troops has given place to an elastic interpretation of instructions; but the thorough dissemination of a sound doctrine is the safest way to ensure intelligent co-operation and the successful execution of the plan of the Higher Command.

Les ballons de protection. By A. Ae. A short article on balloon barrages for anti-aircraft protection. This form of protection has been revived recently in most countries. The "apron" fringe used in the defence of London in 1918 is dismissed as unpractical. Various types of balloon are discussed; their limitations of height, etc. The subject is assuming increasing importance, and practical experience of it is very limited.

(*May*, 1938.)—*Pages d'histoire de l'Armée Belge. Le IV/12 A. dans l'offensive des Flandres.* By Lieut.-General Semet. An account of the experiences of a group of the 12th Regiment of Artillery during the final operations of the Belgian Army from August 21st to the Armistice. The Belgians had by this time taken over a portion of the British line north of Ypres, and the article is interspersed with the old familiar names of Mouse Trap Farm, Oblong Farm, Winnipeg, etc.

Pages d'histoire: La défense de Dixmude. By Major Wanty. The concluding instalment of this interesting account. The fall of Dixmude on November 10th brought to a close a gallant episode of 1914. The withdrawal of Grossetti's 42nd Division for operations south of Dixmude left the Marine Brigade and the Belgians hard pressed; their ranks were depleted, and their ammunition running short. On November 10th the German 43rd Division made a renewed attack and penetrated the town. The survivors fell back, and took up the line of the Yser for defence. The bridgehead had served its purpose. It had given time for the main Belgian forces to organize their positions; and had covered the point of junction with Foch's Northern Group.

Renseignements sur l'ennemi et obéissance passive. By Captain Jacques. This second instalment gives examples from the Great War of notable discord between orders and locally-gathered information. The first of these is illustrated by the operations of the French 4th Corps in Luxembourg on August 22nd, 1914. The 4th Corps formed the left wing of the Third Army, which on August 20th received orders to counter-attack any hostile force which tried to engage the right of the Fourth Army. According to intelligence received from the Army, the 4th Corps had an empty gap in front of it, and it was ordered to advance into it. Cavalry patrols pushed out by the Corps were met by enemy patrols, and were prevented from getting much information. The infantry columns moved forward slowly towards the wooded country of Luxembourg, and were uneasy. Air reconnaissance was hampered by mist. The German XIII and V Corps had moved south-westwards instead of north-west, and were close at hand in the woods. In spite of gallant action by the cavalry and personal reconnaissance by the Corps commander, the infantry divisions blundered on into a mass of Germans and suffered very severely in the ensuing fighting at Ethe and Virton. The French were unable to fall upon the German columns as they emerged from the woods.

The spirit which had been inculcated for forty years in the French Army impelled the older generals to forward action, but there were some among the commanders who would have acted more cautiously and more successfully had they been in the higher posts.

It is the old question come forward in its modern complexity. Personal reconnaissance of the wider and more rapidly-changing scene of operations to-day is becoming more and more difficult. A commander cannot take post with the advanced guards and still direct the columns behind. Even instantaneous transmission of information is of little assistance if its interpretation behind is at fault. Training is the sole solution. (*To be continued.*)

L'eau et la défense de la Belgique au cours de son histoire. By Colonel Verhaegen. For centuries the cockpit of Europe, Belgium lies in the path of invasion whenever the western countries go to war. She has no well-defined natural frontiers, but she has a valuable system of rivers and canals. The author points out the numerous historical occasions on which the waterways of Belgium have aided in its defence; and where nature has not provided sufficient obstacle, man has been able to supplement her work by artificial inundations, from the wet moat around the *château* to the wide sheet of water spreading the rivers. He shows how the rivers of Belgium successively aided the retreat of the Belgian divisions in 1914.

The best example is, of course, the flooding of the Yser region in October, 1914. Here the dykes were opened just in time to save Nieuport, Dunkerque and Calais. The Belgian forces, at the last stage of exhaustion, were rallied behind the waters, and for four years were protected between Dixmude and the sea by the impassable barrier. German batteries were thus kept at a distance; raiding parties were debarred, trench mortars were useless, and the small Belgian army was enabled to refit and conserve its strength until the day of deliverance.

No technical details of the inundations are given, nor is there any map to show their extent.

(*June*, 1938.)—*Pages d'histoire de l'Armée Belge : Les debuts de l'Aviation militaire Belge*. By General Mathieu. The beginnings of the Belgian Air Force were on very much the same lines as those of our own, but we had made an earlier start. The officer commanding the Balloon Company was the first to set about forming the School of Aviation in the Belgian Army, and in 1911 he started with a single Henry Farman machine. This came early to grief, and it was some time before funds would allow of the purchase of another. The author of the article was himself a sub-lieutenant of the Balloon Company in 1896, and in 1911 he succeeded to the command of the new Aviation School. He gives the full story of the development of the Air Force from these modest beginnings up to January, 1915, when the whole force was reorganized ; the first instalment carries us to the first week of the war.

At the beginning of the Great War, Belgium had two squadrons ready and two others nearing completion. There were 37 pilots and observers.

Renseignements sur l'ennemi et obéissance passive. By Captain Jacques. (*Conclusion.*) The results of the French blunder at Virton are outlined, and a comparison is made between the instinctively correct action of the Germans, although their columns were still in the thick of the woods, and the rigid adherence to rules of the French. The Germans deployed ; the French columns were tightly held to the roads and ordered to continue their advance.

The author has given us a well-reasoned study of the failure of the French doctrine at the beginning of the campaign. The losses sustained by the French Army in the first ten days were very heavy ; they were not made known at the time.

Reflexions sur la liaison du Génie avec les autres armes. By General Coppens. Demolitions are now such an important item in a Continental campaign that a fuller understanding of their application is essential in the higher commands. Motorization of the forces adds still more weight to this argument. A wider knowledge of the time required to effect demolitions, of the amount of material needed and the suitable priority of execution is emphasized in this article. Even if there are officers of engineer origin on a headquarters staff, there should be an engineer officer attached to all staffs in the field.

