THE ROYAL ENGINEERS JOURNAL.—DECEMBER, 1934.—Pages 505—68[illegible].

The Royal Engineers Journal.

VOL. XLVIII. DECEMBER, 1934.

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

LONDON:
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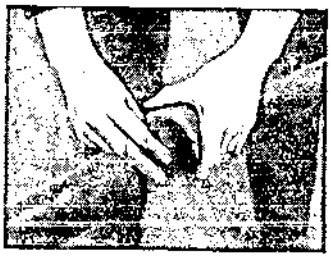

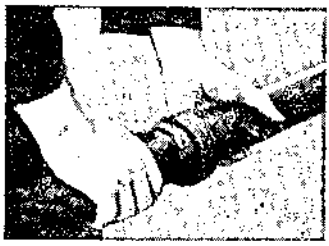

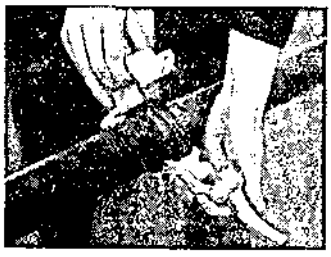

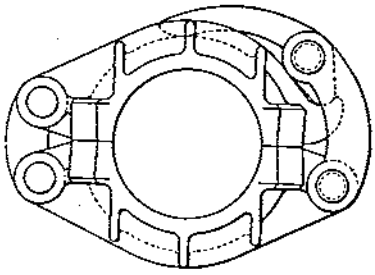

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Plate 1.

Full Dress, 1857.

The officer in the foreground is serving with a company; those in the background, in other employment.

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THE UNIFORMS OF THE CORPS OF ROYAL ENGINEERS UP TO 1914.

By the late LIEUT.-COLONEL P. H. KEALY, R.E. (*retired*).

PART II.

(*The publication of this part has been supervised by Mr. P. W. Reynolds.*)

PART I brought the history of the uniforms of the Corps up to 1855. In that year, the Board of Ordnance was abolished and R.E. officers came under the orders of the War Office. In 1857, the latter issued its first regulations for the dress of R.E. officers as follows :—

REGULATIONS
for the
DRESS AND APPOINTMENTS
of the
CORPS OF ROYAL ENGINEERS.

MEMORANDUM.

Horse Guards, 1st April, 1857.

These Regulations for the Dress of the Corps of Royal Engineers having received the sanction of Her Majesty, the Inspector-General of Fortifications directs attention to the General Order of 1st April, 1857, conveying Her Majesty's commands that these Regulations shall be strictly adhered to, and declaring that Commanding Officers are prohibited from taking upon themselves to allow any deviation from the approved patterns.

A copy of these Regulations must be in the possession of every Officer and of every Company, and will be shewn with other official books at stated times.

By order of the Inspector-General of Fortifications,

J. W. GORDON, Colonel,
Deputy Adjutant-General, Royal Engineers.

ROYAL ENGINEERS.

GENERAL AND STAFF OFFICERS.

General Officers are to wear the dress and appointments as laid down for their respective ranks by Her Majesty's Regulations.

Staff Officers are to conform to the Regulations for the dress of the Staff of the Army, except that in full dress they will wear the regimental collar and shoulder knot, and that the sleeve ornament of the Assistant Adjutant-General be that ordered for Field Officers of the Corps, and that of a Brigade Major (if not a Field Officer) a similar device, but with one row only of figured braiding above the chevron.

Facings of garter blue velvet.

The lace on the trowsers, cocked hat, etc., to be of the regimental pattern.

The plume to be of the regimental shape and size, with scarlet and white feathers mixed.

The undress and all appointments to be of the regimental pattern, and to be worn as herein directed, except that the peak of the forage cap is to be embroidered.

Badge of the Corps of Royal Engineers.

The Royal Arms and Supporters, with the Motto,
Ubique ;
Quo fas et gloria ducunt ;
(underneath)

Distinctions of Rank.

Dress.

Collar Badges— Colonel, Crown and Star. Lieutenant-Colonel, Crown. Brevet-Major, Star.	Collar laced all round with ½-inch gold lace (Corps pattern), inside the gold cord. Sleeve ornament.—Chevron of 1½-inch flat gold lace (Corps pattern) with three rows of small gold braid outside of chevron, two rows figured and centre row plain, eleven inches deep.
Captain, Crown and Star. Lieutenant, Crown.	Collar laced round the top with ½-inch gold lace (Corps pattern) inside the gold cord. Sleeve ornament.—Austrian knot of round back gold cord, traced in and out with small gold braid 8 inches deep, and figured, for Captains ; 7 inches deep and plain for Lieutenants.

The collar badge of the tunic for all ranks to be in silver embroidery.

Tunic.—Scarlet cloth edged with blue velvet, single-breasted, buttons 2 inches asunder. Collars and cuffs of garter blue velvet.

Round back gold cord on edge of collar and collar seam, skirt plain and lined with white kerseymere, 10½ inches long for an Officer 5 feet 9 inches in height, with ¼-inch more or less for each inch difference in height.

Sleeve.—Not to exceed 10½ inches in circumference at the wrist.

Shoulder Knot.—Round back gold cord, treble twist, with silver grenade (embroidered).

Hat.—Cocked (Corps pattern), with tassels of small gold bullion, corners 4¾ inches long, ends 2½ inches broad, fan 7½ inches high, front flap 6¾ inches high, with a loop of gold lace (Corps pattern) 1 inch wide, small regimental button, and watered ribbon cockade; ribbon on sides, front, and rear plain.

Feather.—White cock, 5½ inches long, mushroom shape.

N.B. Officers appointed to Companies to wear the same headdress as the Men, when paraded with them. The Men to wear a Busby; pattern deposited at the Army Clothing Department.

Busby.—Picked seal skin, 8 inches high in front and 9½ behind; light blue bag to hang over the right side, and hooked down to the Busby; leather chin strap, and gilt grenade on left side to hold the plume.

Plume.—White goat's hair, 6 inches in length, to be worn on left side of Busby.

Trowsers.—Dress.—Dark Oxford mixture, gold lace stripe (Corps pattern) 1¾ inches wide, down outer seam.

Sword.—Regulation pattern blade for Infantry, 32½ inches long by 1⅛ inches wide, hilt of rolled metal, gilt, scroll pattern, pierced and engraved.

Scabbard.—For Field Officers, *brass*; for other ranks, *steel.*

Sword Knot.—Round gold cord, with acorn.

Sword Belt.—(To be worn over the tunic.) Russia leather, 1½ inches wide; two stripes of gold embroidery ¼-inch wide, plain gilt buckles, carriages embroidered on both sides; gilt plate with Corps' device in silver.

Boots.—Wellington.

Spurs.—Brass; crane neck 2 inches long, including rowels.

Gloves.—White leather.

Stock.—Black silk, or patent leather.

Pouch Belt.—Russia leather, 2 inches wide, one stripe of gold embroidery ⅜-inch wide on either edge, and one in a scroll down the centre.

Buckle, tip and slide, gilt and engraved.

Pouch.—Black patent leather, regimental badge gilt, on outside leaf; box 5 inches long, 2½ inches deep, and 1½ inches wide (interior dimensions).

Undress.

Frock Coat.—Blue cloth, single-breasted, rolling collar, to hook-and-eye up to 5 inches from bottom of stock.

Eight loops of ¾-inch braid (mohair) down front, and two rows of netted barrel buttons 1⅛ inches long on each side.

Front edges and collar, back seams, and hind arm trimmed with $\frac{7}{8}$-inch braid and traced, two streamers of $\frac{7}{8}$-inch braid 8 inches long on each skirt, traced, and finished with points and crow's feet.

Cuffs pointed 5 inches deep of 1-inch braid, traced and finished with crow's feet; an extra row of small figured braiding on the cuff of a Captain, and the tracing of the cuff of a Field Officer to be as on the tunic. Field Officers to wear the relative collar badge embroidered in gold on the collar.

Jacket.—Scarlet cloth, single-breasted, to hook-and-eye, and with gilt studs down the front; plain gold braid all round, and on collar seam, finished with a crow's foot at centre of waist and collar seam.

Shoulder cord, a single twist.

Collar, garter blue velvet, rounded in front.

Cuffs, garter blue velvet, pointed, 5 inches deep; for a Lieutenant, edged with plain gold braid, and a crow's foot at point; for a Captain, an additional row of small figured braiding; for a Field Officer, a chevron of gold lace (Corps pattern), 1 inch wide, edged with plain braid, and crow's feet at points.

Field Officers only to wear the collar badges, and these to be embroidered in gold.

No lace to be worn on the collars of the shell jacket by any rank.

Waistcoat.—Scarlet cloth, single-breasted, to hook-and-eye, and with gilt studs down the front; plain gold braid all round on collar and seam; pockets edged top and bottom with gold braid, crow's foot at each end, and treble twist in centre.

Trowsers.—Dark Oxford mixture, a scarlet stripe $1\frac{3}{4}$ inches wide down outer seam. Pockets allowed down the outside seam.

White linen or Russia drill on foreign stations in summer.

Forage Cap.—Blue cloth, a gold netted button in centre of crown, which is in eight parts, and edged with scarlet piping. Band of gold lace, $1\frac{3}{4}$ inches wide (Corps pattern), projecting peak; oilskin cover may be worn in wet weather.

Cloak.—Blue cloth, with cape and sleeves lined with scarlet; upright scarlet cloth collar, with gilt clasps, chain and grenades.

Sketching Case.—Black patent leather, fitted up to contain drawing materials, to be attached to sword-belt by three narrow slings of corresponding pattern to the belt. Regimental badge, etc., gilt.

The sketching case is not part of any of the parade dresses, nor of evening dress; it is to be worn only when required in the field.

The following may be worn on active service:—

Pouch Belt.—Bridle leather $1\frac{1}{2}$ inches wide, without embroidery, but with buckles and mountings as for Russia leather belt.

Sword Belt.—Bridle leather, $1\frac{1}{2}$ inches wide, without embroidery, but with same plate and mountings as for Russia leather belt.

Sketching Case.—As before, but attached to bridle leather sword belt by three narrow slings of bridle leather.

HORSE FURNITURE.

Saddle Cloth.—Dark blue cloth, 2 feet 10 inches long, each flap 1 foot 10 inches deep; one row of gold lace (Corps pattern), 1 inch wide on scarlet cloth round outer edge.

Field Officers to have the badge of their Army rank at each corner, embroidered in silver. (Patterns deposited at the Army Clothing Department.)

Saddle.—Including stirrups and leathers, all of hunting pattern.

Bridle.—Of brown leather, and cross-face piece, ornamented with rosettes of the same; bent branch bit, with gilt bosses, having V.R. in the centre, encircled with the words "Royal Engineers," and a crown above; front and rosettes of garter blue velvet.

Breastplate and Crupper.—Of brown leather, ornamented with rosettes of the same.

Girths.—White.

Head Collar.—Of brown leather, with steel collar chain.

Brown Leather Wallets.—Covered with black bearskin, except in tropical climates, where they are to be covered with black patent leather.

REGIMENTAL STAFF OFFICERS.

Adjutants.—To wear the dress and appointments as ordered for their respective ranks.

Quartermasters.—The dress and appointments to assimilate in every respect to those of the Subaltern Officers of Royal Engineers, except that the sword and pouch belts are to be of white patent leather, with gilt buckles and mountings.

Dress to be observed by officers on the following occasions:—

Levees, Drawing Rooms, Evening, Review order.

Tunic, Cocked hat and feather, Sword belt, Pouch and belt, Dress trowsers, Sword, etc., Gloves.

Church parade, Garrison duty.

Tunic, Cocked hat and feather, Sword belt, Pouch and belt, Undress trowsers, Sword, etc., Gloves.

Marching order.

Tunic, Cocked hat and feather, Sword belt, Pouch and belt, Undress trowsers, Sword, etc., Gloves.

Drill order, Orderly duty.

Jacket, Forage cap, Sword belt, Pouch and belt, Undress trowsers, Sword, etc., Gloves.

Mess.

Jacket (open), Waistcoat, Dress trowsers.

Officers attached to companies, when on parade, to wear busby and plume, instead of cocked hat and feather.

Frock Coat.—The frock coat to be worn always with scarlet waistcoat, and hooked up to 5 inches from bottom of stock; with sword belt (under surtout), and forage cap on regimental courts-martial, courts of inquiry, and committees, inspection of barracks, etc., and as a common dress in quarters.

Also with cocked hat and feather when on staff duty, but never on garrison or orderly duty.

As regards mounted duty:—

The saddle cloth in review order only. The wallets and cover in marching and drill order. The bridle is invariably the same.

Notes.

1. The sword belt never to be worn without the sword.
2. Pouch and belt to be worn at all times with the tunic; always with the shell jacket on duty; but not to be considered as part of any parade dress or staff duty with the surtout. To be worn with the surtout only when required in the field.
3. The forage cap never to be worn with the tunic.
4. When swords are drawn, the scabbards to be hooked up.
5. No outside pockets allowed in the tunic, surtout, or jacket. Trinkets and long watch chains are forbidden to be worn with uniform.
6. A piece of crape on the left arm (above the elbow) is the only indication of private mourning to be worn.
7. Shirt collars never to be worn in uniform and undress.

Remarks.

1. The full-dress tunic in place of the coatee was introduced for the men in 1855, and a similar change was made in the dress of the officers at the same time, though no copy of the order has been found. The Regulations of 1857 incorporate the changes made in 1855.
2. The black leather scabbard has disappeared.
3. The present pattern of gold sword knot is now introduced.
4. The officers continued to wear the cocked hat in full dress when on parade with the men till the introduction of the busby by these Regulations of 1857. A photograph of the I.G.F.'s half-yearly inspection in 1856 shows the officers wearing cocked hats, the men wearing shakos, and both officers and men wearing tunics.
5. It would have been very awkward to wear the sword belt under a long-skirted frock coat. The last previous reference to this (see page 202) in 1830 showed the belt worn over the frock coat. The next regulations show a reversion to this method, perhaps because the wearing of the belt under the frock coat was found to be impracticable, or perhaps because the word "under" was a misprint in the 1857 Regulations, and no change really enforced.

Plates 1, 2 and 3, illustrating these Regulations, are from *Army Equipment*, edited by Colonel (afterwards Lieut.-General Sir Henry) James, R.E., Part III, Sec. 1.

The next set of Regulations is dated 1st April, 1861. These contain but few alterations. The height of the busby is reduced to $7\frac{1}{2}$ inches in front and $8\frac{5}{8}$ inches behind, and is to be worn by all officers appointed to companies and by all subaltern officers on first joining at Chatham. The pouch is replaced by a telescope case of black patent leather with gilt regimental badge. In the horse

furniture, there are steel chain reins of staff pattern. With the frock coat, the sword belt to be worn *over* the surtout instead of *under*; and the telescope case and belt to be worn with this coat on garrison and staff duty as well as in the field. (Amendment of 22nd May, 1861.)

The next Regulations are dated 1874. They contained the following alterations :—

Tunic.—The two back plaits up to waist to be edged with garter blue velvet piping (*i.e.*, the flaps with buttons as shown on Plate 3 had disappeared).

Frock Coat.—The pattern remained unchanged, but to be worn only by regimental Field Officers. In its place for other ranks was introduced a

Patrol Jacket.—Blue cloth, velvet collar and cuffs, one-inch braid all round and up open slit at the sides ; five loops with crow's feet of flat braid up front, the top loop 8½ inches long, the bottom one 4½ inches, with three rows of knitted olivets (15 in all) ; stand and fall collar, to hook-and-eye up front to neck, crow's feet on sleeve . . . double rows of flat plait up curved side seams, with crow's foot at top and bottom of each ; with pockets.

This jacket was *not* to be worn by Regimental Colonels, *might* be worn by Lieutenant-Colonels, *must* be worn by all others. Field officers had their distinguishing badges embroidered in gold on the collar. This jacket replaced the scarlet shell jacket for drill order, but the latter was worn till nearly the end of the century by officers with R.E. " Troops " in drill order.

Forage Cap.—The same as before, but the peak now *horizontal.*

In practice, the peak had been horizontal since 1861, but hitherto it had not been so described in regulations.

Trowsers.—For mounted duties the trowser to be booted with leather, staff pattern, but not in full dress order.

Busby.—Seal skin, 5¼ inches high in front and 8 inches behind. Lines of gold, round, plaited across in front, double cord curved round back to fasten on left side with flounders and eggs. Chain bright gilt curb on velvet, to fasten on lion-head hook behind and ear-pieces. Gold gimp boss in front 1½ inches long. Plume worn in front, of white goat's hair with blue feather at base 2½ inches long, the whole measuring 6½ inches long. Socket, gilt fuse and ball.

Overalls and Wellingtons, instead of trousers and ankle boots, came in in the 1880's. There was apparently no order, the fashion

being due simply to a reaction against loose trousers and "sloppy" garments generally.

On the reorganization of the Army, many changes were introduced into the *Regulations of 17th May*, 1883, issued under the signature of Wolseley as Adjutant-General. The wearing of emblems of rank on the shoulder straps and the grenade on the collar, introduced in 1880, now appeared in Regulations. The emblems were as at present except that Captains only wore two stars, Lieutenants one and 2nd-Lieutenants none. Brass spurs were worn with dress trousers, and dress pantaloons with 1¾-inch gold stripes and knee-boots, which had been worn by mounted officers since 1872, were now incorporated in the Regulations. The home-pattern helmet now appeared in Regulations. It had been introduced in 1878, and remained the full-dress head-dress of the Corps till 1928, when the busby was again introduced. Plate 5 shows the head-dresses of the Corps from 1857 till present day. The cocked hat survived, to be worn in full dress by all officers, when not with troops. The pattern of the forage cap was changed, and it was now of blue cloth, straight up, 3 inches high with band of 1¾-inch gold lace, black patent leather drooping peak and chin strap. The peak ornamented with ½-inch full gold embroidery. A gold-netted button on the crown. Field officers to wear a gold French braid welt round the crown; others a blue cloth welt. A new forage cap was authorized for active service and manœuvres, consisting of a blue cloth folding cap 5 inches high, with an embroidered badge on the left side (a grenade). On the shell jacket the shoulder knots were of the same pattern as on the tunic.

By *General Order* 16 *of* 1885 a scarlet serge patrol jacket was authorized; it had a red collar edged all round with ⅛-inch Russia gold braid, and no grenade; slit for sword; one breast and two side pockets. The front, bottom, side slits and pocket flaps edged with blue cloth; a pocket inside each breast; badges of rank in gold on red shoulder straps. This appeared in the *Dress Regulations* of 1891.

In the *Dress Regulations* of 1894 the scarlet serge patrol jacket was described as full in chest; collar and cuffs of blue cloth; shoulder straps of red cloth; a small regimental button at top of the shoulder strap. Badges of rank in metal. Stand-up collar, cut half-round in front, black silk tab. Hook for sword. Five buttons, two breast, two side patch pockets. Cuffs pointed; collar badge, grenade in gold. Russian ¼-inch gold braid round bottom of collar and round cuffs.

By these Regulations an undress sword belt was introduced, of plain bridle leather with mountings as for full dress; also worn on active service.

Plate 2.

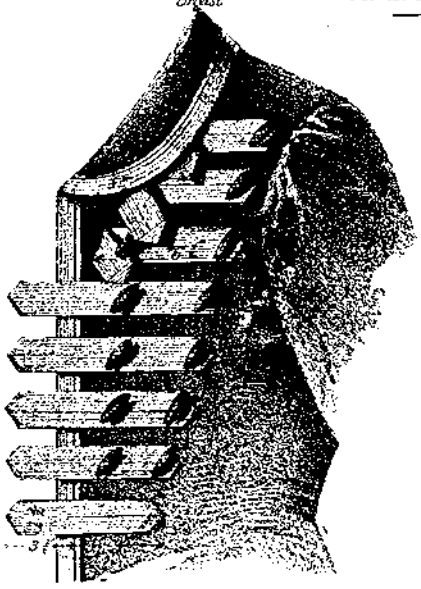
Undress (Frock Coat), 1857.

The right-hand officer in the background is wearing Drill Order; the left-hand officer is in undress, doing staff duty.

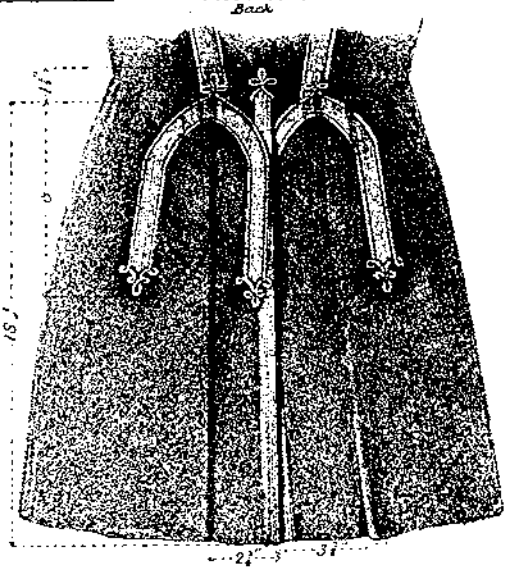
DETAILS OF OFFICERS' DRESS

For an Officer 5 ft. 10 in. high.

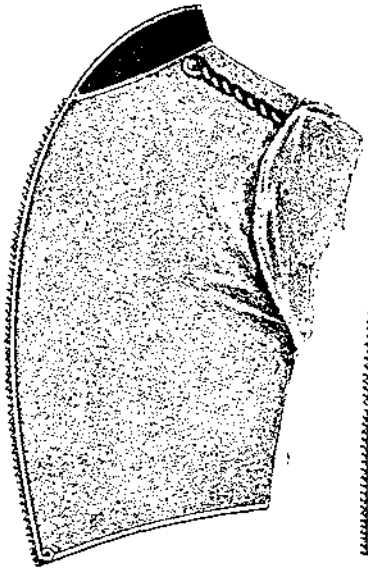
FROCK COAT
Breast



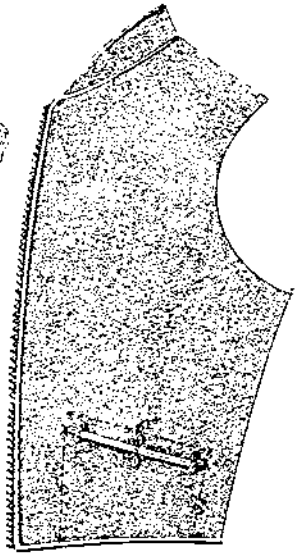
FROCK COAT
Back



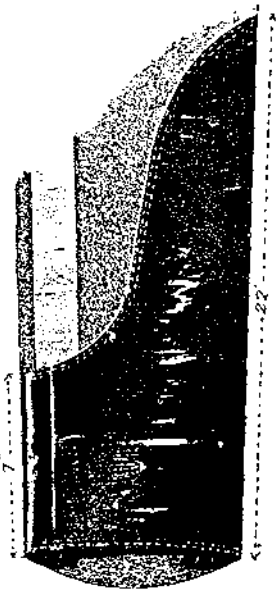
JACKET



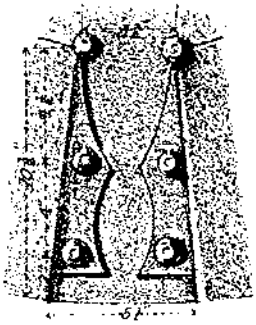
WAISTCOAT



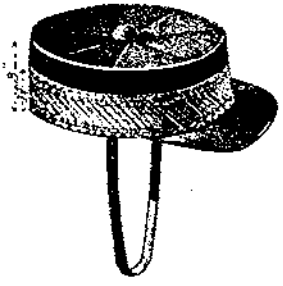
BOOTING



TUNIC



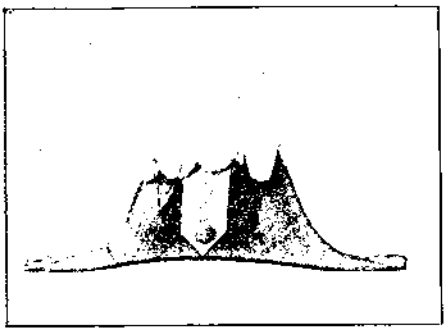
CAP

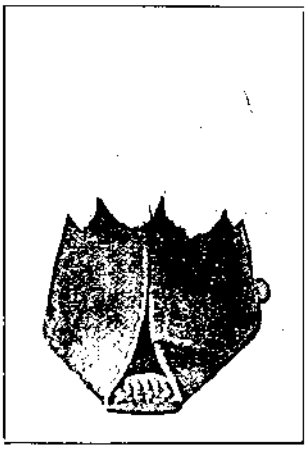


SCALE

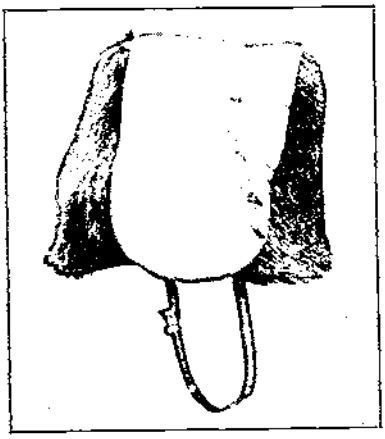
Plate 3.
1857.

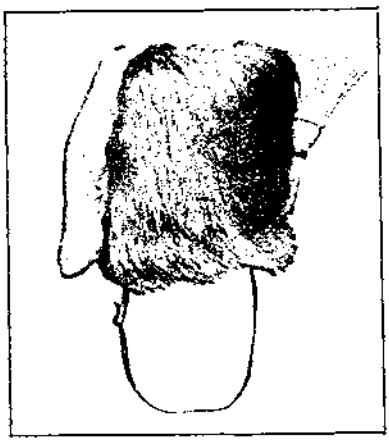
Plate 4.
Officer serving with mounted troops, 1870.
(From a silhouette in R.E. Museum.)





Cocked Hat, 1855–1857. All officers.
1857–1914. Officers not serving with troops.

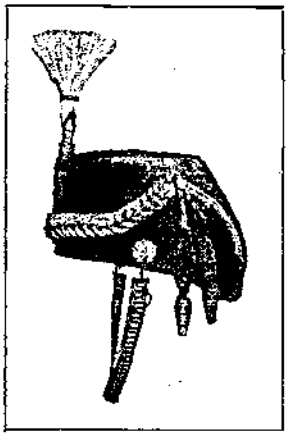




Busby, 1857–1870, with troops. 1929—present day.

F

Full Dress Hea



Busby, 1870–1878, with troops.

Helmet, 1878–1928. With troops.

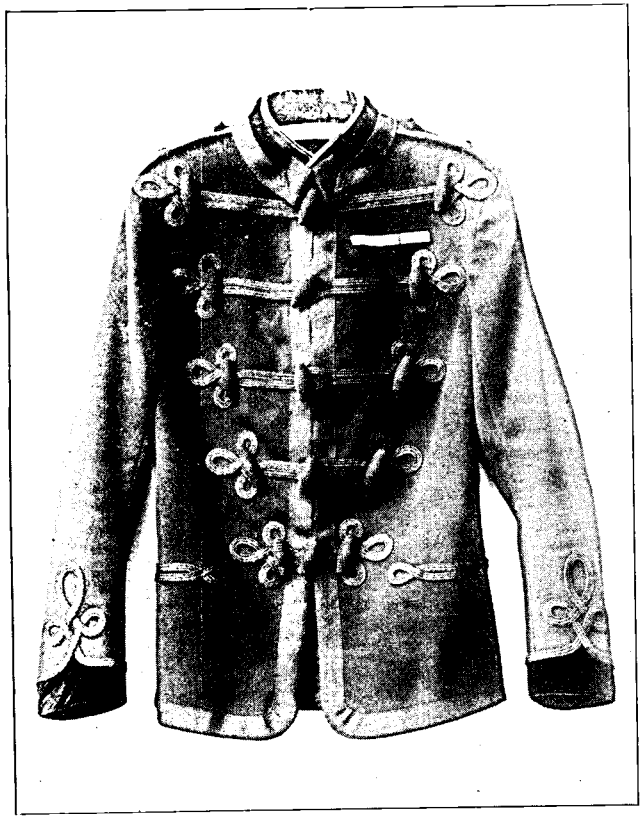


Plate 6.
Patrol Jacket, 1870–1896.

Plate 7.
Scarlet Patrol Jacket, 1885–1904 (1897 pattern).

Plate 8.
Frock Coat, 1904.

Plate 9.

Service Dress, 1904.

(From a silhouette in the R.E. Museum.)

The principal differences from the present are :—Stand-up collar with linen inner collar; badges of rank on sleeves; strapped leggings; long-necked spurs.

In the *Dress Regulations* of 1900 the forage cap was given a bell top in one piece. The scarlet frock (sealed pattern 29.7.97) now had shoulder straps of the colour of the regimental facings, with a pointed flap and small button for the breast pockets. The blue frock, introduced in 1896, was of the same pattern as the scarlet frock but all of blue, and replaced the braided blue patrol of 1870.

In 1902 the badges of rank were changed for the junior ranks; the 2nd-Lieutenant, who previously had worn none, now was given one star on each shoulder, and the stars for Lieutenants and Captains were increased by one each to two and three respectively.

The *Dress Regulations* of 1904 incorporated the changes introduced after the South African War. The subaltern's pattern tunic was adopted for all ranks, the difference in rank being shown by the badges only. The old shell-jacket mess dress with red waistcoat buttoning to the neck disappeared, and in its place the modern mess dress with roll collar was adopted. The gold lace stripe on the mess overalls was replaced by the present scarlet stripe. A double-breasted universal pattern frock coat was introduced, with a gold-embroidered grenade on the collar. The patrol jacket and scarlet serge disappeared. A service dress was adopted, the material being a special mixture serge, as still worn; the colour of the jacket is an adaptation of khaki (*Hindustani*—dusty) to the conditions of Europe. The jacket originally had a stand-up collar. The open jacket worn with a flannel shirt, collar and tie, was introduced in 1913. The Sam Browne belt, which had been in use in India for some time, was worn with service dress. Badges of rank of worsted embroidery were worn on the cuffs, supplemented by one or more rings of worsted chevron lace and tracing braid round the cuff according to rank. A stiff-topped peaked khaki forage cap of universal pattern similar to that now worn was authorized for the service dress, and a blue cap of the same universal pattern with blue cloth band, scarlet welt round crown and top of band, with the R.E. cap badge, was worn with other dress except the tunic.

There were no further changes of importance in the uniform of the officers up to 1914.

Note on the First Article (June, 1934).

Mr. Reynolds points out, with reference to paragraph 5 on page 208, that the shell jacket was already frogged, *i.e.*, it had nine loops of flat braid with loose ends. It appears in a plate published by Ackerman in May, 1846.

A BRIDGING EXERCISE.

1st Division Exercise No. 2.

By LIEUT.-COLONEL N. T. FITZPATRICK, D.S.O., M.C., R.E., *C.R.E. 1st Division.*

ONE of the objects of the 1st Division Exercise No. 2 (13th to 15th September) was to try out under service conditions the new bridging equipment now allotted a Field Park Company R.E. to meet the requirements of a Division.

The obstacle to be dealt with was the Kennet and Avon Canal between Alton Priors and Devizes, a fairly formidable affair owing to the nature of its banks. The bridging work had to be done in the realistic conditions of a rapid occupation and evacuation of a bridgehead, and in consequence an account of the exercise may be of general interest.

The scheme opened with the acting Divisional Commander, Brigadier T. G. Dalby, D.S.O., being told that a severely hammered enemy had retired in considerable disorder, and that we had lost contact. Our army was to advance on 13th September and pass through the outpost line Shrewton Folly—West Down—South Camp—Tilshead at 1100 hours, with our first objective the Kennet and Avon Canal, and our second, the line Marlborough—Cherhill.

As regards the enemy, according to our information none were reported south of Marlborough—Cherhill, but north of that line it was said there were considerable enemy concentrations.

The G.O.C.'s appreciation took up for three main factors :—

1. Speed was to be the essence of the contract, to cross and secure a footing north of the canal before the enemy had a chance of seriously opposing us on the crossings.
2. On the right of our sector the dominating open ground, with spurs reaching down to the canal (*vide* map), made a frontal attack in that area a very hazardous operation.
3. The communications in the whole of our Divisional area had purposely been made meagre (*vide* boundaries), but in the right half, the roads led forward to nowhere, and the only possible through communications were in the left sector.

In view of all this, the G.O.C.'s plan was to force the canal on the left, with an initial bridgehead Hill 530—Bishops Cannings—Round-

way Hill—Roundway, subsequently capturing the Ann's Hill *massif* by a flank attack from the bridgehead, and finally to work forward on to the second objective.

Our first move, a couple of days before zero, was to ask for air photos of the whole length of the canal on our front. We expected that the enemy would destroy the canal bridges before we ever could reach them, and as the approaches about Horton Bridge and the Devizes Barracks were obviously the only ones by which we might re-establish communications rapidly across to the north bank, we called for obliques of the above, and also of the area south of 530 near Allington.

These photos (copies attached) reached us on zero day and confirmed the indications of maps and intelligence reports, that the cutting in which the canal lay all along the left of our sector was a most awkward proposition. Some 70′ to 80′ wide at the top, anything from 10′ to 15′ down to water-level, and an actual waterway of 40′ to 45′ with a maximum depth of 7′ to 8′ below the towpath-level. In addition, spoil from the excavations had been left piled up above field-level along the top of the banks, and the whole proposition appeared as awkward as one could wish for with Divisional bridging equipment consisting of the light box girder and folding boats.

As regards our resources, we had one box girder, rather less than one set of folding boats, and about 170′ of kapok, as against the divisional allowance of 312′ in the Corps Pontoon Bridge Park—about half the total authorized divisional equipment. The agreement, however, was that as the first phase of the operations, the Roundway bridgehead, amounted to about half of the Divisional task, our quota of the equipment should suffice and we were to do the best we could.

The bridging arrangements had to take up for three items :—

A. Assaulting Infantry.

B. Close support vehicles.

C. All remaining divisional loads.

From the maps and the air photos we were able to make an outline bridging plan, which was as follows :—

(i) On the right.—For the hill at Pt. 530, which was to be a limited battalion objective, two kapoks, and a folding-boat trestle with a couple of bays of superstructure to bridge what appeared to be a narrow and disused old bridge site south of 530, marked " Z " in the air photograph.

(ii) For the centre at Horton Bridge, four folding boats, one track raft, and the balance of the folding-boat trestle equipment

were allotted. Site " Y " was obviously a most awkward one for trestle work, but by ramping down and putting in trestles fairly high, we hoped it could be made passable for H.T. and all loads up to 4½ tons.

(iii) On the left, the box girder was to be used. Here the uneven banks looked like being very awkward for girder construction and launching, but the site was the best one available owing to approaches. In addition, a couple of folding boats and one track raft were allotted to this area for assaulting infantry and their close support vehicles.

The above stretched our resources as far as they would go, and our only reserves were two kapok bridges.

Our next step was to send an R.E. subaltern—Lieut. Holbrook—up with the R.A.F. to see what information he could gain from a rapid reconnaissance over the canal as to the practicability of the proposed bridging arrangements. The machine detailed was an Audax, designed only for one passenger—a gunner facing the stern sheets. To look forward and see what he was coming to, Holbrook had to stand up the entire time looking over the pilot's head. Nevertheless he returned with the heartening news that the bridging sites in order of practicability were Barracks Bridge, Horton Bridge, and Townsend Farm—the very order for which we had hoped.

Armed with this information, one had almost to decide on the bridging plans, but at the same time it was understood that R.E. officers would have to make detailed ground reconnaissances before the arrangements could be assured.

Meanwhile, the G.O.C. had arrived at the conclusion that the speed factor was of paramount importance, and in consequence he was determined to force the crossings practically in his stride and be over the canal by the morning of the 14th. From the outpost line to the canal was nine miles—over which negligible opposition was expected. Zero was to be 1100 hours on the 13th September, and the plan in general was as follows :—

A squadron of divisional cavalry with R.E. reconnaissance parties in Austins, out in front; it was expected that they would reach the canal during the afternoon.

The Division was to go through the outposts in brigade groups, which were also expected to make the canal well before nightfall.

Zero for the canal crossing was to be the moment the bridging gear could be got forward—the idea was about 2200 hours. As soon as small bridgeheads were secured at Pt. 436, Horton Bridge and Barracks Bridge, bridge-building was to commence, and the G.O.C. counted on a considerable amount of his wheeled transport being passed over before daybreak on the 14th. Pace, pace and pace again was to be the slogan and surprise.

On the above timing, we maintained that we would not be behindhand with the bridging in spite of the difficulties presented.

B Group of the Field Park Company was improvised out of our Field Company resources supplemented by a varied selection of civilian lorries, and put under Lieut. Rees, who was detached for the purpose from the 26th (Barker's) Field Company. Thanks to our very good friend the C.R.A.S.C., Major Davies, this fledgling, though somewhat strange to look upon, never let us down in its going. The plan for the Field Park Company was that it would be pushed forward in the mechanized Divisional Column, as soon as circumstances and roads permitted, to a central rendezvous at Etchilhampton, whence the various portions were to be guided forward by Field Company personnel to the infantry or the bridge sites.

Barker and his 26th Field Company were responsible for the right sector, where the Cameronians were to go over, Greenwood and his 12th Field Company took the Horton Bridge and the passage of the Wilts, and King and the 23rd Field Company had the Barracks Bridge, the crossing of the Northamptons and the box girder.

The G.O.C. held a conference on the afternoon of the 12th dealing with his proposals, and there we can leave preliminary arrangements and tell of what took place.

In spite of the information, the enemy proved to be south of the canal on the 13th afternoon. We imagine the director (Major-General J. Kennedy, C.B., C.M.G., D.S.O.) laid this on as his part of the "surprise." Furthermore, the enemy were given bussed infantry which enabled them to come considerably south of the canal to cover their demolition parties, and, as we had no A.F.V's of any kind, our one squadron of cavalry (Major Leaf's Squadron of 15/19th Hussars) was prevented from reaching the canal anywhere in the sector during daylight of the 13th.