The possibilities of engineer operations such as the passage of rivers requires to be better known. The rapidity with which rivers were crossed in 1918 was only attained after four years of war had familiarized the staffs with engineer work. The habit of calling upon the engineers too late in the operations to be of much use is still prevalent, and this can only be overcome by a better understanding and liaison between the staffs and the executive engineers. At the outset of a campaign, troops and staffs are unfamiliar with each other—especially where large numbers of reservists compose the forces ; and full value is not obtained out of the possibilities of engineer work.

À propos du Siège de Vienne par Kara Mustapha en 1683. By Lieut.-Colonel Beaupain. The unearthing of an epic poem on the Siege of Vienna in 1683 is the occasion of this short article, which seeks to compare the poetical version of the event with the actual history of it as known. The author finds an unexpected accord between the two.

W.H.K.

REVUE MILITAIRE SUISSE.

(*April*, 1938.)—*Une solution au problème du Haut-Commandement*. The Central Committee of the Swiss Officers' Society has recently been considering the problem of the Higher Command in the Swiss Army, and was so impressed with the urgency

of the problem that its members appointed a Commission to draw up a report which has been presented to the Federal Military Department. The proposals make considerable changes, all in the direction of simplifying the responsibilities of the Chief of the Federal Military Department, and separating troops and training from supply, sanitation and services generally. Diagrams showing the present and the proposed systems are added, from which it would appear that the Swiss organization has hitherto lagged behind the general practice in other countries.

Le 8e. Concours hippique international de Genève. By Colonel H. Poudret. An account of the International Horse Show recently held.

La défense anti-chars. By Captain Daniel. A well-written article in a concise form, dealing with this modern problem. Beginning with a brief outline of the characteristics of the two main types of tank—that which is to accompany the infantry in the attack, and the swifter-moving vehicle now included in the mobile armoured divisions—the author describes the principles of anti-tank defence. Until the anti-tank defences are overcome, the tank will have little chance of success. When held up, it is an easy prey to anti-tank weapons. Tanks are still unable to go everywhere and do everything; and the author indicates the chief natural obstacles. But he does not want his Swiss readers to suppose that their mountainous valleys are safe from mechanical invasion. Switzerland is richer than most countries in obstacles to armoured vehicles, and the organization of her anti-tank defence presents less difficulty than is the case with her neighbours.

(*May*, 1938.)—*Guerres offensives des Suisses aux XVe. et XVIe. Siècles.* By Colonel Lecomte. Of historical interest only.

La défense anti-chars. By Captain Daniel. (*Conclusion of last month's article.*) The probable development of the battle with tanks and anti-tank defences is clearly sketched, and the arguments are well reasoned. Against an enemy well equipped with masses of tanks, the Swiss Army must have recourse to the fullest organization of natural defences, as well as an increase in its anti-tank weapons. A Swiss division at present has 27 anti-tank guns and 36 trench mortars. The advantage of surprise gained by carefully-concealed guns over tanks advancing in the open, handicapped by restricted vision, is stressed, and the amount of work which will fall to the engineers in the organization of a defensive position is referred to.

A tank attack against troops in movement is equally well dealt with. The chief defence in such a case lies in the skilful use of the ground. Just as troops are taught to take cover from air observation, they must be taught to use tracks which afford security against tank attack. Warning of such attack must be given by the divisional reconnaissance group. At all costs troops must avoid the danger of being caught in the act of deployment by armoured vehicles.

The defence against tanks during a retreat is also dealt with.

Le 8e. Concours hippique international de Genève. (*Conclusion.*)

(*June*, 1938.)—*Infanterie et artillerie modernes.* By General Rouquerol. In spite of the progressive introduction of novelties, artillery and infantry remain with their essential characteristics. Certain changes have been made in the organization and equipment of them both, but no position can be captured and held except by infantry. Added to the necessity for protection from air observation is the necessity for protection against gas, and against tanks, but the infantryman remains the final resource in the actual capture of the position. For the infantry, freedom of movement; for the artillery, the concentration and mobility of their fire are the chief requisites to-day.

L'exercice de l'initiative. By Lieut.-Colonel E. Mayer. This veteran writer compares the systems of Napoleon and Moltke in ensuring obedience to orders. Napoleon prepared elaborate instructions for his Corps Commanders; Moltke preferred to leave wide powers of discretion to them, trusting to the common doctrine spread in

times of peace. The latter, a Dane sprung from humble origin, had to issue orders to Crown Princes and Prussian notabilities. It will be recalled how Moltke the younger went too far in this direction and lost control of the giant machine in 1914.

Un cas concret de tactique d'infanterie. By Captain Nicolas. An example taken from the last manœuvres of the Swiss 1st Division. The action of an infantry company operating independently; although such cases will be extremely rare in Continental warfare.

W.H.K.

MILITÄRWISSENSCHAFTLICHE MITTEILUNGEN.

(*April*, 1938.)—*The Control of the Armed Forces of the Great Powers.* By Lieut. Field-Marshal Schaefer.

Prior to the World War, there were only two branches of the service, the Navy and the Army. In all great countries they were controlled independently. In the case of Austria, as soon as the war broke out, the Navy was placed under the supreme command of the Army. In other countries the Navy and Army collaborated, but each under separate control.

The end of the war found each of the great powers in possession of an Air Force. Great Britain and Italy were the first two countries to form an independent air ministry. Germany, after acquiring her freedom in regard to her armed forces, appointed a war minister with full control over all three branches of the service. Great Britain has appointed a co-ordinating minister without actual command over the forces. France has found it difficult to make up her mind to have a combined control over her fighting services.

The Dawn of the Tank. By Lieut.-Colonel Theisz.

Anti-tank defence is more efficient than it was during the war. The tank arm has been greatly improved and increased in numbers. It will not be possible to gauge its actual value correctly until after a war between two opponents of approximately equal strength. The order of the day is to be suitably prepared for such a decision.

Greater Germany. Defensive Progress in the First Quarter of 1938.

Major-General Paschek gives a sketch of the main events that occurred in February and March, leading to the incorporation of Austria in the German Reich. The union is regarded as foreshadowing a new epoch for Central Europe.

The Importance of Forestry in War Organization. By Lieut. Handel-Mazzetti.

A war can be lost, without defeat in the field, if a country is deprived of its sources of raw material. The writer of this article dwells on the importance of preserving and exploiting forests in time of peace. During the Great War, Austria-Hungary was self-supporting as regards timber; Germany was able to supplement her requirements from countries in her occupation. Great Britain, always an importing country, was able to obtain supplies from France, as well as from other countries. France exploited her own timber supplies to the utmost. As the result of the devastation of the area occupied by the enemy, it will take sixty years for her forests to recover. Intensive efforts are being made in Britain, France and Italy in the way of re-afforestation.

Timber supplies three important substitutes, of great value in war-time, in the event of outside supplies being cut off: wood gas, wood sugar, and cellulose for the manufacture of artificial silk. Coniferous trees are specially suitable for the manufacture of wood sugar.

The writer suggests a working plan for Greater Germany, by which the country can be rendered far more independent of timber imports than she is now.

Tactical Problems for small Units. By Lieut.-Colonel Roma.

Various problems are worked out with the aid of maps.

Circular Mounting for Mechanical-Electrical Training of Anti-Aircraft Machine-Guns. By Dr. Server.

A description of a circular mounting for the 20 mm. " Oerlikon " machine-gun. The vertical and lateral training is worked electro-hydraulically; the loading, cocking, and firing pneumatically.

Water Heater for Motor Vehicles. By Dr. Staeger.

A description of the " Moto-calor " apparatus for keeping the water in a radiator warm in frosty weather.

The Conflict in East Asia. By General Wiesinger.

In reviewing the general situation, the writer expresses the opinion that China's military, industrial and financial position is serious but not hopeless. Her enormous area and the time required for her conquest make up China's strength. These factors will be able to exhaust Japan's resources and change the whole situation. If this view is correct, a long war in the Far East may be expected.

The fourth stage of the operations is described after the conclusion of the fighting round Shanghai, and the Japanese advance on Nanking about the middle of December. The Chinese forces appear to be hard pressed, but their retreat into the central area, Anking–Nanchang–Hankow, is still open. Chiang-Kai-Shek might prepare a defence on a large scale there or, alternately, make a counter-attack in the Kaifeng area.

(*May*, 1938.)—*Colonel-General Victor Count of Scheuchenstuel.*

An obituary notice of a distinguished Austrian Engineer officer who died on Easter Sunday.

Industrial Strategy of Raw Materials.

Lieut.-Colonel Ringel wrote this article before the " Anschluss " of Austria with Germany. He points out the close connection between industry and war strategy. The war taught all countries the necessity for organizing their industry and making themselves as independent as possible of the import of raw materials.

The writer deals, in turn, with food, clothing, sources of power, rubber, metals and timber. Austria could be made to produce more meat; artificial cotton can be made from wood, artificial wool from skim milk, the available water power might be more fully developed, and the manufacture of artificial rubber encouraged. Many other suggestions are made.

Greater Germany. Political and Military Events in the First Quarter of 1938. By Major-General Paschek.

The most important occurrence in the quarter is the annexation of Austria. The writer describes the events as they took place, and the effect produced on other countries. The old Austrian Army now forms the 5th group of the German Army, and has been organized in two army corps and other units.

The Angle of Elevation in Anti-Aircraft Gun Fire. By Major Kurz.

A study of the trajectories of anti-aircraft projectiles, with six sketches.

Modern Forms of Construction for Gun Wheels. By Dr. Staeger.

The essential qualities of a modern gun wheel are :—

(1) Lightness combined with strength.
(2) Wide bearing surface and gripping power.
(3) Silence.
(4) Freedom from skidding and immunity from punctures.

A sketch is given of a gun wheel manufactured by the Ambrosetti Company at Lugano. The wheel is a disc of " avional " alloy, *i.e.* aluminium, with small admixtures of copper, silica, manganese and magnesium. The hub is of sheet steel and is riveted to the disc. The wheel is detachable from the axle. The tyres are of the unpuncturable " Cellastic " type.

Some Aspects of the Spanish Civil War. By Lieut. Ehler.

In examining the import and export trade of Spain, the writer draws the following conclusions :—

(1) Spain is an agrarian country producing large quantities for export.
(2) She has a superabundance of raw materials, specially useful for armament purposes.
(3) She has a shortage of finished products.
(4) As an ally she can upset the balance of power in the Mediterranean.

Lieut. Ehler traces the causes of the civil war to unsatisfactory social conditions. In no country has the contrast between rich and poor, between big landowners and small farmers been more marked.

He maintains that the civil war has divided Europe into two camps : Britain, France and Russia on the side of the Republic, and Germany and Italy on the side of the Nationalists. The solution of the Spanish question and the termination of the war are essential for the peace of Europe.

(*June*, 1938.)—*The Bombardment of Paris during the World War.*

Colonel von Longarevic-Syposs gives a full account of the big gun used by the Germans in 1918 for the bombardment of Paris. The site selected for it was near Crepy, a village not far from Laon. It was the nearest point to Paris in the German line, the distance being 120 km.

The gun was 34 metres long, its outside diameter was about one metre, the thickness of metal averaged 40 cm., the calibre was 21 cm. (8·27 in.). It weighed 400 tons, the carriage weighed 500 tons. Calculations showed that the gun would require re-lining after firing 65 rounds. To allow for the wear of the bore, the 65 shells were numbered, each being made slightly bigger than the one fired before it ; the shells were calibrated from 21 to 23·5 cm.

With an angle of elevation of 52 degrees, the range was 128 km. The highest point of the trajectory (allowing for the earth's curvature) was 40 km., the time of flight 3½ minutes. The cost of the gun was 11,200,000 marks ; thus the cost of each round fired (320 shells all told) was 35,000 marks.