Reports of possible enemy A.F.V. action came into Divisional Headquarters while the approach march was in progress, and it was 2 p.m. on the 13th before Divisional H.Q. was able to move forward from Shrewton Folly to the Bell Inn just north of Urchfont.

Meanwhile the R.E. units were gradually moving forward. The 26th Field Company—Sappers marching—with 3rd Infantry Brigade, 23rd Field Company—mostly mechanized—with 2nd Infantry Brigade on left, 12th Field Company—wholly mechanized—at Durrington Farm, waiting to move forward with the Divisional M.T. Column in which was also the Field Park Company.

Each Field Company during this phase was under the command of the Group Commander for precautions against enemy A.F.V's, and 23rd and 26th Field Companies had to compete with water supply as required under brigade arrangements, but apart from that it was understood all Sappers would revert to the C.R.E.'s control as soon as the bridging operations commenced.

By 4 p.m. it was realized at Divisional H.Q. that things were not moving forward quite as quickly as had been hoped, and as far as our forward R.E. reconnaissances were concerned nothing had come in. The Cavalry were being forced to hand over the forward fighting to the infantry all along the sector, and our R.E. subalterns, anxious to get a daylight look at the canal, were unable to reconnoitre anything.

At 5 p.m. the Divisional Commander decided to risk all in a personal reconnaissance. Sleuthed by an umpire, he ventured forward with an equally brave G., C.R.A. and C.R.E., and the party advanced in a most commendable manner to reach the top of Etchilhampton Hill as a fine fighting section of the front line of the 1st Wilts. A very fine performance. Mercifully no one was "killed" by our kind umpire, or by the I. of R.E. who appeared out of the blue to the C.R.E.'s amazement at this critical juncture on the bullet-swept top of Etchilhampton Hill.

Lying on our tummies and peering over the tufts (1st Division staff only) we saw Roundway, Bishops Cannings, etc., etc., and did much business in intensive map reading. The Divisional Commander saw enough to fix his plan, and so back to Divisional H.Q. at 6.30 p.m.

A Divisional conference, including Field Company Commanders, followed at 2nd Infantry Brigade H.Q. at 9 p.m. No lights for cars, no moon, tent very small and C.R.E. rather late through waiting at Divisional H.Q. for the forward reconnaissance reports, which reached him finally in the nick of time. Plan fixed, but with zero at 0130 hours, 14th—and we had hoped for 2200 hours, 13th! However, the only thing to do was to go through with it as best we could.

To go back for a moment to follow the moves of units.

It has taken some time before we could get the Field Park Company and the mechanized 12th Field Company run through from the Divisional M.T. column to their Etchilhampton rendezvous. In theory these moves take place with no difficulties, but even on manœuvres the R.E. naturally become only one of the pebbles on the Divisional beach, and have to take their turn. The 12th Field Company eventually got to their rendezvous at 6.30 p.m., but our Field Park Company with its variety of vehicles took some time coming down Redhorn Hill and eventually reached Etchilhampton at 7.45 p.m.

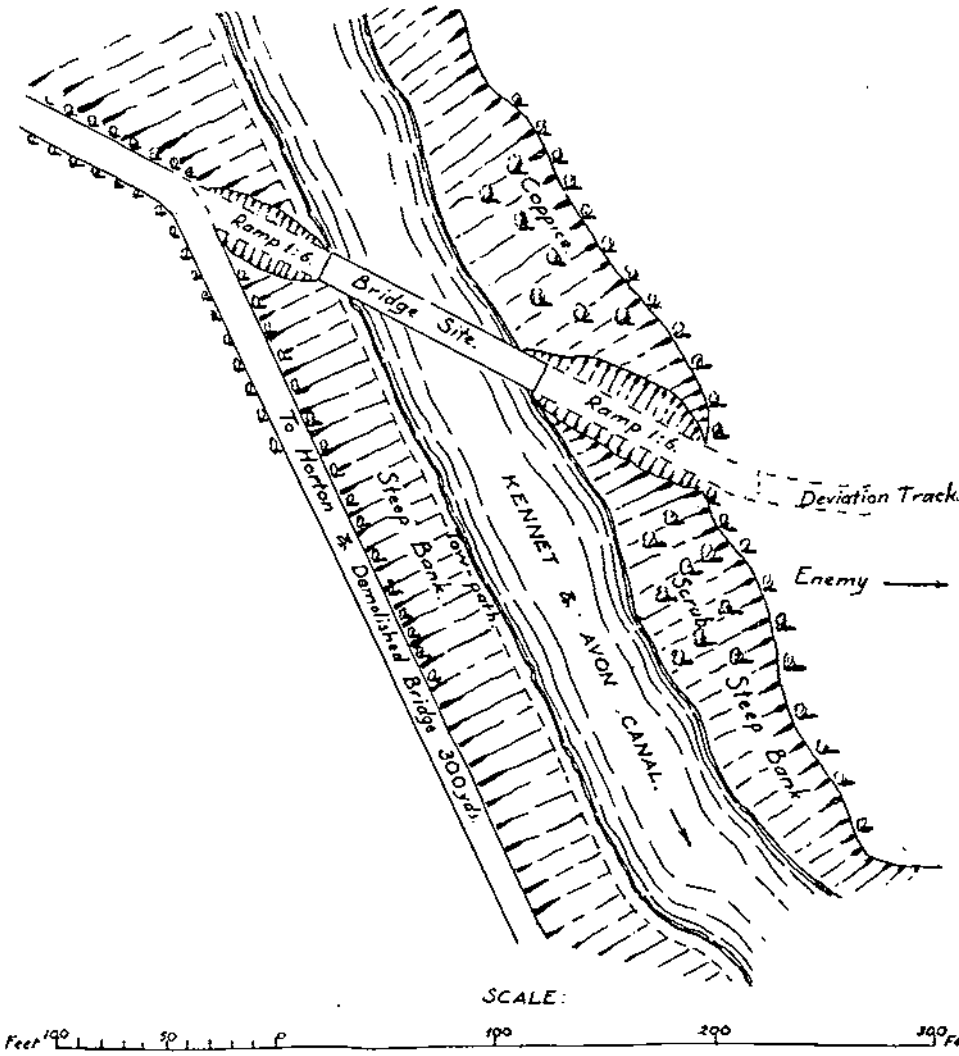
About Field Park Company transport. Rees had been particularly warned to reconnoitre exits as well as entrances at the rendezvous, for with four-wheeled trailers it by no means follows that the entrances from one direction can equally well be exits for another direction. These trailers want watching very closely, for manhandling is laborious and slow. Rees's exit had to be quite different

from the entry, and it had to be enlarged to be negotiable. To make sure of the subsequent forward moves of the trailers, instructions were given for every twist and turn of road to be reconnoitred, for one impractical bend can completely dislocate all arrangements. The turning circle of a lorry and trailer has a radius of some 40 feet.

To come now to the Field Companies and taking things from right to left. We had hoped the Cameronians would do their kapok work nearby the only place where we had sufficient trestle bridging to span the gap, *i.e.*, near Pt. 436—up to which there were incidentally quite good approaches for M.T. Owing, however, to the rush and hurry in which the whole attack was eventually staged, the Cameronians decided to try their luck farther over to the east, near All Cannings Bridge. The forward carry of the kapok at this latter site was ideal—straight up the main road—but as was rather to be expected, an enemy post was at the end of this enfiladed approach. One kapok was wiped out, only one ever got into the canal, the Cameronian bridgehead was restricted, and did not include, to commence with, our only possible bridging site at Pt. 436. Barker got his gear right up to Pt. 436 under cover of the canal banks, but when the men got to the site, there, too, were the enemy. The gap looked profound—these distances at night are most deceptive—and all during the night the 26th Field Company thought their material totally inadequate for the " chasm " in front of them ! About 5 a.m. on the 14th, things took a turn for the better on this front and the enemy withdrew. Bridging started at 5 a.m., it was completed by 7 a.m., and that left the Cameronians with the means of getting forward their close support vehicles and cookers.

Next about Greenwood and Horton Bridge. Over went the Wilts in the folding boats at 0130 hours on 14th. This famous battalion operating within a couple of miles of their depot, was altogether too good a match for any enemy put against them. The local bridgehead was cleared by 0200 hours and away started the bridging. The Director, who has the uncanny knack of being at the critical place at the critical moment, was at Horton Bridge at 0200 hours on the 14th, and this is what he told us he saw, or rather heard, at the silent " knife in teeth " sort of crossing. First of all up sailed two-thirds of the box-girder equipment due for the Barracks Bridge. This resulted in a very active service conversation and general mix-up between the 12th and 23rd Field Companies, the one endeavouring *coute qui coute* to prevent their folding-boat equipment from becoming muddled up, the other determined at all costs to restore their box-girder gear to the proper place. Next, the close-support vehicles of a complete battalion nearly went into the canal through a hole the Sappers had made in the hedge for the ramp down to the bridge. Then some officer made an impassioned speech in a stentorian voice appealing for peace and fair play amongst all concerned.

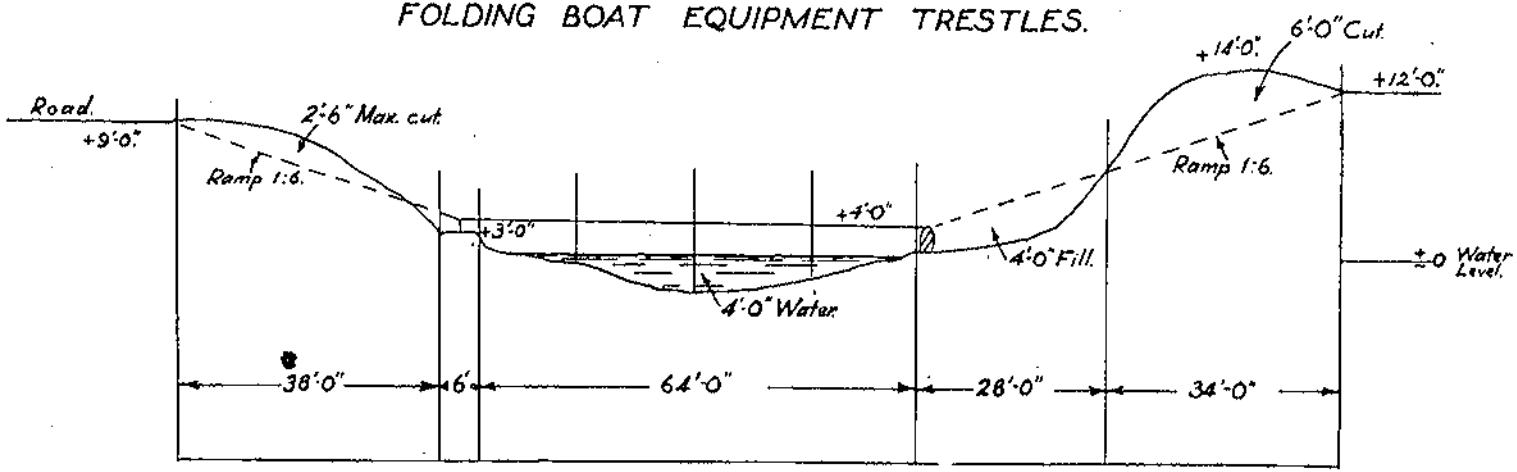
HORTON BRIDGE SITE.
SKETCH PLAN.



HORTON BRIDGE.

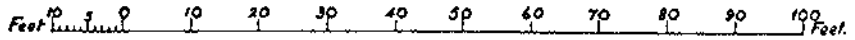
SECTION OF GAP AS BRIDGED.

FOLDING BOAT EQUIPMENT TRESTLES.



HORIZONTAL SCALE:

VERTICAL SCALE: TWICE HORIZONTAL.



Finally an exasperated motor-driver, driven almost demented in this terribly "built in" area, decided to risk all natures of law and sounded his horn! All this, as the General told an appreciative audience, showed how much we had to learn in perfecting the making of a silent crossing.

As a site for folding-boat equipment, Horton Bridge was about as awkward as it could be. On the skew, ramps at one-sixth, and banks full of roots. Boats were out of the question as they would have meant losing too much height. One was tempted to brush aside the tactical aspect and go for the easier technical site just east of Horton, but tactically this would have been unsound as the bridge itself would have been in full view of the enemy throughout the 14th and as long as he remained on Ann's Hill. At the site chosen, the bridge was tucked away in the cutting and hidden from anything but air observation. In addition, the approach east of the road bridge would have involved an awkward right turn in the open, and the track on the north bank would have meant much work over a long stretch of pot-holed ground. On balance site Y was considered the best.

Work started at 0200 hours. The cover enabled 12th Field Company to use pilot lights from Austins to shine southwards from the far bank, and the sketches show what had to be done.

The 12th Field Company were warned to bring some old clothes for their party, and by 6 a.m. the variety of outfit approximated quite closely to that allowed on service. Officers, however, set throughout a shining example by retaining their full and complete battle regalia as per the little green book. By 7.30 a.m. the job was done. Safely it took the M.T. loads up to 4½ tons, and in spite of the ramp slopes, *mirabile dictu*, it took also the complete H.T. of the Dukes.

The track raft was all laid out for the crossing, but as the infantry had never used it even by day, the Wilts thought they should not risk their Carden Lloyds over the arrangement by night for the first time. They accordingly decided to wait for the trestle bridge, and as a matter of fact all was well.

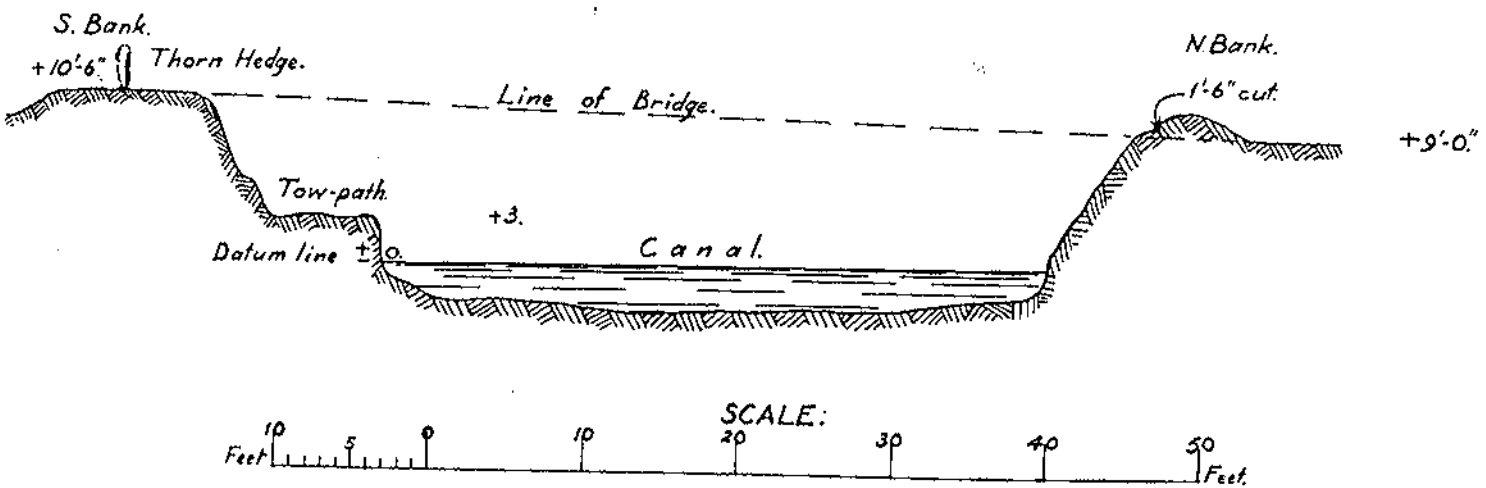
To come now to the Barrack Bridge, a chapter of minor mishaps ending up with success.

To commence with we had the box-girder gear going astray as already described. The Director was delighted when he saw this happening, for he knew the lesson it would teach. We all had realized the vital importance of getting gear to correct sites to time, and the whole approach had been carefully reconnoitred by Nottingham, who had gone off in ample time, with all his lorries closely trailing him. He halted and closed the convoy up 50 yards south of the first turn, and then went slowly round the corner. Owing, however, to the inevitable distances made between vehicles when moving off in the

SITE OF BARRACKS BRIDGE OVER KENNET-AVON CANAL.

SMALL BOX GIRDER.

SECTION OF GAP.



dark, only two of his lorries trailed him round the corner. The others going on to fame and Horton Bridge. No shells, no enemy interference, lorry drivers admittedly civilians, but very good reliable fellows. Lesson: In these approaches, every twist and turn must be picketed by men, in fog one would need men almost holding hands, and one has to make sure that gear goes to the right place.

Mishap No. 2.—The approach for 23rd Field Company Sappers was also over tricky ground. They went forward in M.T., admittedly unnecessary on second thoughts, one lorry got ditched, result —delay. Not only for Sappers but also for the Northamptons who were behind.

No. 3.—The turn round for the folding-boat trailer into the field. In spite of apparently ample space, there was not sufficient room, and had not someone happened to be at a particular gate-post, the whole of the folding-boat trailer would have been upset. Manhandling, more delay, delay in unloading. King had counted on getting the boats laid on the floor with everything comfortably ready by 2330 hours; actually the carry forward over the last 250 yards did not commence till 0100 hours. The net result was that the Northamptons' first wave went over the canal at 0145 hours *vice* 0130 hours.

A most awkward site for folding-boat ferries. The boats, however, lowered down very quietly, but seven out of every ten of the Northamptons as they stepped fully loaded on the sloping bows lost their footings. The straw on the bottom of the boat muffled the noise of their falling, and what muffled the ejaculations of the gallant Northamptons is not known, but not a sound was audible. Over went the waves without much trouble.

King's next tasks were the box girder and the track raft. The site for the former was bad—the site for the latter was worse.

King had none too many men for the two jobs. Hunter on the track raft finally reported that with the handful of men allotted him he could never make a reasonable Carden Lloyd approach in time to get them over before dawn. King, too, was wondering about the box girder, and the question was whether it would be better to concentrate on the box girder, let the track raft go, and bank on getting the box-girder route open before dawn.

Dawn was 0700 hours, and with zero for bridge building having been put back from the anticipated 2200 hours on the 13th to 0200 hours on the 14th, there was none too much time. It was a case of Hobson's choice, and the decision was made to concentrate on the box girder.

Immediately this was done, up rattled all the Northamptons' Carden Lloyds, a seemingly endless queue in the dark, to line up in column of route with the leading vehicle abreast the gap through

Heavy line in foreground shows site of bridge.

Horton bridge

Approach shown by heavy line.

Site of bridge shown by heavy line in middle distance.

Royal Air Force Official. Crown copyright reserved.

Barracks bridge

which they had hoped to go. Quite apart from enemy action, one imagined the sayings of the umpires, and of O.C. Northamptons, if the box girder perchance failed to come up to the most optimistic expectations, and dawn broke on a well-dressed line of Carden Lloyds *en pleine campagne*. The hazard was too great even for the field of peace manœuvres, so S.O.S. reinforcements had to be sent for from 26th Field Company away on the right, by 23rd Field Company M.T., and there the track raft can be left for the moment.

The box-girder gap looked prodigious. Eventually the tape was over—71 feet and construction at first sight impossible! However, by juggling down the bank and coming to the limit of sound footing, a 60-foot gap was found.

The launching site had a cross-section like a hog's back, and one remembers the drillbook dictum of a level launching site being almost essential. Away pegged the 23rd, very good roller work, King and Holbrook composed and serene in spite of close-ups by sympathetic umpires and spectators, and by dint of hard work on the part of all concerned the bridge was finished about 0730 hours.

Just after the first girder had been launched at about 0500 hours, the C.R.E. heard an ominous splash along the canal at the track-raft site, and wondering whether some of the machines might be in the process of being mysteriously winkled by an amphibious enemy, he went along to see, and found a surprising situation. Far from any enemy plot, it was Hunter who had pegged away quietly with his 4-track raft men, and having prepared some impossible-looking high dive for the leading Carden Lloyd, he had asked " What about it " ? The leading Northampton driver, in a whisper, took the challenge on, sidled to the brink, got sliding, and then put all his machinery to " Halt." Result, a noiseless slither followed by a loud bang and there was the Carden Lloyd in the ferry and over the canal and up the other side. For the remainder of the cavalcade, it was merely a matter of repeating the motion and the battalion's close support vehicles were over the canal in no time. A very good try-out of the track raft.

So much for the forcing of the Kennet Canal.

The 14th morning we spent in snatches of breakfast, sleep and make and mend, but by noon the ominous rumour had gone round that vastly superior enemy forces had assembled against our bridgehead, and we would have to withdraw.

Plans were hurriedly made. The upshot was that the last wheels would go over the bridges at 2200 hours and kapok had to be redistributed to provide footbridges for the rear parties, the last of which would cross the canal at 0115 hours.

During the above interval we had to dismantle and get away what we could of the bridging equipment. Anything left behind

was to be "utterly destroyed"—the fate in store for the four kapoks when finished with by the rear parties. How does one utterly destroy kapok? We said we could set it alight with petrol, but perhaps some reader with experience could throw light on this point?

As regards salving equipment. We had to get away as much as could be dismantled and loaded in three hours. Arrangements were made accordingly and all went exceedingly well. Everything was salved and reloaded, and the whole of the Divisional Engineers —including the Field Park Company—were marshalled *via* the Etchilhampton Loop at Foxley Corner by 0100 hours.

Redhorn Hill was the final poser. The maximum grade at an awkward bend is 1 in 7, and we were in some doubt as to how the bridging M.T. would go up at night what it had with some difficulty come down by day. However, Barker and Broomhall came to the rescue. In front of every civilian van with an attendant four-wheel trailer, they put, while at the Foxley halt, a 30-cwt. army lorry. Before Redhorn Hill was breasted, tows were fixed and up went the 30-cwt. lorries on their lowest reduction, followed by the vans with their trailers, and by 0140 hours not a single lorry was left in that pleasant Pewsey Vale.

All companies went off in clouds of steam, delegated once again to Brigade control for the hasty occupations of a defensive line about Ell-Barrow.

That ended an exercise which had been a very good one in every way. We learnt a great deal, and to conclude the account it is suggested that the following points are noteworthy:—

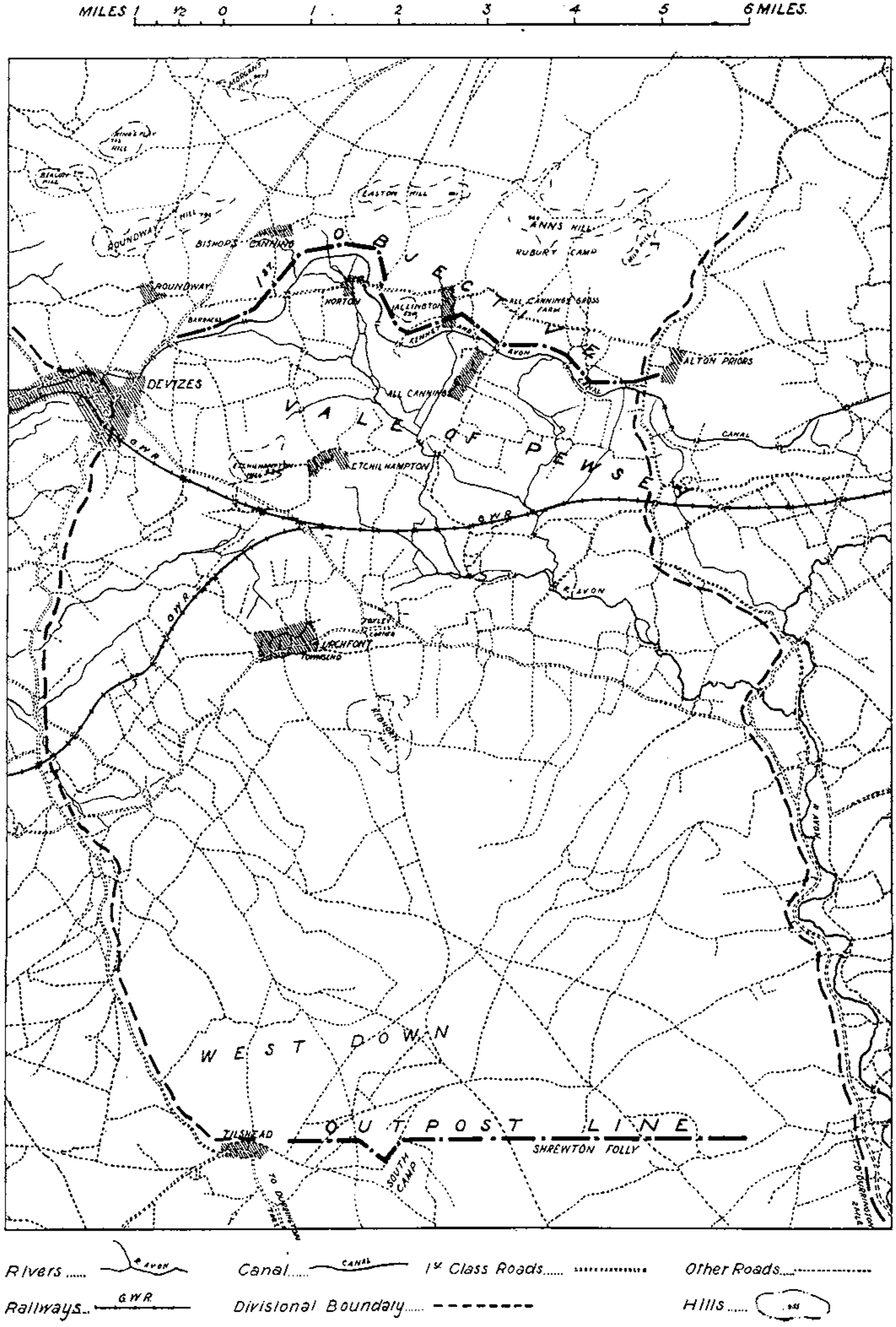
LESSONS.

1. Aeroplane reconnaissance, photos and obliques are all most valuable to frame a bridging scheme in general terms, but failing accurate reports of gaps in actual feet, or a ground reconnaissance of the sites in daylight, a first view of a gap by night is most disconcerting.

2. The simplest plan is essential for moving bridging M.T. forward, and the final approach marches have to be foolproof.

3. We require much co-operation and training with infantry in folding-boat ferrying. The gear is good and flexible, and the rafting in this exercise shows it is practicable in awkward circumstances. It took, however, some years for the

SCALE.



MILES 1 ½ 0 1 2 3 4 5 6 MILES.
EASTON HILL
ROUNDWAY HILL
BISHOPS CANNING
ROUNDWAY
ANNS HILL
RUBURY CAMP
HORTON
ALL CANNINGS CROSS FARM
OBJECTIVE
DEVIZES
ALTON PRIORS
ALL CANNINGS
VALE OF PEWSEY
ETCHILHAMPTON
CANAL
AVON
G.W.R.
R. AVON
URCHFONT
WEST DOWN
TILSHEAD
OUTPOST LINE
SHREWTON FOLLY
SOUTH CAMP
Rivers
Canal
1st Class Roads
Other Roads
Railways
Divisional Boundary
Hills

handling of kapok to become known generally; there is a good deal more in the handling of folding boats, but they are worth the practice.

4. As regards the folding-boat and box-girder bridging equipment the exercise showed what awkward sites this gear can deal with, and also that it can be handled at night provided reasonable illumination is allowed.

5. The four-wheeled trailers carrying assault folding boats require careful watching. The boats are heavy carries and one must move them forward as far as possible in M.T. for a quick operation; anything in the way of a sharp turn means delay in manhandling trailers.

6. The tractive power of the 30-cwt. lorry on low reduction gear is amazing.

7. Finally, practical exercises of this nature are of untold value.

With the box girder wholly on lorries, and the folding-boat equipment on lorries and trailers, the former is handier than the latter.

According to this exercise, the scale of divisional bridging equipment appeared just about right.

THE NILE CONTROL AND IRRIGATION PROBLEMS OF EGYPT.

By CAPTAIN F. C. T. NOAKES, R.E.

INTRODUCTION.

THE object of this article is to give a very brief outline of the irrigation problems which had to be faced by the Egyptian Government, and the schemes undertaken by them to safeguard potential developments of the country.

GENERAL.

The Nile is one of the most remarkable rivers in the world, and although its volume of water is exceeded by many rivers, in scientific interest it is exceeded by none. Its basin covers nearly three million square kilometres, and the problem of effectively harnessing such an enormous amount of water has been the study of some of the most famous irrigation engineers of the twentieth century.

Egypt is entirely dependent upon the Nile for its water supply, and from ancient times its irregular flow has caused great anxiety to the tribes living along its banks. In those early days, when the poor floods came, the resulting loss of crops was not so much due to the actual shortage of water in the river, but to the fact that the level was not high enough to overflow its banks.

The first method adopted by the Ancient Egyptians to overcome this difficulty was to construct canals, and then as the areas under cultivation gradually increased, to lengthen them, and give them offtakes much higher up the river. From such beginnings the great and elaborate system of basin irrigation in Egypt gradually arose.

Egypt is a country practically without rainfall, and yet holds a unique position in the agricultural world by reason of the great fertility of its soil, and the fact that its agricultural prosperity is entirely dependent upon artificial irrigation.

The White Nile rising in the lakes of Central Africa is fed on its course northwards by the Gazal and Sobat rivers, and eventually joins the Blue Nile at Khartoum. From this junction northwards the river is known as the Nile and receives its only tributary, the Atbara, two hundred miles north of this point. It enters Egypt at Aswan, and the Ancient Nileometer built there is still the standard gauge for recording the state of the river.

Briefly, the river floods about the end of May, and then there is a

continuous slow rise until the end of June, due to the flood water coming down the White Nile. At the end of June, the floods coming down the Blue Nile and the Atbara are felt. These two tributaries rise rapidly, and during the months of August and September, the Nile is in full flood at Aswan and is heavily charged with rich fertilizing mud. From the beginning of this rising, *i.e.*, about the end of May, until the maximum is attained about the middle of September, the discharge of the river rises in an average year from four hundred cubic metres to ten thousand cubic metres per second. It has been calculated that the river carries yearly 85 million tons of silt, 59 million tons of which is carried to the sea, leaving 26 million tons spread over the land by means of canals and inundations. The silt-bearing volume originates in the Abyssinian Hills, where the slopes are steep and the heavy rains wash the soil down to the Nile tributaries. Wherever the river slopes flatten out and the current slackens sufficiently to allow part of the load of silt to be dropped, deposits take place. Thus flood succeeded flood and the bed of the river rose (*pari passu*) with the adjoining banks. With low floods it follows that deep channels would need to be cut to flood the land. By this process the control of the Nile water was gradually established and the principal channels were developed more or less on the lines they follow to-day. How ancient this control is, can be gathered from various paintings and records in ancient tombs in Upper Egypt. There is shown in one what is, perhaps, the oldest known regulator of stone, by which water entering the Fayoum from the Nile Valley could be controlled. The ancient Kings of Upper and Lower Egypt were continually fighting over this key position, and whoever possessed it controlled the destinies of the tribes of Lower Egypt. From the early days, therefore, the control of the Nile has been closely connected with the prosperity of the country.

One of the most important characteristics of the Nile is the fact that practically all the water which it carries comes from the tributaries which enter it at or above Khartoum, nearly two thousand miles from its mouth. From this point northwards to the Mediterranean the volume of water in the river continually diminishes owing to the heavy evaporation, which is quite the reverse of most rivers. Similarly there are losses on the White Nile between Malakal and Khartoum.

Position up to 1921.

The Nile supply was controlled by the Aswan Dam, Isna, Asyut, Delta and Zifta Barrages, and (during the summer) by two earth sudds or dams in the Rosetta and Damietta branches of the Nile near the sea.

The most important was the Aswan Dam, which collected and

stored clear water (not flood) during the winter months up to 2,700 million cubic metres or tons, to supplement the low or deficient supply of the river in April, May, June and part of July, till the rising flood produced a sufficient natural discharge. This reservoir was filled in March and then gradually emptied until no stored water remained.

At Isna, about 170 kilometres north of Aswan, was the first barrage constructed to raise the level of low floods so that the water could enter the canals, thereby filling the basin systems to the north of the barrage.

At Asyut, 400 kilometres south of Cairo, another barrage controlled both the summer and low flood water and fed the Ibrahmiya Canal, which perennially irrigates the western side of the valley including the Fayoum down to the Delta Barrage.

There were also many large feeder canals along the whole length of the river from Aswan northwards, which took off direct from the river and fed the basin systems dependent on them.

At the Delta Barrage the Nile bifurcates into the Rosetta (West) and the Damietta (East) branches, and their levels are controlled at this point.

COMPARISON OF SUPPLY AND REQUIREMENTS.

(*Note.*—Feddan is roughly one acre.)

Present Day.—33,000,000,000 cubic metres at main canal heads (basin and perennial).

At the present time the estimated perennial area is about 4,000,000 feddans and the basin area about 1,500,000 feddans. The water consumed annually is 27,000 million cubic metres and 6,000 million cubic metres respectively.

Eventual (all perennial).—58,000,000,000 cubic metres at main canal heads.

The estimated requirements of Egypt in 1955, *i.e.*, when the irrigation system is completely developed, will be 50,000 million cubic metres for irrigation with roughly 2,000 million cubic metres to enable navigation of the river in the period (January) during the canal clearance. The Sudan will probably require 6,000 million cubic metres. This gives a total of 58,000 million cubic metres per annum.

The longest series of records dealing with the Nile, are the readings of the Roda gauge (Cairo). Of these the annual maxima and minima for two periods are available—one from 641 to 1451 A.D. and the other from 1737 A.D. with one small break, up to the present time. Since 1870 daily records of Aswan and Roda gauges exist and the discharge of the river has been measured.

The following table of discharges in million cubic metres per

annum at Aswan shows that the supply in a year like 1913 would be totally inadequate to meet potential demands, even if full use was made of the distribution.

Year.	*Million Cubic Metres.*
1902	67,000
1907	63,000
1913	41,000
1915	65,000

The reason for this is that silt-laden water (flood) cannot be stored. In very lean years at flood time the discharge is in excess of requirements, so there has always been water wasted by flowing into the sea.

It is, therefore, obvious that to meet potential requirements a reserve of water must be stored from good years in reservoirs in which excessive evaporation losses are small. By this means the water supply will be more than enough to meet requirements for cultivation in both countries.

The valuable crops to which Egypt now owes her prosperity, namely cotton, rice, sugar-canes and fruit, require frequent waterings extending practically over the whole year.

Efficiency of Water in Canals.

Canals are designed to accommodate the maximum demands. The discharge to meet this demand is called "full supply" of the canal and is calculated by means of formula $\frac{Q\,F}{E}$.

Q equals discharge entering head sluice in cubic metres per feddan.

F equals field duty in cubic metres per feddan per crop per diem.

E equals efficiency of water, ·75 approximately.

Some of the factors influencing water efficiency are losses of absorption, evaporation, seepage, nature of the soil, level of subsoil water and, above all, the distribution system.

These losses vary greatly throughout the whole length of the Nile on account of the enormous difference in temperature and depth of subsoil water.

The Egyptian Irrigation Department have worked out most interesting formulæ for each section of the river and tables for calculating the amount of water required in any district or "circle."

Systems of Irrigation.

The system of irrigation depends on the geological and climatic condition of the country as well as the nature of the crops to be

watered and it is, perhaps, best defined as the operation, or series of operations, carried out with the object of utilizing water for the purpose of agriculture.

A system of irrigation to be healthy should embody the principle of movement everywhere and stagnation nowhere. It, therefore, follows that where natural drainage cannot be expected, artificial drainage must be established simultaneously with the irrigation canals.

There are two distinct systems in Egypt, namely "Basin" and "Perennial."

Basin irrigation implies the yearly flooding of the natural or artificial terraces forming the valley of the river. In their simplest form these terraces are surrounded on three sides by artificial banks and on the other side by the desert, which form the "basins" extending in some cases over very considerable areas. The water is conveyed by a simple system of canals, thereby flooding the ground, which has become baked hard during the previous summer months. The water that remains after evaporation and absorption is passed forward if necessary to complete the inundation of the lower basins or discharged back into the river channel by means of "escapes."

Until the beginning of the last century basin irrigation was applied to practically the whole of the irrigated land of Egypt. It was the simplest, cheapest and most natural system under the condition that existed, and as the Nile flooded only during the late summer months, the ground had to lie fallow or unproductive for the remainder of the year.

The system of irrigation known as "perennial" now extends practically over the whole of Lower Egypt, and the heart of this system is the Delta Barrage. The great change of converting Lower Egypt from "basin" to "perennial" irrigation was inaugurated by Mohammed Aly Pasha in the early years of the last century. He constructed certain regulating works to make it possible at any time of the year to produce the exact water-level required to fill the canals of Lower Egypt. No Nile water reaches the sea during the period March–August except by filtration, and it was with the object of conserving part of the enormous volume of flood water that the large regulating works erected along its banks were constructed.

The ultimate aim of converting basin system to perennial will at the present rate reach its utmost limit by 1955, and it is estimated that the Nile can well meet the demands of Egypt and the Sudan under all conditions, including further expansion of the Sudan.

DISTRIBUTION.

Irrigation rotations at present practised is a term used to denote the system under which the water supply is distributed by time and

locality with regard to land under cultivation. They are applied to canals in various forms according to the different seasons of the year, and vary with the amount of water supply available. The normal rotation is what is known as an " eighteen day," which enables land to be watered once in eighteen days. The canal and the areas served by it are divided into three divisions. Each division in turn is permitted to take water during its supply period of six days, while the other two divisions remain without water.

When the Nile is at its lowest level, it is a " contravention " to take water out of turn and landowners breaking this regulation are liable to be punished by imprisonment. Should there be an exceptionally low Nile these regulations are altered to allow for one or two days of general stoppage between each section's turn. As the water supply begins to improve in July the rotations are modified accordingly.