The bombardment of Paris began on March 23rd, 1918. Thanks to the secret service organization, the result of the first two shots fired was known at the German G.H.Q., via Switzerland, in four hours. 320 shells had been dropped into Paris by August 9th, causing heavy material and moral damage. In the German retreat the gun was taken back to Germany on the last train that got past Soissons. It was eventually taken to Cologne, where it disappeared without trace.

The Strategic Importance of the Murman Coast. By Lieut. Field-Marshal Schaefer.

For over two centuries Russia has been trying to find an ice-free outlet to the open sea, other than the Black Sea and the Baltic, the outlets from which can easily be closed by a hostile naval power. Her progress in the Far East has been foiled by Japan.

By the construction of the Stalin canal she has established connection between the Baltic and the White Sea via the Ladoga and Onega Lakes. But the canal is only four metres deep, and is frozen over for six months in the year. It is useless for ships of any size.

There is, however, an ice-free port on the Arctic Ocean at Murmansk, which is connected by rail with Leningrad. Although it is within the Arctic Circle it gets the benefit of the proximity of the Gulf Stream.

The harbour of Murmansk offers the following advantages to the Soviet Union :—

(1) Development of North Siberian mineral products.
(2) An important sea and air base for operations against North European countries.
(3) A point for receiving reinforcements or armaments from possible allies.

Experiences of Attachment to Infantry. Lieut. Eimannsberger, an artillery officer

who has recently been attached to the infantry, stresses the importance of the mechanized branches of the service knowing more of the work of the infantry, and vice versa.

Depth Charges. By Lieut. Handel-Mazzetti.

Defence measures employed against submarines during the World War were comparatively ineffective. The writer quotes the unsuccessful use of torpedoes against the French submarine *Cugnot* in the Gulf of Cattaro in November, 1914, and the attack on the British ship *Justitia* by the German submarines *U* 64 and *U* 54 in July, 1918. The *Justitia* was steaming in convoy, and numerous depth charges dropped by the destroyers accompanying the convoy failed to put the U-boats out of action, or prevent them from sinking the *Justitia* with torpedoes.

Recent experiments made with depth charges of 300 kg. of T.N.T. (twice the amount used at the end of the war) show that a submarine can be completely wrecked by a depth charge fired underneath it at a distance of fifteen metres. If the charge explodes above the submarine, the same effect is produced at half the distance and, if at the same level, the effect is mid-way between the two.

While anti-submarine measures have increased in efficiency in recent years, points in favour of the submarine are: it can submerge in less time than formerly and can sink to a depth of 100 metres and over.

Synthetic Fibres. Lieut. Hicker describes the various kinds of synthetic fibres made from cellulose, and also artificial wools made from casein obtained from skim milk, from fish roe and from wool and silk waste. They will all have considerable value in war-time.

The United States, Japan, Italy and Germany are the biggest producers of synthetic fibres.

A.S.H.

WEHRTECHNISCHE MONATSHEFTE.

(April, 1938.)—*The Austro-German "Anschluss."*

As might be expected, a good deal of satisfaction is expressed at the incorporation of Austria in the German Reich. Apart from the political and commercial advantages that it reaps from the union, Germany is now in a far stronger military position than before. She has an additional population of whom 6½ millions are liable to service, and she has established contact with a nation with whom she is on friendly terms.

Direction-finding Instruments for Tanks.

Major Olbrich discusses the possibility of using direction-finding instruments in tanks. The choice lies between the magnetic compass and the gyro-compass. The large mass of steel surrounding it makes the magnetic compass unreliable, and even if suitable means of compensation were introduced, there would be disturbances due to such causes as the revolving of gun-turrets and the shifting and expenditure of ammunition.

The gyro-compass, excellent as it is for use in ships, is not equally suitable for use in tanks. Its main drawbacks are (1) its bulk and weight in a confined space, (2) the fact that, in order to damp out the oscillations (due to precessional force), it would have to be run for three to four hours before being taken into use.

Geo-strategy. By Dr. Ruprecht.

A study of strategy in relation to the geographical position of a country. Great Britain owes much of her success to her insular position. It is possible to impose one's will on a recalcitrant nation without going to war, *e.g.*, by imposing sanctions. The only time these were tried they failed in their object, the reason being that Great Britain, as the controlling power of the League, was not strong enough to enforce them against Italy.

The strategy to be adopted against any nation depends upon its possession of raw materials, its size, geographical position and the nature of its population. The effect of propaganda on the latter may be decisive, as in the case of Russia during the Great War.

The World War has given proof that victory will not necessarily go to the side that has the largest resources in foodstuffs and raw materials at the outbreak of war, but to the side that can maintain its flow of supplies longest. In spite of aerial warfare, we may still have to allow for wars lasting several years in future.

Illumination at Night.

Dr. Lochle concludes his study in this number. He gives some formulæ and figures for photometric study. The illuminating power on a moonless, starlit night is a ten-thousandth part of a *lux*. In order to distinguish anything in such a light, there must be a visual angle of at least a degree, and there must be a strong black and white contrast.

A lesson learnt from night attacks is the difficulty of seeing distinguishing marks such as white arm-bands. Luminous paint has proved useful on occasions. A point to remember is the tendency to over-estimate distances at night.

Night is the airman's friend. When flying above the clouds, the reflection of light from the latter is often of assistance to him, whereas the anti-aircraft gunner is handicapped, and range finding at night is a very difficult matter. The tremendous speed of the modern aeroplane makes observation very difficult.

New German Military Aeroplane Designs. By Wowa.

A description is given of each of the following aeroplanes :—

Heinkel He 112 single-seater chaser.

Henschel Hs 126 two-seater (scout and light bomber).

Henschel Hs 124 twin-engine three-seater (scout and bomber).

(*May*, 1938.)—*The Value of the 2-cm. Anti-tank Rifle as an Infantry Weapon.*

A description, with photographs, of an anti-tank rifle made by the Solothurn arms factory. The weapon is mounted on a low stand and is fired from the shoulder of a man lying down. It fires different kinds of shells with a muzzle velocity of 720 to 755 metres per second. At a range of 500 metres it will perforate a chrome steel plate 25 mm. (1 inch) thick. The weapon weighs 42 kg.

The Testing of Materials with X-Rays.

Colonel Bluemner describes an apparatus for testing materials, *e.g.*, steel, copper, light metals, concrete, for flaws, cracks, air-bubbles, etc., without destruction, by means of X-rays. In certain cases gamma rays are used instead of X-rays, especially where the thickness of the materials is considerable, but they do not give so clear a picture.

In Germany, the tests are used concurrently with many manufacturing processes : in the U.S.A. they are used to a still greater extent, but in other European countries they are confined to tests for military, naval, and air-force purposes.

The Supply of Copper to the World's Armament Factories. By Dr. Ruprecht.

Germany's annual consumption of copper amounts to about 220,000 tons : of this, she obtains about 30,000 tons from her own mines ; the balance is imported. Great Britain possesses the richest copper mines in Europe, but the ore lies at so great a depth that it does not pay to work them. The United States of America are the greatest producers of copper ; Chile comes next, and Russia is believed to have great possibilities. Africa has been greatly developed in recent years.

Whereas oil is only found in a limited number of countries, copper is found in 25, of which 12 are in Europe. The idea of applying copper sanctions against any particular country is therefore not feasible.

War and Raw Materials.

Dr. Leonhardt traces the connection between war and the raw materials necessary

for conducting it. All countries are, to a greater or less extent, dependent upon imports for their raw materials, but are trying to be as self-contained as circumstances will permit.

Telegraph and Balloon in 1794. By Dr. Hartmann.

The French were the first to take advantage of the hydrogen gas balloon by utilizing it for military purposes. The physicist Coutelle formed the first balloon company in 1794, consisting of three officers, five N.C.O's and twenty-six men. The balloon was first used during the siege of Maubeuge by the Austrians. Although subjected to heavy fire, it was found possible to keep it above range of the enemy's howitzers. Subsequently the balloon made several ascents, but it was never in great favour, owing to unreliable reports signalled by observers. Balloon companies were disbanded in 1799.

The Construction of Coast Defences. By Colonel Lange (of the Imperial Russian Army).

The writer describes how some of the Kronstadt batteries were erected in the late autumn of 1909. They were purposely built at this inclement time of year to escape observation. All aggregate, steel and water used in concrete were specially heated.

As points of support for the fleet, batteries can be of three kinds; open, in turrets, or on rails. The suitability of each kind is discussed in relation to its position, and the writer goes into detail over the radii of curvature of rails.

(*June*, 1938.)—*The Factory in War-Time.*

Dr. Leonhardt lays stress on the importance of "militarizing" factories in war-time, particularly in the case of armament works. Militarizing does not imply anything in the way of drill, but merely gives both employer and workman to understand that they are just as much soldiers in a totalitarian war as the men at the front.

Italy has realized the position and has placed the whole of her civil population under war discipline. In France, all important factories working for Government are under state control.

The Development of the Arms Industry based on Official Statistics.

Taking the figures for the years 1928 to 1937, there has been an almost steady diminution, year by year, in the number of patents issued and in the number of patterns registered in Germany. On the other hand, patents and registered patterns relating to fire arms and matters connected with the arms industry have shown an almost equally steady increase.

The Straits of Messina.

This article is a discussion of a proposal by Professor Ando to drive a tunnel under the Straits of Messina to connect Sicily with the Italian mainland. Strategically, such a tunnel would have considerable value, and if the present régime in Italy approved of its construction, it is not likely to be deterred by the magnitude of the undertaking. The depth of water at the narrowest point is less than 100 metres. It would only be necessary to go to a depth of 150 metres. The length of the tunnel would be 11 km. The Severn Tunnel is 7·5 km. and the Simplon Tunnel 19·8 km. long. One serious drawback to the scheme is the liability of the region to earthquakes.

Trade Routes and their Importance for National Defence. By Major Mende.

Trade routes are of four kinds: road, rail, water and air. The writer of this article is chiefly concerned with inland routes, of which road and rail are the most important. Air transport is only suitable for light goods when high speed is essential. Inland waterways are economical but very slow. Railways are the most important means of transport, on the other hand, motor transport by road has the great advantage of doing away with trans-shipment. The German *Autobahnen* have been introduced largely for strategical purposes. But whereas they are of great value to an advancing force, they would also help an invading army. Hence the possibility of having to destroy essential portions of them must be borne in mind.

A.S.H.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*May*, 1938.)—*The Engineers of the Austro-Hungarian XXIIIrd Corps during the Piave Offensive between the 15th and 24th June*, 1918. By General Heppner.

The last offensive attempted by the Austro-Hungarian Army took place on the Piave between the 15th and 24th June, 1918. At that time the Piave, and in its lower reaches, the Vecchia Piave, formed the dividing line between the Italian and Austro-Hungarian forces.

Preparations for the offensive were begun in April. The two months available were by no means too long a time for getting ready and for training the men, some of whom had no experience in pontooning.

In this article General Heppner describes at considerable length the work done by the engineers of the XXIIIrd Corps, which occupied a frontage along the Piave from the village of Noventa to the Adriatic, roughly 18 miles. The VIIth Corps occupied the front to the right of the XXIIIrd Corps.

The engineers at the disposal of the XXIIIrd Corps consisted of the following units : six sapper companies, one bridging company, two electro-companies, eighteen construction companies, six horsed bridging trains.

Two girder bridges (a railway and a road bridge), near S. Donà, at the right (up-stream) end of the Corps front, had been destroyed by the Italians during their retirement. A vast amount of logs and other floating material brought down by the river had been piled up against the piers and broken girders.

The tasks allotted to the engineers were as follows : the attacking (10th) division was to be ferried across the river in two places near S. Donà. After a successful passage two ordinary pontoon bridges were to be thrown across at S. Donà, and a heavy bridge a mile down-stream of that place. As the advance on the west bank of the Piave progressed, a reinforced bridge of captured Italian pontoons, and a heavy bridge of steel barges were to be built up-stream and down-stream of S. Donà. In the event of the destruction of the heavy bridge, two ferries were to take its place. If the operations continued successful, a heavy bridge for two lines of traffic was to be erected to replace the destroyed road bridge.