During the month of January the canal discharges are reduced and the canals are closed for cleaning. This closure is most necessary in drying up the ground which has become thoroughly saturated by the flood, and in lowering the subsoil water.

In 1921 a Nile Projects Commission was appointed to report on " How to make the Nile water supply meet the progressive demands of agriculture at all seasons of the year," and the necessity of saving Egypt from the effects of an abnormally high flood.

After very careful consideration of many schemes, the following series was recommended :—

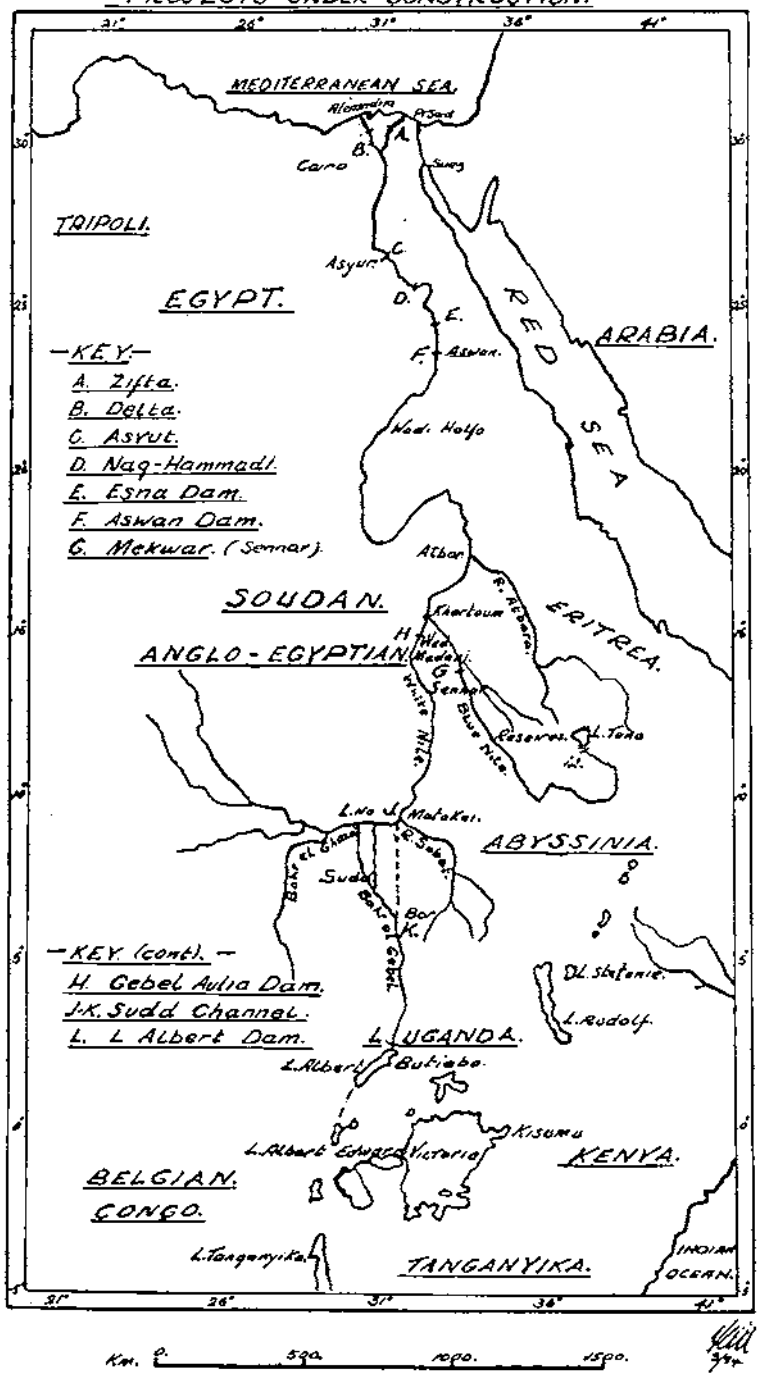
(1) A reservoir in the White Nile with a masonry dam at Gebel Aulia, to increase Egypt's summer supply and afford a protection against high floods. (H)
(2) A small reservoir on the Blue Nile with its dam at Sennar to irrigate the Gezira Plain. (G)
(3) A barrage at Nag Hammadi to protect flood cultivation in that part of Upper Egypt. (D)
(4) A reservoir on the Upper Blue Nile to increase the Sudan supply and assist flood control.
(5) A reservoir at Lake Albert to complete the storage necessary to meet the ultimate demands of Egypt. (L)
(6) A channel in the Sudd region to ensure the Lake Albert reservoir water reaching the main Nile. (J–K)

The above works carried out in the order named would ensure that, step by step as cultivation increases, water could be made available to meet the country's need.

(1). Gebel Aulia Dam.

It is curious to note that owing to the rapid rise of the Blue Nile a considerable amount of natural " ponding " of the waters of the

MAP OF THE NILE BASIN, SHOWING. EXISTING BARRAGES AND PROJECTS UNDER CONSTRUCTION.



-KEY:-
A. Zifta.
B. Delta.
C. Asyut.
D. Nag-Hammadi.
E. Esna Dam.
F. Aswan Dam.
G. Mekwar. (Sennar).

-KEY. (cont). -
H. Gebel Aulia Dam.
J-K. Sudd Channel.
L. L Albert Dam.

White Nile takes place and as soon as the Blue Nile begins to fall, these waters are released, considerably increasing the White Nile discharge, which at normal times is comparatively small. Therefore a dam constructed on the White Nile with sufficient storage capacity, would enable the ponded water to be entirely held up. Although the proposed White Nile dam will not enable the crest of the flood to be lowered very much, it will considerably shorten the duration of the high water levels in Egypt. Therefore, to have a maximum effect the dam should be near the junction of the White and Blue Niles.

There are two possible sites for such a dam, Gebel Aulia and Gebelain. The latter being 400 kilometres from Khartoum was ruled out as it was considered too far off to control the ponded White Nile waters.

Whatever project for the storage of water higher up the White Nile is considered, a regulator or barrage near the junction of the White and Blue Niles will be an indispensable adjunct for securing full advantage of this water.

The best site for this dam was considered to be at Gebel Aulia, 45 kilometres south of Khartoum, as it would assist in protecting Egypt from the dangers of high flood and at the same time provide storage for lean periods of Low Nile. The river-banks in Lower Egypt will also receive a very large measure of protection, and the great damage to crops at present caused by infiltration will cease.

The Sudan Government at first regarded the project with some alarm, which meant "drowning out" 4,400 square kilometres of the White Nile Province, but eventually agreed that after the reservoir was built, the population would not only have more and better land available for cultivation, but would no longer be dependent on the vagaries of the Nile flood.

The scheme for the construction of this dam was finally approved by the Egyptian Government and commenced last year.

Subsidiary to this project and the heightening of the Aswan Dam is the remodelling of the Asyut and Delta Barrages, which will be done simultaneously, and will cost about £E. 3 million.

(2) Sennar Dam.

The next project to be considered was the Gezira Irrigation Scheme and Blue Nile Sennar Dam.

The object of this was to provide for the irrigation of the northern portion of the Gezira Plain, which may be roughly described as the triangular tract of country lying between the Blue and White Niles and bounded on the south by the Sennar and Kosti railway,

composing an area of roughly five million feddans, of which three million are irrigable. The plain is bounded on the east by the Blue Nile.

(3) NAG HAMMADI BARRAGE.

It has been pointed out in the White Nile Dam project (a work to be built for the benefit of Egypt's summer supply), that its effect on the flood will be to lower its height. Therefore, to give adequate flood irrigation to Upper Egypt, further protective works are necessary and the Nag Hammadi Barrage was constructed and is now in use. Owing to political reasons, however, it was constructed out of its turn, against the recommendations of the Commission, and it naturally follows that the full benefit of this barrage will not be effective until the Gebel Aulia Dam is completed. Work on the Nag Hammadi Barrage was actually commenced towards the end of 1927, and completed in October, 1930. It comprises one hundred openings of six metres' width each. At the western end of the barrage there is a lock 16 metres wide and 80 metres long. With the construction of this barrage, the irrigation of all Upper Egypt's basins has been fully guaranteed, and it will secure the irrigation of this district regardless of low floods.

This barrage commands an area of about half a million feddans, and will, in future, be a means for the conversion from basin to perennial irrigation of 540,000 feddans.

The cost of constructing the barrage amounted to a little over £E. 2 million.

(4) UPPER BLUE NILE DAM.

It is possible to construct a dam on the upper reaches of the Blue Nile to form a reservoir having a capacity of 7,000 million cubic metres and this will enable some control to be exercised on the amount of water passing down the river. The construction of this dam is essential for the future development of the Sudan. Whereas Egypt can provide for its own needs from the White Nile, it is only water flowing in the Blue Nile that can be utilized in the Sudan Gezira. It naturally follows that the dam should be constructed as far up the Nile as possible.

(5) LAKE ALBERT DAM.

Lake Albert is about 175 kilometres long and 45 broad and has an area of about 5,300 square kilometres, so that raising the water-level by a metre is equivalent to storing an additional 5,300 million cubic metres. It lies at an altitude of about 620 metres

above sea-level and its principal feeder is the Somliki River, which comes from Lake Edward and flows to the west of Ruwenzori. This lake has very steep sides, except in one place, so that by building the dam the surface area will not be appreciably altered, and the additional evaporation losses should be minimized.

(6) Sudd Channel.

From the Bahr el Ghazal Junction to the junction of the Sobat, the White Nile flows from west to east. The Bahr el Ghazal draws its water from the northern slopes of the Nile-Congo watershed. Many streams descend from this into the Sudan Plain, where they form vast swamps, in which practically all the inflowing water is evaporated, and only a very small proportion flows out through the Bahr el Ghazal. It is estimated that 12,175,000,000 cubic metres of water are lost annually by rapid evaporation, and unless a channel can be cut through to circumvent this huge swamp, it would be useless to accumulate such a huge storage of water at Lake Albert. Available information was scanty and only main lines of study were outlined for investigation by the Commission. Until levels can be taken and more accurate figures available, estimates could only be tentative.

An Air Survey Company has just completed the photographic air survey of 50,000 square kilometres of this Sudd region, which has been carried out as a preliminary to this project. The photographs reveal courses of rivers never before surveyed and others not even known to exist.

It was estimated that these projects when completed would increase the total crop areas of Egypt from over five million to eleven and a half million feddans, and those of the Sudan from over two hundred thousand to one million feddans.

Aswan Dam Second Heightening.

In 1929 an International Commission sat to report on the possibility of heightening this dam, and they recommended it being carried out at a cost of £E. 3 million. This enormous undertaking was commenced the same year, and the maximum new storage level will be raised, giving a capacity of 5,670 million cubic metres compared to the present capacity of approximately 2,700 million cubic metres.

The work includes the following :—

(*a*) Construction of buttresses on the downstream face of dam.
(*b*) Heightening of the dam.

(*c*) Heightening and thickening of the first lock walls.
(*d*) Making two extensions at the eastern and western ends of the existing dam.
(*e*) Construction of two subsidiary dams near Shellal.

A project is now under construction by the Egyptian Government for the construction of a large hydro-electric power plant whereby full use can be made of the enormous head of water. The plant suggested will consist of four large turbines each generating 40,000 kilowatts.

The Aswan Dam is now practically complete and is an engineering structure of no mean importance, embodying in its design and construction all the latest theories of engineering science and practice.

CONCLUSION.

The ultimate result of the foregoing projects will be that Egypt will be completely protected from the vagaries of the Nile and the enormous resources of the river fully developed.

CORRECTION.

THE NORTHERN FRONTIER OF INDIA.

THE above article, published in the September number of *The Royal Engineers Journal*, by an unfortunate error was described as a lecture delivered by Lieut.-Colonel C. E. Bruce, C.S.I., C.I.E., C.B.E.

The lecture was actually the work of Colonel P. Neame, V.C., D.S.O.

General view of the downstream side of the dam from the west end; showing dressing face of dam for laying non-corrosive plates to take the new masonry addition. The heightening of the dam is approaching from the east.

Aswan Dam heightening

The Sappers' camel (in the gardens of the Zoological Society) and goat from the Crimea.

The Sappers' camel and goat

"THE SAPPERS' CAMEL AND GOAT."

(Reproduced from the "Illustrated London News" of 3rd January, 1857, by the courtesy of the Editor.)

DURING the early part of the siege of Sebastopol three Bactrian camels used to roam and graze in the Grand Ravine and the Valley of the Shadow of Death, which, as our readers may remember, separated the British Left Attack from the French attack on the Bastion du Mât, where they were exposed to the fire from the Russian batteries. These animals at the time, naturally enough, caused great excitement amongst our troops and those of our allies, and to such a pitch did it rise that parties of Artillery, Line, and blue-jackets, repeatedly endeavoured to drive them up into their camps, but they always evaded capture and returned to their old haunts. However, one day, in the latter end of November, 1854, Lieutenant Lennox,* Royal Engineers, who was on duty in the trenches, ordered his party of Sappers, when relieved in the afternoon, to try and drive them up to camp. This, it may be imagined, was not by any means an easy task, especially as they had become very wild from previous attempts; but, as the word "impossible" is unknown in the soldier's vocabulary, nightfall saw the three four-footed animals in the Royal Engineers' park, Left Attack camp; and there they remained under the orders of Col. Chapman, C.B.,† till the severity of the weather made it necessary to send them to Balaclava, under the care of Lieut. Leahy,‡ R.E., where they would be better protected from the snow and rain, which they cannot endure. During this ever-memorable winter they became very tractable, and the mother of the one whose portrait we have given, furnished daily, during the summer of 1855, for some time Sir Harry Jones's§ table with a small quantity of milk; but the youngest of the three, just previous to Christmas-day, 1854, when he was to have provided the officers in camp with a great feast, was found one morning frozen to death. The two survivors, in the spring of 1855, were again moved up to the front, where grass was more plentiful, and it was on the morning after the capture of the Mamelon and quarries by the Allied armies that the camel here represented was born in the Royal

* General Sir Wilbraham Lennox, V.C., K.C.B.
† General Sir Frederick Chapman, K.C.B.
‡ Lt.-Col. A. Leahy.
§ Lt.-Gen. Sir Harry Jones, G.C.B.

Engineers' camp. The large camels proved to be very valuable as transport animals, and during the siege were employed bringing Engineer stores to the front, either in arabas or on pack saddles. They likewise, as long as the supply lasted, carried bales of sandbags down to the trenches, each bale containing 125 bags. At last the winter of 1855 found the Allies in possession of Sebastopol, and employed in demolishing its five magnificent docks and basin entrance; and the two old camels, with the young one, were made use of for fetching down materials and provisions, being stabled in a shed close by. During this winter one of the old ones died. The two survivors marched to Balaclava, with the headquarters of the Royal Sappers and Miners, under the command of Major Robertson, in June, 1856; and on the 9th of July the mother was turned adrift, and the young one put on board the steam-transport *Clarendon*, for passage to England, under the charge of Lieutenant Graham,* R.E. On the 30th of July this steamer, after calling on her road at Constantinople, Malta and Gibraltar, met with a severe gale, and the following day she was run ashore about six miles to the west of Cadiz. This obliged the camel, with all the Engineer horses and their grooms, to be put on board her Majesty's ship *Centaur*, which arrived at Portsmouth on the 14th of August. The camel was then sent with her keeper to the head-quarters of the Corps at Chatham, and arrived in time to be inspected on the 19th August by His Royal Highness the Commander-in-Chief and General Sir John Burgoyne. Private George Low, who had charge of the camel in the Crimea, states that the old camels frequently went without water for four or five days together, although regularly taken to water every day. In the Crimea they drew rations as bât ponies—the daily allowance for each being 9 lb. of corn and 10 lb. of chopped straw, with occasionally a mixture of hay and straw, instead of straw alone. The young camel was very fond of biscuit, and on this she principally fed until she was old and strong enough to be retained and used as a baggage or transport animal, when she drew rations as a bât pony. She was taken from the Head Quarters of the Royal Engineers, Chatham, to the Zoological Society's Gardens on the 18th November.

We have also engraved the goat taken in the first reconnaissance before Sebastopol, Oct., 1854, which remained with the Sappers and Miners in the Left Attack Engineer park, under Colonel Chapman, C.B., till after the fall of the town; and latterly on Balaclava heights; finally he embarked for England with the 10th Company Royal Sappers and Miners, in H.M.S. *Dragon*, on the 12th July last.

For the foregoing account we are indebted to Captain Brine, R.E.

* Lt.-Gen. Sir Gerald Graham, V.C, G.C.B., G.C.M.G.

TEMPORARY ROADS DEPARTMENT—VI.

Odds and Ends.

By "Roadsurvey."

I. A new idea in reconnaissances.

Life is so easy in England that we are apt to forget that it is by no means so in all countries, even of the Empire. This is especially the case when we want to get from place to place. Most people can read an Ordnance Survey Map with sufficient accuracy to enable them to arrive at their destination without taking more than two or three wrong turnings, generally due to the person who is directing the driver saying right when she means left! But it is a very different matter when it is not a case of finding the way over open country along good roads, but of reconnoitring a route for a road through bush country, using a few native tracks and a map compiled almost entirely from imagination by a previous traveller. "Wild tribes live here" and "Unexplored" look intriguing on a frontispiece map for a treasure-seeking novel, but such information is of little assistance when looking for a good line for a road.

In 1928 the T.R.D. were told to survey a line from Wiawso to Krokosua. The ordinary Gold Coast 1-inch maps were available for our use over the first half of the route, but for some reason no such maps could be produced for the last 25 to 30 miles. The only map we did succeed in obtaining was one to a scale of 1/500,000. It showed a few villages, native paths and streams, and vaguely indicated that there was some nasty high ground between us and the village chosen as roadhead.

This appeared to be an excellent opportunity for trying out something novel in the way of reconnaissances. We thought that one person might be able to do the job, but that two would be more likely to produce some accurate results; so two of us, hereafter known as No. 1 and No. 2, proceeded into the "unexplored" regions to see what we could find.

It was a curious thing, but for some unexplained reason the T.R.D. was always pressed for time. If memory does not play one false, on this occasion the necessity for getting a move on had something to do with the prospect of a rather hectic Christmas party

at Headquarters, the said party having unknown possibilities owing to the unexpected arrival of some new (soft !) blood from England ! In any case, there was need for hurry !

It was quickly decided that the only feasible way of producing a useful reconnaissance map was by some form of pace-and-compass traverse, and that the map, if possible, must give a general picture of the topography on each side of the route. Barometers, of course, were useless, because there was no possible means of setting and checking them.

In order to travel fast and far in the bush, it is necessary to travel light. We therefore cut down the paraphernalia to the absolute limit and found that all we required was a guide, a haversack-boy to interpret and carry the sandwich lunch, a hand compass and a notebook. The guide should, of course, have a cutlass for cutting through bad places and for use—flat side only—to spur him on to greater efforts. Incidentally, the guide was not told that the object of the day's exercise was to find a line for a road, as he would then have taken us as near as possible to his own village and those of his friends, however hilly such a line might be. We told him the place we wanted to get to and that he was to go by the easiest bush path.

Behind the guide came No. 1, carrying the hand compass and doing the pacing. He took an ordinary walking pace and watched the swing of the compass as the path wound through the bush. Having taken one hundred and twenty paces (*i.e.*, 110 yards), he called out the average bearing registered over that portion of the path. He continued to do this at every one hundred and twentieth pace until he was fed up and suggested a change over with No. 2, or even a rest.

One hundred and twenty is not necessarily the correct number of paces for everybody. It is best for each member of the party to check himself over a measured distance of 110 yards *along a rough bush path*, so that he can find out the average number of paces he takes to cover this distance when walking naturally. The accuracy of the reconnaissance must depend largely on the accuracy of the pacing and due allowance must be made for short and long pacing when going up or down steep slopes. It is no use striding out over the measured 110 yards, because by the time ten miles have been done the distance covered by the original number of paces will have been roughly halved.

To those who know the wonderful zig-zagging course taken by most bush paths, it may seem incredible that anybody could obtain a good average bearing with the compass. It was certainly somewhat difficult at first, but with a little practice the accuracy obtained was surprisingly good.

No. 1's whole attention was fixed on watching the bearings and in pacing correctly. It was a whole-time job and he did not attempt to study the ground or the varied insect life buzzing around him.

No. 2 stumbled along behind No. 1 within easy hearing distance and concentrated on the formation of the country. Every time No. 1 called out a bearing he wrote it down in his notebook on a specially prepared page (see page 544). At the same time, he was noting down the lie of the ground by means of the hieroglyphics shown, and explained, on page 544.

Before going farther, it is necessary to utter a grave warning. It is absolutely essential that every No. 2 should adopt the same procedure when entering up the details in his notebook. It does not matter whether every No. 2 begins his entries at the top or the bottom of the page, but the same procedure must be followed in every case, otherwise it is obvious that, much sooner than later, someone who has done the job will forget which end of the page he did start his entries. If, when plotting the results, he reads the "little jiggers" the wrong way round, every downhill slope will be shown as going up-hill, and all the bearings will be wrong.

It is recommended, therefore, that everyone should adopt the conventional method of booking chainages, *i.e.*, start at the bottom of the page and work upwards.

At first we found it somewhat difficult to know when to use →, or ⟶→, but a little practice soon made the choice easy. Normally, only one hieroglyphic was used to depict the lie of the ground over one bearing, but where there were sudden changes of slope in the middle of a paced distance, as when crossing a stream or gulley, these changes were shown.

The sizes of the culverts entered by No. 2 were only approximations, but when comparing two alternative routes such information was invaluable in gauging the comparative costs. It is necessary to take great care to show the streams flowing in the right direction, as the details obtained as to the lie of the ground are not necessarily sufficient to enable the direction of the flow of the stream to be plotted correctly. It is, however, not always so easy as it sounds to decide the direction of flow when there is no water in the stream-bed.

All villages on the route were marked in by name and all the paths that joined the route were shown, with their destinations.

If opportunity allowed, we always checked the accuracy of our traverse by closing back on the starting point. This was not nearly such a gruesome and tedious business as it sounds, for there were almost always at least two alternative routes (along bush paths) and having examined one on the outward journey it was natural to go home by the other route. Besides which, it meant a

SPECIMEN PAGE OF TRAVERSE BOOKING.

NOTE.
The direction of slope is shown by direction of the arrow.

↑ = Gently sloping ground which can be used without cuttings or embankments (not considering flood levels).

= Slopes which can be negotiated using reasonable cuttings and embankments.

= Ground which should be avoided. When marked as side-long slopes would necessitate use of retaining walls.

No arrows denotes level ground.

Slope of ground on left of path.	Slope of ground along path.	Average bearing per 110 yards.	Slope of ground on right of path.	Notes.	Average bearing per ¼ mile.
		290°		Continued bottom p. 2.	
		290°			
		310°		Batamano Village.	300°
		310°			
		320°			
		320°			
				←R. Asuabo.	
		320°		Double 5′ 6″ culvert.	325°
				←River.	
		340°			
		325°			
		300°			311°
		310°			
		310°			
		340°		Dubu Village.	
		340°			313°
		300°			
		270°			
				←R. Mofu.	
		280°		5′ 6″ culvert.	290°
		290°			
		300°			
		290°			
		290°			
		265°			
				←Dry stream bed,	284°
				2′ culvert.	
		280°		R. Krokosua.	
				← 3′ 6″ culvert.	
		300°			
				←Dry stream bed.	
		290°		2′ culvert.	280°
		270°			
		270°			
		290°		Page 1.	

START.

change of scenery! As to the accuracy which can be expected, accurate pacing in very hilly country was exceedingly difficult, but we found it generally possible to keep the closing error down to about 2%, or two miles in a 100 (circular) traverse.

When we arrived in camp each evening, we got down to the job of plotting the day's results so that we could see how things were going. The example on a previous page shows the bearings bracketed in groups of four, the average bearing over this distance being shown. Some of these averages were worked out in camp, but as far as possible they were done during rests when trekking, early to bed and early to rise being a good principle in the bush and much more pleasant than the same procedure in England. Each group of four paced distances was taken as representing a quarter of a mile and the results plotted to a scale of four inches to one mile. This scale is quite arbitrary and may be found a little large for use over big distances, but it gave very good results for all ordinary traverses.

Having plotted the angles and marked off the necessary divisions, the ground details (arrows), streams, villages, paths, etc., were copied on to the plan.

We found that the simplest way of visualizing the information obtained was to draw form lines on the plan, showing the nature of the country immediately surrounding the paths traversed, and the probable lie of the country in the intermediate areas. It is when doing this that it is essential to have accurate data as to the direction of flow of the streams and almost as essential to have a traverse enclosing the area. It is also very necessary to get the guide to name as many streams as possible, for if the same one crosses one or more traverses, the positions of the valleys in the intermediate area can be gauged with much greater accuracy.

Plan I gives the plotted results obtained when we were looking for a line to Krokosua. Plan II shows the attempt that was made to visualize the lie of the ground. The thick straight line was drawn to indicate to the surveyor who was to run the Preliminary Line for the road, the approximate route which we thought might be found most suitable. He was, of course, given the whole map of the area covered by the compass traverse, which he found extremely useful.

The line shown on Plan II turned out to be a very close approximation to the final line of the road, and on another portion of the map the surveyor was able to run a four-mile straight up to the only suitable valley through a range of hills. This valley was not traversed by any bush path (the nearest one passing over the top of the ridge), so that it was due to assumptions based on the information given by the compass traverse map that we were able

to discover this route. Perhaps we *were* a trifle lucky, but this type of reconnaissance has its good points. It is certainly speedy, for we averaged a good fifteen miles a day for four days on end; it is tolerably accurate, considering the difficulties of taking bearings and pacing along bush paths; and last, but not least, in this case it had the very good point that we did arrive back in H.Q. in time for our party.

2. SURVEY IN MOUNTAINOUS COUNTRY.

It must be admitted that the Temporary Roads Department gained very little, if any, experience of actual mountain road work, because there are no mountains in the Gold Coast Colony. But there were two occasions on which the normal method of survey and location, as described in the March, 1934, number of *The R.E. Journal*, were found to be unsatisfactory owing to the difficulty of using them in very hilly country.

It may be of interest, therefore, to give a short description of the two methods which were improvised, as they gave successful results and appear to be applicable to real mountain survey work. These methods were christened—1. Location by Short Straights, and 2. Location by Topo Pole without Prelim.

Location by Short Straights.

Those members of the Corps who, worn out by acrimonious correspondence with their tailors and/or more intimate friends, decided on a temporary retirement to the seclusion of the Gold Coast bush may remember a tedious and exhausting trek from Insu to Enchi. More particularly they may have recollections of the very nasty bit of country on the Insu side of the Tano river near Jumuro. This was the place where we found it necessary to change our normal methods.

The Preliminary Line was run as for an ordinary survey, but the cross sections were cut at every 100 feet and the chain (not pacing) was used for the topo. When the plan was completed, the Location Line was put on it in short straights one chain in length. This is best done with a pair of dividers, set to represent a distance of 100 feet.

Having decided on the gradient of the road (say 5%) we set off the chain straights with the dividers so that the rise or fall, as shown by the contours, was five feet in every 100-foot length of the road. The bearings of these straights were then taken off the plan and run on the ground in the ordinary way.

Unfortunately, this method proved to have the following serious disadvantages :—

(a) It was very slow. Considerable time and care were necessary to obtain very accurate topography over difficult ground with the eye-level and topo pole. It was also a slow and tedious job to abstract all the necessary bearings from the plan, and if any inaccuracies had occurred in these bearings, the line run on the ground would not be by any means the best and cheapest, so that it would have had to be re-run.
(b) The line of the road depended on the accuracy with which the bearings taken from the plan were run on the ground. It is by no means an easy matter to lay out accurate bearings on steep side-long slopes.

In spite of these disadvantages, this method has a definite use for places where the side-long slope is not too steep and the bad ground not more than about half-a-mile long. Under these circumstances it gives more latitude in the choice of the Location Line. But when the problem is the survey of a length of mountain road, the next method is undoubtedly the better.

Location by Topo Pole without Prelim.

Some time in October, 1930, the T.R.D. were asked to " vet " a line which had been run over the Fomena Scarp by a surveyor from another department. Time was again very short, for there was a great deal to be done before the survivors of the T.R.D. were due to pack up their " traps " for the last time and sail for England's sunny shores. But one member of that " vetting " party has never been able to consider that this was sufficient excuse for crossing that —— Scarp four times in one day. But then he was the small boy of the party!

The first thing we found was that the chosen line had a total rise and fall of 1,608 feet in five miles and that the grade of over two miles of this line exceeded the T.R.D. ruling gradient of 7%. It was obvious that a better line must be found, if possible, and that that Scarp was going to be climbed many more times before a satisfactory survey could be completed.

It did not take us long to discover that if we could use a certain saddle, the total rise and fall could be reduced by 805 feet without any appreciable alteration in the length of the road. We also decided that the best way of tackling the problem would be to start at the highest point, that is, at the saddle, and to try to find our way down, rather than to try to find a way up to the saddle. When-

ever possible, we recommend this procedure as the only sane one, because if the surveyor tries to work upwards he will find it impossible to know how far he has got to wind in and out of the various re-entrants in order to obtain sufficient length in which to reach the top without exceeding the ruling gradient. The other case has its difficulties, but it is generally a matter of using all the length that can be obtained so as to get to the bottom as soon as possible.

But if we did now have our saddle, we were not much forwarder, because our daily scramblings over and around the Scarp had soon convinced us that our ordinary survey methods were not going to be of much use to us. A new idea in survey was required and no new ideas were forthcoming.

As an experiment, we made a start at the saddle previously mentioned, and tried a method of survey very similar to Location by Short Straights. One surveyor went ahead with a few cutters and judging the fall of the ground by eye, reconnoitred and marked with pegs what he considered would be a close approximation to the final location line. Periodically he sent back messages to the other surveyor, who was doing an ordinary Preliminary Line Compass Traverse behind him, to tell him how things were going and to give a rough bearing for the various changes in direction.

Unfortunately, it was soon decided that things were not going too well. Although the method might give satisfactory results. there was no proof, before the line was levelled and topoed, that it would be any use at all. The thought of so many journeys up and down that Scarp, with a possible complete misfire at the end, was most unpleasant, so we decided on a little quiet reflection in the cool of the evening before proceeding farther.

The next suggestion was that we should run the line by means of the level. Pegs would be put in at every chain, a 5% grade being obtained by holding the staff at the end of the 100-foot chain and moving it about until a position was obtained which was five feet below the level of the preceding peg. This method would be very accurate, but would have the serious disadvantage of being slow and tedious. It is by no means easy to set up and read a level with any speed on an uncleared one-in-one slope, and a great deal of difficult cutting has to be done so that the staff can be read through the telescope.

Another suggestion was that the eye-level and topo pole might be used. It would be very much quicker than the level, no setting up or very careful clearing being required, but it could not be used to give a gradient of much more than 5% and it was doubtful how accurate the results would be. But it was considered to be well worth a trial, so next day we climbed the Scarp once again and made a fresh start at the saddle. One of the party reconnoitred the ground ahead and periodically sent back messages to say whether

the line on which we were working offered any hopes of reaching the bottom of the Scarp. During the day it was found that it might be possible to reach the bottom on the suggested line, and the following procedure was then adopted.

One surveyor went ahead with an eye-level and a topo pole, placing a peg at every chain so that the difference in level between any two consecutive pegs was, as near as possible, five feet. Behind him came the leveller. By using two staffs and a large clearing gang, he was able to keep reasonably close to the surveyor and to keep reducing his levels about every ten chains. When he found that the surveyor was beginning to increase (or decrease) the level between consecutive pegs above (or below) five feet, he informed him immediately and the mistake could be rectified with comparatively little trouble or loss of time. There was thus no longer any possibility of the surveyor completing the line to the bottom of the Scarp and then finding that most of it was useless owing to a mistake or to a constant small error in the levels obtained with the topo pole.

Behind the leveller came the second surveyor. He set up the compass at each chain peg and took the bearing to the next peg ahead. The bearings were entered in the traverse book, together with the distances, in the usual way.

This method turned out to be quite a success and the whole of the really difficult part of the survey was done in this way. Our original attempt to use a method somewhat similar to Location by Short Straights proved to be quite useless, as no Location Line of the required grade could be obtained on the portion of the ground covered by the topo.

But although the method was a success, the job proved to be by no means easy, because we were constantly coming up against several interesting practical difficulties.

The worst of these was due to the fact that there were many re-entrants, deep gorges and stream-beds and sharp spurs on the sides of the Scarp. The question arose as to whether it was cheaper to run straight across the re-entrant, gorge, etc., with a big bank, or to run back into the depression, cross it higher up with a smaller bank (and culvert) and then run out of it again along the opposite side.

This problem proved to be a real teaser. As we wanted to get down the Scarp as soon as possible, it was obviously better from this point of view to run into the re-entrant as far as possible, so that we could use the extra length so gained to bring us out of it again at the lowest possible level. Another argument for doing this was that great care would have to be taken during construction to ensure that there was no possibility of the big banks otherwise necessary being washed away or slipping down the hillside. They would probably have to be supported by retaining walls where the side-

long was very steep, and high retaining walls are very expensive. But against these arguments was the fact that embankments on mountain roads are generally cheaper than cuts in side-long, as the ground is usually very rocky a few feet below the surface. It would also be much easier to avoid the use of sharp curves.

In the end we generally decided on a compromise. Other surveyors might have disagreed with us, but this must always be the case when no rules can be laid down. The chief thing was that we achieved our object. We found a route up and down the Scarp that was undoubtedly much better than the previous one, and which enabled us to stick to our rules for the maximum gradient, sharpest curve, etc. Unfortunately we were unable to construct the road owing to lack of funds and it is very unlikely that anything further has been done in the matter since we left the Gold Coast. But if this road is ever built it will undoubtedly prove to be a very interesting job for somebody. Let us hope that he will be a member of the Corps.

One final word before leaving this subject of mountain surveys. It will be seen that in this type of survey, as its name indicates, there is no Preliminary Line, the one (and only) line put on the ground being the Location. It is not essential, therefore, to make a plan of the route, especially if the road is to be constructed immediately after the completion of the Survey, which would be the case in war. In most cases, however, it is advisable to make a plan. Not only will it show the line of the road and the positions of the streams, bridges, etc., but it will be much easier to estimate the cost and to work out the easiest curves that can be used.

Although we have insisted on the use of true simple curves on all roads, it is, unfortunately, very often quite impossible to use them on a mountain route. A compromise must be made, but it is still essential to stick as closely as possible to the various principles given in the second of these articles, which was published in the December, 1933, *R.E. Journal* under the heading of "We discuss some Road Survey Problems."

3. A COMPARISON WITH TACHEOMETRY.

Since it was boldly claimed in a previous article that this method of road survey, although designed in the first case for bush country, has a general application, it might be useful to compare it with the more widely known method of tacheometry for work in open country. Such a comparison may assist an officer to make his choice of method when he is confronted with a road survey problem.

Throughout this unbiased (?) comparison of the two methods

it would be well to bear in mind the fact that it is a fainthearted parent who deserts his own child, and in addition that the parent in this case has a very limited experience of practical tacheometry.

Accuracy.—In the normal case where a narrow strip of topography about 1,000 feet wide is required, the accuracy of the two methods is approximately the same—about 1/500. If, however, for some reason a greater width of topo (say 2,000 feet), is required, then tacheometry with its accuracy still approximating to 1/500 would at once be more accurate than the T.R.D. method, since the latter would then require cross-sections some ten chains long, and at this distance from the Preliminary Traverse topo with an eye-level would be of rather doubtful value. The T.R.D. team could, of course, by running two Preliminary Traverses, obtain the same accuracy as a tacheometer team, but this would involve a great deal of extra work and waste of time.

Speed.—Tacheometry, requiring no chainage of distance, is speedier in the field and requires a smaller team; it is also less tiring in the field than the T.R.D. method. In fact, at this point tacheometry seems to be winning hand over fist. But having come in from the field, the tacheometer team at once find themselves embroiled up to the neck in laborious computations, which unpleasant experience the T.R.D. team, though they arrive in later, completely avoid. Actual comparative details are lacking, but it would appear that the T.R.D. team will complete their map well ahead of their rivals.

The introduction of "direct reading tacheometers" to eliminate computations is a doubtful asset, since according to reports they require a fortnight to adjust, even in the hands of an expert, and are apt to maladjust themselves rapidly. They are, moreover, never met with in the Service.

Personnel.—The personnel for a tacheometer team must all be trained surveyors, including the staff men, on whom a great deal of the speed depends. They are required to handle a theodolite and carry out computations; in addition a good "eye for country" is essential. The personnel for a T.R.D. team need not be experienced surveyors at all. The most experienced are the topo men and levellers, and the extent of the knowledge of both can be limited to familiarity with the level, since the eye-level and topo pole correspond so closely to the level and level staff. Little eye for country is required, since the control for the topo is so close. The cost of a tacheometer team will, therefore, be greater than that of a T.R.D. team. This is important in the Colonies, where most of our practical peace-time work is carried out, for not only is the salary of a European surveyor about eight times that of the most experienced native

in his party, but the experienced native surveyor is a very rare bird and difficult to come by.

In war this question of personnel becomes even more important. The ranks of military surveyors will presumably be swollen by civilian surveyors, who at a modest guess spend 90% of their time in peace handling levels and chains, but have little opportunity for acquiring an eye for country. Here, then, in the rush of war we have the ingredients of a good ready-made T.R.D. team, but of a poor tacheometer team.

The instruments for a T.R.D. team are comparatively cheap and durable, though as some of us discovered, not as durable as we could wish! For tacheometry, a theodolite is required, which is anything but cheap or durable.

There is one condition under which the T.R.D. method falls down completely, and that is in the presence of local magnetic attraction, which renders the substitution of a theodolite for a compass essential. This snag is serious but can be easily over-estimated, as such a condition arose only once in six years' work on the Gold Coast.

In the unbiased (???) opinion of the authors, therefore, the T.R.D. method is the more useful since it is at once simpler, cheaper and more speedy.

4. IS ANY ROAD SURVEY NECESSARY IN WAR?

A few paragraphs farther back a reference was made to war, and it is remarkable how many people say "No time to mess about with survey in war. Cost is nothing, speed everything. Let's get on with the war." No one will quibble with the statement "Speed is everything; cost nothing," and the sentiment "Let's get on with the war" is excellent, but without any involved mental gymnastics, it is obvious that cost and speed are in this case almost synonymous.

(*a*) The shorter the length, the less the cost and the greater the speed.

(*b*) The less the earthworks, the less the cost and the greater the speed.

(*c*) The fewer bridges and culverts, the less the cost and the greater the speed.

In fact, all the specification for a good location in peace applies at once to a good location in war, with the addition of certain

obvious strategical and tactical considerations of cover and defence which need no elaboration here.

As in peace, a bad location in war will entail heavy maintenance on the road itself and heavy wear and tear on the personnel and vehicles using the road. A modern army still moves on its stomach, even though it is now supplied with a mechanized stomach; it is also very dependent on its artillery, which must generally move along the same routes as the other vehicles. A poor location can lead only to chronic digestive trouble in the mechanized stomach, and such troubles quickly react on the remainder of the body.

If it is accepted, therefore, that at least a *good location* is essential, it might be profitable to consider whether it is possible to obtain a good location "by eye," and, further, whether it is not possible to obtain the best location by survey, without undue waste of time.

In West Africa it was found in practice that an officer who had spent about two years on road survey work, could in easy open country certainly produce a good location by eye, or in other words his Prelim. Traverse was always close to the final location. In average country he was not nearly so happy in his choice, and in difficult country it was rarely possible. This is considering the case of an officer of considerably more experience than most officers to whose lot it may fall to locate a road in war, and it would appear very doubtful if good location by eye is possible in any but the very easiest country, unless an officer of considerable experience is available.

Now let us consider the first part of the statement "No time to mess about with survey in war," and see how much "*waste of time*" is incurred.

A commander of a force decides that he wants a road 12 miles in length constructed quickly and allots to the work one A.T. Coy., plus certain extra labour (a Road Construction Coy. or organized local labour equipped with grader and excavator).

The party required for the survey of this line would probably be:—

1 R.E. Officer.
2 to 4 Surveyors Engineering (as available).
4 Sappers.
1 Draughtsman (if available—by no means essential).
20 troops (Infantry carrying party).

(*Note.*—No specialist is required from any survey organization—the Surveyors Engineering being the ordinary R.E. Tradesmen.)

Once the survey party has got under weigh they will outdistance the construction party, since a party of the size mentioned would be capable of turning out one to one and a half miles of location

in two days by the T.R.D. method in average country. It will be sufficient, therefore, to consider the movements of the two parties in the initial stages of the work.

The O. i/c. Survey party has first of all to carry out his reconnaissance on the ground and then the general line has to be approved by his C.R.E. If he has a six-inch or 1/25,000 map available his reconnaissance will be complete in one day, but with only a small-scale map he will probably require two days—so we will allot him two days. His party commence work on the third day, and allowing for a slow start, has completed three-quarters of a mile of location by the end of the fourth day and two miles by the end of the sixth day.

The A.T. Coy. is stationed 15 miles from the work. They will take the first day to move on to the site of the work, and *at least* two days to organize labour to get up the tools and initial stores for the work. They are, therefore, in the best circumstances ready to start work on the fourth day, and in the worst circumstances the survey party has nothing ready for them until the fifth day—a possible loss of one day.

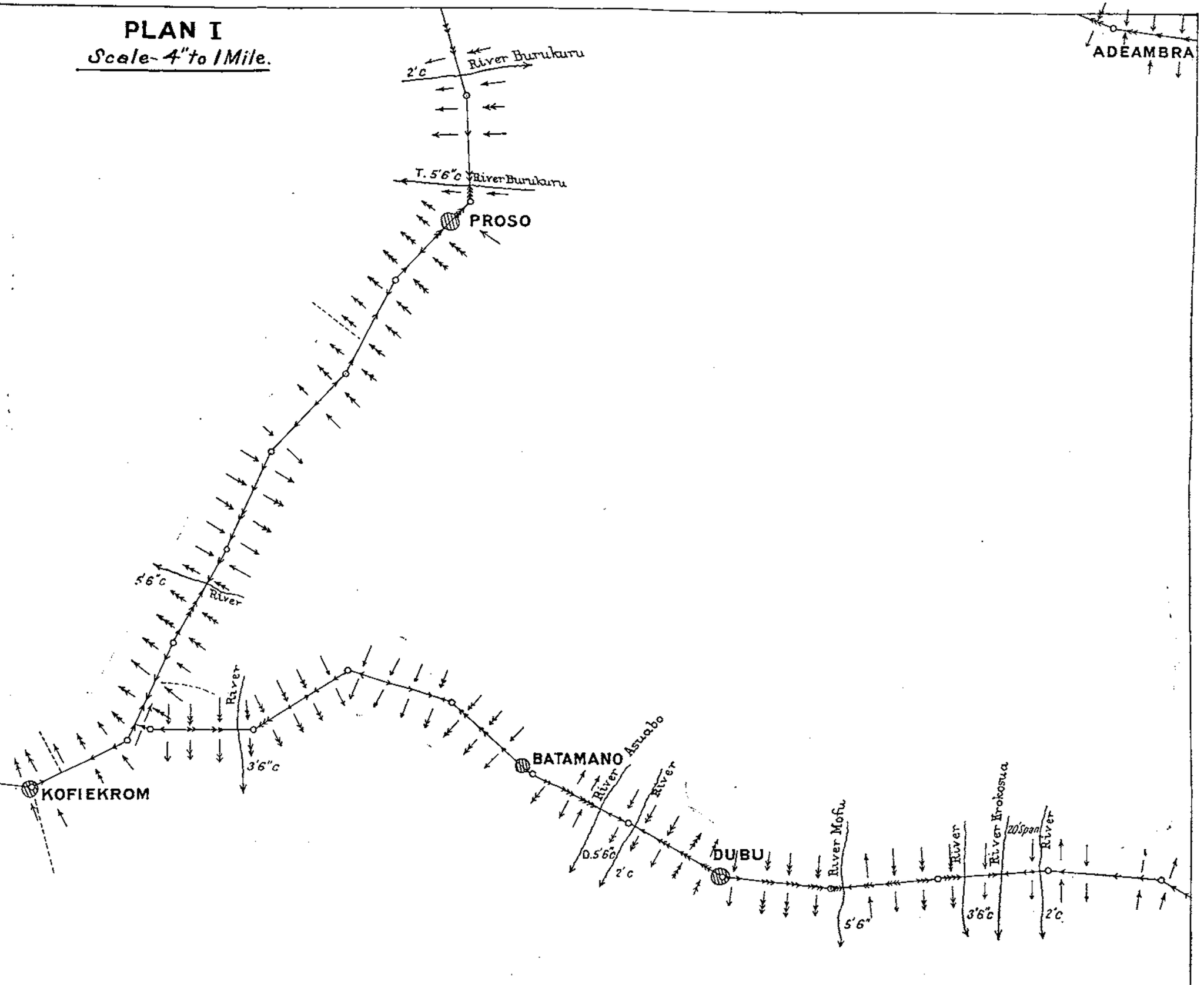
If we assume that there is no particular construction difficulty about the work—no large bridge and only a few culverts, and that the ground is suitable for a grader to work and for the construction of the quickest form of road (*i.e.*, mix-in-place), the estimated time for the completion of the construction (author's opinion only) is four to five weeks. If these figures are accepted we are faced with a delay of one day in a four weeks' job in the least favourable circumstances; and against this can be set the indisputable fact that a good location can save at least a week in construction over an inferior location.

An excellent concrete example of trouble arising out of inferior road location has been related by an officer who had recently travelled in North Africa. The Spaniards, finding themselves involved in a troublesome campaign against the Riffs, decided that the first step was to ensure good communications from front to rear, and located, "with no waste of time on survey," a road on which they proposed to base their operations. As soon as this road, or, as military writers would term it, "the lifeline of the Spanish force," was completed, the operations were put in hand. No sooner were the operations commenced than they were brought to a standstill, as much by transport troubles as by opposition from the Riffs. Patchwork on the road failed to straighten matters out, and this sequence was carried out several times. In fact, the Riffs were relieved of all necessity to attempt to cut the "lifeline," since the "lifeline" cut itself regularly and automatically.

When the Spanish authorities were able to review the situation

PLAN I

Scale- 4" to 1 Mile.



PLAN II

Scale 4" to 1 Mile.

Asuabo River crossed compass traverse

ADEAMBRA

HIGH GROUND

2'c

River

T. 5'6"c River Burukuru

PROSO

S P u r

Suggested Approximate Line for Preliminary Traverse

HIGH GROUND

Krokosua R. crossed Traverse again off this sheet.

SMALL HILL

Local Ridge

River Asuabo

S p u r

HIGH GROUND

HIGH GROUND

KOFIEKROM

River

3'6"c

BATAMANO

D. 5'6"c

2'c

DUBU

River Mafo

5'6"c

S p u r

RIVER KROKOSUA

20' Span

3'6"c

2'c

Valley

Valley

Valley

Valley

Krokosua Mile

in the calm light of peace, they at once discarded the wartime road, and set about the survey for a new one, which was located at an average distance of half a mile from the original one, and crossed the latter several times. This second road is now a permanent civilian highway and gives no trouble at all.

The sting of this episode lies in the fact that from the R.E. Officer's own observations, he was able to state that the work involved in the construction of the surveyed line *was very much less* than that of the first one. It is reasonable to suppose, therefore, that had the Spaniards carried out a survey in the first instance, they would not only have got a very much better road to start with but would also have got it much more quickly.

The moral is obvious. An elementary and simple piece of survey is a cheap and effective form of insurance against waste of time in construction, and against maintenance and transport difficulties later. In short, in any road construction in war, the survey must be considered as an important part of the problem, bearing in mind that the survey is merely a means to an end, and in this case does not call for highly skilled surveyors or complicated methods with a high degree of accuracy.

5. CONCLUSION.

Two very good reasons now make it necessary to close this series of articles; the first is the complete exhaustion of the authors, the second is the sinister and warning look in the Editor's eye. The latter's patience becomes all the more surprising when it is realized that, apart from the authors, he alone has been faced with the ghastly necessity for reading each of the six articles from start to finish.

THE CONSTRUCTION OF A SWIMMING BATH.

By MAJOR C. P. WORSFOLD, M.C., R.E.

THE following account of the construction of a swimming bath under somewhat novel conditions and with very limited financial resources may be of assistance in helping others to avoid pitfalls in design, and of interest as an illustration of what can be achieved in peace by active and willing co-operation between engineers and other arms.

In February, 1932, the Guards Depot at Caterham had accumulated some £1,500 in their regimental funds, with the object, eventually, of constructing a swimming bath. It still seemed to be a long way off, since previous estimates of the cost of a swimming bath of the size desired had amounted to from £5,000 to £6,000. The Depot were very keen on the project, and it seemed worth while re-examining the problem to see if some use could not be made of this enthusiasm in reduction of the cost. A careful estimate was made of the minimum cost for materials and plant, assuming that free labour and transport could be found from military sources. It was found that £1,700 would be just sufficient to cover the cost under those conditions.

The additional £200 being forthcoming from various sources, it seemed a golden opportunity both for co-operation between the engineers and the Depot, and also for providing experience in supervising direct labour on a fairly large service. Authority therefore smiled on the project. Not only was the Depot allowed to use its own military labour and transport free of charge, but the works staff were authorized to regard it as a normal works service without overhead charges, the materials and plant being, of course, charged against regimental funds. Moreover an R.E. N.C.O. and some Sappers were promised from 59 Field Coy., and the loan of a concrete mixer from the Command Pool of plant.

The first choice lay between an open-air bath with dressing-rooms, and an indoor bath in the Cinema, a very large corrugated iron building which served as a concert hall, etc. In either case the price of water (1s. 11d. a thousand gallons) made a continuous filtration plant essential. The disadvantage of having the swimming bath in the Cinema was that it would be necessary to provide a removable floor, so that the building could be put to its normal use during the winter. In spite of this, however, the greater utility of an indoor

bath and the fact that it can be heated economically decided the question in favour of using the Cinema.

This choice meant that the construction of the bath and the removable floor had to be completed by the beginning of November. Authority for its construction did not arrive until the middle of July, which only left just over three months for construction.

Preparations had, however, reached an advanced stage during the period that the project was under consideration.

Detailed plans, specifications and lists of stores had been drawn up, tools had been collected, and contract documents had been prepared for the plant. More important still, the Depot had been allowed to start excavating, on a promise to fill in again should the scheme be disallowed. Thanks to the start thus obtained, it was possible to get the bath itself and the removable floor finished by the end of October, although another three weeks elapsed before the contractors finished installing the filtration and heating plant. The latter did not, however, interfere with the use of the building as a theatre.

The resources available in labour consisted of a large supply of enthusiastic excavators from all ranks of the Depot, about eight Guardsmen pioneers, half bricklayers and half carpenters, and seven Sappers, four bricklayers, two carpenters and one plumber. One or two very useful men were found amongst the recruits. One had spent a long time in civil life laying glazed bricks. Another had experience in running a concrete-mixer.

For supervision, besides the Garrison Engineer and Clerk of Works, who, as usual, had many other duties, there were the Quartermaster of the Depot, almost an engineer, the Pioneer Serjeant, a most resourceful genius, and an R.E. Serjeant from the 59th Coy. The team work of this mixed bag was extraordinarily good, and, in fact, was the only thing that made the construction possible in the time available.

The Design.

The chief difficulty in building a swimming bath is to make it watertight. If it is to be made cheaply the floor and walls cannot be very massive. It is, therefore, essential to allow for expansion and to pay very careful attention to the filling of expansion joints. The floor and walls are kept as separate structures by an expansion joint running all round the bath. The floor slab needs expansion joints at every change of slope and in any case at intervals of not more than 50 feet.

The writer was informed some time after the bath was completed that reinforcement round the corners of the walls is very important, but though none was put in no cracks have appeared. Thanks to

certain departures from standard practice, a considerable thickness of concrete was provided at the corners, and this has probably been sufficient without reinforcement. The matter is mentioned here merely as a precaution to be observed.

The floor slab is laid on either ashes or sand, depending on the subsoil. It is best to use ashes on a clay subsoil; another discovery that was made too late in this case. If this is done a floor slab six inches thick, reinforced with B.R.C. fabric is quite sufficient provided that care is taken to secure a dense mix of concrete.

The question of subsoil drainage was a matter that required careful investigation. The thin floor slab is designed to be sufficient to keep water in the bath when supported by the subsoil, it cannot be expected to keep subsoil water out.

The usual practice is to lay subsoil drains at six-foot intervals running the length of the bath. Owing to the flatness of the site and the shallowness of the existing drainage, it was evident that drainage of the subsoil would greatly increase the cost and the labour involved. It was equally evident that the bath could not be allowed to fill with subsoil water in the winter. A trial pit was dug. The subsoil was found to be clay with a large number of flints, and apparently held no water at all. Subsoil drainage was, therefore, dispensed with. Unfortunately one corner of the bath hit an old rainwater soakaway and this caused a certain amount of water to percolate into the bath from the subsoil until the rainwater was led away elsewhere.

The size of the bath was settled primarily by the funds available. Its dimensions are shown on the plan (Fig. 1). The length, 75 feet, is about the minimum for good water polo. The breadth, 36 feet, allows of six starters in swimming races. The maximum depth, seven feet, is rather less than that allowed in most modern baths, depths up to nine feet being quite usual, but it was originally intended to have no diving board higher than eight feet. It should be noted that it is usual nowadays to have the deepest part of the bath at 12 to 15 feet from the deep end, and also to provide at least two-thirds of the bath for non-swimmers. This explains the changes in slope of the bottom, which may at first seem unnecessary.

The principal problem which arose in designing the bath was to make construction as simple as possible, since it was to be built mainly by pioneer bricklayers and carpenters, assisted by ample unskilled labour. The use of reinforced concrete is usual, but shuttering, placing of reinforcement, and subsequent tiling all seemed to demand rather too high a degree of technical skill.

For these reasons it was decided to adopt a method which had been successfully used in a swimming bath built as a relief work for unemployed. This was to build the walls of concrete faced by glazed bricks on one side, and on the other either by the face of the excavation

or by a half-brick wall of common bricks according to the depth. A reference to the sections in Fig. 2 will make the method clear. The brickwork was built up several courses at a time using mortar made with Ferrocrete rapid-setting cement, and the concrete was poured after the mortar had been allowed four days for setting. Although the brickwork was used as shuttering it could be taken into account in calculating the thickness necessary to retain the soil.

The floor slab was kept an entirely separate structure from the walls although resting on the footings. It was six inches thick, reinforced with B.R.C. fabric, and, to give it a finish, floated with a half-inch layer of Snowcrete swimming-bath mixture consisting of Snowcrete cement and a special white aggregate, marketed by the Cement Marketing Company. Glazed tiles would have been preferred for the floor, but their cost was prohibitive.

A great economy was effected by making pre-cast concrete blocks for the coping and the paving round the bath. The coping blocks were made of the Snowcrete mixture with a coating of carborundum powder. Red Colorcrete cement with an aggregate of ¼-inch grit was used for the paving blocks. A special non-slip surface was devised for them by the pioneer serjeant with the aid of the old lining of a potato-peeling machine. The paving blocks were laid on sand and grouted with Colorcrete.

It is usual to provide a channel all the way round the bath at water-level to take off the scum which sometimes forms on continuously filtered baths. This proved to be very expensive and also led to drainage complications. A hint was, therefore, taken from the bath superintendent of one of the older London swimming baths and a hose was provided for sweeping the scum along the surface of the bath to the deep end, and scum channelling was only provided at that end.

A handrail of 1½-inch G.I. pipe was arranged on either side of the bath, fixed at 5-ft. intervals by holderbats of School Board pattern. In order to give the latter a proper anchorage they were fastened into the concrete core of the wall with iron tie-rods.

The drainage of the bath presented some difficulty, since all drainage in the neighbourhood of the building was shallow and of small capacity. Moreover the bath could not be built up above ground-level to any extent, owing to the necessity of maintaining the existing level for the wooden floor. Drainage had to be provided for emptying the bath, for washing the filter, for the scum channel, and for the paved surround. Emptying the bath was arranged by pumping it slowly into the rainwater system with the filtration pump. Washing the filter required a flow of about 1,000 gallons in five minutes once or twice a week. The only way of dealing with this was to construct a sump.

The removable wooden floor shown in Fig. 3 was designed for a

load of 1¼ cwt. a square foot, including the decking. The factors which formed the basis of the design were as follows :—

(*a*) Use to be made of existing flooring for economy.
(*b*) No complicated joints.
(*c*) Everything to pack as flat as possible when not in use.
(*d*) Standardization of sizes and shapes as much as possible.
(*e*) Timber of cheapest sizes to be used.

The deck was made up from the old flooring and joists in panels 9 ft. x 5 ft. so as to span three trestles. The panels were made as large as could be handled with reasonable convenience.

The trestles were arranged longitudinally. The transoms consisted of two 7 in. x 3 in. bolted to the legs and jointed with a halved joint on alternate legs. The spacing of the legs, 7 ft. 6 in. centres, was determined by the most economical length for the transoms and the maximum interval permissible for the 6 in. x 4 in. legs. The trestles were braced in both directions alternately at the tops and bottoms of the legs. The braces were of 4½ in. x 1½ in. and were bolted to the legs. In order to keep the slope of the legs uniform built-up ledgers were used to make up the steeper slopes at the deep end. These can be seen in Photo 1 stacked on the right-hand side of the bath. Dowels of ¾-in. tubing were used for jointing legs to ledgers and ends of ledgers into each other.

The whole floor proved very stable when tested with the full strength of the depot. Erection and dismantling were easily carried out by a small fatigue party in a few hours.

The dressing arrangements were designed to meet the needs of bathing parties of 40 men at a time. Portable dressing-racks and benches were provided on the stage. In order to reduce the strain on the filtration plant a range of three showers, supplied with warm water, were so fixed that everyone entering the bath from the dressing-room passed through the shower.

Three sets of oak steps were made for entering the bath. These were varnished as a precaution against the formation of scum.

The diving platform shown in the left-hand corner of Photo 1 was made up of tubular-steel scaffolding so that it could be readily dismantled. Diving boards, procured from a firm specializing in their manufacture, were provided at four, eight and twelve feet above water-level.

PLANT SPECIFICATION.

The specification of the heating and filtration plant was a very important feature in planning the bath. It was necessary to secure an efficient plant at the lowest possible price. A copy of the War

Office specification for a plant sent out to Singapore for a bath of similar size was first obtained. The advice of specialist firms was then sought.

Finally, visits were made to a number of baths in London and the suburbs in order to get first-hand information as to the advantages and disadvantages of the different systems.

On this basis a specification was built up for a plant which would exactly meet the requirements of this particular bath.

For the benefit of those unfamiliar with the modern system of continuous filtration the process consists of the following stages :—

(*a*) Dosing with soda and alum to secure sedimentation.
(*b*) Filtering through a sand filter under a slight head.
(*c*) Aerating.
(*d*) Chlorinating with chlorine gas.

The water is circulated continuously by a pump.

The rate at which the bath water is turned over is all-important in relation to the cost of the plant. The Ministry of Health specification calls for a four-hour turn-over. This is intended for public baths, which are liable to be very crowded in warm weather with people who are not compelled to take a shower bath before entering the water. Moreover, the bath attendants are only expected to work an eight-hour day, whereas the Depot could put on extra shifts if necessary to run the plant at night. It was, therefore, decided to be content with an eight-hour turn-over. Since the capacity of the bath was to be approximately 80,000 gallons, this meant a flow through the filtration plant of 10,000 gallons an hour.

Other points in the specification were as follows :—

The rate of filtration through the sand filter not to exceed 250 gallons an hour to a square foot of filter.

The filters to be adapted for both air and hydraulic scouring.

The water to reach certain specified standards of purity and clarity.

When put out to tender, most firms offered some variations on the specification to meet their own special patents, and some were able to suggest economies. The tendering was very competitive and showed a substantial saving on the estimate.

The contract for the filtration plant was let to the Paterson Engineering Company, Kingsway. The modifications made at their suggestion were the substitution of a steam-jet air-injector for the air-compressor used for scouring the filter, and washing the filter with water from the main instead of from the bath and so greatly reducing the size of pump required.

The flow of water needed for washing the filters was considerably

beyond the capacity of the main, but since it was only required for a few minutes, the installation of a 1,000-gallon tank provided an ample supply.

Tenders for the heating plant were called for separately from those for the filtration plant, though some firms were invited to tender for both. The specification called for either a heater or an injector supplying live steam to the bath water as it circulated. The steam had to be applied just after filtration, so that the water had the whole length of the bath to condense and mix with the steam to attain an even temperature.

A rise in temperature of five degrees Fahrenheit at the normal rate of flow was considered to be sufficient heating for the bath, since it was only to be in operation from April to September. By operating throughout the 24 hours it would thus be possible to secure a rise in temperature of at least ten degrees, allowing for a reasonable loss of five degrees by radiation, etc. An unnecessarily large boiler was actually installed in order to pave the way for the central heating of the building in the winter. This boiler gave a seven-degree rise at the normal rate of operation. Filling the bath from the main was such a slow process that the boiler raised the temperature by fourteen degrees at the first filling, and at times the water was flowing in at an uncomfortably high temperature. The boiler capacity was 700 lb. of steam an hour easy steaming at 100 lb. normal pressure. It was of the Vertical Cross Tube type with a steel flue.

CONSTRUCTION.

For the benefit of anyone contemplating a similar undertaking the time-table of construction and the labour required was roughly as follows :—

Item.	*Period.*	*Man-days.*	
		Skilled.	*Unskilled.*
Tearing up the wooden floor	1st to 10th June ..	40	—
Excavating	13th June to 23rd July ..	—	660
Concreting and bricklaying	25th July to 14th October ..	400	260
Constructing removable floor and partition for plant room	13th June to 31st October ..	440	—
Installation of plant ..	1st Oct. to 14th November ..	Carried out by contractors.	

Few difficulties were encountered in the construction, and those that were met were readily overcome, thanks to the resourcefulness of the Pioneer Serjeant and the R.E. N.C.O. on the job. Excavation was rendered comparatively simple by the soil standing firm without revetment or strutting. One small cave-in occurred through an attempt to secure wider footings by undercutting in the neighbourhood of an old soakaway, but this was easily remedied with a little reinforced concrete.

In building the walls the nine-inch brickwork and the half-brick back walls were built up to full height and the concrete core was then filled in, the mix being made as dry as possible and well rodded. The front walls of glazed brick were built four courses at a time and then filled. Each layer of concrete was carefully swept and covered with grout before adding the next layer to make certain that no cracks should be left to allow leakage. The face of the walls was finished by pointing with Parian cement mortar mixed with Pudlo.

The floor was laid in four longitudinal sections. Two alternate sections were cast on successive days, and then three days' interval was allowed for shrinkage before casting the remaining sections. The floating coat of Snowcrete mixture was applied within 24 hours after the casting of each section in order to ensure a good bond. The surface of the Snowcrete was kept wet for 14 days by covering with damp sawdust.

Some difficulty was experienced in working the bituminous compound into the expansion joints. The joints were made wedge-shaped, but proved to be rather too narrow. The compound was plastic and difficult to liquify. The combination of these circumstances made filling the joints a laborious process.

Work on the removable wooden floor went on concurrently with work on the bath itself. At first it was thought possible to saw the existing floor and joists into sections which with a little strutting could be laid down again. Owing to the irregular spacing of the joists and to the bad condition of the floorboards this idea was abandoned. The old flooring and joists were pulled up and the sections made up from them. The edges of the sections were framed, the ends of the joists being let into the framing to secure sufficient bearing on the trestles.

Testing and Operation.

The bath was finished too late in the year to make any extensive use of it. In order to give the plant a thorough test, however, and to locate possible leaks, the bath was filled in November. All the personnel of the Depot, some 500 men, bathed for three days in succession. The water was then put through the filtration plant and

tested after eight hours' running. The results of the test were highly satisfactory.

A certain amount of leakage took place through the expansion joints. This was remedied by going over the joints very thoroughly and ramming the filling composition into them. A small settlement crack appeared in one longitudinal wall near the shallow end. This was remedied by taking down a part of the facing wall and grouting. It might have been prevented by a small amount of horizontal reinforcement in the longitudinal walls, which could have been put in with very little trouble.

CONCLUSION.

The Works Service at home is regarded by many officers as affording little scope for enterprise or for gaining engineering experience. This is an illusion which should be readily dispelled if it were realized how frequently the opportunity occurs of carrying out jobs like the construction of this swimming bath. Surely there is no engineer officer who would not welcome an opportunity such as this to get out a scheme for an unusual type of construction, to draw the plans, to specify the plant, to collect stores and labour, to supervise construction, and finally to see the results of his labours within the short space of nine months.

In addition it is by works of this nature, in which a unit is intensely interested, that the best form of liaison and co-operation is established between the engineers and other arms.

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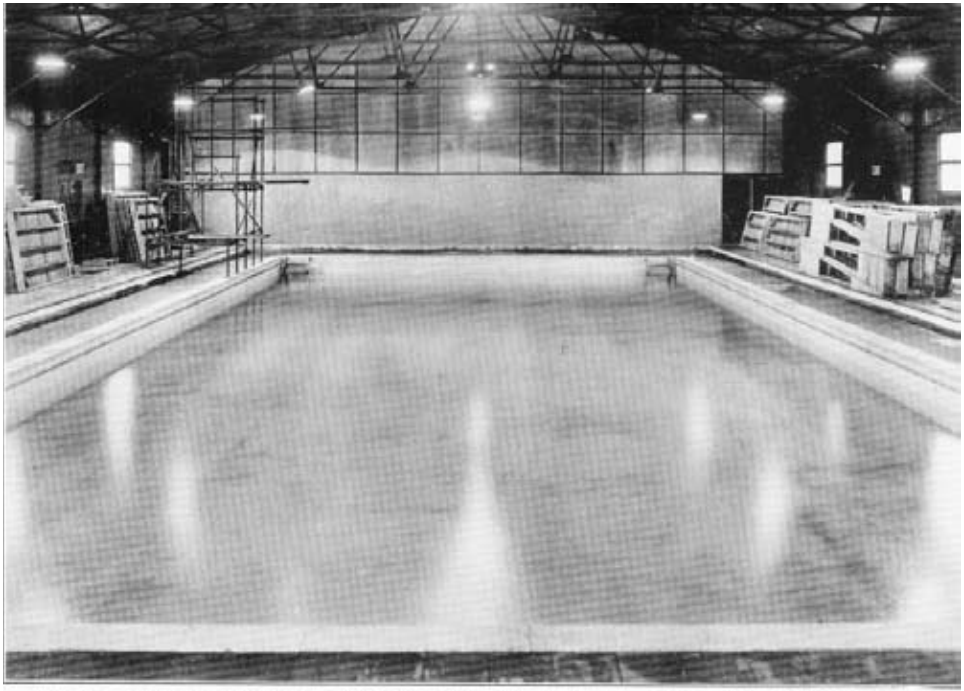


Photo 1.—The bath looking towards the deep end. The plant is housed behind the partition at the end.
Photograph by courtesy of Messrs. G. & H. Isaacs, Westerau, Caterham.

The construction of a swimming bath 1.

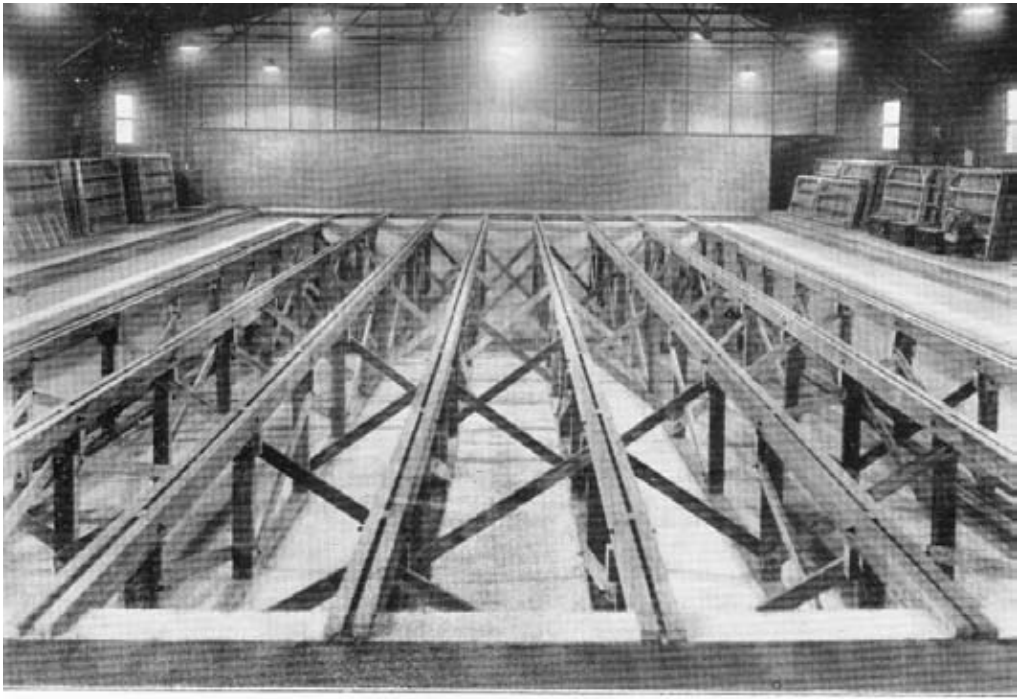


Photo 2.—Bath emptied and trestles in position.

Photograph by courtesy of Messrs. G. & H. Bance, Westway, Caterham.

The construction of a swimming bath 2.

Photo 3.—Wooden floor in position.

Photograph by courtesy of Messrs. G. & H. Barnes, Westerly, Caterham.

The construction of a swimming bath 3.

1.—The road before treatment. Gatton to Grantham

2.—The machine at work. Note the "clinkers" of burnt earth behind the machine.

3.—The same road after treatment. Not quite the same spot, but within half a mile of the above.

Black soil and an experiment in road making

BLACK SOIL AND AN EXPERIMENT IN ROAD-MAKING.

By MAJOR H. C. H. ROBERTSON, D.S.O., *p.s.c., Australian Staff Corps.*

QUEENSLAND and Northern New South Wales have many areas of heavy black soil varying in extent from a few square yards to several hundred square miles. Even in sandy districts, patches of black soil exist, and they are generally found along the valleys and on the low-lying flats. Black soil, when dry, is a hard mass with little tendency to crumble. Traffic consolidates it, so, in its natural state, it makes quite a serviceable road. Even when ploughed and graded the soil soon sets into a good surface, although heavy traffic causes a certain amount of dust.

During wet weather, however, black soil is a trap. A few cents of rain make the surface so greasy that motor vehicles will not steer, but slide off the crown of the road into the drains, where they bog. Heavy rain produces a quagmire into which motor vehicles dig themselves. There are two intermediate stages—when the soil is becoming wet, and when it is drying. In both these the soil " picks up " on tyres and wheels, and, as it sticks like glue, it soon packs such a load round the wheels that the engine will not turn them, or the whole mass jams between wheels and mud-guards. Chains on the tyres merely increase this evil.

In the wet season, when Queensland has its tropical rains, he who takes a motor vehicle on to black soil roads is looking for trouble, and will surely find it. Only recently a friend of the writer was caught on the Darling Downs with his car as the rains started, and he got his car back to Brisbane a fortnight later. Those rains, however, only come once a year, but thunderstorms can make a road impassable, and, like the poor, these are always with us. When driving over black soil roads one's eye constantly watches the sky to see if some roving thunderstorm is crossing the route. The storms are very local and may pass in a belt only a few miles wide, so some fast driving may get one past before the storm reaches the road. If one is unlucky one halts at the nearest town, or camps in the car till the sun is well up next morning. (The writer always carried a sleeping-bag, rubber boots, rope and tyre chains in the back of the car.) Those who live in black soil country are quite stoical, and all appointments and social functions are understood to be " weather permitting."

There is, however, plenty of power in the Queensland sun, and a

road which has been impassable all night may be quite usable by 10 or 11 a.m. The art of getting through during the morning is to let someone else try first. The first car "makes the track," and others use the ruts, which, consolidated by the first car's weight, improve as each car passes. The sides of the ruts keep the wheels from sliding off the road. In parts which are still very wet the ruts may, with use, get so deep that the undercarriage grounds. The next car along then pulls the first one out, and one of them makes a fresh set of tracks across the bog. A light-weight car with plenty of power is needed in black soil country, and it must have the standard 4′ 8″ track.

In recent years the fast motor-lorry came into use in Queensland in competition with the State railways. The lorry picked out the profitable freight and left the low-rate goods to the railway. The driver was generally interested in the earnings, and was content to work long hours as long as he got his load through. Damage to the road did not worry him, since he lived in Brisbane and was not concerned with the problems he left to the local Council; consequently he would push his lorry through when a local resident might have had some consideration for the road. The lorry-drivers became expert at picking a track after rain, and where an ordinary driver would get hopelessly bogged, these men would zigzag their way along, making enormous ruts in what was before the rain a well-graded surface. As a last resort, when almost bogged, they "rocked" forward a foot or two at a time with the engine roaring and mud flying in all directions. The damage which one lorry can do to a road after rain must be seen to be appreciated.

Mobs of cattle are a further trouble on black soil roads. When the road is dry they make no impression, but if it is thoroughly wet the hooves sink several inches into the soil and leave holes all over it. As the road dries the sides of these holes harden as if cast in cement, and driving over them is about the most unpleasant motoring experience the writer has ever had. A wet black soil road is a severe trial of engine, chassis, and driver, but a cattle-marked dry road is a torture. No matter how slowly one goes the car seems to be torn in every direction, and every now and then a strong periodic vibration sets in.

The Queensland Main Roads Board have spent much time and thought on the black soil problem, and, where they have tackled it, results are excellent. Drainage is the first step. Then a solid foundation is put in and the road raised well above the soil on each side. A waterproof tar or bitumen surface is then added. In the low-lying bogs, where drainage is difficult, construction is more elaborate. Road metal under load sinks into wet black soil so the road has to be raised two or three feet, and the sides revetted with huge logs held in place by heavy posts. The logs prevent the road

from spreading and sinking in the mud. In places the surface is made of heavy concrete instead of tar or bitumen paving.

This construction is very expensive and can only be afforded on important roads. Queensland covers a very large area, and the population per square mile is small. There are, consequently, more miles of road per head of population than in almost any other country. Black soil is also good agricultural land, and population has spread in the black soil areas, with the result that a large proportion of the roads are black soil—some thousands of miles of them. If a cheap method of treating the normal black soil road could be devised, then most of the roads could be made "all weather." The low-lying and very boggy pieces could then be attacked by the thorough and more expensive method.

Within the last couple of years the Queensland Main Roads Board have had under test a system of heat treatment of black soil put forward by Mr. L. H. R. Irvine. It has been established that certain fusible constituents of most soils can be melted, and these set hard when allowed to cool. The process is similar to brick-making. Mr. Irvine designed a machine for the purpose, and, by arrangement with the Main Roads Board, carried out an experiment on a stretch of road north of Walloon, some thirty-five miles west of Brisbane. The machine is self-propelled and burns wood to make producer gas, which is used for the heating. The site of the test was selected because ample supplies of wood were readily available, and, as the machine was still experimental, proximity to workshops at Ipswich was advisable.