The preparations for the construction of these bridges are described at length, together with the orders issued by the 10th division. On the 14th June, it was announced that zero hour for the attack would be 6.55 a.m. on the 15th.

The rest of the article is a detailed diary of the occurrences from the 15th to the 24th June. On the 15th, after a 4-hour artillery preparation, the passage of the Piave was begun and successfully accomplished. Construction of the two pontoon bridges started well, but the enemy's artillery fire increased in accuracy, causing heavy casualties amongst the sappers and a great destruction of pontoons. By noon there were not enough pontoons left to complete either of the two bridges. A further supply had to be brought up, and trained sappers had to be replaced by untrained men.

The up-stream bridge at S. Donà was ready on the morning of the 16th ; it was heavily damaged in the course of the day, but eventually restored by 3 a.m. on the 17th. The southern bridge fared worse. It was so severely attacked by enemy airmen that it was impossible to keep it up any longer after 10 a.m. on the 16th. Two ferries took its place, but they had to be abandoned before long. Out of 96 pontoon sections available on the 15th, only 20 remained and several of those were damaged.

The 18th was a day of disaster. Rain had fallen on the two previous days, and the river had been steadily rising. The driftwood accumulated up-stream of the destroyed railway bridge was carried down-stream and bore down upon the pontoon bridge. By releasing the cables and allowing the bridge to break in two, and the two halves to swing alongside the banks, most of the materials were saved. Other bridges farther down-stream were either damaged or destroyed.

Various expedients were adopted to maintain the passage of the river from the 19th to the 22nd. On that day, the VIIth Corps retired across the river, and the XXIIIrd

Corps had to conform to its movements. The retirement of the XXIIIrd Corps was completed on the night of the 23rd to 24th. Most of the bridging material that had survived was brought back to the left bank and salvaged under cover.

The writer draws his conclusions from the events of these critical days.

The sites for the bridges were well chosen, but, in this respect, the XXIIIrd Corps was more fortunate than the Corps up-stream, which had several branches of the river to cross.

The critical time was not so much the crossing itself as the subsequent period, when the enemy tried to cut off the troops who had crossed by an artillery barrage and to destroy the bridges by bombing. The Austrians were deficient in long-range artillery and could not reply to monitors firing from the sea. They were also insufficiently prepared against aircraft.

Only 30 per cent. of the bridging material was recovered; of pontoons, only 22·5 per cent. The number of pontoons allowed for ferrying, and then for bridging, was insufficient. Actually, 11/12ths of the available pontoons were used for ferrying, so as to complete the passage as soon as possible. Losses had been allowed for, but not on the scale that was found necessary for replacements.

Pontoon bridges are extraordinarily vulnerable. If the depth of the water and the current admit of their use, trestle bridges are preferable, even if they take longer to build.

The short training that the sapper companies had received in pontooning was not long enough to enable them to tackle successfully the severe task of bridging under fire.

The Austrian Engineers, Past and Present. By Captain Mueller.

The formation of the Corps of Austrian Engineers dates back to the days of Prince Eugene. The latter founded the Miner Corps (then part of the Artillery) in 1716, and the Engineer Corps in the following year. The Corps of Sappers was formed in 1760; the Corps of Miners became part of the Engineers in 1772. The first two Pontoon companies were formed under the Empress Maria Theresa, and the first pioneer battalion made its appearance in 1758.

In contrast to the Prussian and German nomenclature, the term *Pioneer* in Austria is restricted to units serving on the water.

Various changes in organization took place up to the Great War and during the course of the latter: the strength and organization being vastly increased by the addition of many units of specialists.

The Austrian engineers were handicapped by having no Commanding Engineer (as in Germany). They merely had an Engineer Adviser (*Referent*) without powers of command.

In 1918 Austria was restricted to an army of 30,000 men by the treaty of St. Germain. These restrictions were removed in 1935 by agreement of the powers. Universal service was re-introduced on the 1st April, 1936, and the strength of the army was raised to seven divisions, one rapid division and an independent brigade, besides an air force and army troops. Each division now has an engineer battalion (*Pionier-Bataillon*) consisting of headquarters, two companies, and an engineer park. The first company is similar to a German engineer company, the second consists of specialists. No. 2 battalion has, in addition, a railway company.

The rapid division has a special motorized engineer company. The army troops include, amongst others, a bridging battalion and the Danube flotilla.

General Weber Pasha. By Major Guenther.

An account of the career of General Weber, a distinguished engineer officer, who died in 1933. The most interesting part of his career was at the time when he was appointed member of the military mission to Turkey under General Liman von Sanders. Colonel Weber (as he was then), became responsible for the engineer and fortification branch of the Turkish Army. He undertook the strengthening and

arming of the Dardanelles defences. As the war developed, he foresaw that the British and French would probably attack the Cape Helles end of the peninsula, whereas General von Sanders thought the Gulf of Saros a more probable objective. The invisible infantry and machine-gun emplacements cut into the rock under Weber's instructions caused heavy losses to the British landing force, and the dummy batteries misled the naval artillery. In March, 1915, General Weber held command of the XVth Turkish Army Corps on the Asiatic side. After the termination of the Gallipoli campaign he held various high commands on the western front.

Dyke Construction on the Yser south of Nieuport in 1917. By Lieut.-Colonel Baumgaertel.

In October, 1914, the German attack on Nieuport was held up by the Belgians opening the canal sluices and flooding a large area between the Yser and the railway to Dixmude. This flooded area remained an impassable barrier between the opposing forces. The Allies, retaining control of the Nieuport sluices, were able to regulate the supply of water.

When the battle of Flanders began in the summer of 1917, the Germans noticed that the water level was falling, and that part of the area was drying up. Connecting this with the British advance farther south, they anticipated a British attack over the drying area.

They were unable to control the sluices connected with the sea, but they were, to some extent, able to control the water flowing down the Yser. They consequently set to work to build two dams with the object of holding up the Yser water and keeping the ground between them and the British under water.

Lieut.-Colonel Baumgaertel, who had charge of the work, describes the building of the dams, the difficulties that he had to face owing to constant interruption by British gun-fire, and his final success. The dams were still standing when the Germans evacuated Belgium in 1918.

Tasks of an Engineer Company in Mobile Warfare.

Major-General Klingbeil describes some work carried out by the 2nd/ Pi.2 between the 25th and the 28th August, 1914. On the 25th August, the company erected a standard pontoon bridge over the Scheldt canal near Condé. The same night they commenced the erection of a heavy pile bridge, 42 metres long, at Hergnies. This was completed on the 26th. The pontoon bridge was dismantled and loaded up the same day, and the march was resumed the following morning. On the day after, while the division was advancing from Cambrai to Bapaume, the company took part in an engagement at Hermies.

Development of Fort Armour. By Dr. Kraus.

In this article the writer describes the steel armour used for the protection of guns. The use of iron in the masonry work of fortifications dates back to the second half of the eighteenth century, but the idea of using it as a shield to guns is not a hundred years old. Its use did away with the wide opening of the gun embrasure, and a still further improvement was made by the British invention of pivoting the gun at the actual opening in the shield.

Dr. Kraus traces the development of iron and steel armour from 1860 onwards. The first German ironclads, made in France and England, were protected with wrought-iron plates. Next came the " sandwich " type of armour, *i.e.*, two iron plates with wooden packing between them. In 1892 an improved armour plate was designed, in which 7 per cent. of nickel was added to the steel. A few years later a further improvement was introduced, in which a chrome-nickel alloy took the place of the nickel.

Various cross-sections of steel cupolas are shown in this article.

The writer states that, in the battle of Jutland, British shells of 34 and 38 cm. calibre broke up on the armour of German ships, whereas some of the German 28 cm. and 30·5 cm. shells penetrated the armour of British ships.

Royal Louise.

Major-General von Held gives an account of a model frigate, one-third full size, presented by King George IV of England in 1830 to the King of Prussia. After a varied career, the *Royal Louise* was allowed to fall into disrepair, but she has recently been restored, and now stands as an interesting memorial in the saluting battery in Kiel-Wik.

A Pioneer in the Turkish Service.

Major Mueller relates his experiences as member of a German mission sent to Turkey in June, 1916, to raise and organize two Turkish Pioneer (Engineer) battalions, the 16th and the 17th. The mission consisted of ten officers and about twenty N.C.O's. The writer was a company commander. The arrangements made by the Turkish authorities were not altogether satisfactory, and, within a year, the mission was recalled.

A.S.H.

THE INDIAN FORESTER.

(*April*, 1938.)—An article describes a visit by Mr. V. D. Limaye to the Canadian Woodpipe and Tanks, Limited, at Vancouver, B.C. Wooden pipes and tanks have been in use in America for over thirty years, and are giving very satisfactory results. Pipes can be made from 2 inches to 60 inches diameter, and tanks, 60 feet in diameter, of 300,000 gallons capacity have been constructed; pipes and tanks are used for municipal and house supply, and for mining and irrigation purposes. Both are made of a number of wood staves, machined so as to produce a perfect circle of the required size. In smaller sizes of pipes, the staves are held together by galvanized wire; in larger pipes and tanks, by steel bands. The couplings used are illustrated in a diagram, while a photo shows a 130,000 tank on a 40-foot timber tower.

Forest Ranger students in India are trained in field works at Roorkee by the Bengal Sappers, and an article, with photos by the students themselves, shows a trestle pile driver, a portable frame pile driver, a standing derrick, a suspension, trestle and cantilever bridge, all carried out by one class of about 30 students in 3 weeks. In addition, instruction is given in simple masonry work, and in the use of explosives and in other subjects. Truly, a good deal must be packed into 3 weeks!

An extract from *Current Science* describes stereoscopic mapping with multiplex projector, now in use in the U.S.A. Army Air Corps while another from the *Evening News* describes the largest forest nursery in these islands, in the Denny Hills in West Fife. It is interesting to know that the inhabitants of St. Kilda, which was evacuated in 1930, have been settled there.

(*May*, 1938.)—Mr. S. J. Sinha of the Bihar Forest Service contributes an article on Re-afforestation in Italy, where arid hills are being converted into forest at the rate of 42 square miles a year. The author compares the bare heights with those surrounding the Khaibar, and the photos certainly bear him out. The *modus operandi* is to make a series of contour trenches, 16 inches deep by 40 to 48 inches wide, with earth filling sloping inwards, and slightly overlapping the front edge. This is found to be preferable to the normal method of a hole to every plant, which way is, however, still used on flattish ground where the contour trenches would be at too wide a distance apart. Seeds from all parts of the world are being used, including deodar, with good results. It is surprising to learn that 19·5% of the productive area of Italy (17·9% of the whole) is under forest.

The forest administration report for Assam for 1936–37, records a great amount of depredation caused by elephants. A campaign against them resulted in the capture of 571, of which 123 were released and 23 died or were shot. The issue of free licences to shoot them results often in their being merely wounded, and in further damage to crops and even to life by the infuriated animals.

(*June*, 1938.)—The extent to which foresters are becoming alarmed by soil losses due to disforestation and overgrazing is emphasized by the fact that three articles, 20 out of 72 pages of this number, deal with this subject. The U.S.A., Canada, Nigeria and Kenya, as well as India, are affected; and to the credit of the Indian Forest Service be it said, India seems to have been the first to start remedial measures. Here is a description of the results of afforestation, in a quarter of a century, in a badly eroded area near Dehra Dun, "Many eroded stream-channels surveyed in 1876 have ceased to exist, being overgrown with young trees and bushes. In the case of the Ratanau basin, the sides and slopes of the hills were clothed with grass and young seedlings, and the water no longer rushed down carrying silt with it; the floods in the streams had, as a result, become reduced in volume, the water channels had become narrower and deeper, and the old beds were overgrown with grass and thousands of *sissu* and *khair* seedlings. The little silt washed down was caught by the grass tufts, resulting in the elevation of the banks in the stream's bed and the deepening and constricting of the water channels."