The first piece of road treated was mostly clay, and the treatment gave a surface which looked like a mixture of gravel and brick-dust. It did not appear to absorb water and, on the several journeys the writer made over it, travel was quite comfortable. To extend the test to black soil, some hundreds of loads were carted on to this road and similarly treated, with apparently good results. As yet, however, the test could not be considered conclusive, for the treated surface rested on undulating clay soil which gave good support. The road treated is also an unimportant side road with scarcely any heavy traffic.

The burnt earth has been tried as an aggregate for cement, and tests of strength compare favourably with other mixtures. This should facilitate the construction of culverts in areas where metal is not available.

So promising did the tests on the Walloon road appear that the Main Roads Board authorized a further series on a pure black soil road. The piece selected was on the main Brisbane-Toowoomba road between Gatton and Grantham. The traveller has for years had the choice of two roads between Gatton and Grantham. The northern route runs through sand and sandstone

country, and is a rough track passable in all weathers except for the half-mile before entering Grantham. Here motorists vanished into the famous Grantham black soil bog and stayed there until a team of horses came to pull them out. The bog has now been bridged by a raised metal road with the sides well revetted. The southern route and the preferable one in dry weather, although one mile longer, is a black soil road running part of the way alongside the Lockyer Creek. In wet weather this road is impassable throughout most of its length. It seems to have no bottom and countless cars have bogged in it. This southern road is the scene of the second test.

The machine, which had been improved as a result of the experience near Walloon, worked on this section of the road. The process was as follows :—The area is drained and the surface formed. The machine travels along on one side of the crown baking a strip six feet wide. On a second run six feet on the other side of the crown are baked, making a surface twelve feet wide. The earth after baking looks like clinker and lies in lumps up to three or four inches in diameter. This clinker is then broken up into a gravel and spread evenly over twelve feet of road. The result so far is a firm surface similar to a good gravel road, and suitable for both horses and motor-vehicles.

Two miles of road were treated, and the first section, after nine months' use, during which there have been several periods of wet weather, still gives a good running surface. The treated surface does not appear to have sunk in the surrounding black soil, as was feared. The average traffic on the road is about 300 vehicles per day, and, although corrugations have appeared, they are less than similar traffic causes on good gravel roads. As the Brisbane-Toowoomba road is a main highway, it is to be made into a tar-paved road throughout its length, so the experimental section will not have much further test on this road. The treated surface is, however, to be used as a foundation, the bituminous macadam being placed on top.

Many country roads in Australia carry less than 50 vehicles per day, and a further experiment is now proceeding on four miles of road between Dirranbandi and Bollon, Queensland. This area has been selected because there is no road-building material in the district, and the treated surface, no matter how it fares, is unlikely to be disturbed for many years.

Some details of the machine and of costs were supplied by the inventor (Mr. L. H. R. Irvine) to the Institution of Engineers, Australia, by whose courtesy the following, as well as the accompanying illustrations, are supplied :—

The machine is 24 feet long and 8 feet 6 inches wide, and it draws itself along the road through a drum, on which is wound a wire rope attached to an anchorage ahead of the machine. The rate of movement can be varied between about five feet and eighty feet per hour.

On the Gatton-Grantham section an average rate of twenty-two feet per hour was maintained, giving, with three eight-hour shifts, a movement of four to five hundred feet per day.

The fuel consumed is about sixty-eight cords of firewood per mile for each course. The wood is put through a door on top of the machine and, passing downwards, is converted into charcoal which burns in the lower part of the combustion chamber. So complete is combustion that there is practically no ash and what little there is is no inconvenience. The products of combustion from this chamber are then led through ducts into a three-sided second chamber which rests so that the road surface forms the fourth side. A stream of pre-heated air is then forced into this second chamber, and combustion takes place on the surface of the road. The temperature generated varies between 1500° and 2500° Fahrenheit, the best temperature for black soil being about 1800° Fahrenheit. The heat penetrates the soil to depths varying from two to eight inches.

The cost of treatment has been estimated at £450 per mile for a twelve-foot road similar to a light gravel one, and, where gravel or metal have to be carried over ten miles, the heat-treated road is cheaper. The cost rises to as much as £3,600 per mile for a high-class pavement like bituminous macadam.

The inventor claims that the system is suitable for five types of road construction :—

1. Treating black soil or other clayey formations to make the equivalent of a gravel road in one or more courses.
2. Providing a foundation for other types of road construction over bad clay by dehydrating the clay prior to construction.
3. Rapid and economical treatment of earth roads with the object, not necessarily of producing a hard aggregate, but of improving the nature of the surface soil sufficiently to make it equivalent to a sand clay. Such a treatment might be used as a base for tar or bitumen surfacing.
4. Treating black soil roads which have already been improved by the addition of sand or loam. The result would be similar to a gravel road. Such treatment would constitute a further stage in construction and would prevent the blowing or washing away of the loam by wind and rain.
5. Treatment of gravel roads on muddy subgrades where the mud has worked up through the gravel and further supplies of gravel are not readily obtainable.

The experiment is being watched with much interest in Australia, and it seems probable that, in black soil or clay districts where firewood is plentiful but road-making material scarce, extensive use will be made of the invention.

SKEW GUNS AND SURVEY.

By O's R. AND B.

" If the map isn't big, why, we stands up an' surveys one as we've been taught ;
If there isn't a grid, why, we sits down and draws in one, as gunners ought.
You've got to make maps in our business an' stop wastin' cordite and shells.
D'you say you want fire on that farmhouse ? But, Sir, we must survey it first—
Hell's Bells.
You must survey all skew guns, or the skew guns are no use to you.
So when we call round with a few guns, o'course you will know what to do—hoo !
hoo !
Just give us six hours for a survey—then death if they fights or they runs ;
Or else say what you please, even pray on your knees, but you won't get a hit from
the guns ! "

—(With profound apologies to Kipling.)

WE trust that the Regiment, as well as Kipling, will be able to accept our profound apologies for the above parody of a very famous barrack-room ballad. We also hope that this article may enable us to obtain the answers to one or two problems which we have, as yet, failed to solve.

The whole difficulty arose at one of those Tactical Exercises without Troops which one of us was suddenly called upon to attend. Previous to the T.E.W.T. in question, the Sapper was firmly under the impression that all offensive action, which he vaguely remembered as an *essential* and *immutable* Principle of War, was organized and conducted with one object in view—that of enabling the Infantry " with whom the eventual decision rests " to close with the enemy *as rapidly as possible*. Now he is not so sure.

On a certain day, three officers assembled at H.Q. to depart by car for the area allotted for the tactical exercise. The party, including the Sapper, was as cheerful as Monday morning and a weather report " Rain with some hail and snow " would permit.

As soon as the party was under way, the senior member expressed the opinion that the exercise, when stripped of all map references and camouflage, would turn out to be the passage of a river by a Brigade in the face of a weak opposition. " All we have to do is to dash across somewhere and blow 'em out. Don't you agree ? " The Sapper, thus consulted, agreed hastily and then, remembering that he had not yet read the Scheme, settled down in the back of the car with " Opening Narrative," four hopelessly uncontrollable O.S. 1" sheets, all of which were required to follow the Narrative, *F.S.R.*, *I.T.*, *E.T.*, *A.T.*, and S.L. (Sandwich Lunch).

It appeared that Southland had once again caught Northland unprepared, and that the leading Southland Brigade was rapidly

approaching what, on the map, looked like one of the seven largest rivers in the world. The senior member appeared correct in his deductions—but what to do? There must obviously be some hint somewhere, and after a quick search through the Opening Narrative, the following hint caught the eye. "Read *F.S.R.* Vol. II, Sec. 134."

Sec. 134 appeared to be a pithy discourse on "Bush Warfare" and special diet for troops fighting in the Tropics. This was odd, very odd! The Sapper had a feeling that something was wrong somewhere. In an offhand way he enquired what Sec. 134, *F.S.R.*, Vol. II, was about. The answer came back promptly from the front seat, "Operation Instructions." Another rapid inspection of the volume in his hand still showed the title to be *F.S.R.* Vol. II. It was really extremely odd, especially as the volume was brand new and contained no amendments. Apparently there were two official volumes in circulation of the same name, but giving different information!

The full party for the exercise assembled at a map reference on time (surely a record), and Syndicate No. 1, of which the Sapper was a member, was found to contain members of several other arms of the Service. There were five syndicates in all, and one very special syndicate known as the Directing Staff (D.S.).

Several members of No. 1 Syndicate, having taken part in such performances before, were by no means disheartened to learn that the D.S. solution to problem No. 1 differed materially from their own, and the incident passed without comment. The D.S. solution to problem No. 2 could be summed up by the one word "No." No. 1 Syndicate's answer was "Yes." However, as the syndicate leader pointed out, the problem was one to which both answers could be absolutely right!

The solution of problem No. 3 brought matters to a head. The answer from No. 1 Syndicate was again absolutely opposed to the D.S. solution, and this time the problem was quite definitely one to which answers "Yes" and "No" could not both be right. Nasty suspicions that all was not well occurred to several members of the syndicate, who were loath to admit any significance in the fact that the other four syndicates agreed with the D.S. solution.

The deduction that one problem would be the crossing of the river by a Brigade proved to be correct. Stated briefly, the facts were as follows:—The leading Southland Brigade, supported by a Brigade of R.A., was required to cross a river over which all the bridges had been destroyed. A Cavalry Regt., already on the other side of the river, but away on the left flank, would also assist, together with a Field Co. R.E. which had somehow come by certain miscellaneous bridging materials. So far as was known, the opposition consisted of one Cavalry Squadron only.

No. 1 Syndicate, unaffected by the queer solutions previously put forward by the D.S. and the other four syndicates, were unanimous that the place of crossing should be chosen by the Sapper. A reconnaissance of the river followed, and in due course the Sapper gave as his solution two places.

He explained that both were equally unsuitable, but that they were the best he could do with such an outsize and unsatisfactory piece of river. He would be prepared to provide four assault bridges of sorts at any time of the day or night, and in addition would prepare and operate two folding-boat "track" rafts, suitable only for passing light vehicles over the river. The whole operation, in spite of the enormous difficulties, would be child's play to his unit.

This solution set a dashing note to the proceedings and, filled with the will to win, all gathered round to hear the opinions of the other members.

The Infantry man next expounded his theory of the attack, and was heard to mutter "Dawn—dash—surprise—pinch them out—bayonet—Heaven help them." He was clearly contemplating offensive action of the most offensive kind.

He was followed by the Machine-Gunner, who discoursed on "Zones of fire—fields of fire—grazing fire—plunging fire—hell of a fire." He, too, was clearly prepared to act with the maximum of violence.

By this time the *morale* of the syndicate had risen to great heights, and the battle to all intents and purposes was over. This conclusion was confirmed by the view of the Cavalryman, who immediately agreed with all that had been said, and was quite prepared to act alone to clear the opposition away at the gallop.

The Gunner was then asked what contribution he would make to the quick disruption of Northland. Amidst a hush of surprise he was heard to state that this sort of headlong and unprepared action was hardly his line of country. He pointed out that the Brigade was due to reach the neighbourhood of the river only late in the afternoon, and would apparently be at grips with the enemy at dawn the following day. There was, therefore, no possibility of his carrying out a "survey," and without a "survey" and with only a 1" map available, such shooting as he could do would be of little assistance to the Infantry, and might quite likely do them a serious wrong. He would require at least six hours of daylight and probably longer, to carry out his "survey" and make his own grid.

Several members of the syndicate, who appeared to be having trouble with their breathing, pointed out that their 1" maps already had one grid on them. How anyone could want to add another grid passed their comprehension. A map with two grids would surely reduce map-reading to an impossibility.

The syndicate leader, who had studied much, suggested that it

might be possible to adopt a procedure which he believed had been used once or twice before; that of siting the guns on some suitable high ground (there was ample selection available), pointing them in roughly the desired direction, and then making such adjustments to range and direction as the shell-bursts would appear to indicate.

The Gunner passed over the question of two grids. He agreed that the method suggested by the syndicate leader had been used with some success in the past, but was now obsolete and should not be considered. It would certainly lead to a waste of ammunition, as several rounds would be uselessly expended before the target was hit. His supplies of ammunition would not permit of such waste.

This was a set-back, but *morale* was still so high that the syndicate refused to be daunted. After all, a few more "Zones of fire" and an extra charge thrown in by the Cavalry would probably compensate for the loss of the Artillery.

The Transport Officer next added his contribution. He was prepared to see his vehicles go over in the rafts, but how were his animals to cross? That was an easy one, and was answered by a chorus of "swim them."

A look of horror spread over the Transport Officer's face. "It was unthinkable to swim the horses—it couldn't be done. In France, Mespot, and Palestine bridges were always supplied for horses; in fact, not since the South African War had they been called upon to swim. The swimming method of crossing horses over a river must therefore be considered obsolete and ruled out of the discussion." This was the second set-back, and, as it involved leaving behind greatcoats, cookers and mess carts, it had an insidious effect. Confused muttering broke out on all sides.

The Machine-Gunner then asked leave to amend his scheme. On looking at the ground again he considered that he had been rather hasty and optimistic. The ground was very deceptive and much better results could be obtained if his M.G's were surveyed in first. He was prepared to do without an extra grid, but some form of survey was a necessity.

The Infantryman followed suit at once. He had just noticed in *War Establishments for use in Examinations* that the enemy squadron was probably armed with light automatics. The ground had obviously become more difficult since his first appreciation of the situation, and he was not prepared to fight the war alone with his troops, while the others engaged in a little mild survey amidst the pleasant surroundings of cookers and mess carts.

A major rot had now set in, and in vain the Cavalryman scoffed at all enemy squadrons and light automatics, and repeated his very generous offer to invade Northland alone. In vain the Sapper pointed out the advantages to be gained from map-reading, and

offered to erect dozens of winches (secured from somewhere or anywhere) on the far bank of the river to pull the animals over.

In desperation the syndicate leader appealed to the Tank Officer to suggest something to awaken the lost offensive spirit. The Tank Officer spoke briefly and to the point :—

(*a*) No tanks were allotted to the job.

(*b*) There were no bridges for tanks.

Although the odds in favour of Southland remained the same and though the ground had not noticeably changed since the discussion started, it was obviously necessary to reappreciate the situation. After a desultory discussion it appeared that the position of the leading Southland Brigade was something in the nature of a death trap, sandwiched as it was between an enemy squadron (now armed with light automatics) and an unsurveyed brigade of artillery, with the unsurveyed M.G's dotted about all over the place.

It would obviously be necessary for the Brigade to drop all idea of offensive action for the moment and to cling on to its ground as best it could until one or all of the following things happened :—

(*a*) The enemy squadron were definitely known to have withdrawn, complete with light automatics.

(*b*) The second and third Southland Brigades bumped into the first and pushed it into or over the river.

(*c*) The R.A. completed a survey and were prepared to join in the war again.

(*d*) The *morale* of the syndicate recovered.

The Cavalryman and Sapper, feeling rather out of their depth, and acting on the strategic advice of " reculer pour mieux sauter," withdrew apart from the others to a charming old-world cottage with the curious name of " The Shoulder of Mutton." There, over a double Bovril, they discussed several technical subjects such as high withers and low withers, road-hogs and wart-hogs, spavin and bog spavin, cracked heels and cold feet. Thence by easy stages and more double Bovrils they arrived at a discussion of the latest Stock Exchange quotations, " have you heard the one, etc., etc." They were eventually discovered by the remainder of the syndicate engaged in a hotly-contested combat of " Noughts and Crosses," which was being fought on the margin of the Cavalryman's map.

Having been discovered, they were drawn into the discussion again to assist in the formation of a defensive position for the Brigade. The Cavalryman's reaction was simple and prompt ; he at once

withdrew to the rear to water and feed. The Sapper undertook to block all roads shown on the map; some, of course, were already conveniently blocked by the bridging materials waiting to be used. He was also prepared to remove one medium-sized forest and two villages to provide additional fields for some kind of fire, and suggested that while he was busy with the "heavy stuff" (*i.e.*, the removal of whole villages), the "light stuff" (*i.e.*, the loopholing of the few houses that were to be retained) should be undertaken by the unit pioneers.

After further discussion the "light stuff" was also allotted to the Sappers, because it was considered that the Pioneers, being very valuable men, would not have followed the Brigade into its present precarious position. Moreover, punching holes in brick walls was hardly their *métier;* they were by training better suited to making glass-fronted cabinets and the like.

Unfortunately the time required to formulate two completely separate plans—the discarded one of attack and the new one of defence—was so great that the D.S. burst upon No. 1 Syndicate with a cry of "Time, Gentlemen, please," before the latter could attend to the mass of dreary oddments which are usually catalogued after "Method of Execution."

Captain X. was called upon by the D.S. to "do the honours." He fought well but got inextricably mixed up between the first and second plans, whilst another member of the syndicate walked around growling "Order—Counterorder—Disorder." Through lack of time, Brigade H.Q. had not been located anywhere by the syndicate, but Captain X. was not put out of his stride by a searching question on this point. He promptly allotted it to the nearest large house that he could see, forgetting that he had already handed over the house in question to the Sapper for inclusion in the "heavy stuff." The D.S. quietly pointed this out, whereupon Captain X. hotly denied the accusation and hinted at inattention on the part of the D.S. In order to press home his point he endeavoured to re-explain the whole plan by pointing it out to the D.S. on a map which he seized from the Cavalryman's hands before he could be stopped—the final error—the first thing that caught the eye of the D.S. being the scarred battlefield of O's and X's in the margin of the map!

* * * * * *

On the way home in the car a somewhat bewildered Sapper attempted to sort out his impressions of the Exercise.

(1) Horses were not what they used to be, since the modern horse could not swim. The South African War of 1899-1902 was obviously not a feasible proposition with the 1934 model horse. Was this altogether the fault of the horse?

(2) What happened to Unit Pioneers in attack and defence? Did they, like the bandsmen, become stretcher-bearers?

(3) The advantages to Gunners of a survey, silent registration, etc., in a deliberate attack on a prepared position were both obvious and overwhelming, but was it sane or reasonable to drag it in in questions of advance guards, raids, and preliminary encounter battles such as we practised on most T.E.W.T's.

(4) In any case would not 75% of the value of any survey be lost if large-scale maps of the battle area were not available?

What are the chances of such maps being available in countries where the British Army is likely to fight?

(5) If a survey is to be a *sine qua non* for a gun to fire there will probably be numerous occasions on which either the infantry must fight alone or else the enemy will be given six very valuable hours in which to prepare to "repel boarders," and complete his own survey.

(6) If the six hours are considered vital to success, and the Infantry are pushed to the attack unsupported by Artillery, it would be regrettable in the extreme if the enemy Artillery suddenly discarded survey, and decided to shoot his guns by ground and air observation only.

On the following day the Sapper discovered that his *F.S.R.* Vol. II, in spite of its newness and lack of amendments, was dated 1924, as against the more modern edition dated 1929. As far as that difficulty goes, all is well again!

SOME SERVICE APPLICATIONS OF THE HIGH SPEED DIESEL ENGINE.

By CAPTAIN W. M. BLAGDEN, R.E.

I. DEFINITION.

BY the term "diesel engine," we mean the type of internal combustion engine that ignites its fuel by the heat of compression alone, the said fuel being forced into the cylinder in the form of a very fine spray, just before the end of the compression stroke, by an accurately timed fuel pump.

If exception is taken, by purists or patriots, to our use of the name of the illustrious Dr. Diesel in this connection, we must plead as our excuse that the service designation "compression-ignition engine" is difficult to use in conversation. It is the sort of thing that the policeman invites you to say, after you have taken part in a road accident.

By the description "high speed," we mean an engine that runs at 1,000 r.p.m. and over. It is an arbitrary figure, and slow compared with most petrol engine speeds, but it is at the moment a critical one, and engines designed to run at higher speeds are very different from those that run slower.

II. MOTOR TRANSPORT ENGINES.

The high speed diesel has been developed primarily as a rival to the petrol or paraffin engine, in the field of motor transport. Its qualifications in this respect are already fairly widely known, and we need only deal briefly with them.

Advantages of High Speed Diesel over Petrol Engine.

i. *Economy.* It uses a cheaper fuel, and less of it. The fuel costs about 4d. a gallon, and the consumption is something in the neighbourhood of 0·4 pints per b.h.p. hour, as against about 0·6 pints per b.h.p. hour of petrol.

ii. *Safety from Fire.* The flash point of light diesel oil is much higher than that of petrol or paraffin, and it is, therefore, much safer to deal with, both on the vehicle and in store.

iii. *Reliability.* There is less to go wrong; the fuel pump is a relatively sturdy affair, and it replaces both the electric ignition and the carburettor of the petrol engine.

iv. *Overload Capacity.* The output of a high speed diesel is normally limited by the fact that it emits a black exhaust when too highly loaded. If this is not objected to, it can take a fairly severe overload without difficulty, and this is a useful feature. The overload capacity of the petrol engine is very small.

Disadvantages of High Speed Diesel.

i. *Rough running and dirty exhaust.* These faults are rapidly being overcome as the breed is improved by experience and research.

ii. *Power/Weight Ratio.* This, both on account of the greater stresses involved, and the slower maximum speed at which it as yet can run, seems inevitably to be lower than that of the petrol engine, but it is gradually being improved.

iii. *Higher First Cost.* It is still more expensive to produce than a petrol engine of the same power, and likely to remain so.

Applications in Transport Work.

The engine has been put to many different uses, for different reasons.

For aircraft and also for armoured fighting vehicles, it is attractive on the score of safety from fire-risk, general reliability, and the economy which makes for a wider cruising range. It also possesses the characteristic of losing less power at high altitudes than does the un-supercharged petrol engine.

With commercial road-transport vehicles, its economy in fuel costs has led to its widespread adoption in spite of its high price and weight, and it is likely to stay.

It has been used with particular success in small motor vessels, railway locomotives, and light railway tractors.

III. Stationary Engines.

All those applications of the high speed diesel, in which it is made to replace the petrol engine, are fairly obvious ones, and most engineers nowadays are alive to the possibilities of the situation. There is, however, a totally different field of utility for this engine which is apt to be overlooked, and which, by virtue of certain special conditions of the Service, is of peculiar interest to the R.E. officer.

This is its application as a stationary engine which is used for generating electrical or mechanical energy.

In considering the merits of the high speed diesel for stationary work, we are up against a different set of conditions altogether. In this case it is competing, not with the petrol engine, but with its own larger relative, the low speed diesel, which may be of the solid injection or the air-blast type.

We find that the majority of those characteristics, in which it

held the advantage over the petrol engine, are now against it, and that a totally different set of points can be advanced in its favour.

Advantages of High Speed over Low Speed Diesel.

i. *Power/Weight Ratio.* This is much higher than that of the low speed engine.

ii. *Power/Bulk Ratio.* The high speed engine takes up much less space than the low speed; this applies particularly to head-room, which in the case of low speed sets must allow for the installation of a travelling crane high enough to draw the piston, and possibly also the connecting rod, clear of the cylinder.

iii. *Cost per B.H.P.* The high speed machine costs less.

Disadvantages of High Speed Diesel.

i. *Fuel Cost.* It cannot run on the heavy crude and residual diesel oils, but requires something lighter and more refined. The difference in the actual consumption is very slight.

ii. *Fire-Risk.* Light diesel oil is slightly more inflammable than the heavy oils.

iii. *Reliability.* The lower speed machine is more reliable, and has a longer life.

In considering a complete electrical generating set, it is well to remember that a high speed electrical machine will be lighter, smaller and cheaper than a low speed machine of the same output. This is important because it is found that direct coupling is by far the most satisfactory form of drive.

Applications in Stationary Work.

The disadvantages outlined above make it normally inadvisable to install high speed diesel sets in power stations and factories. Their use in civil life can only be justified in special cases, where space is restricted, as in mines or floating docks.

The Service outlook is rather different from the purely civilian one, and is worth going into more fully. The requirements of the Army in war are so different from its peace-time needs, that it will be necessary to consider them separately.

War, of course, comes first.

IV. Military Applications in War.

In modern warfare, mechanical power is needed for a great variety of purposes, all fairly obvious. Broadly speaking, the most important of these are:

i. The development of electric power for use in base workshops, bakeries, laundries, etc., and for the lighting of camps and hutments.

ii. The development of mechanical power for direct use in pumps and compressors, for water supply and drainage.

Ruling Considerations.

When an expeditionary force is sent overseas to take part in major perations of war, its requirements in machinery will probably have to be supplied from home, and they will be wanted immediately. In war, time is the primary factor. Armed with this vital platitude we will consider the question of the suitability of the high speed diesel for our purposes.

The Case for the High Speed Diesel.

i. *Light Weight.* If sufficiently light, sets, with engine and generator on a common bedplate, can be shipped complete. These are easily handled, and can be installed on the most simple foundations. They need no erection on site, and can be put into service the moment they are in position.

ii. *Small Size.* They occupy a smaller tonnage in the store ship, and when installed, can be accommodated in a smaller building than is required by low speed machines. No travelling crane is needed, and comparatively low buildings can be used, which can be of quite light construction. Sectional corrugated-iron hutting could be shipped with the sets and put together very quickly.

Small buildings are, of course, less conspicuous to air observation, and do not afford an easy target.

iii. *High Speed.* This type of engine can be coupled direct to centrifugal pumps, without the need of gearing.

iv. *Reliability.* Although the high speed engine is less reliable than the low speed, it is possible to ensure the reliability of the installation as a whole, by dividing up the load among a number of sets which, though fairly small, would be reasonably efficient. One or two extra sets can then be installed as spares, to allow for laying off, and a further set might be held in store as a replacement, in the event of one of the sets breaking down altogether.

v. *Ease of Repair.* These engines are very accessible, and easy to repair and overhaul. Their spare parts are light, and do not take up much room.

vi. *Fuel Economy.* In war, economy is usually of secondary importance, and the difference between the cost of light diesel oil and heavy diesel oil would not be regarded as very serious. On the other hand, it is probable that supplies of the light oil would have to be present in the field, for the use of such M.T. vehicles as might require it, and a certain simplification would result from having to handle one type only.

vii. *Security.* Another advantage to be derived from the use of a number of small sets, as opposed to a few large ones, in a base power station, is that they can be installed in two or more buildings, connected by link feeders. Then if one building is destroyed by a bomb, the entire supply will not be cut off.

Selection of Power Units.

Assuming, as an example, that a base power station is to be installed, with a total capacity of 1,000 kw., including the allowance for spare plant, we have to decide what is the largest fraction of this output that we can afford to concentrate into one set.

It will be preferable to select one standard size, and stick to it, so as to simplify the questions of stores and layout; this size should be the largest that can conveniently be handled. It will not do to break up the load into a very large number of fractions, as each unit will require its own switch, and a multiplicity of switches means extra weight and space.

It is thought that the load should, in this case, be divided among not less than six, or more than eight power units. The former arrangement requires 170-kw. alternators, and the latter 125 kw., calling for a power input of about 275 b.h.p. and 200 b.h.p. respectively. In the case of the smaller size, the weight of the set complete with fabricated base-plate could be a trifle less than five tons, and this might be a deciding factor in favour of its adoption.

In selecting units for pumping plant, it is probable that much smaller engines would be used, and there is a large range of such engines available on the market, running at speeds between 1,000 and 1,200 r.p.m. If the pump is made specially for the engine, the latter can be run at its rated speed. If the pump is purchased "off the peg," it will have to be run at the speed for which it has been designed, centrifugal pumps being very touchy in this respect. In this case it is well to remember that the power output of a diesel is more or less directly proportional to its speed, and if not run at the rated speed, it will not deliver the rated b.h.p.

Comparison of Weights and Sizes.

The following table of weights and sizes of high and low speed 170-kw. sets, has been roughly estimated from makers' catalogues. The two speeds selected are suitable for alternators generating at a frequency of 50 cycles.

	Low Speed.	*High Speed.*
Speed of Engine	428 r.p.m.	1,000 r.p.m.
Weight of Engine	11 tons	2½ tons
Weight of Alternator ..	5 tons	2½ tons
Weight of Base-plate ..	1 ton	½ ton
Length of Set	20 feet	13 feet
Width of Set	5 feet	4 feet
Height of Set..	8 feet	5 feet
Height of Crane Hook ..	10 feet	Not needed

From this it is seen that the 275-b.h.p. high speed machine, although it makes up a set that weighs more than five tons, can be broken up into components that can be carried in a 3-ton lorry.

V. MILITARY APPLICATIONS IN PEACE.

In peace-time, the military user of power is on much the same footing as the civilian. The ordinary requirements for barrack lighting, ordnance factories, and so forth, are so similar to the corresponding demands of civil life, that they call for no special treatment. The case of plant used for coast defence purposes, however, provides an important exception, which we must now consider.

Ruling Considerations.

If time is the chief factor in war, finance is clearly predominant in peace. Time, in fact, can hardly be said to exist for us except, perhaps, in those unforeseen cases where hard-won funds are in danger of lapsing.

When it comes to a question of using a high speed diesel in place of a low speed machine, one has to weigh up very carefully the advantage gained in the reduced first cost of plant and buildings against the increased cost of fuel and maintenance. With things as they are, it is pretty certain that for most purposes the low speed machine is the more economical in the long run.

Whenever it is considered necessary to install engines underground, or in bomb-proof engine-rooms, the high speed diesel becomes a good proposition. It is for these purposes that we will consider the case for its adoption.

The Case for the High Speed Diesel.

i. *Cheaper Building.* There will be less total excavation required, and less material used in the construction of the building.

ii. *Better Protection Possible.* For a given thickness, the strength of the roof varies inversely as the square of the span. The span can be considerably reduced if high speed sets are installed. If the roof consists of a concrete slab over pressed steel troughing, a given gauge of troughing can carry a deeper slab.

iii. *Less Headroom Needed.* This is due both to the smallness of the engine and to the absence of a travelling crane. It is especially important if the engine-room has to be sited on marshy ground, or in a place where the level of the subsoil is unduly near the surface. In these cases it may be necessary to keep the floor of the engine-room at ground level, and build up a turfed embankment all round it; the smaller this has to be, the better.

iv. *Foundations.* D.E.L. stations often have to be sited down on the sea-shore, or on soils where it is difficult to provide adequate foundations for heavy sets, without piling.

v. *Entrance Doors or Tunnels.* These can be made fairly narrow without making it difficult to install the high speed sets.

vi. *Engine Starting.* This can be done by hand, and the absence of air-bottles and a standby compressor makes for simplicity and economy in space.

vii. *Spare Plant.* The sub-division of the load among a number of units makes it possible to allow a lower percentage of spare plant.

viii. *Repairs.* The high speed sets are more quickly and easily repaired than the low speed ones, and they have the advantage of being able to be withdrawn entire from the engine-room, for overhaul or replacement.

ix. *Tactical Advantages.* The smaller engine-room offers less of a target to enemy attack, and is stronger. It is also more easily concealed if it has to be built above ground.

Selection of Power Units.

Here again a standard size of set can be selected, as was done during the last war in the case of the Crossley DV4 petrol-paraffin engine. The number to be installed in each case would depend on the number of lights to be served, allowance being made for spare plant. For the big guns, the size of engine will depend on the calibre of the gun and the type of mounting.

Taking the case of D.E.L. plant as an example, a suitable set might be made up with a 40-b.h.p. 4-cylinder engine driving a 24-kw. generator. This naturally depends very much on the type of lamp that is going to be used.

Comparative Layouts.

The accompanying sketch gives the outline of two comparative engine-room layouts, each capable of supplying a number of search-light emplacements, of which the aggregate demand is 50 kw. One of the low speed machines, or two of the high speed, are supposed to be able to carry the load, the remaining sets being spare.

The most important reductions brought about by the use of the high speed sets instead of the low speed ones, are in the span and height of the roof, and the size of the machine foundations. In addition to this, the breaking up of the load among two power units decreases the amount of spare plant needed.

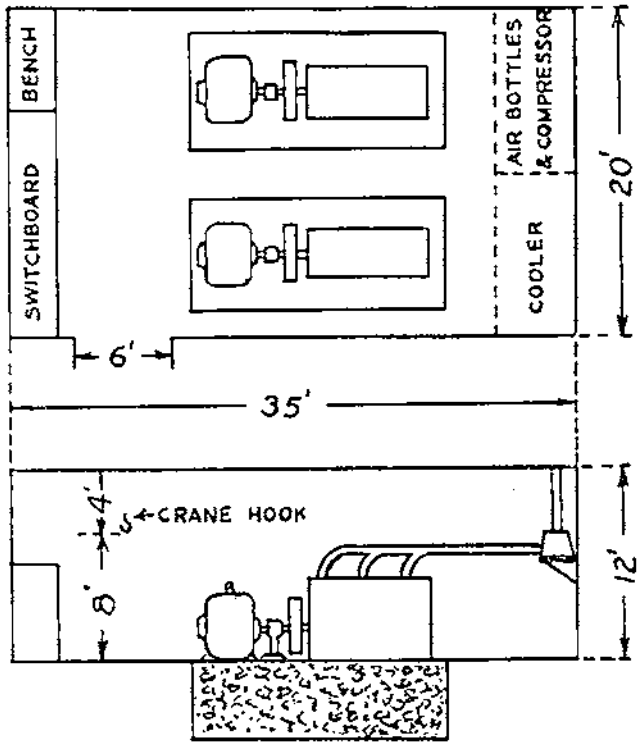
It has been assumed that for any serious repair to one of the high speed machines, the whole set will be withdrawn to the workshop, and little room has been allowed for dismantling.

VI. Engines Suitable for Stationary Work.

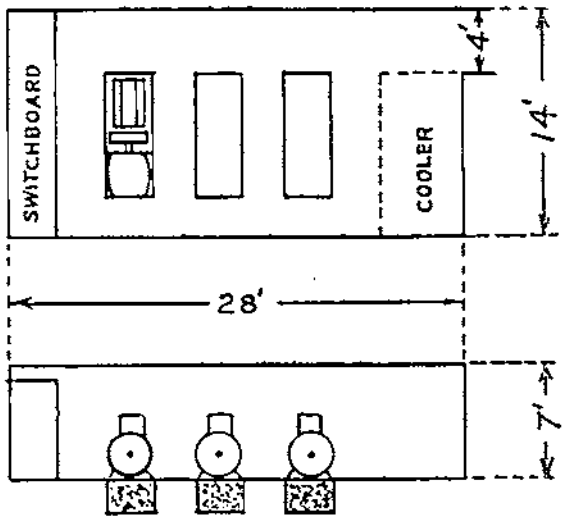
The high speed diesel engines used in lorries and buses are built with the view to being as light as possible. This does not matter much on the road, as they are not loaded up to their full capacity except when climbing the steepest of hills with the maximum weight on board. Most of the time they are propelling the vehicle along the level, and having a comparatively easy time of it.

This type of engine is therefore not suitable for stationary work, where a machine is expected to run fully loaded for hours at a stretch; it would not be sufficiently reliable under such conditions. The

COMPARATIVE LAYOUTS OF UNDERGROUND POWER STATIONS



TWO 600 r.p.m MACHINES



THREE 1200 r.p.m. MACHINES

type to employ in this case is the one that has been developed for use in diesel electric locomotives, small motor vessels, or large ships' lighting sets. These are heavier in build, and more robust.

There are not so many makers of this class of engine as there are of the purely M.T. type, and their products vary very much in weight. They range from 20–50 lb. per b.h.p., and generally speaking, the heavier they are, the better they should wear.

The engine taken as an example for the base power station alternator sets is a Beardmore High Speed Diesel, developing about 33 b.h.p. per cylinder, and running at 1,000 r.p.m.

The machine on which the D.E.L. engine-room layout has been based, is the latest Tangye or Gardner stationary high speed diesel, only 10 b.h.p. per cylinder and comparatively light in build, though heavier than the lorry engines made by the same firms. It is considered to be quite able to withstand the rather intermittent demand made upon D.E.L. engines, and it is much more sturdy and reliable than a petrol-paraffin engine, such as the Crossley DV4. It is also suitable for many of the smaller jobs which call for the driving of pumps, fans, compressors and suchlike, being obtainable in quite small units.

Nearly all high speed diesel manufacturers produce a range of engines of various capacities, having different numbers of the same sized cylinder, from 1 up to 8 or even 12. If possible, one should avoid using a 3-cylinder engine for driving a 3-phase alternator.

VII. Conclusions.

The strides made in the development of the high speed diesel in the last few years have been very rapid indeed. There is a very good case for their use, now, as stationary engines for certain Service duties. If their performance is still further improved in the next few years, it is probable that they will be challenging their low speed rivals in the civilian field as well.

The makers of low speed engines have done their utmost to keep pace with the march of events, by increasing the speeds of their machines by almost 100% within the last four years, without altering their size to any very great extent. They are still comparatively large and heavy, but their power has been rated proportionately higher. Messrs. Ruston, for instance, now run their 20 b.h.p. per cylinder engines at 750 r.p.m., and their 75 b.h.p. per cylinder size at 428 r.p.m., and these machines still use heavy oil.

It is possible that within a few years, heavy oil engines of 50 b.h.p. per cylinder and under will all be running at speeds of 1,000 r.p.m. and over, and will have correspondingly reduced weights and dimensions. If this comes to pass, the arguments that we have been setting out at such length will have been superfluous, and an apology will be due to the reader for having wasted his valuable time.

A TWO-COLOUR PROCESS FOR THE RAPID PREPARATION OF PRINTING PLATES IN THE FIELD.

By CAPTAIN D. R. CRONE, R.E.

MAPS are of primary importance in field operations and are frequently required to be prepared at very short notice. The graphical method of mapping from air photographs developed by the War Office is peculiarly suited to the rapid survey of large areas of country and an equivalent speeding up in the processes of reproduction is highly desirable. The greatest delay is occasioned by the separation of the work into the components which require to be printed in different colours.

In peace-time practice, the original survey is drawn in appropriate colours, it is then photographed and blue prints of it are inked up in uniform style to form the originals for the colour plates. A separate print can be inked up for each colour, but climatic changes distort each print differently and the colours would not fit (or register) correctly on the final map. A separate original is generally prepared for the brown and the other colours are all shown on the "detail original." Separate printing plates for each colour are prepared from this detail original by taking as many identical negatives as there are colours in the final map and painting out (duffing) by hand on each negative all detail other than that to be shown in the colour which that negative represents. This process is clearly too laborious and some of the possible solutions of the problem are :—

(i) the printing of the battle map in one colour only by direct photography ;
(ii) direct photography of the original survey on to two or more negatives and painting out of detail of other colours ;
(iii) direct drawing on zinc plates (one for each colour) carrying all the detail offset from a plate prepared as in (i) ;
(iv) the compilation at the time of survey of each colour on a separate original and the preparation of printing plates from these direct by photography ;
(v) the separation of the colours on the original survey by a photographic two- or three-colour method.

Each of these methods has its disadvantages. It is generally essential for legibility to have at least two colours on a map. When the map is not overcrowded, painting out on two negatives may be suitable, but it is laborious work and cannot be rushed. Drawing on

zinc avoids errors of registration and gives a uniform style of drawing, but requires specially trained men. Compilation on several originals, especially when working at high pressure, may involve gross errors of registration and at the best is liable to the errors of distortion of the material on which the work is compiled. This method has been given an extensive trial in India and has been found unsuitable. The process to be described is a method of photographic separation of two colours from a combined original, evolved to suit the conditions postulated on a campaign in which an Indian Field Survey Company might be employed.

The theory of two- or three-colour reproduction is well known and extensively practised. The difficulties in the way of utilizing the theory in the field are practical ones imposed by the conditions.

In the first place, the Indian Field Survey Company is organized for movement by pack transport and therefore has no process camera with Company H.Q. or Field Survey Sections and only one small one with the Air Survey Section, which is generally well behind and moves by M.T. This condition means that the photographic method must be by contact printing or at any rate suitable for contact printing. A contact printing process requires a reasonably colourless, transparent material for the original. It also means that the inks used must be transparent.

The essentials are, then :—

(*a*) a colourless transparent material with the usual qualities of toughness to resist handling in compiling the survey and a surface to take drawing inks.

(*b*) two inks, transparent, of complementary colours and suitable for use on the material chosen. They must also be easy to work to avoid delaying the drawing.

(*c*) two colour-filters matching the inks selected.

(*d*) a photographic film sufficiently sensitive to the colours chosen.

After considerable investigation, a suitable set of materials has been found which produces the desired result. The original experiments were carried out in the camera with ordinary camera filters, while the transparency was tested visually. A difficulty arose after the selection of the materials, in that the firm supplying the camera filters was not prepared to supply large areas of celluloid filter to match. The method of preparing the filters which was adopted is therefore given below. The materials selected are :—

(*a*) " Kodatrace," a proprietary tracing material of cellulose base marketed by Messrs. Kodak Ltd. The " Standard Tracing " quality was used and was found suitable, the " Special Thin " will not stand much handling, whilst the " Extra Heavy " would probably not give a sharp negative, although it has not yet been tested.

(*b*) Reeves' Waterproof Drawing inks, Scarlet and Cobalt Blue Tint.

(*c*) The filters are prepared as follows :—

A piece of unexposed photographic film of the required size is taken and fixed in 10% Hypo Solution and thoroughly washed ; it is then placed in a dish and the dye solution given below flowed over it. The film is removed after five minutes and hung up to dry in a place free from dust.

The formula for the red dye is :—Tartrazine, ½ oz. Crocein Scarlet ½ oz. Water, 60 oz.

The formula for the blue dye is :—Methyl Blue, 40 grains. Water, 60 oz.

The dye must be thoroughly dissolved and the solution carefully filtered before use.

(*d*) The photographic film is Typon Film, manufactured by Typary and Typon Co., Ltd.

The whole method is as follows :—

The survey is compiled from air photographs in the usual way on to Standard Tracing " Kodatrace." The work is inked up on the Kodatrace with Reeves' Transparent Waterproof Inks, Scarlet or Cobalt Blue. All work within the body of the map is completed, names and figures being entered by hand printing. The blue filter is placed on the glass of the printing frame ; the Kodatrace is placed on top of it with the work downwards or towards the filter if the printing press is direct, or upwards if offset presses are to be used ; Typon film is placed on top and the frame closed and exposed to parallel light in the usual way. The film is developed, fixed, washed and dried. It is combined with a negative film of the headings, borders and footnotes required and the printing plate prepared by the heliozincographic process from the combined negative. The printing plate of the second colour is prepared similarly, using the red filter. If hand printing of names on the original is impracticable, the typing of names, heights, etc., with the hand typing machine may be postponed until the negative of the colour other than black has been taken, when the typing can be done in black on the Kodatrace. This is not very satisfactory and a separate name plate may be advisable.

It is immediately obvious from the above description that the final map is on the same scale as the air survey compilation. This is a natural corollary of the absence of a suitable process camera with the forward troops. The implications of this fact form another problem which need not be discussed here.

SKI-ING IN AUSTRIA.

(December, 1933—January, 1934.)

By COLONEL SACKVILLE HAMILTON, D.S.O. (late R.E.).

SKI-ING as a sport is annually increasing in popularity. This is largely due to the fact that, though to become really expert it is normally necessary to start in early youth, the average man and woman can become sufficiently good in a very few days to be able to enjoy themselves thoroughly.

But the information given in many of the articles published in the past year or so, particularly in reference to Austria, seems apt to lead those who may be considering a ski-ing holiday to a belief that a grand opportunity awaits them at a very cheap cost.

Replies received from Switzerland in 1933 led to the reluctant conclusion that a ski-ing project must probably be abandoned on the score of expense. Later a chance acquaintance brought the conversation to ski-ing and his experiences in Austria the previous winter. This finally resulted in arrival, on the 28th December, 1933, at the Hotel Alpenrose, Zurs am Arlberg.

Ski-ing in Austria is undoubtedly cheaper than in Switzerland but nowhere, with the heavy costs of travel added, can it be said to be very cheap.

Having just returned to India it has been suggested that an account of my experiences may be of interest.

As a ski-er I am a novice.

It is to give those, who may also be novices and may be considering such a holiday in Austria, a basis on which to make a fair estimate of costs and to add to the information already available as to where to go and how to get there, what to take with a view to avoiding unnecessary expense and adding to comfort, and what may be better obtained in the country, from the point of view of another novice, that this article has been written, in the hope that my experiences may assist and be of use and interest to others.

The first essential as to where to go and how to get there is a map.

The ski-map of Austria herewith has been prepared from an assortment of Austrian maps purchased at various towns and is intended to illustrate the context by showing the positions of all places named.

From Buchs to Vienna, Austria is studded with ski-ing resorts dotted over the mountain ranges.

Snow conditions are very reliable and ski-ing is in full swing from the middle of December until March and even May in the higher parts.

The majority of English people confine themselves to the Vorarlberg and Tyrol Provinces which lie at the west end of the Austrian Alps, probably on account of their being nearer Home.

The Tyrol forms a narrow strip of land approximately 160 miles long by an average of 40 miles wide.

The chief town, Innsbruck, lies very nearly in the centre; Kitzbühel lies near the north-east boundary. At the western end is St. Anton.

The Tyrol is easily accessible from all parts of Europe. Innsbruck is the point of intersection of the lines London-Paris-Basle-Buchs-Salzburg-Vienna; and Berlin-Munich-Rome.

Venice, almost due south from Innsbruck, *via* the Brenner Pass, is some 300 miles distant; Munich, due north, is but 120 miles.

If travelling from England the cheapest and quickest route is *via* Calais or Boulogne-Laon-Basle.

Leaving Victoria at 11 a.m. Innsbruck is reached at 1 p.m. next day and Kitzbühel at 3.30 p.m. All through trains stop at Bludenz, Langen, St. Anton, Landeck and Jenbach.

By far the most comfortable method is to take the above train from Victoria and travel to Paris, arriving there at 6.10 p.m. and from thence go by the 9.15 p.m. Arlberg-Orient express (*gare de l'est*) by *3rd class sleeper*, a new innovation commenced this last season. Sheets, blankets and pillow; basin with h. and c. and a heater are provided. They run from Paris only, for two months from 20th December, and are taken off at Innsbruck. They run daily during this period, and should be booked well in advance through a Tourist Agency. The train from Calais is joined at Basle—and the time of arrival in Austria is the same by either route.

The return train from Austria leaves Kitzbühel at 3.30 p.m., Innsbruck 5 p.m., Langen 7 p.m. It bifurcates at Basle and the 3rd class sleeper arrives at Paris at 9 a.m. next morning.

Of those going to Austria many go to Kitzbühel for the whole holiday. Others, attracted by the advantages of a cable railway, gravitate there, or to some other similarly endowed resort, later.

Meals on trains are expensive; a luncheon basket, especially with the privacy of a sleeper, can reduce expenses considerably.

Information as to train times, fares, or any other details regarding travel is supplied on application to the Continental Enquiry Office at Victoria Station, the Austrian Federal Railways, Eros House, Piccadilly Circus, and all principal Tourist Agencies—see also Appendix I herewith.

It should be remembered that at Basle watches must be corrected

to Central European time, which differs from English or French time by one hour.

In travelling to Austria direct from India two routes are available, the one *via* the Ports of Italy and Venice to Innsbruck, the other *via* Marseilles and thence either *via* Lyons-Basle, or Paris-Basle.

By a new " P. & O. " arrangement, 1st and 2nd class ticket-holders, either from or to India, but *not* tourist class, who book all the way round *via* the Bay of Biscay, are, on declaring their wish *before* embarkation, issued with a free rail ticket of the equivalent class from Marseilles to London—or *vice versa*.

This valuable and attractive concession is available for one month from date of issue and for those breaking journey in either direction for a ski-ing holiday can be used to Paris or Lyons. Probably, if approached, the P. & O. Company for a small extra payment would issue tickets to London *via* Lyons-Basle-Laon.

Other than by air the time taken from Bombay to Innsbruck *via* " P. & O. " and Marseilles is approximately 14½ days, and *via* Lloyd-Triestino and Venice 11½ days. This assumes no delay in train connections.

The Federal Railway system of Austria is electric throughout and is extremely smooth running.

Local railways extend wherever the terrain admits, and are augmented by cable railways in several places and by many motor and bus services.

One very important item to remember from the point of view of expense is that travel by ordinary train costs exactly half that of travel by mail trains. The extra time taken is of small account for short journeys.

There is no reduction for return rail tickets in Austria. Many keen skiers travel 3rd class there or in Switzerland.

All travellers on Austrian railways, whatever class, are entitled to use the restaurant car.

Currency.

The unit of currency is the Austrian *schilling*, which is divided into 100 *groschen*.

Any amount of any foreign currency may be taken into the country. This should be declared at the frontier and care taken that it is entered in your passport. The same, or smaller amount, may then be taken out of the country on leaving. Without such an entry no more than the equivalent of 500 Austrian *schillings* in foreign currency may be taken out, and in no case, whether entered in the passport or not, may more than 200 Austrian *schillings* in cash be taken.

At 28 Austrian *schillings* to the pound sterling, one Austrian

schilling may be taken as the equivalent of ninepence. Details of prices given herein, with the abbreviation *sch.* for Austrian *schillings* and *gr.* for *groschen*, are on this basis.

It should be noted that the rate given by an exchange bank, which is to be found in all large towns or tourist centres—there is one at Zürs—is about 90 *groschen* per pound sterling more than allowed by an hotel bureau, and quite a saving can be made on even a short stay by taking the trouble to find out and go to the former.

As a general rule hotel bills may be paid in Austrian money, or in any foreign currency, or by cheque.

PASSPORTS.

British subjects do not require a visa for entering Austria, but they must be in possession of a valid passport.

SKI-ING KIT AND EQUIPMENT.

As to provision of kit. Buy a ski-ing suit—and glare-glasses and possibly a ski-cap, with earflaps to let down over the ears in cold windy weather, in England, and *everything else* in Austria—either at Bludenz, if proceeding *via* Basle, or at Innsbruck, if proceeding *via* Venice. If *via* Basle one can get out and complete all purchases in ample time to catch the next train on to reach destination the same night. At Innsbruck one has to change trains in any case. This, however, is not to say that a ski-ing suit purchased in Austria is not just as serviceable as any other.

No novice should buy himself or herself a pair of skis without the advice of an expert ski-er, either a friend, or, if not available, a ski-master who, either with or without a small fee, can always be relied on to take an infinity of trouble to make the best selection.

The fashion in skis has been changed by the Arlberg technique, skis being now shorter and wider than formerly.

It is generally accepted that hickory skis should be used by anyone at all heavy, for a broken ski may mean a broken limb, but hickory is heavy and ash may be preferred on account of the greater lightness of the wood. Steel or brass or composition edges can be added to choice later. Bindings made of duralumin greatly help to lighten the weight.

The price at Zürs of the best hickory skis of average length was 95 *sch.* inclusive of the most modern bindings. Very long skis are slightly more expensive.

Ash skis with ordinary strap bindings cost at Zürs 40 *sch.*

At Innsbruck good hickory skis are available at 20 to 30 *sch.* according to length. Ash skis about 3/5th that price—modern up-to-date bindings about 25 *sch.*

For sticks and their correct length trust your expert but remember that sticks too long can always be cut—prices at Zürs 8 to 20 *sch.*

The hire of skis and sticks at Zürs is 1·50 *sch.* per day for ash or short skis and 2 to 2·50 *sch.* for good hickory skis or those of extra length. At Innsbruck, Kitzbühel or St. Anton the very best skis with perfect bindings can be hired at the rate of 1 *sch.* per diem which is also the normal rate of hire at nearly all other places. Nowhere is there any reduction for hiring for longer periods than one day, and when hiring a deposit of 20–25 *sch.* has to be made. Therefore if your stay is to be over three weeks or if further visits are anticipated in future years it pays to purchase your skis rather than hire. Purchase should be anticipated and made before arrival at an expensive hill resort. For anyone proceeding direct from India and taking up ski-ing for the first time, Bludenz, Innsbruck or Kitzbühel would be the cheapest places at which to buy.

" Skins " are a necessity whether under instruction or on tour.

The cheap strap and buckle variety of skin should be avoided and care taken that they are provided with a patent fastener which stretches the skin to a sufficient tautness on the ski. The novice should remember that skins loosely put on cause endless worry to the ski-er, require frequent adjustment—are extremely tiring to use, and worst of all, when with a party, delay the other members.

All those about to take up ski-ing should know that thick " ski " socks are worn over the ordinary sock or stocking inside the boot.

The greatest care should be taken to see that the boots are large enough to take both pairs of socks easily. The boot should pull on comfortably. If too tight boots are worn the inevitable result will be frost-bite.

A very excellent boot called the " Arlberg boot," with steel strengtheners let into the leather on either side of the instep to prevent buckling, is available at Bludenz at a small shop near the railway station—price 65 *sch.* or without the steel pieces 45 *sch.* Both kinds can also be purchased elsewhere.

Glare-glasses are very necessary as a safeguard against snow-blindness when climbing on tour. Woolworths' sixpenny glare-glasses are light, and comfortable to wear, and, in the case of a fall, safer to the eyes than the more expensive article.

Two pairs of gloves are required, one woollen, the other waterproof with suitable lining. If rubber is chosen for the latter the inner side of the fingers and the palms of the hands should be covered with leather—but this makes them somewhat heavy and for this reason a glove made of thickly woven waterproofed canvas is preferable. Many novices used cheap string gloves, which must have been an agony to wear when wet and cold and are most unsuitable.

Men should be particularly careful not to forget to take tennis shirts with collar attached, which can then be worn open at the neck.

Two vests, one thin gauze or cotton, and the other to choice, are much better than a single garment of a heavy material.

Long drawers are too warm except at very high altitudes.

A cap with earflaps to let down over the ears in cold windy weather is an essential.

The blue ski cap supplied by many English firms looks well but is heavy on the head.

Austria provides a variety of head-gear at reasonable cost.

A rucksack is another necessity. For use on the daily lesson or on tour a small one will suffice. Special care should be taken that it is as light as possible and of the triangular pattern in which the armhole straps are held on the same string which, running through eyelets, ties the whole together at the top. The most suitable are obtainable in Switzerland or Austria at the equivalent of a few shillings.

For expeditions, larger and more elaborate rucksacks are required costing up to twice the above.

The definition of a " tour " is when the party returns to the hotel or other regular abode before nightfall, and of an " expedition " when the party remains away one or more nights.

DOMESTIC COMFORT.

All hotels, *pensions*, "*gasthäuser*," and most private houses in which visitors would be likely to stay, are fitted with central heating. In hotels the public rooms are usually stuffy and oppressive but bedrooms are kept at a reasonable temperature which can be adjusted by the regulator and an open window.

Electric light is universal and good.

The majority of hotels, and many *pensions*, have basins with running hot and cold water fitted in the bedrooms, such rooms being more expensive than those without. This is not usual in *gasthäuser*, but may often be found in private apartments.

A bath towel of one's own will be found extremely useful.

As bedsheets are usually not wide enough, take one of your own and also two blankets or rugs and a thin under blanket—all of which can be fitted in the holdall without adding to chargeable weight.

Photography is an expensive item, the charges at Kitzbühel being much the same as in England, but at Zürs about 30 per cent. more for developing and 50 per cent. for printing. The work is generally very well and carefully done.

Films are available everywhere—expensive in the higher or more remote ski-ing resorts but normal prices elsewhere.

Anyone wishing to play cards should not omit to take playing

cards with them—for in Austria they cost 7 *sch.* (*i.e.*, over five English shillings) per pack.

English tobacco and cigarettes, except in the large towns, are generally very difficult to obtain, are expensive and not the desired brand. Austrian cigars and cigarettes are not pleasing to English taste, so take your own, and, if a pipe smoker, take pipe cleaners.

Both playing cards and tobacco must be declared to the customs, but reasonable quantities are allowed free.

Food throughout is good. For all meals taken in bedrooms 20 per cent. is usually added to the ordinary cost. Cold lunch to be taken out is provided everywhere without extra charge. The water is excellent and can be drunk everywhere with perfect safety.

The universal minimum charge for afternoon tea at hotels, *gasthäuser*, restaurants, cafés or elsewhere was 1·80 *sch.* per person. So that it pays many times over to take English tea and a spirit stove with you; if the latter is thought too much trouble, arrangements can usually be made with someone in the village to provide boiling water.

Expenses.

As it may perhaps be of use to others, I give below an abstract cost in £ s. d. of exactly one month's holiday from England and return for two; for I was accompanied by my son, aged 10½ years. Children over 10 cost the same as a grown-up, so there was no reduction on that account.

So far as the object—ski-ing—went, we had everything we wanted and the holiday was an unqualified success.

Travel and living expenses—two persons for one month, Dover-Zürs-Kitzbühel-Folkestone *via* Paris.

Board and lodging inclusive of baths and laundry for a stay of exactly three weeks at Zürs worked out at £5 per week per person and for Kitzbühel at £4 10s. For dancing add about 4 *sch.* per person per evening, inclusive of drinks and incidental expenses.

The abstract of expenditure given shows some items which possibly others can do without but, if so, they will be certain to be replaced by others. Inclusive of afternoon tea and drinks, ski-ing instruction, and all other charges, the cost per person at Zürs came to £7 per week. Zürs is more expensive than other places. Five guineas a week "all-in" should be sufficient in smaller resorts, but where a cable railway exists the difference will soon be made up.

A reduction of from 25 to 30 shillings a week can be made on the above by living in apartments, where available.

Practically all ski-ing resorts in the Tyrol have a doctor of some kind, but broken bones necessitate a journey to Innsbruck or Kitzbühel to ensure their being properly set.

	£	s.	d.
2 return tickets Dover–Langen 2nd class* to Paris and thence 3rd class sleeper	26	2	6
Sleeping-car attendant (both ways)	0	8	0
2 supplements 1st class across Channel	0	10	0
Outward: Taxis, Porters, and registration skis	1	2	6
Outward: Food on journey (dinner at Paris)	1	10	0
Outward: Sledge—Langen to Zürs	0	13	6
Board and lodging, Zürs, 28/12 to 17/1 at 18·50 *sch.* per person per diem, inclusive of tax, and service	27	15	0
Afternoon tea and drinks, same period	3	12	6
Ski-ing instruction at Zürs	2	10	0
One pair ash skis with sticks	1	12	0
Occasional hire of skis and skins	1	15	0
Baths and laundry	1	13	0
Photography, stamps, picture postcards	2	3	0
Sundries	1	0	0
Transfer Zürs to Kitzbühel—sledge	0	9	6
Two 3rd class rail tickets Langen–Kitz	1	0	0
Porters and motor-car to hotel—Kitz	0	6	6
Board and lodging, Kitzbühel, 18/1 to 24/1 at 16·50 per diem including daily bath, tax, and service	7	5	0
Afternoon tea and drinks—same period	0	18	6
Photography and picture postcards	0	6	6
5 days cable railway (1 run each per day)	2	10	0
Homeward: Porterage Hotel to Kitzbühel R.S.	0	4	6
Homeward: Rail fare 3rd class to Langen	1	0	0
Homeward: Taxis—Porters and registration—skis	1	6	0
Homeward: Food on journey (including day at Innsbruck)	1	15	0
Total	£89	8	0

INDIVIDUAL SKI-ING RESORTS.

Space forbids mention of all the places marked on the map of which notes have been made either from a personal visit and observation or from those residents or visitors who have had first-hand knowledge of them.

I have therefore confined myself to remarks on the more important.

A list of hotels, *pensions* and *gasthäuser* and their *en pension* charges at the various resorts named is given in Appendix II. The daily rates quoted are exclusive of 10 per cent. for service, visitors' tax,

* At exchange rates of December, 1933.

which varies from 30 *gr.* to 1 *sch.* per day and is usually included by hotels when giving terms, and baths.

In all cases afternoon tea is extra.

When occupying apartments the charges include morning rolls and coffee and arrangements can be made to include baths also. Lunch and dinner, for which separate arrangements must be made at hotels or *gasthäuser*, cost together from 7 to 9 *sch.* per day.

The list names only a few hotels and is to give intending ski-ers somewhere to go to start with.

Further information, if desired, as to these or other individual places can be obtained from the London Office of the Austrian Federal Railways in Piccadilly Circus.

The Arlberg.

The Arlberg District is the name given to the mountainous tract which, running north and south, divides Vorarlberg from the Tyrol. The Arlberg itself is a high Alpine pass beneath which, on the main line between Buchs and Innsbruck, runs the Arlberg tunnel, six miles in length, the most eastern of the five great tunnels through the Alps.

Zürs (5,642 feet).

The station for Zürs is Langen, situated at the west end of the Arlberg tunnel.

The distance from Langen to Zürs is 4½ miles. Zürs is reached in two hours by sledge. The charge for the sledge, which takes two persons and their baggage, is 18 *sch.* for the upward and 12 *sch.* for the downward journey.

At the top of the "Flexenstrasse" pass (5,798 feet), the Zürs valley, well over a mile in length by about half a mile wide, suddenly opens out to view. And the view to the novice, when the season is in full swing is surprising; for the slopes from one end of the valley to the other are covered by row after row, each of some dozen or more people lined up under instruction, totalling four or five hundred persons.

The hotels at Zürs are the Alpenrose, Lorunser, Flezen and Edelweiss, recommended in that order. Practically no other accommodation is available.

The Alpenrose is undoubtedly the best hotel, and has accommodation for 240 people in 165 bedrooms. Other hotels can accommodate about 250 between them.

Zürs possesses two great attractions. The one, which many may

consider an unnecessary adjunct but which undoubtedly adds considerably to the gaiety and enjoyment of the young, is the Dance Band. It is the most original, entertaining, imaginative and lively band possible and, if transported to London, could not help making a fortune.

The other attraction at Zürs, now world-famed, is the Schneider ski-school, an offshoot of the Hannes-Schneider school at St. Anton, run by Schneider's brother Frederick.

There is yet a third brother. All are perfect masters of the ski.

There are ten classes of instruction, from the most advanced to the lowest.

Each class is further sub-divided into groups with English, French or German speaking instructors according to the numbers attending.

Each period of instruction lasts two hours, viz., from 10 to 12 in the mornings and from 2 to 4 in the afternoons.

The trouble taken and the patience displayed by each and every instructor is amazing.

Newcomers are tested and placed in class accordingly. Herr Frederick Schneider himself visits each class daily and on test passes pupils from one class to the next.

The two senior classes spend a great deal of the time on tour under advanced instruction and are also given *slalom* practice. Other of the less junior classes are taken out on tour according to progress.

The charges for instruction are moderate. Each lesson costs 2·50 *sch.* Books of 12 tickets can be bought from various notified places for 30 *sch.* and one ticket is handed to the instructor at the end of each lesson.

Short tours by class are paid for in a similar way by ticket—if an all-day tour two tickets are given up.

It is not incumbent on those under instruction to attend every class, but for the best progress it is advisable to attend five or six a week.

Private tours organized in parties with a guide in attendance are somewhat expensive, the minimum number of persons in the party for which a guide will be spared from his normal instructional duties being eight at six *sch.* each, or, if less than eight persons, a minimum charge of 48 *sch.*

The fee for a privately hired instructor over a period, when available, is 25 *sch.* per diem and he may not take more than four people on tour or expedition.

The Zürs valley is enclosed by high mountains with steep slopes on both sides and is primarily suited to schooling. There are half a dozen short tours requiring one to two hours' climbing well suited to the novice, while for the more experienced there are others more difficult and of longer duration.

Lech (4,747 feet).

Four miles farther north down the valley from Zürs.

The practice slopes are not extensive and being situated along the river of the same name, more climbing is required for tours than if a higher resort is selected.

Oberlech (5,540 feet).

Oberlech is reached by horse sledge from Langen in 3½ hours—charge 27 *sch.* with an additional charge of 4 *sch.* for luggage, which goes up the 800 feet from Lech on a ropeway.

The Goldenerberg Hotel can put up 50 people.

The ski-ing grounds are truly wonderful and give great scope for variety over an area some two miles across.

Any ski-er can climb anywhere in this area up to 2,000 feet above the hotel in perfect safety without a guide and on the return journey finish with a *christi* outside the hotel door, a convenience pertaining to very few places.

The Goldenerberg ski-ing area, being well up on the south and east slopes of the Mohnenflüh (8,356 feet), catches every ray of sunshine from dawn to dusk. It is a beautiful setting and well worth a visit. There is excellent instruction at the same charges as at Zürs. The chief instructor, Harrer, is one of the champion ski-racers of Austria.

At the time of my visit there were very few English people at the hotel and any such contemplating a stay would be well advised to go in a party of eight or ten, for whom all hotel managers throughout Austria are prepared to accept reduced terms. There is no dancing.

St. Anton (4,278 feet).

Retracing our steps southwards we come to St. Anton, the headquarters of the famous Hannes-Schneider Ski-School, situated at the eastern end of the Arlberg Tunnel.

The Hotel Post is the chief hotel, comfortable and rather expensive.

There are of course other and cheaper places at which to live.

As regards the ski-school, all that has been said of the Schneider School at Zürs also applies here.

Though good tours, demanding varying grades of skill, are available, St. Anton is essentially a centre of instruction. But the practice slopes are poor compared with other places, *e.g.*, Zürs and Oberlech, and the elevation being low, snow is not always assured, at any rate before the end of January. Frequently it is necessary to go up to St. Christoph, three miles distant either by motor bus or motor sleigh, which adds considerably to the expense. Personally I do not recommend it.

ST. CHRISTOPH (5,900 FEET).

Is worth a visit for a day or two but is not worth a prolonged stay.

GALTUR (4,249 FEET).

To reach Galtur, one must disembark either at Landeck, if by mail, or at Wiesberg, if travelling by slow train.

Thence either by private or post motor-car or by horse sledge, the latter taking 2½ hours, over a distance of just under 20 miles.

I am told that though Galtur is a fine halting place for a few days on the way through to Switzerland, yet the slopes generally are rather too steep for the average beginner.

SERFAUS (4,682 FEET).

Serfaus is also reached from Landeck, about 12 miles by bus to Tschuppach on the Upper Inn, where one changes to a horse sledge and so up the hill, total journey about two hours; cost: bus 6 *sch.*, sledge 8 *sch.*—total, 14 *sch.*

Places at which to stay are the *gasthof* Schwarzer Adler or Alpen *gasthof* Furgler; there are others, or apartments if preferred. But that specially recommended by a friend, after many visits, is Kölner *Haus* at Komperdell (6,500 feet), 1½ hours farther up the hill past the main village, which can take some 70 people.

Instruction is, as elsewhere, by state certificated ski-trainers and guides.

There are some 30 different tours, for the longer of which huts are provided at all convenient sites *en route*.

Serfaus, enjoying all the available hours of sunshine, is a virtual ski-ers' paradise, and is given up to that pursuit only; there is no skating.

Though fairly easy to reach it is not yet so well known or so well developed as some other places, and is consequently considerably cheaper. There is no dancing, and dinner jackets are unnecessary.

OBER GURGL (6,332 FEET).

Some 16 miles nearer to Innsbruck from Landeck is Otztal station (slow train for which change from mail at Landeck or start from Innsbruck), from where a comfortable motor bus service takes one south up the beautiful Otz valley 25 miles to the end of the motor road at Zwieselstein (comfortable hotel). From here the road branches to Ober Gurgl (6,332) and Vent (5,700).

The bus journey occupies two hours, and on to Ober Gurgl by sleigh another two hours.

Ober Gurgl is the highest village with a church in Europe. It is situated in a beautiful open valley surrounded by the glaciers and

peaks of the Otztal Alps, the highest in Austria. The valley is higher than the famous Engadine of Switzerland and is considered by many to surpass it in beauty and grandeur.

It is the ski-er's paradise, with extensive nursery slopes, numerous tours taking the beginner to "cols" and peaks from which he can look down on the Italian Dolomites and feel that he is on the roof of the world. For the experienced ski-er the terrain is the finest in Europe. Snow is certain from the middle of November until May.

There are two very good hotels, Hotel Edelweiss and Hotel Gurgl, and three or four *gasthäuser*. The Gurgl ski club has produced some of the finest international ski-runners, and there is an excellent ski-school. Complete ski-ing outfit including skis and clothes can be purchased in Ober Gurgl. Ober Gurgl is cheaper than other Austrian resorts owing to its distance from the nearest railway station.

The German and Austrian Alpine Club have provided in the Otztal Alps a number of "glacier hotels." Some of these ski-huts in addition to the usual dormitories have over thirty single rooms complete with feather beds and all conveniences. They provide excellent meals. The Karlsruhe hut, the Samoar hut, the Hochjoch Hospiz, the Similaun hut, the Brandenburg hut are some of these glacier hotels situated in gorgeous scenery from which innumerable peaks can be ascended by the ski-er of quite medium experience. A tour from Ober Gurgl to these glacier hotels is something to dream about, and one need not park one's skis until the end of June.

Vent is a village in a deep valley surrounded by steep mountains. It is far from ideal as a ski-ing resort and is used chiefly as a halting place on the way to the "glacier hotels" beyond. There is a good hotel and several *gasthäuser*.

KUHTAI (6,000 FEET).

Kematen is the station for Kuhtai; three-quarters of an hour by motor from there to Gries in the Sellrain valley, from whence the walk to Kuhtai, in winter an easy ascent on skis, takes about $3\frac{1}{2}$ hours, or can be done by horse sledge if preferred, cost 20 *sch.* including baggage. If arriving by mail train to Innsbruck the journey by road motor to Gries takes $1\frac{1}{4}$ hours, cost about 20 *sch.* according to fortune; or by motor bus which will take oneself and one's kit at a quarter the cost. To go by road from Innsbruck, however, may necessitate a halt there for a night.

If desired, luggage for Kuhtai can be booked in advance to the Hotel Grieberhof, Gries, Sellrain.

At Kuhtai, situated between the Otz and Sellrain valleys, there is only the one *gasthaus*, a converted hunting-box, the Alpen *gasthaus*, Kuhtai, standing alone on the Pass. There is a post office, a ski workshop, and a ski-school (Arlberg method) with its attendant

instructors and guides. In case of accidents—actual illness is rare amongst ski-ers—Innsbruck is close at hand.

No dancing, and dinner jackets are seldom seen.

Kuhtai offers good snow, long hours of sunshine, and is easy to reach. It is cheap.

Though there are the Hocheder (9,177 feet), Birchkogl (9,288 feet) and Zwolferkogl (9,820 feet) to climb, yet the expert may eventually feel somewhat confined and require longer tours.

But for the beginner who is prepared to climb for his fun it would be difficult to surpass it.

INNSBRUCK (1,890 FEET).

Innsbruck is the centre for Tyrolese ski-ing resorts. Its setting, with the great Nordkette range towering above the city, is at once beautiful and arresting.

Daily ski tours in many directions can be done from Innsbruck if desired, but distances are far, time short and conveyances expensive.

Innsbruck has the second largest skating rink in Austria and provides all manner of amusements. Winter sports events, ski-joring, a bob-run, theatre, cinemas, concerts and dancing; but if you go to Austria to ski don't remain in Innsbruck.

GERLOS (4,504 FEET).

Eastwards from Innsbruck in three-quarters of an hour by slow train we reach Jenbach. From here a toy train takes one in three hours to Zell-am-Ziller due south and thence due east, a four-hour journey by horse sledge to Gerlos—third class rail fare about 4 *sch.* and sledge 15 *sch.* Total distance, Innsbruck to Gerlos—50 miles.

Hotels are the *Gasthäuser*, Gaspingerhof, the Oberwirth, the Alpenrose, or the Kroller.

The best thing to do is to stay a night in an hotel—obtain a list of apartments available and make your selection for bed and breakfast; thereafter dine at the Alpenrose, where the food is better.

Though low, Gerlos, due to something to do with its position, is always assured of snow—and has long hours of sunshine.

There is a post and telegraph office, chemist and ski-school.

The nursery slopes are good and the neighbourhood provides some marvellous ski tours, many of which can be tackled by the less advanced, though the return, as one reaches the village, is always through a wood and somewhat difficult. Gerlos is one of the cheaper places, quite suitable for a beginner and thoroughly to be recommended—no cable railway, no dancing and no frills—just ski-ing.

KITZBÜHEL (2,640 FEET).

An extremely picturesque Tyrolese town some 700 years old, Kitzbühel lies in a broad valley about the centre of the northern confines of the Kitzbühler Alps.

Contrary to popular imagination there are high Alps reaching up to 6,000 feet and more on all sides.

The climate is mild and extremely healthy. The snow conditions are exceptional and for some reason unexplained Kitzbühel has snow before other places of greater elevation.

The scenery is superb.

There are many hotels, *gasthäuser*, *pensions* and apartments. The Hotel Weisses Rossel, Hotel Pension Therèse, Hotel Reich, and the Pension Villa Licht are all to be recommended.

The two first named hotels are conveniently situated near the centre of the town, a few minutes' walk from the practice slopes, to which the last named is close.

The Hotel Reich is in the main street and is where many of the younger generation assemble for the daily tea dance on completion of their ski-ing exertions; it specializes as a café, of which there are also others.

Details of the cheaper *pensions*, *gasthäuser*, and apartments can be obtained from the *Reisebureau* in the main street.

If such accommodation be required the best course is to spend a night or more in one of the above hotels while searching for what is required and then transfer when found.

Kitzbühel possesses a hospital and an X-ray institute. There are doctors and dentists, chemists and hairdressers, and all the usual shops pertaining to a large town. The shops are good, and prices moderate. There is, of course, a ski-school which, as at all other resorts, provides first-class instructors. As elsewhere the hours of instruction are from 10 to 12 and 2 to 4, *i.e.*, two lessons per day at 2·50 *sch.* per lesson. The Arlberg method is taught throughout.

The practice (or nursery) slopes are on the south side of the town and are good, roomy and wide.

There are over 50 different ski-runs round about of all degrees of length and steepness.

If one wishes to ski cheaply, the slopes of the Kitzbühler Horn (6,555 feet), and the Korstein (6,309 feet), on the north provide ample choice for numerous expeditions, tours and daily runs including short climbs which can be done in an afternoon as well as all-day excursions.

Several of these tours bring the ski-er straight back into Kitzbühel, whilst for those which take him farther afield, the St. Johann-Kitzbühel section of the railway provides an easy return journey.

For these latter it would probably be advantageous, and undoubtedly cheaper, to move out of Kitzbühel to a previously selected *gasthaus* at some village along the railway, *e.g.*, Griesenau, Hoglern or Steinbach.

But the crowning convenience of Kitzbühel for those who like to have their climbing done for them is its cable railway (the station is just next the practice slopes), which takes them up to the Hahnenkamm (5,550 feet), a prominent and precipitous ridge on the south side of the town, so called from its resemblance to a cockscomb when illuminated by the first rays of the rising sun.

From this point the ski-er can travel due south on more or less level ground to the Ehrenbachhöhe (5,922 feet), Pengelstein (6,365 feet), (one hour's further climb), Steinberg-Kegel (6,467 feet) (three hours) and Kleiner Rettenstein (7,274 feet) yet farther on again, from all of which wonderful runs are available—on the east down to a convenient valley and the village of Jochberg (2,986 feet) (among other terminations), whence motor buses run back to Kitzbühel, or on the west to yet another convenient valley and a similar service of motor buses.

The bus fares vary according to distance, but the average may be taken at 80 *gr.* per person.

The most popular runs for the novice, probably due to their being easier and lying full in the afternoon sun, are the Fleck, Ochsen, Kaiser, and Brunn Alps, all of which lead down into the town of Kirchberg (2,800 feet) to the north-west in the above-mentioned valley.

In addition to a bus service, Kirchberg is also served by a shuttle train service at half-hour intervals—fare 50 *gr.*, which is quicker and more comfortable than the bus.

Except at the highest points of the main peaks, all the 50 or more ski-runs are over safe ground and are devoid of danger from avalanches.

There are restaurants and huts at various convenient points all over the area, where the ski-er can consume the contents of his nosebag or have a meal made ready and wash it down with the product of the local brewery or other beverage.

The cable car carries 14 people and their skis and the rate of transport at full pressure averages one person per minute, so that it behoves one to be in time. If not, a wait of two hours in a queue is not uncommon.