Mr. Kamesam's Latest Developments in the utilization of timber in India and abroad "tell of self-supporting radio towers built of timber to a height of 550 feet and roof trusses with spans of 250 feet, made possible with modern connectors." The article, a most fascinating one, goes on to record waterproof plywood, as strong, weight for weight, as steel. By the injection of synthetic resin into beechwood it is possible to increase its strength several hundred per cent. As it is seldom possible to carry poles from the hills in India long enough in one piece to make electric standards, an economical and efficient pole joint has been invented; it is said that municipalities and other users look askance at poles which are not perfectly straight, and consequently teak, sal and other timbers, though obtainable in sufficient lengths, have to be ruled out in favour of the straighter conifers from the Himalayas. Mention is made of the increasing use of charcoal for producing gas, and of various food and fodder substitutes made out of wood, needless to say in Germany.

F.C.M.

CONTRIBUTIONS FOR THE R.E. JOURNAL.

INSTRUCTIONS regarding the method of submitting articles for publication in *The R.E. Journal* appear on page 341 of this issue and it is hoped that authors of technical articles will bear the following points in mind :—

A technical article for *The R.E. Journal* should not be overburdened with detail, and should not usually exceed 6,000 to 7,000 words in length. The object of the article, as a rule, should be to give sufficient detail only to interest the reader, and show generally how a job has been or can be carried out. An officer who has read the article and is called upon to carry out a similar job would realize from what source he could obtain more detailed information should he require it.

The following hints are given as to the form in which illustrations to articles should be submitted. **But, as the expense of reproducing these is heavy, they should be limited to what is actually necessary to explain the text.**

Photographs.—These should be glossy bromide prints, with good contrast and sharp definition. Matt surface or sepia-toned prints do not reproduce well. Prints reproduced in half-tone lose contrast, and photographs from badly-exposed negatives, or from flat or badly focused plates or films, cannot be reproduced satisfactorily.

Drawings, plans, etc.—**Ferrotypes or similar sun-prints are not suitable for reproduction.** A good plain black outline, on a white background, or a black-lined tracing give the best results. Different colours on plans should be avoided, as these can only be reproduced by successive printings, and the cost is high. All place names should, wherever possible, appear in plain block capitals, and it should be borne in mind that it is frequently found desirable to reduce a drawing so as to fit into a page of *The R.E. Journal;* it is **therefore essential that lettering and detail should be clear. A plan that requires a lot of folding is not only inconvenient to read, but expensive to reproduce and such should only be used when absolutely essential.**

Scales.—Where the scale of a drawing is given, it should be in the form of a line showing the dimensions; the designation and R.F. should be omitted, as reduction renders these incorrect.

Reprints.—Contributors stationed abroad are requested to inform the Secretary, when submitting articles, whether any reprints are required on payment.

Rewards, totalling about £50 an issue, are available for contributors of original articles to *The R.E. Journal.*

THE MONTGOMERIE PRIZE.

Attention is invited to the conditions under which this prize, in value about £14, is offered for competition each year.

1. The Prize is awarded by the Council of the Institution of R.E. in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. The Prize is confined to Officers on the Active List not above the rank of substantive Major, either singly or in syndicates.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

The following are suggested as subjects for contributions:—

(*a*) Descriptions of works actually carried out in peace or war. (*b*) Invention. (*c*) Design (excluding works of defence). (*d*) Labour organization on work. (*e*) Scientific investigations generally. (*f*) Accounts of exploration work and surveys.

THE ARTHUR FFOLLIOTT GARRETT PRIZE.

The Arthur ffolliott Garrett Prize is awarded for the best article received and published in *The Royal Engineers Journal* in any year, which deals with any of the following subjects:—

1. Irrigation and Water Supply.
2. Railways.
3. Survey.

The Prize is confined to officers on the Active List not above the rank of substantive Major, either singly or in syndicates, and its value is about £10.

NOTES ON COOMBE HOUSE.

COOMBE HOUSE belongs to the wife of a retired Lieut.-Colonel, R.E. It was her home before she was married, and on the death of her father in 1927 it was left to her.

She did not like the thought of it standing empty so she had the idea that, as many people were finding life difficult after the war, it might be utilized to give R.E. Officers and their families who needed it, a few weeks' rest in peaceful surroundings.

The Representative Colonel Commandant at the time interested himself in the scheme and formed a small committee to consider applications and allot dates to applicants. The following rules were framed:—

> R.E. Officers, serving and retired, the widows of R.E. Officers, and dependent members of their families over 16 years of age, are eligible. The normal length of a visit is three weeks.
> No one can be received who requires nursing or meals in bed, or cannot eat a normal diet.
> No pets can be received.

Anyone who would appreciate a few weeks' rest in pleasant surroundings is welcome. **There are no charges.** No enquiries are made as to applicants' means, but naturally it is primarily intended for those who, owing to their circumstances, find it difficult to get such a rest otherwise.

The following information may be useful to intending visitors:—

The owner is not strong and cannot undertake running the house and looking after guests, therefore she has put Miss Saville, a friend of hers, in charge of the house to run it and act as hostess in her place.

Coombe House is two miles from East Croydon Station, with a good service of trains to London. It has pleasant gardens and grounds and so should prove particularly attractive to people who are fond of gardens. There are several golf courses in the neighbourhood and putting on the lawn.

The house is run very quietly with a small staff and on teetotal lines. The general routine is breakfast at 9 a.m., lunch 1 p.m., tea about 4.30 p.m., and dinner at 7.30 p.m.

Four guests can be accommodated at the same time.

It is a convenience to Miss Saville if intending visitors will arrange the time of their arrival with her and she can generally send a car to meet them at East Croydon.

There is garage accommodation for those who bring their own car.

It is requested that all correspondence with reference to proposed visits should be addressed to The Secretary, R.E. Corps Committee, Room 231, War Office, London, S.W.1, and NOT to Miss Saville until after dates have been fixed and an invitation received.

It would help the Committee if those writing to propose themselves for a visit would give as much information as possible as to the dates on which they would like their visits to start and finish. If possible, alternative dates should be given.