The first car starts up at 9 a.m. daily. The fare is 6·50 *sch.* for a single ticket, or an *abonnement* containing ten tickets, which are not transferable, for 50 *sch.*

Including the fare up, a drink at lunch, and the return fare by bus or shuttle train, the cost per run is the equivalent of five English shillings.

Those not using the cable railway can climb to the top in about three hours from the practice slopes.

In 1929 a fine ski-jump was constructed where international and other ski-jumping contests take place from time to time.

The skating rink is sufficiently large and the ice well kept. A good skating instructor is available and exhibitions are arranged at intervals, but the main interest is ski-ing.

Tobogganing, sleighing and ski-joring are also available.

Those who wish can dance at one or other of the larger hotels on most evenings. Fancy dress balls are held at frequent intervals.

The devotee of bridge will find ample opportunity for play.

Conclusion.

The Arlberg ski-ing technique prevails throughout Austria. Excellent ski-instructors are immediately available at all resorts. The charges already stated are practically universal and are cheap for what one receives in return.

To the smaller and less known places it is best to go in a party, as otherwise there is not much to do in the evenings, which draw in so quickly in the winter months. By writing in advance considerable reductions can be obtained from all hotels for parties of six or more —the larger the party the greater the reduction—for a minimum stay of three or more weeks. There is an off-season from the 4th to 24th January, when reductions are made to all, whether singly or in parties, who stay a full three weeks during that period—this off-season is said to be due to a lull between the Christmas holidays and the period when the snow begins to be at its best.

The best time for all winter sports is from the beginning of February until the end of March, though most places are sure of snow before Christmas. Ski-ing can be continued into the middle of May at the higher elevations.

Keen ski-ers, whether novice or expert, would do well to provide themselves as soon as possible with a copy of the local ski-map.

The days on tour are those best remembered and the harder the climb or the run down, and the greater the exertion, the greater the pleasure in reflection. Thus the great ambition of the novice should be to learn quickly—break away from instruction and get out on tour as soon as possible. But, though it may be fun, just to fall down the hills anyhow is of no value. So pay attention to the teaching and work hard. On the other hand, take it quietly and do not overdo it to start with. Except possibly once or twice a week, two lessons a day is too strenuous. Five or six lessons a week is sufficient and are usually best taken in the mornings, allowing time for practice in the afternoons. Everywhere the instruction is rather too accurate and meticulous and with the object of qualifying himself to be fit to go

out on tour the novice should learn to " christi " as soon as he can reasonably do so—bearing in mind it does not pay to learn to run before one can walk. One golden rule always to be observed on tour is to follow one's guide accurately. Failure to do so may result in the demise of the offender over a precipice.

All over Austria there is danger from avalanches after new snow —a good deal more so than in Switzerland. But warning notices are always posted in good time by those responsible.

To him who has never skied in Austria before, I would say, go to Zürs for 10 or 14 days to begin with. He can be sure of snow from mid-December onwards—and there are slopes for all of every possible steepness. Zürs is, I think, the best of all for schooling, due in part to Herr Frederick Schneider and the better discipline, but also because the large numbers make for competition and more regular attendance at lessons than other places.

Zürs is a real centre of instruction and invaluable as giving the novice a true perspective and an idea of what he has to learn, but elsewhere the instruction is every bit as good by men just as well qualified to teach. So if he prefers to do so the novice can go elsewhere, either straight away or later after an initiation as above.

Having completed some initial instruction at Zürs, a transfer to Oberlech is very easy and inexpensive and well worth going on to for a week or more. Later, if time permits, a transfer to one of the three places named below increases one's experience and knowledge of the country.

The novice who prefers to start elsewhere than at Zürs or those who already have some knowledge of the art, should go to Serfaus (Komperdell), Kuhtai, or Gerlos and stay there, or at some other resort where there is no cable railway, until they feel they've done enough climbing.

Then go to Kitzbühel for the finish of the holiday and enjoy its advantages.

Some small knowledge of German is almost essential in the smaller hotels and *gasthäuser*.

APPENDIX I.

TABLE OF TRAIN FARES.

(At Exchange rates existing in February, 1934.)

2ND CLASS FARES, LONDON TO SWITZERLAND :—

Wengen ; single £5-15-2 ; return £10-11-6 ; sleeper £2-19-4 each way.

Davos ; single £7-7-0 ; return £12-12-9 ; sleeper £4-3-9 each way.

St. Cergue ; single £5-19-10 ; return £10-6-4 ; sleeper £3-4-7 each way.

Return tickets are available for 45 days.

2ND CLASS FARES, LONDON TO AUSTRIA :—

Via Calais—Laon—Basle—Buchs :—

St. Anton ; single £7-17-11 ; return £13-18-5.

Innsbruck, Kitzbühel, Zell-am-See, Salzburg ; single £7-19-11 ; return £14-15-7.

Vienna ; single £10-12-1 ; return £19-19-0.

Fares *via* other routes are slightly less.

The Southampton-Havre route is useful for those living in the West of England.

Through 2nd class sleepers Calais-Basle-Innsbruck run on Mondays, Wednesdays and Fridays—cost per berth £2-18-5 each way.

1st class fares are 33⅓ per cent. more than the above.

2nd class in France and 3rd class onwards can be combined.

Via Calais—Paris—Basle :—

Innsbruck ; Kitzbühel ; 2nd class to Paris and thence by 3rd class sleeper ; single £8-7-6 ; return £15-10-1.

The 3rd class fare, with second on steamer—Dover—Ostend—Munich—Innsbruck is : single £5-8-1 ; return £10-16-2.

Return tickets are available for 60 days *via* Ostend, 45 days *via* Calais—Basle, and 30 days *via* Paris.

Children between 4 and 10 years travel at half-fare ; if over 10 the full fare is charged.

2ND CLASS FARE, VENICE TO AUSTRIA :—

Innsbruck ; single £2-18-0 ; return £3-14-0, but this return concession is only granted after spending six days in Italy. The journey is *via* Verona and takes 11 hours.

2ND CLASS FARE, MARSEILLES TO AUSTRIA :—

Innsbruck, *via* Lyons—Basle ; single £7-7-0. The reduction on a return ticket is small and bounded by various troublesome conditions. The journey takes 21 hours.

RETURN STEAMSHIP FARES FROM AND TO BOMBAY FOR 1934 ARE :—

Via P. & O.—to Marseilles—1st class (off-season, any grade), £95-0-0 ; 2nd class, £65-0-0.

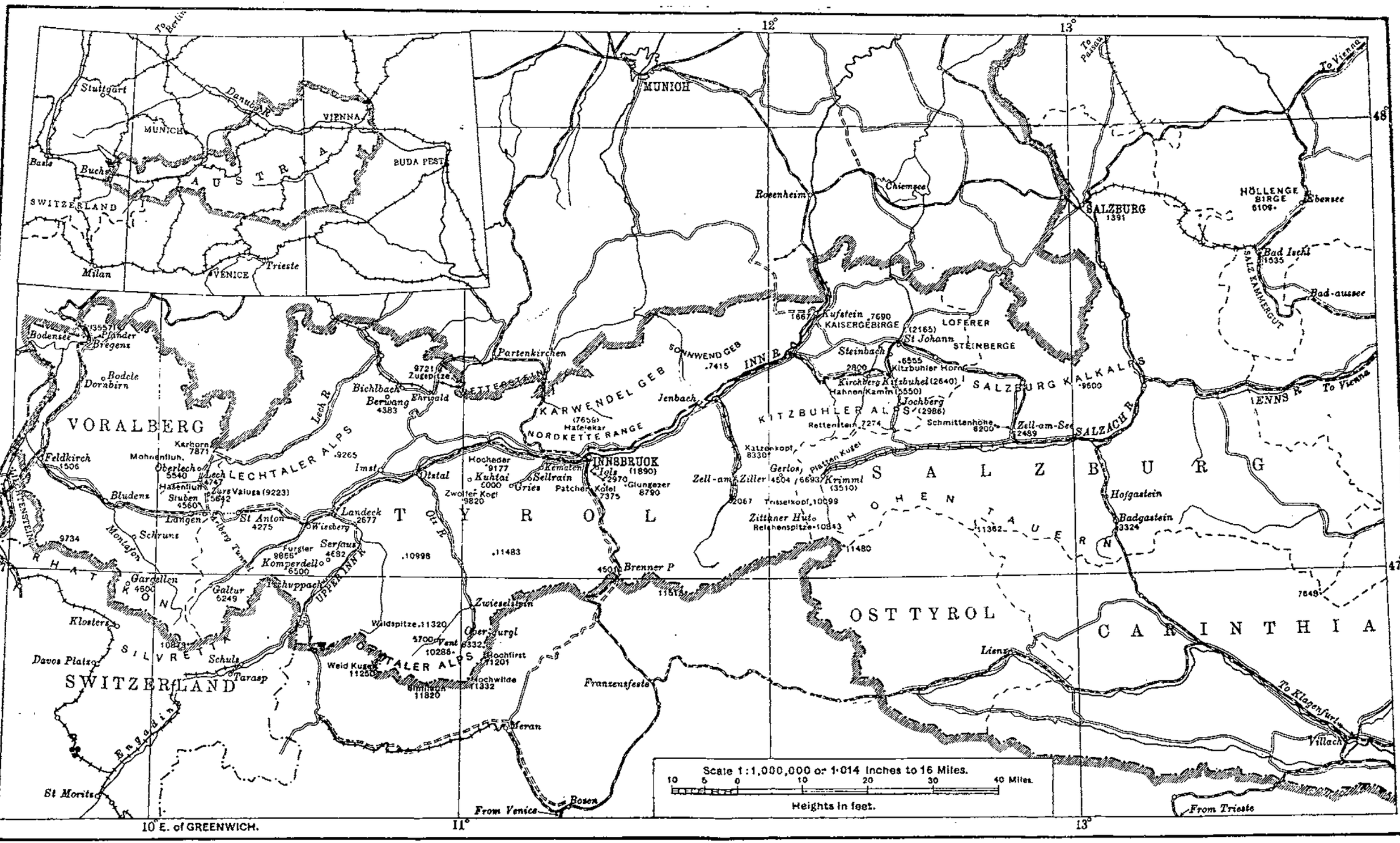
Via Lloyd—Triestino—to Venice—1st class, £86-0-0 ; 2nd class, £65-0-0.

APPENDIX II.

LIST OF HOTELS.

Name of Skiing Resort.	Name of Hotel, *Pension* or *Gasthaus*.	Daily charges *en pension* per person.	Whether with fitted h. & c. in bedrooms	Remarks.
		Schillings.		
Berwang ...	Hotel Singer	10—15	Yes	
Galtur ...	Hotel Alpenhaus Fluthorn	15—18	Yes	Several apartments 2·50 to 4 *sch.* per day.
	Gasthof Zeinisjoch	12—14	No	
Gargellen	Hotel Vergalden	17—20	Yes	
Gerlos ...	*Gasthaus* Gaspingerhof	10—12	No	Numerous apartments 1·50 to 2·50 *sch.* per day.
	„ Oberwirth „ Alpenrose „ Kroller	7—8	No	
Innsbruck	Hotel Europa „ Tyrol	18—27	Yes	
Kitzbühel	Hotel Weisses Rossel	13—18		Baths, 1·50 *sch.* or daily 10 *sch.* per week.
	„ Pension Therèse	14—17	Yes	
	„ Reich	14—18		
	Pension Villa Licht	12—16		Many apartments available, 2·50 to 4 *sch.* per day.
	Grand Hotel	23—27		
	Cheaper *Gasthäuser* and *Pensions.*	9—13	No	Details from *Reisebureau.*
Kuhtai ...	*Gasthof* Alpengasthaus	9—10 (Nov.-Jan.) 10—12 (Feb.-April)	h. & c. in corridors	Baths, 2 *sch.*
Lech ...	Hotel Krone	12·50—14	No	Rooms in private houses 3 to 5 *sch.* per day.
Ober-Gurgl	Hotel Gurgl	13	Yes	
	„ Edelweiss	12		
Ober-lech	Goldenerberg Hotel	16 (12 in Annexe)	Yes	
St. Anton	Hotel Post	18·50—27	Lower charges without h. & c.	Add 2 *sch.* per day for heating.
	Gasthof Alpenrose	16—25		Daily bath, 15 *sch.* per week.
				Private lodgings 4 to 6 *sch.* per day.
St. Christoph	*Gasthof* "Hospiz"	17—19	Yes	
Serfaus ...	*Gasthof* Schwarzer Adler; Alpengasth of Furgler	7—9	No	Apartments 2 to 3·50 *sch.* per day.
Serfaus ... (Komperdell)	Kolner *Häus*	9—14	h. & c. in corridors	
Stuben ...	*Gasthof Post*	10—12	No	
Vent ...	Hotel Vent	9—15	Yes	
Zell-am-See	Sporthotel Debzelter	10—17		Apartments also available.
	Hotel Excelsior			
	Cheaper *gasthäuser*	8—14	No	
Zürs ...	Hotel Alpenrose	18—22	Lower charges are without h. & c.	Baths, 3 *sch.* daily or 17·50 *sch.* per week.
	„ Lorunser			
	„ Flexen	15—21		There is no private accommodation.
	„ Edelweiss			

MAP TO ILLUSTRATE SKIING RESORTS IN THE TYROL AND ADJOINING PROVINCES.



PROFESSIONAL NOTE.

THE LYDD MILITARY RAILWAY.

AN article entitled "The Lydd (Kent) Military Railway and its Locomotives," by O. J. Morris, appeared in *The Locomotive* of August 15th, 1934.

This railway, six miles in length and running between Lydd Station and the Camp, was built in 1883 and finally went out of existence shortly after the war, when the R.A. Gunnery Establishment at Lydd was closed down and a battalion of the Royal Tank Corps stationed there instead. The track was taken up in 1926 and 1927 with the exception of a stretch one-and-a-half miles in length, which is still in existence between the Royal Engineer Office and the sea wall. The only other surviving link with the past is the locomotive *Betty*, which now leads an active life on the Tidworth Camp Railway.

Mr. Morris gives interesting details of the various locomotives which ran on the Lydd Railway during its forty years of existence. The first two had an unusual career, for they were built originally for the Sudan and bore the inscription "Suakin and Berber Railway" on the sides of their saddle tanks. They were despatched to the Sudan for use on a railway, the building of which commenced shortly after the advance of an expeditionary force following the fall of Khartoum. In 1885, however, owing to the fear of trouble on the Indian frontier, British troops were withdrawn from the Sudan, the unfinished railway was abandoned and the two locomotives made the long journey back to England.

In 1906 and 1907, they were replaced on the Lydd Railway by new engines bearing the names of two famous Sappers, *Napier* and *Nicholson*. These locomotives gave good service for ten years, and were eventually replaced during the war by the *Trafford* and the *Betty* mentioned above.

The railway is now no more, but Mr. Morris has been at pains to collect a great deal of information about it and his article gives an historical record which will be of considerable interest to future generations of Sapper officers, particularly those whose special bent is railway engineering.

MEMOIRS.

MAJOR-GENERAL JAMES ARCHIBALD FERRIER, C.B., D.S.O.

MAJOR-GENERAL FERRIER died at his home, Poynings, Crowthorne, Berkshire, on July 25th, at the age of 80, after having been ill for some considerable time; he bore this period of gradually declining strength with his usual cheerfulness and courage.

He was the youngest son of Major Ilay Ferrier, Belsyde, Linlithgow, who had been in the service of the East India Company. His great-grandfather, Ilay Ferrier, who died in 1812 as a Major-General and Lieutenant-Governor of Dumbarton Castle, raised in 1793 a battalion of the Scotch Brigade which became the 94th Foot and later the second battalion of the Connaught Rangers, a curious fact which tends to show that the Irish invasion of Scotland began many years ago. His grandfather also started his career in this regiment and then entered the Customs Service of Scotland, but later also commanded the Linlithgowshire Yeomanry.

General Ferrier was born on March 25th, 1854, and was at St. James' School, Jersey, before passing into the Royal Military Academy. He passed in second, and passed out third of his batch, and received his commission as Lieutenant in January, 1873. (All his four brothers had previously entered the Army.)

In January, 1876, he went to India and joined the Bengal Sappers and Miners at Roorkee—Sir Bindon Blood then being second-in-command—but was transferred to the Military Works Department at Lucknow, and then Allahabad and Cawnpore.

The Afghan War broke out in the autumn of 1878, and in February, 1879, Ferrier was ordered up the Khaiber and employed with the 2nd Division, chiefly on survey work in addition to roadmaking, hutting and water supply. Curiously enough, the result of his survey work was of considerable use in the Tirah campaign of 1897. He was informed by an officer in the Intelligence Dept. that it had no information about the country round Landi Kotal and east of it, except an old small-scale map, and a wire to Simla produced the large-scale maps Ferrier had made. He left the Khaiber in August, 1880, after a varied experience extending to Jelalabad. Conditions had been rendered more unpleasant owing to cholera having broken out all along the valley of the Kabul River.

On arrival back at Peshawar—to show how conditions have changed—he found that no *dâks*, which were the only regular means of transport to Rawalpindi, were available for a month, so he, with Shone (later Lieut.-General), started to ride with their baggage in *ekkas*. He finally reached Lucknow in September, in spite of many difficulties due to abnormally heavy rain and floods.

After being stationed at Allahabad again and then Calcutta, Morar, etc., he returned home at the end of 1882, joining a Depot company at Chatham and becoming Officer-in-Charge of Workshops.

In 1884, before a relief expedition for Egypt was decided on, finally after much delay, the 8th Railway Coy., to which Ferrier was posted, was brought up to strength and the personnel were distributed in detachments on the London, Chatham and Dover Railway—the officers doing duty with them in plain clothes, and the men in blue serges without badges. The Company embarked in September, and was soon engaged in overhauling and improving the 3′ 6″ line to Sarras and remained at this work till the relief expedition began to return—typhoid fever being the chief cause of casualties (at one time one-third of the Company being down with it, but it was luckily of a mild type).

The line had been extended to Akasheh, 50 miles beyond Sarras, and the work had been assisted by gangs of Indian plate-layers under Captain Olivier.

The relief expedition to save Gordon at Khartoum had failed in its object, as is well known, and orders were received to stop further work, as the troops were being withdrawn and the line was to be rolled up as far as Wadi Halfa. Calculations, however, were upset by the Mahdi and the troops were followed by a host of dervishes. The Cameron Highlanders with some R.E. and a few gunners were moved to Koskey, ten miles beyond Akasheh, and a fort constructed there which checked the invaders for some time. Captain Olivier returned to India and Ferrier was appointed Managing Director of the line. One morning he received telegraphic orders to proceed to Ambigole Wells, about 60 miles above Wadi Halfa, where there was a watering tank and pump and a small redoubt, with a garrison of about 30 R. West Kents under Lieut. Ainslie, with some R.E. and telegraph details.

The line had been destroyed by the dervishes five miles farther on. On returning to Ambigole Wells after repairing the line, he found that post being attacked. About 700 dervishes had worked round and attacked the post unexpectedly, bringing a small field-gun into action, and had cut the railway and telegraph lines above and below the station. In the train with Ferrier were about 50 men of the Royal Berks, under Lieut. Fitton. The dervishes attacked this post for about three days and were driven off practically before relieving forces from Wadi Halfa and Akasheh arrived. Ferrier had been in

command and an officer of the relieving troops has reported that he seemed as unperturbed and cheerful as usual. Then troops poured up from Cairo, the battle of Ginnis was fought and the dervishes were thoroughly cowed and vanished into thin air. For his action at Ambigole Wells and his other services he was eventually awarded the D.S.O. Incidentally he was one of the first eight to receive this order after its institution.

Shortly afterwards he returned to England on leave and in July, 1886, rejoined the 8th Coy. at Chatham, and the following January he took over command of the 10th Railway Coy. at Devonport. In the autumn of 1888 he was appointed Adjutant R.E. at Chatham—the last to hold that appointment as it subsequently became Adjutant S.M.E.

In the autumn of 1892 he again proceeded to India and became Executive Engineer, M.W.D., Madras. At the end of 1894 he was appointed Personal Assistant to the D.G.M.W. at Simla. In 1897 considerable signs of unrest became visible in India itself and on the Frontier. Trouble first started in June in the Tochi Valley with the treacherous attack at Maizar and a force was sent there. It then extended to the Malakand and troops were hurried there in September. Then the Mohmands and later the Afridis joined in. The Tirah Field Force of two Divisions and other troops concentrated at Kohat. At the end of September Major Ferrier was appointed Field Engineer of the 1st Brigade, and his previous knowledge was of great utility as the R.E. officers with the 1st Division had had no previous experience of the N.W. Frontier.

It is forgotten probably now that the Tirah Campaign was a very severe one—in it, for the first and last time, the heart of the Afridi country was penetrated. The army had first to force the Dargai and then the Sampagha Passes, and having penetrated into the interior it proceeded to destroy the chief villages and towers in the country. Finally a large portion of the force, with which was Ferrier, had to cut itself off from its line of communication and push its way down the Bara Valley to Jamrood. All through the campaign there was a great deal of fighting and almost continuous sniping—the casualties were heavy and the physical difficulties to be overcome were great. After arrival in the Khaiber, Ferrier was appointed Brigade-Major, R.E. The force was broken up in April, 1898.

One incident may be quoted which shows his generosity combined with humour. When on the top of the Arhanga Pass he was waiting to interview the General, a tired-looking R.E. subaltern accosted him and said he had been sent by L.-of-C. to report whether a camel road could be made up it; he said he did not think it could be done, and confessed he had had no experience. Ferrier read the report, which he himself had made, and indicated the salient points; then, tore the leaves out of his own pocket-book and handed them to the

subaltern, telling him to make a fair copy and sign it and expressed a hope that he would get a D.S.O.—and this he did!

Ferrier was reported as worthy of special recognition for his services, one extract reading: "An excellent practical engineer in the field, energetic, reliable, cheerful under all circumstances, and prompt in carrying out his duties." He was awarded a Brevet Lieut.-Colonelcy. He also received a personal letter of thanks from the Nawab of Laharu for the kind care and support he had given to the company of Maler Kotla Sappers who had served with the 1st Division, with Captain Weedon attached to it.

Ferrier rejoined at Simla when the Field Force was broken up, and shortly after proceeded on two years' furlough; a considerable portion of which was spent on the Continent, including attendance at the Swiss manœuvres. In 1899 he applied to revert to Home Service, and in December took over the command of the Training Battalion at Chatham, which he held throughout the South African War and thus missed a further chance of gaining distinction.

In March, 1903, he embarked for Natal. During his stay there he was called on to prepare several defence schemes, one of which was in the event of a Zulu rising, and this was acted on when some years after there was such a rising (Bambata's Rebellion). He left South Africa in September, 1904, and was on half-pay till appointed Chief Engineer, Thames and Medway Defences, in September, 1905.

In April, 1908, he was appointed Commandant, S.M.E. As regards his service as such, the tribute of Colonel A. T. Moore can well be quoted: "As his Adjutant for one period and his Brigade-Major for another, I learnt to appreciate fully his sterling character, his steadfastness, his consistency—one could always foretell how he would view any matter or occurrence—and his loyalty to his subordinates as well as to his superiors—noticeably he was always ready, regardless of his own interests, to support a subordinate whom he considered unfairly treated. He took much pains in the technical, physical and social welfare of the young officers and lower ranks under his command. A poor hater, a firm friend."

Another writer also emphasizes that the outstanding feature of his character was his straightness and the way in which he would always stand up for subordinates, even to his own detriment. Another remembers how General Ferrier, though a master of detail himself, managed not to interfere with those of others.

In June, 1910, Ferrier left the S.M.E. on promotion to Major-General and at the end of May, 1911, was appointed G.O.C. Sierra Leone. His tenure there can best be judged from a letter written by his A.D.C., now Colonel W. McCowan, R.A. "General Ferrier was a delightful man to work for. He was never out of temper and was calm at all times. This does not mean that he suffered fools or knaves gladly. . . . He was eminently practical, most efficient and

clear-sighted in all he did. . . . As a G.O.C. he made it his business, as far as was possible, to know personally all the officers of his garrison. To enable him to do this, he entertained a great deal; he was greatly assisted by Mrs. Ferrier. He was a most energetic man. . . ."

Major-General Clifford Coffin, V.C., writes: "I was his G.S.O.1 in Sierra Leone, 1911–1914, and we were together for nearly two years. He was a charming General to serve under, always kind and always courteous; everyone in S.L. trusted him and liked him. . . . The General was always well and active and set the whole garrison an example in fitness. Whilst in Sierra Leone he re-wrote the Defence Scheme and it was his scheme which was acted on when war broke out."

Brig.-General G. C. Kemp, after confirming what has been said above, added: "I think I can say with truth that few could come in contact with him without being influenced for good, though it was all so quietly impressed. Looking back I feel I owe much to his example, especially in trying to gain the confidence and friendship of my troops and looking after their comfort and health."

Ferrier left Sierra Leone in June, 1914, and went to Canada, where two of his sons were. Immediately on receipt of the news of the outbreak of the Great War, he crossed to England by the first boat, but it was not till May, 1915, that he was employed as G.O.C. at Hull. The Humber Garrison was in the making when he took over. Like most tasks in the war, this was one of extreme difficulty, for not only were the defences under his command and the control of troops, amounting at times to 40,000 men, but he had to deal with the city authorities and those of the docks, and had to try to prevent such things as food, rubber tyres and even picks and shovels being shipped to neutrals for use by Germany.

Colonel Weekes, who served under him after being invalided from France, speaks of his untiring energy in spite of his years and how he kept cool under all circumstances, even when he and his officers were stoned in their cars by the riff-raff of Hull after an air raid because he had not prevented the Boche from coming over!

When in February, 1917, he was replaced by a Major-General on half-pay, he received letters of regret at his departure and appreciation of his services not only from officers serving under him, but from the Admiral, the Lord Mayor and other civilians. They all speak of the assistance and kindly encouragement which he had given them.

Major-General Ferrier retired on retired pay on February 17th, 1917.

So far only "Jim" Ferrier's military career has been touched on, but not only did he show exceptional mental and physical vitality in all his duties, but he never missed an opportunity to indulge in some form of sport, chiefly shooting of any description and when the

Major-General James Archibald Ferrier, CB DSO.

chance occurred, hunting. The writer remembers him starting for Travancore to shoot big game; also with the Ooty Hounds, when he rode with apparent pleasure and comfort a big waler horse, not normally the type to gallop hard downhill, and hounds used to run very fast indeed.

After retirement General Ferrier settled in Crowthorne, Berks, and immediately interested himself in war pension work. Many have cause to be grateful for his untiring work on their behalf when the Ministry of Pensions was in its infancy, and the regulations had not reached the clear and orderly state to which they have since been reduced. A great deal of correspondence with headquarters was necessitated.

When the British Legion was formed, he summoned a meeting which resulted in a branch being formed with him as first Chairman. With exception of an interval of one and a half years when he was absent in Canada and France, he retained the Chairmanship until compelled by ill-health to resign.

General Ferrier married in 1887 Louisa Emily, second daughter of Mr. T. F. Watkins, who survives him, and he left three sons. These all served in the Great War. The eldest, Ilay, born in 1889, passed first into the R.M.C., Sandhurst, joined the 48th Pioneers, I.A., went to Mesopotamia with the 6th Division, was wounded at Shaiba, returned to duty and was invalided from near Ctesiphon; he subsequently passed first into Quetta Staff College and is now a Brevet Lieut.-Colonel, I.A.S.C. The second, Tyrrell, was in the Hydro-Electric Power Commission, Ottawa, came home and was employed in the R.A.O.C. in France and has been incapacitated in Canada since. The youngest, Alan, became a Temporary Lieutenant, R.E., in November, 1914, served in Field companies, was awarded the M.C. for gallantry during the 1918 retreat, and has since been in the Royal Canadian Air Force.

A.L.S.

LIEUT.-COLONEL SIR TANNATT WILLIAM EDGEWORTH DAVID, K.B.E., C.M.G., D.S.O., D.Sc., F.R.S.

THE war was only an incident in the career of Professor Sir Edgeworth David, K.B.E., C.M.G., D.S.O., D.SC., F.R.S., the discoverer of much of the mineral wealth of Australia. In the long obituary notice of him which appeared in *The Times* last August there was so much to say that the war period was dealt with in a paragraph of some 20 lines, and this, unfortunately, was not strictly accurate. As Lieut.-Colonel David, he worked with the Corps, and was a member of the R.E. Staff at G.H.Q., France, and his war services were so eminent that they deserve something more than a passing comment.

Major T. W. E. David, Professor of Geology at Sydney University, N.S.W., Australia, arrived in France in the spring of 1916 as a member of the Headquarter Wing of specialists of the Mining Battalion which was Australia's contribution to the mining situation in France. This unit was raised and equipped under David's personal supervision and advice.

It was originally intended that the Mining Battalion should work as an integral part of the Australian Corps; but it was soon found that the mining situation would never permit of the wholesale removal of a group of three Tunnelling Companies from one section of the front to another solely to accompany a particular infantry formation in its moves.

The battalion organization was, therefore, abandoned; the companies were placed at the disposal of the Inspector of Mines and distributed on the front under his advice by the General Staff, while the specialists were employed at first for the benefit of the Australian Companies, but later for that of the Tunnelling Companies generally.

Major David, as geologist, very quickly became a most valuable asset to the Tunnelling Companies, though the necessity for geological advice in the subject of military mining, as well as for water supply, had not yet been fully recognized by the staff of the E. in C. at G.H.Q. His advice was in constant demand by all the Commanding Officers of the Tunnelling Companies and he was a most welcome guest at all the Company Messes.

He was practically a free lance in the mining areas, and possibly would have continued in that independent role, had it not been for a very serious accident which resulted in his being posted to the office of the Inspector of Mines, at G.H.Q.

The following account of the accident brings out in the strongest light the physical and mental courage and tenacity of the man in circumstances of the most agonizing suffering.

In response to a call for advice for a mining project from the 1st Army front he decided he must go down a disused well in order to make an examination of the strata of the Vimy Ridge. He was descending on a bucket in the usual miner's fashion when the windlass collapsed and he was precipitated to the bottom, a depth of about 80 feet. His fall was so rapid that he reached the bottom still sitting, almost impaled on the bucket. His horrified companions at the top were able to make out that he was still alive and conscious, and got a doctor to go down and render such assistance as was possible to get him up to the surface again.

This was successfully accomplished, but on the way up on the rope, David asked the men who were hauling at the top to stop for a moment, in order that he might examine a stone he saw in the side of the well which might give important information. When he got to the top he steadfastly refused to be taken to hospital until he had shaken hands with, and thanked the doctor who had rendered him such aid in need.

Two or three days after the accident the Inspector of Mines went down to the hospital where David was, and found him sitting up in bed reading. David said to him, " The fact that I am alive is a proof of the theory of the parallelogram of forces." The I. of M. didn't follow ; so he went on, " When the bucket struck the bottom of the well it did so at an angle, for the bucket was canted sideways by my weight. Consequently the resultant force was not in a vertical direction, which must have smashed my back, but was oblique, and so only non-vital bones were broken." It is almost inconceivable that anyone after such an accident, which resulted in terrible injuries, and while suffering severe pain, should be able to think of his accident in the light of the solution of a mathematical problem.

When David returned to work after a long period of sick leave the I. of M. had him posted to his office at G.H.Q., where he could keep an eye on his movements, for by that time he had realized that he had on his staff one of the world's leading scientists, and he was unwilling to incur responsibility for exposing him to the ordinary risks of the front line. It was, therefore, agreed that David should never go within 1,000 yards of the front without the I. of M.'s permission, a condition to which he most unwillingly agreed, but at the same time most loyally obeyed whilst the I. of M. was at G.H.Q.

When he came to G.H.Q. he joined the E.-in-C.'s Mess, where he was a universal favourite. Scraps of information were gradually extracted from him about the more important incidents in his career, notably his expedition to the South Pole with Shackleton, where he was one of three men who located the magnetic South Pole ; but no

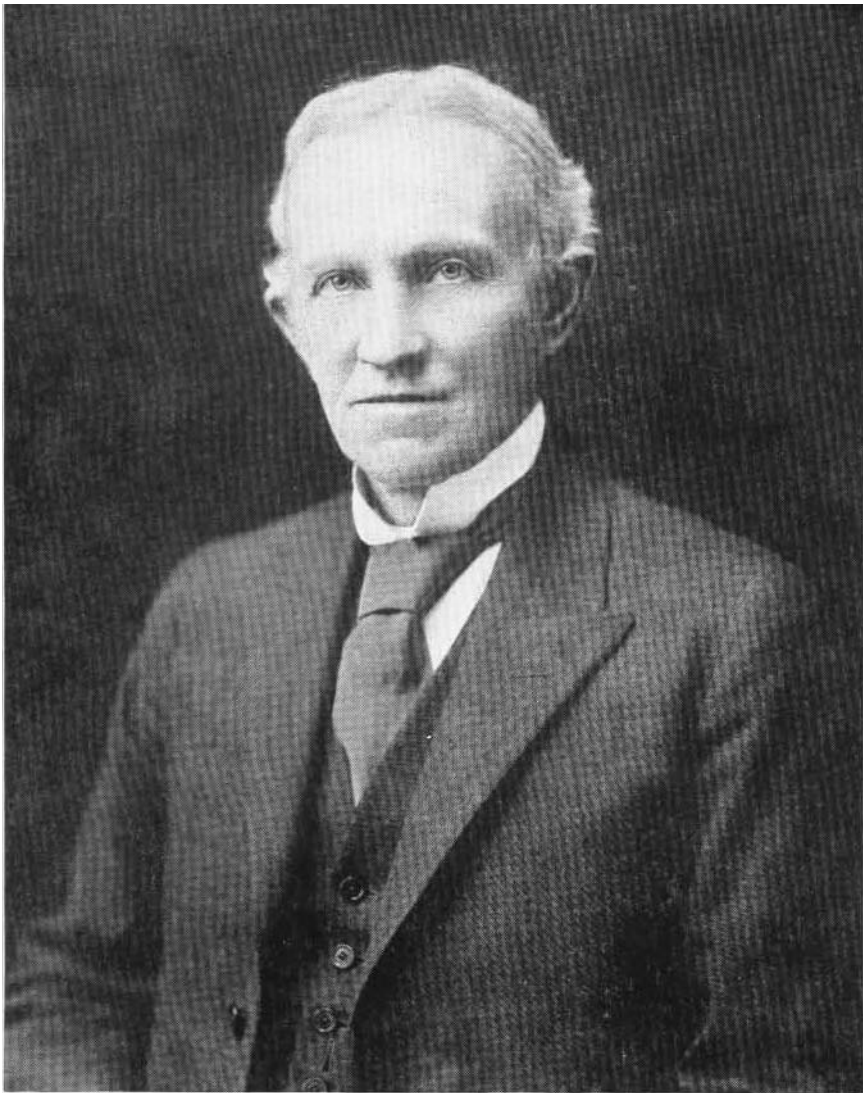
one ever succeeded in getting him to commit himself to any statement which reflected the least credit on himself. An hour's conversation with David was like a breath of fresh air amid the stale and unprofitable discussions which were necessarily based on incidents of the war.

His charm of manner was equal to his depth of knowledge on all things scientific, and his eyes had the most humorous twinkle, which always showed itself when replying to some leading question by the senior member of the Mess, belying the gravity and respect of the manner in which the reply was expressed.

While at G.H.Q. his work included research in connection with the various soils in which the miners had to work for mining and making dug-outs. There was every variety, sea sand on the coast dunes; Flanders clay; blue clay and chalk; all these had their own problems, and it was a great relief to know that close at hand there was a friend and counsellor to advise and suggest up-to-date methods. He was present at G.H.Q. during the latter period of the preparation of the mines for the Messines Battle, and he was very proud of the fact that out of eight companies employed on that scheme, two were of his own raising. The desperate character of the work in connection with the temporary loss and final recovery of the two mines of Hill 60 and the Caterpillar, only a few hours before zero, by the Australian Company responsible for those mines, must have thrilled him to the core.

The periodic rise and fall of the water-level in chalk sub-soil is a geological fact which was only learnt by experience, and the loss of a whole section of mines at Hill 70 for a period of three months, was a sufficiently severe lesson to impress on all military miners the grave risks attaching to mining without geological advice. This was also proved when the gallery of a mine, intended for the Messines Battle, ran into such wet ground, about 70 feet below ground-level, that it was feared that the mine would have to be abandoned. However, David made an examination of the soil that was being got out from the face of the gallery, and decided that it was from an old river-bed. He advised going back a distance and sinking the gallery about 20 feet. This was done; the obstacle was avoided; and the mine played its appointed part in the battle. After mining had ceased, David's advice on the probable depth of blue clay for dug-outs on the Flanders front and the most favourable position for deep well boring proved to be of the highest value.

When Lille was re-entered, David asked permission to go there, as a friend of his, M. Barrois, had been Professor of Geology there and might still be alive. He returned after a few days, reporting that he had found M. Barrois and had a most interesting conversation with him. Amongst other things he learnt that 12 German geologists had used Barrois' laboratory and that on the morning after the



Sir Tannatt William Edgeworth David, KBE CMG DSO DSC FRS.

explosion of the Messines mines the 12 geologists had been paraded, and a German General had then arrived and given them a telling-off, as they had informed him, so he said, that the German mines could not be undermined—as they undoubtedly were. As punishment the geologists under 40 years of age were sent to front-line units, those over 40 back to Berlin. For once David claimed some credit, in that he was worth more than 12 Boche scientists.

Peace did not sever his connection with the Tunnellers. An Old Comrades' Association was formed in London with branches in the Dominions, and David from the first was an enthusiastic member who watched the development in Australia with the greatest interest. His attendance at the annual dinners either in London or Australia was an event which was always hailed with delight. His last meeting with his " Old Comrades " was in Australia only a few weeks before his death.

His mental and physical energy is reflected by the honours for scientific work which were showered on him to the end; and the State funeral which was accorded to him is a most fitting acknowledgment of his wonderful life of usefulness and his most lovable character.

R.N.H.

All Reviews of Books on military subjects are included in the provisions of K.R. 522c.

BOOKS.

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

VAUBAN. 1633–1707.

By COLONEL P. LAZARD, Commandant le 1er Rég. du Génie.

(Librairie Félix Alcan, Paris, 1934.)

A copy of this book has been presented to the Corps by the author, and is in the S.M.E. Library.

On the occasion of the celebration of the third centenary of Vauban's birth, Colonel Lazard was commissioned to write a simple notice on the great engineer. Colonel Lazard has gone to great pains to give an accurate and detailed account, in a volume of 634 pages, of Vauban's life and work, portions of which have now been made public for the first time.

General Weygand had written a short foreword to the book. The latter is divided into three parts, the first dealing with the history of the Corps of Engineers in France since its origin, the second with the story of the Vauban family and Vauban's private life. The third part is devoted to his military services, and the book ends with a short account of his character and work.

The son of Urbain le Prestre, Seigneur de Vauban, Sébastien le Prestre, the future marshal of France, was born on the 15th May, 1633. Tradition has it that he was left an orphan at the age of ten, and that he was self-taught. This, Colonel Lazard tells us, is incorrect. At the age of 17, young Sébastien was presented by his father to the Prince of Condé, who accepted him as a cadet in his regiment. Urbain le Prestre died in 1652, when his son Sébastien was 19.

In the War of the Fronde young Vauban fought under Condé against the King (Louis XIV). In 1653 he was taken prisoner by the royal troops, and was converted into a devoted servant of the King.

Here began the second period of Vauban's military career, *i.e.*, from 1653 to 1668. The war against Spain continued from 1653 to 1658. During this time he was employed in the second siege of St. Ménéhould, where he won a lieutenancy, and at Sténay, where he was twice wounded. In 1655 he became an *ingénieur du roi*. Several other sieges followed. The war with Spain, which had lasted 25 years, ended in 1659 with the Treaty of the Pyrenees.

Then followed eight years of peace, in which Vauban began the works which were to make him famous, amongst which may be mentioned Nancy and Breisach. With the death of Philip IV of Spain, in 1667, war broke out again. King Louis invaded Flanders, and Vauban, under the orders of Clerville, accompanied him. The war ended with the peace of Aix-la-Chapelle.

The third period of Vauban's career (1668–1678) began with the four years of peace that followed, a busy time of project and inspection work. In 1672 war broke out with Holland, and a French army under Turenne invaded that country. In 1673 Vauban conducted the siege of Maestricht, where he introduced a systematic approach by parallels, which, in principle, has been the standard method of attacking a fortress

ever since. Spain declared war again in 1674, and the following year saw the campaign of Luxemburg. Vauban was employed at Besançon, Metz, Toul, Verdun, and elsewhere. The war ended with the peace of Nimègue in 1678. In that year, on the death of Clerville, Vauban was appointed Commissary-General of Fortifications.

The fourth period (1678–1703) began with ten years of comparative peace. During this time Vauban planned and constructed the port of Dunkerque. In 1681 he rebuilt the fortress of Strasburg.

Vauban introduced his "first system of fortification" at Saarlouis for the first time. In 1682 his "second system," which introduced modifications of the first, began to appear. The fortress of Landau, in Lower Alsace, built on this system, was perhaps his masterpiece.

In 1688 Vauban was promoted Lieutenant-General. In that year the war of the League of Augsburg broke out, and lasted nine years. During this war Vauban was engaged in the sieges of Philipsburg, Mannheim, Frankenthal, Mons, Namur, Charleroi and Ath. The peace of Ryswick was signed in 1697.

During the four years of peace that followed Vauban worked on a large number of fortification projects. The peace of Ryswick gave France the Rhine as frontier, and she lost Old Breisach, on the right bank. Vauban designed the fort of New Breisach, on the left bank, on what is known as his "third system."

In 1701 the war of the Spanish Succession broke out. The last siege in which Vauban took part was that of Old Breisach in 1703. In that year he was created a Marshal of France, at the age of 70.

In his last four years he devoted himself to an arrangement of his manuscripts (*Mes oisivetés*), which he published. His last work (*Dixme. royale*)—a protest against excessive taxation—was suppressed by order of the King. This was a great blow to him, and he died on March 30th, 1707.

Colonel Lazard has added great interest to his work by giving a large number of extracts from Vauban's correspondence with Louvois, the Minister for War, and others. These letters give us a good insight into his character, and into the difficulties that he encountered in the execution of his many engineering works. Space forbids more than an allusion to the numerous civil works that he carried out, in which he showed as great skill and thoroughness as in his fortification work and his method of conducting sieges.

In conclusion, Colonel Lazard points out that there could be no finer motto to characterize Vauban's work than the "*Ubique quo fas et gloria ducunt*" of his British comrades of the Royal Engineers.

A.S.H.

THE WAR MEMOIRS OF DAVID LLOYD GEORGE.

Vol. III.

(Ivor Nicholson & Watson. Price 21s.)

Mr. Lloyd George's third volume covers the period from December, 1916, to May, 1917, one of the most critical periods of the whole war. There are two Lloyd Georges in these Memoirs. There is the man whom the whole country acknowledges to have been the most energetic and capable leader on the Allied side; there is the other who cannot refrain from vilifying, even insulting, other great men who opposed some of his hastily-considered schemes; men whose lifelong experience in their work entitled them to oppose him on even terms. History will prove these men to have been right, and the public will cease to be entranced by verbosity and "disclosures" of the "sensational" type of Memoirs. So we must review this book from two points of view, at the risk of blowing hot and cold.

In his opening chapter, Mr. Lloyd George describes his difficulties in forming his three-party Government and the refusal of any of the Asquith Liberals to join him.

He had a formidable task. The war was going badly, and here he had to construct a Government of the most diverse elements, and to do it quickly. No one could have done it better. His indomitable energy and quick grasp of necessities overcame difficulties which would have overwhelmed many a statesman who in less troublous times would have passed for great.

Mr. Lloyd George's best work for the nation was done in his selection of new men to put into the right places, and in the rapid creation of new organizations to control the ever-growing perplexities of the situation. Crises appeared daily. He grappled with each in turn. To communicate a grave situation to him at breakfast-time, was to find him on the way to a solution at lunch-time.

There is a chapter on the German and Wilson Peace Notes of December, 1916, describing the crafty move on Germany's part to forestall President Wilson's attempt at mediation. The Allies dismissed it as a sham proposal. It seems to have been merely a preparation of the ground for the unrestricted submarine campaign which followed soon after. The submarine peril is well described in Chapter XL; there was no greater danger to the Allies than the rapidly increasing loss of their shipping. There were many crises behind the battle-fronts: the ammunition shortage, the man-power crisis, the shipping losses, the food-shortage, but none were so vital as the shipping crisis, for it covered all the others in its solution.

Beyond a doubt the convoy system saved the ships, but we must also remember, as Mr. Lloyd George's own figures show on p. 1181, that the various expedients for destroying the submarines were becoming more and more effective, and were sending them to the bottom at a rate which must have been terrifying to the German crews.

One of the finest features of the story of the submarine peril is the undaunted willingness of the merchant seamen to put to sea time after time when their vessels had been torpedoed. Mr. Lloyd George pays due tribute to these unconquerable men.

Next follow chapters on the Arming of Merchant Vessels, the Establishment of the Ministry of Shipping, Shipping Problems, Controlling the Food Supplies, and a System of National Service. In all of these, the evolution of order out of disorder is described by Mr. Lloyd George with vigour and directness. His masterly handling of these problems behind the battlefronts appears on every page. No one will deny that he was the only man who could have achieved such success.

But it is in the chapters which follow that military readers will be most interested. And here we find the second Lloyd George obtruding himself to the veritable damage of the first. Nearly all the rest of the book is devoted to the military situation. The Allies had already at the Chantilly Conference in November, 1916, agreed upon their plan of campaign for 1917. All their Armies were to be ready for a great effort by February, 1917. Their plans included an offensive by the Salonika forces—an idea long cherished by Mr. Lloyd George, and supported by General Joffre, who considered, with justification, that an army of 300,000 men should be able to exert considerable influence. But Mr. Lloyd George accuses Joffre of never intending to furnish the Salonika Army with sufficient means to carry out any offensive. It was all a question of shipping and guns: they were lacking.

The desperate plight of Rumania, and the desire to review the whole Allied policy for 1917, led Mr. Lloyd George to call for an early Conference. This was arranged at Rome in the beginning of January, 1917, in order to give Generals Sarrail and Milne an opportunity of being present. Mr. Lloyd George opened the proceedings with a Memorandum which he had prepared, urging a re-consideration of the agreed policy for a great offensive on the Western Front, and substituting a heavy reinforcement, particularly in guns, by French and British, on the Italian Front. His strategical arguments are given at length, but he could not carry anyone else with him. The French were already deeply involved in the preparations for the Nivelle offensive. Cadorna pointed out obvious difficulties, which, though dismissed by Mr. Lloyd George as trivial, nevertheless were patent and practical. M. Thomas asked how Lloyd George could send guns both to Russia and Italy (p. 1440). We were still very

deficient in these same guns on the Western Front. So Mr. Lloyd George found himself out-voted, and in consequence he indulges in the most bitter recriminations. He devotes the next two chapters to these attacks.

Mr. Lloyd George himself has already written in Volume II, "No wise civilian would ever dream of embarking upon strategy. A man who did that would be fit for no post in any Ministry. He would be a danger" (p. 763).

Nothing is easier for an amateur than to criticize, after the event, a strategy which has failed. Nothing is easier than to propound alternative plans, and to clothe them with assured success. But no criticism is worth its own ink, which does not examine to the bottom the factors which led to the adoption of the particular plan, to its success or its failure, or the action of the opposing side. The science of war is looked upon as an easy field for the amateur strategist: it is indeed one of the most difficult and intricate of professions.

The British Army was handicapped throughout by the lack of experienced staff officers. The enormous expansion, totally unprepared for, of our Army, called for an ever-increasing number of staffs. The first months of the war had exhausted our supply of trained staff officers and every subsequent expansion temporarily weakened the framework. The wonder was that newcomers could be trained so quickly. But no amount of willingness and enthusiasm can make up for the essential quality of experience, and the heads of our General Staff knew to what limits they could go in putting fresh strains on the great framework. A Ministry of Shipping may be put together in a week, composed of men accustomed to their work, but to find the staffs for a whole new Expeditionary Force, meant weakening many other parts of our already attenuated Army.

The book is full of Mr. Lloyd George's strategical proposals. His appreciations, when read for the first time, appear sound and reasonable, but they give little or no consideration to what the enemy might do; to the problems of transport and supply; to the effect in other theatres. He saw unlimited success in every scheme proposed by himself. The pouring of troops and guns into fresh theatres was to him as easy as emptying nuts out of a bag. Our General Staff would have failed in its duty if it had dashed into his schemes as readily as Mr. Lloyd George wished them to do. There is something more in the Science of War than is dreamt of in the amateur strategist's philosophy, and men who have spent their lives in their profession cannot be set aside with the contemptuous phrases of Mr. Lloyd George.

He writes "If the proposal (a heavy Allied attack in Italy) met with approval "at the Rome Conference, then a simultaneous attack on the Eastern frontier of "Austria could be arranged at the Petrograd Conference. I felt assured that the "French and British Military Staffs would be obdurate. Better death (for other "soldiers) on the Western Front, than victory (for other generals) on any other "flank" (p. 1412). These outrageous words ought to be deleted from the book.

If we have a General Staff at all, we must allow its opinions to have full weight. And when the General Staff, with the full concurrence of its Allied colleagues, and of Allied statesmen, was busy preparing big offensives in the selected theatres, it could not drop them and start on some fresh project just thrown on the table. The organization of a great offensive is something more than the amateur can appreciate. To lay proposals before a Conference, however clear and convincing they may be, is a matter of hours. The subsequent preparations of plans by the staffs for the execution of these schemes is a matter of weeks or months. It is a much quicker operation to reinforce the defence, than to organize the attack.

It was not only the military staffs who opposed the scheme put forward by Mr. Lloyd George at the Rome Conference. M. Briand and the Italians, in fact all the Allied representatives urged that it should be further examined, and none of them were as enthusiastic as the author. Some idea of the difficulties involved were pointed out by General Cadorna, who, as soon as he was called into the Conference room, referred to the length of time it would take to load, transport and unload the guns; to

assimilate the different artillery methods of the various nations, their systems of fire control, etc. (p. 1440). Then there was the reservation that the British and French guns, or at least the latter, might be recalled at short notice for France. All these limitations affected Mr. Lloyd George's proposals. It was not only the obdurate French and British Military Staffs who opposed: all the foreign statesmen listened politely, but did not accept.

"Briand and Thomas, the champions of an attack on Germany through Austria, "became rank and almost rancorous Westerners when it was proposed to place Italy "in the van of the Allied attack for 1917. Thomas and I were great friends. But "he lost his temper with me at the Rome Conference when it was suggested that "Italy should occupy the front seat in the 1917 campaign" (p. 1461).

"Better a doubtful battle in France with a possible victory, than an assured success "in Italy with a probable triumph" (p. 1462) is another of Mr. Lloyd George's contemptuous comments.

There follows a chapter on Joffre, whose military character he estimates with his now customary sarcasm and superficiality. He writes, "He was the paragon type "of those military idols whom the Allied nations worshipped so devotedly, although "they suffered so much from their incompetence—the great Generals who never "learnt anything from failure except how to stage an even bloodier fiasco" (p. 1469). Yet where would the Allies have been in 1914 had it not been for Joffre's calm and steadfast control?

Again, Mr. Lloyd George writes, comparing Joffre, Haig and Robertson:—"There "ought to have been initiative, resource, pliability, vision, imagination, aptitude to "learn from experience, courage and skill to profit by, and not to persist in mistakes. "In all these respects these honourable men had grave deficiencies, and the world "is suffering to-day from the results of their shortcomings" (p. 1470). The plain man thinks the world to-day is suffering more from the mistakes made in mis-handling the victory given by the soldiers.

If any leader had deserved these epithets of Mr. Lloyd George's, would the British Army have followed his lead through 1917 and 1918 to the triumphant end?

In another contemptuous phrase, he writes of Joffre, "His resolute countenance "inspired a sense of strength. That is what a harried people instinctively seek in "trouble. They make the mistake of thinking that the seat of intelligence is in the "chin. Great generals, dictators and bruisers always have that rather grim feature" (p. 1471). It was the men of chin who saved the country in the critical battles of 1914 and 1918. Heaven help us in the next war if there are no chins among the leaders.

He dismisses Joffre thus, "He was given the bâton of a Marshal of France to hang "in the salon of a Parisian villa, and Nivelle took his place" (p. 1471).

We next come to the Nivelle offensive and its disastrous failure, chiefly owing to disclosure of the plans to the enemy. Whether by accident or design, it has not yet been determined, but when military plans are discussed and wrangled over by countless civilian deputies and politicians, it is certain that secrecy has gone by the board.

Chapter LI—the Sequel to the Nivelle offensive—describes the discussions which took place immediately after the failure, and is perhaps the most illuminating chapter in the book. Mr. Lloyd George has declaimed with such vehemence against the Passchendaele offensive, that the reader should pay particular attention to this chapter. There is nothing in the facts, or the reports of the Conferences which he quotes in this volume, to show that he did not acquiesce in the policy carried out in 1917. He was, in fact, in full agreement. In summarizing the Conference held in Paris on the 4th May, 1917, to discuss the whole situation, after the failure of Nivelle's offensive, he writes "Then followed a discussion which in effect emphasized the "agreement which had been reached. General Pétain expressed entire concurrence, "and said that the Generals were in agreement in detail, as well as on general prin-

" ciples. Very shortly, the position was to maintain an offensive by limited action " with definite objectives, and the British Generals made it clear that the full forces " of the French and British Armies were to be employed for this end. *This point " was very emphatically elaborated by me.** I pointed out that both France and " Great Britain were apt to underestimate the measure of success already achieved, " because their standard of comparison was the high and possibly exaggerated hopes " with which their offensive began, . . . Captured documents showed that the " Germans were short of material, and we knew that the food problem was much " more serious for them than for us. *We must go on hitting and hitting with all our " strength, until the German ended, as he always did, by cracking.** M. Ribot accepted " my points. He said that to shut ourselves up on the defensive after three years " of war, would be a reckless and imprudent policy. We must press on with all our " forces. But the question of effectives was really serious, especially for France, " who had stood the brunt of the war practically alone until the British Army was " ready. Therefore France must, although putting forth her full strength, guard " against excessive losses. *I repeated that we were ready to put the full strength of the " British Army into the attack,** but it was no good doing so unless the French did the " same. *Otherwise the German would bring his best men and guns and all his ammuni- " tion against the British Army, and then later against the French* (author's italics). " *Tentative and feeble attacks were really more costly in the end* "* (pp. 1559–1561).

Here, indeed, is the whole matter in a nutshell. Mr. Lloyd George, now turned staunch Westerner, was, in May, 1917, in full agreement with, nay, strongly urged, a policy of continuing to attack. " We must go on hitting and hitting with all our strength " until the German cracked. What further justification is needed? What did Sir Douglas Haig do in 1917, but loyally carry out this agreement, so clearly imposed on him by the British and French Governments? What were the Messines and Passchendaele attacks if they were not attacks with limited objectives, carried out with all our strength? Beyond the mere capture of a ridge was the hope of thereby forcing the Germans away from Ostend and Zeebrugge, where their submarine nests were such vital points. Operations of the Passchendaele nature cannot be broken off at will, just as a surgeon cannot break off a major operation to attend to a minor one just brought to his notice. Haig's instructions from the Government were to go on hitting and hitting with all his strength. " Tentative and feeble attacks were really more costly in the end." Can we blame him for continuing after the weather broke, when we know that the Germans were never deterred by the weather? Were we to allow the Germans to bring division after division from Russia and settle them down while we gave them respite? Would this have been " hitting with all our strength until they cracked "?

The quotations from Mr. Lloyd George show that the Governments never intended such respites. Every word of these quotations shows Mr. Lloyd George's acquiescence in, and even his insistence on, a policy of *continuous* hitting by the British Army. His horror of the losses, his contemptuous phrases about the results, are, of course, the product of reflection after the events. Had the operations succeeded in forcing the Germans away from the Belgian coast, Mr. Lloyd George would have claimed the credit for the policy. Nothing in these Memoirs is more incomprehensible than his *volte-face* on the Flanders offensive. Let the plain man read Chapter LI twice over.

The rest of the volume is devoted to a long and tragic account of Russia's down-fall, and to the entry of America into the war.

With great skill Mr. Lloyd George manipulates the limelight, and stands in front of it himself. But the historians among the audience will not be dazzled by the brilliant rays he directs.

W.H.K.

* Reviewer's italics.

MARLBOROUGH. HIS LIFE AND TIMES.

By THE RIGHT HONOURABLE WINSTON S. CHURCHILL.

(Vol. II. Harrap. Price 25s. net.)

This second volume covers only the short period of 1702-1705, but it includes the whole epic of Blenheim, which was, at one blow, really to change the history of Europe.

It is an amazing story of the capabilities of one man with apparently little executive authority, yet directing the whole affairs of an immense alliance, political and military, as comprehensively as Napoleon, with all his centralized power. Mr. Churchill sums up the situation in his usual definite way: "During the four years covered by the present volume Marlborough led England as Captain-General, and, with Godolphin, as virtual Prime Minister. He conducted by personal negotiation with sovereigns and potentates the essentials of England's foreign policy. He was the mainspring of the Grand Alliance and its many signatory states. His tent or headquarters were the clearing house for all the ceaseless disputes and tangles of the whole confederacy against Louis XIV. He was the central link on which everything was fastened. He supplied whatever there was of unity of command, of cohesion and design." One sees here, as earlier, the same political intrigues and party politics (only now, if anything, more intricate and intensified by the bitter eagerness of Sarah), hampering him in all his attempts and belittling his successes. His difficulties with the Dutch deputies became more pronounced, though the author is very fair to the few who helped. The situation on August 2nd, 1702, must be unique in war. Marlborough, on the Meuse, had moved from Grave on Lille St. Hubert: Boufflers at Cleves had immediately "quitted his camp to dance after him," and was forced to make a flank march across Marlborough's front. At last, a chance of a decisive stroke had been produced: Marlborough obtained the consent of the deputies to attack. Just as orders were being issued, they withdrew their consent. After endless arguments and entreaties Marlborough had to give way, but he made a condition that the deputies should ride out with him to see what might have happened. "They did so, and beheld during the whole of the morning of the 2nd the French army, in imposing numbers but considerable disorder, streaming across their front, with their whole flank exposed."

To military students, the campaign of Blenheim will be the most interesting part of this story. The first suggestion of the march to the Danube is attributed to Wratislaw, but it was Marlborough who saw the full possibilities of this campaign. There is little actually new in the account, but it is singularly clear and complete, and the sequence of the campaign is most clearly illustrated by a series of small sketches, in the text, of all phases of the operation. This is a method of elucidating a campaign which is very much to be commended.

Mr. Churchill explains away the legend of the alternative command of Marlborough and the Margrave: they worked as independent leaders of equal status, with the understanding that the responsibility of the main direction of the war lay with the Englishman. It was only the password of the day that they issued alternatively.

In some ways the period after Blenheim is of even more interest to military students. One sees the genius of Marlborough, first shown as supreme in mobile operations, now turned to the defeat of the main French defensive lines in the Netherlands. The "unfought Waterloo"—unfought because Slangenberg, the Dutch General, refused to co-operate—was a tragedy. Success there, and success appeared certain, might have ended the war in 1705.

This biography must become a classic, and it is good to realize that the Corps has had some small share in its production. Colonel R. D. Pakenham-Walsh has been collaborating on all military matters with the author, with whom he visited and traversed all the battlefields, and Mr. Churchill in his preface, expresses his appreciation of having "enjoyed the advantage of his excellent professional opinion."

"GAS!"

THE STORY OF THE SPECIAL BRIGADE.

By MAJOR-GENERAL C. H. FOULKES, C.B., C.M.G., D.S.O.

(William Blackwood & Son, Ltd. 1934. Price 30s.)

It has been claimed for gas that it was easily the most effective weapon used in the Great War. However this may be, Major-General Foulkes has no difficulty in showing that gas was certainly one of the factors which led to the Allied victory and that it was increasing in importance and might have played a decisive part had the struggle lasted another year.

In 1914 practically nothing was known in this country of chemical substances which might be used offensively, and the manufacturing plant available for their production was almost non-existent. The German gas attacks at Ypres in April, 1915, consequently found our troops with no protection whatsoever against gas and totally unprepared for any retaliation in kind. Such retaliation was decided upon by the British and French Governments a month later and Sir John French, feeling that the employment of gas might develop into a big thing and that gas might become a fifth arm, appointed Major Foulkes, R.E., as he then was, to take charge of the matter in France.

The new "fifth arm" had to be created, armed and trained at speed. The author describes how this was done—the experimental work, the development of a technique for gas warfare and the organization and training of the Special Companies. It was all compressed into the space of a few months and on 25th September, just five months after the first German gas attack, we struck back at the battle of Loos. From over 4,000 cylinders a gas cloud preceding the infantry assault rolled towards the enemy trenches. Marked success attended the operation, which established an ascendancy over the Germans in the use of cloud gas that we maintained to the end of the war. No doubt we were aided by meteorological conditions, for the wind favoured the Allies ten times as frequently as it did the Germans. Perhaps the latter realized when it was too late that they had made a blunder in introducing the cloud attack on the Western Front. Their attack at Wieltje, in August, 1916, was the last occasion on which they used the method against us.

For the next twelve months the German side of the gas war consisted in the use of shells with lethal gas-filling. Very large numbers of these shells were fired, but the results were generally poor. Shortage of ammunition postponed any serious use of gas shells by our artillery. The Special Brigade, however, into which, early in 1916, the four Special Companies had been expanded, had considerably increased its activities. Of its twenty-one companies there were sixteen for cloud-gas enterprises, four for gas projection from Stokes mortars, and one for flame projectors. Phosgene had now become our main battle-gas and remained so for the rest of the war. The Special Brigade was at this time perfecting a new method of discharging it. This was by means of the Livens projectors which were used for the first time on a large scale at the opening of the battle of Arras on 4th April, 1917. They proved to be a most effective means of making a gas attack and the concentrations that could be established were such that the German respirators, even when adjusted in plenty of time, were useless against them. So alarmed were the Germans at the casualties they suffered from our projectors that they were compelled to imitate them in retaliation. The weapon they adopted, however, their ordinary 18-cm. *minenwerfer*, fired bombs whose gas content was only half that of ours.

With our ascendancy in gas warfare so established, it was disconcerting at this stage to find that the Germans were still able to forestall us with a new chemical substance. The division gas officers were always very much on the alert for the appearance of any innovation from the German side and on the occasion of the first mustard-gas bombardment, on 12th July, 1917, the fact that a new gas had appeared "smelling slightly of garlic or mustard" was immediately recognized.

The substance was not in a point of fact an unknown one. Not only had it been examined by French chemists in 1916, but in March of that year it was actually proposed for use by a British chemist in the anti-gas department in London. Unfortunately the matter was allowed to drop. As a result the first British shells with mustard-gas filling were not fired till the last days of September, 1918—fourteen months behind the Germans.

Except for the first cloud attacks at Ypres in 1915, the introduction of mustard gas was the sole event in the gas war from which the Germans derived any substantial benefit. The advantage gained, however, was only temporary and had already disappeared at the time of the Armistice. Had the war continued into 1919 we should have been ready with our "M" device. This, Major-General Foulkes considers, if properly and fully exploited, would have had a more important bearing on the course of the war, than any other measure that was put to a practical trial on the battlefield or that was even considered. He believes that in 1919 the whole character of the war would have changed. Armies would have been kept apart by a barrier of poisonous fumes, and trenches and strong points would only have had to be located to have been rendered untenable by mustard gas.

Gas and tanks were the only important offensive innovations of the war. Tanks can be met by physical obstacles, mines and anti-tank guns. We have still to find the real answer to gas. The respirator gives partial protection, but only to the eyes and lungs, and then only for a while. It is impossible to wear it all the time and the complete evacuation of gas-filled areas is the only alternative.

There can be no better introduction to an appreciation of the possibilities of gas warfare than the authoritative pages of this book.

H.W.H.

AUSTRIA-HUNGARY'S LAST WAR.

Edited by the Austrian Army Ministry and the War Archives, published by the *Militaerwissenschaftliche Mitteilungen*.

VOL. I.—THE WAR-YEAR 1914.

It was said in its latest days of the Austro-Hungarian Empire, which, tracing its descent from the Ostmark created in 803 by Charlemagne to defend the eastern boundaries of his empire, through the Archdukes of Austria, who were also at times Emperors of Germany, and whose dominions extended to the Netherlands and to Spain, that there were three things which mainly held together the twelve nations and the fifty million inhabitants which it comprised. These three were considered to be:—The Hapsburg dynasty, which, dating from when Edward I was settling the trouble between Robert Bruce and John Balliol, had completed its sixth century of rule; the unity of the civil service, a strength not easy of comprehension in lands which know not bureaucracy; and the use of one language—German—for words of command throughout the army. After the social revolution of 1848, the loss of Lombardy, the defeat by Prussia, the loss of Venice, and the discovery of a kinship between the Southern Slavs and Russia, which followed the annexation of Bosnia and Herzegovina, the bonds of empire became much weakened. It was then often prophesied that the Austro-Hungarian Empire would not survive the aged and venerated Emperor Francis Joseph. Actually the Empire was broken to pieces by the loss of the Great War and the subsequent Treaty of Versailles, so that the lineal descendant of the old and proud empire became the Austria of to-day, one-eighth the size of its predecessor, and with a population of only six and a half millions.

The pathos of this downfall, which must be present to every patriotic Austrian, is reflected in the title of the work now under review. That under the circumstances an official history of the war should appear at all seemed at first, and indeed for a long time, less than likely. The public interest in war was *nil*: the Austrian army

had dwindled in proportion to the diminution of the country; the General Staff had ceased to exist. Three outstanding factors, however, worked together and were able to triumph over all difficulties. They were the initiative and energy of Glaise-Horstenau, the Keeper of the War Archive, the sporting courage of the *Militaer-wissenschaftliche Mitteilungen*, and the keenness and devotion of a number of ex-officers, who looked upon the production of the History both as a memorial to their fallen comrades, and as a duty to the Empire that had ceased to exist.

The result of these joint efforts is an Austrian official history of the war, which reflects great credit on all concerned in its production, and this in regard to quality and apart from the obstacles that had to be overcome. Little trace of the latter is apparent in the published work, and that only where signs of compression are noticeable. This is particularly the case in the first three admirable articles, and generally in all accounts of fighting. The various writers to whom the different chapters were entrusted have evidently adopted as guiding principles, that the first task in writing a war history is to establish events, and the next is to relate them in historical fidelity. The responsibility for this is borne by the respective authors of the sub-heads: the forming of judgments they leave to their readers. Criticism, except in as far as it may be unavoidably revealed in the way events are related, is in general omitted.

Volume I has, in addition to its handsome appearance, two innovations. Roman print has been chosen instead of Gothic, a choice welcome to all non-German readers. Less happy is the idea of giving on the title-page a list of the officers, who are the contributors, by name only, and omitting all mention of their ranks and titles. Sublime in its simplicity, this juxtaposition of six surnames, preceded only by the respective Christian names, reads so like the old grey mare's cargo going to Widdecombe Fair as to suggest irresistibly the well-known conclusion of that list—in fact it constitutes a warning to others. Moreover, an officer's rank when he writes on military subjects is his credential.

The contents of this volume, which appeared originally in six parts, are:—*Preparations in Peace*, and *Mobilization and Assembly-March*, both by Lieut.-Colonel Kiszling; *The Austro-Hungarian Forces in* 1914, by Lieut.-Colonel Glaise-Horstenau; *War-organization*, by Major Czegka; *The August* 1914 *Campaign against Serbia and Montenegro*, by Field-Marshal Hoen; *The Summer* 1914 *Campaign against Russia*, by Lieut.-Colonel Kiszling; *The Autumn* 1914 *Campaign against Russia*, by Captain Wisshaupt; *The Autumn* 1914 *Campaign against Serbia and Montenegro*, by Field-Marshal Hoen; and *The Campaign of Limanova-Lapanov*, by Major-General Steinitz, the whole comprising over 800 pages, with 27 maps and 56 sketches, the two latter being contained in a box made up as a companion volume.

To the leader of this symposium, Lieut.-Colonel Kiszling, fell the most difficult tasks of all, for he is called upon to give an account of the military measures preparing for war which were made in peace, while the international political previous history of the war, owing to lack of space, has to be dealt with in only a few sentences. He has, further, to treat of the one subject about which, perhaps, more controversy has raged than about any other, viz., how the 2nd Army came to be included in the mobilization scheme in the forces taking the field against Serbia, when its presence was also necessary as an integral part of the army in Galicia sent to oppose the Russians.

The account he gives is shortly that two plans of mobilization and assembly (mainly the allotment and working of the railway service) had been worked out, one against Russia, called R, and one against Italy, called I. As it became subsequently clear that the alliance of Serbia with either of these powers could be taken for granted, a third plan had to be worked out, providing troops to deal with Serbia. This plan was called B (viz., Balkans). As Italy entered the war nine months later it is only necessary here to consider plans R and B. The army for these purposes was divided into three portions, known as Echelon A, the Balkan Minimum Group, and Echelon B, respectively. Of these the largest, Echelon A, consisting mainly of 28½ infantry

and 10 cavalry divisions, was earmarked for use against Russia only. It would occupy the railway network fully up to the 18th day of mobilization. The Balkan Minimum Group was a force calculated as just strong enough to hold the Serbians in check, and no more. Echelon B consisted of the remainder of the Austro-Hungarian army, mainly 12 infantry divisions, and had an alternative employment. If Russia remained quiet during a war with Serbia, it was to bring the Balkan Minimum Group up to a strength which would be sufficient to attack and defeat Serbia. If, however, Russia at once declared war, Echelon B was to follow Echelon A after the 18th day of mobilization to the Russian front.

The dangers in this plan are obvious, and they were pointed out more than once. General Kirchnawe says that an officer who had already been nominated as G.O.C. 2nd Army on mobilization, together with his Chief of the Staff, lost his post because on the occasion of a staff-ride he made objections to the scheme. The trouble would occur if Echelon B joined the Balkan Minimum Group and got involved in fighting the Serbians before Russia showed its hand. Actually what happened was worse than this, for the 2nd Army as part of Echelon B was sent to the Serbian front and became involved there *after* war had been declared upon Russia. It was then pulled out again and sent to the Russian front, only to find that Conrad, without waiting for its arrival, had already launched three armies against the Russians. While his left and centre were winning victories, the result of the whole operation was being decided elsewhere, for in the absence of the 2nd Army, the right, or decisive, wing was in process of being overwhelmed. The army which composed this wing, almost encircled by two Russian armies, managed to extricate itself by retirement on Lemberg on August 27th, just when the first corps of the 2nd Army to arrive was detraining, seven days behind time.

The writer, like a good historian, avoids anything like controversy. He leaves it to the reader himself to decide whether the plan itself was sound enough, and broke down only because it was not adhered to, or whether it was inherently defective, since the presence of Echelon B on the Serbian front (although under orders for Galicia), together with the desirability of obtaining a quick success against the Serbians, in order to impress Bulgaria and Rumania, led to an offensive which would not otherwise have been undertaken, and which incidentally ended in complete failure.

The period covered ends with the 31st December, 1914.

VOLUME II.

The high standard set by Vol. I is maintained. The sub-heads are:—*The World-Situation at the New Year*, 1915, and *The Situation in the Austro-Hungarian Forces*, both by Lieut.-Col. Horstenau and Major Franck; *The 1914-15 Winter in the Carpathians*, by Major-General Steinitz; *From a War on Two Fronts to a War on Three Fronts*, by Lieut.-Col. Horstenau, including a contribution about the Italian front by Lieut.-Col. Kiszling, and another by Lieut.-Col. Mühlhofer about the Balkan front; *From Gorlice to Lemberg*, by Lieut.-Col. Horstenau; *Introductory Battles* (1st and 2nd Isonzo) *on the S.W. Front*, by Lieut.-Col. Kiszling; *The Campaign of Brest-Litovsk*, and *The Summer Battles against Italy*, by the same officer, with, for the account of the fighting against Russia, the help of four assistants.

In all these articles the outstanding feature is the greatness of Austro-Hungary's effort. Evidence of what the country did, and of what it suffered, is constantly forthcoming. Huge figures could doubtless be produced relating to any and every sphere of the nation's war-activity. The figures given here are chiefly those of army-strengths and of casualties. They are impressive enough. Of the 900,000 who composed the Austro-Hungarian northern army, which took the field in August, 1914, after nearly four weeks of unbroken marching and fighting, there returned to the San, according to a Hungarian account, 578,000 men, according to a Russian estimate of casualties which are "not much exaggerated," 550,000. Considering the quality of the material alone, this was a loss which during the whole war could not be made

good. Ivanoff's army opposing them in the same period lost one-quarter of its strength of one million. In the first four months of the war Austro-Hungary put into the field, north and south, against Russia and Serbia, one and a half million men, and sent after them 800,000 reinforcements. At the end of those four months, on the 31st December, 1914, there were left in the field 940,000 men, showing a loss of over one and one-third millions.

The difficulties of a war of coalition constantly recur in these pages. The diverging interests of allies are bound to lead to friction, and the weaker ally will surely feel that insufficient regard is being paid to his requirements, his wishes and his advice. Without directly complaining, the Austrian account nevertheless shows clearly enough what a very uncomfortable ally Germany must have been. One example of this must suffice, showing a sad ignorance of what is cricket. German G.H.Q., owing to the importance of complying with Turkish requests for ammunition in November, 1914, offered a German division to Austro-Hungarian G.H.Q. to assist in opening up a way through N.E. Serbia and Bulgaria. This offer was refused on the ground that the Austrian southern army had no troops to spare for side-shows. The Prussian War Ministry then tried to circumvent Austro-Hungarian G.H.Q. by inducing the Austro-Hungarian representative in Berlin to approach the C.-in-C. of the Austrian southern army direct. The result of this method of approach was a not unmerited raspberry, as the C.-in-C. referred them back to Austro-Hungarian G.H.Q.

In this, as in all other difficulties, and throughout the campaigns in these two volumes, stands like a Colossus the personality that was Conrad—Field-Marshal Graf Conrad von Hötzendorf, as he became. It was Conrad, the indomitable and unwearying, who as Chief of the General Staff bore the heat and burden of the day, who kept his head up "bloody, but unbow'd," after appalling disasters on two battle-fronts, and faced a fresh enemy on a third front. This was the man who, being convinced that Italy as third partner in the Triple Alliance was unreliable, and might even in war be found on the enemy's side, and foreseeing that in this case the encirclement of Germany and Austria by their foes would be complete, seriously proposed, as far back as 1907, to pick a quarrel with Italy, so as to wage a preventive war against her. He thus earned a reputation as a fire-eater, and forfeited many people's confidence. It was Conrad who made up his mind that when Austria declared war on Serbia, the latter's mighty ally Russia would be so slow in taking the field that a brisk little campaign against Serbia could polish her off first. How far he may have been influenced in this decision by the German General Staff's "six weeks" required to settle with France, before reinforcements could be spared from the western front for the eastern front, can hardly be said, but he was none the less responsible for the disaster which befell the Austrians in Serbia in August, 1914, in that he gave them a task beyond their strength. It was Conrad who, with almost boyish impetuosity, sent three armies against five Russian armies, without first satisfying himself that German co-operation, promised five years earlier, would be really forthcoming, and thus subjected the Austro-Hungarian army in Galicia to losses on a scale so stupendous that its fighting value never recovered. It needed only Brussilow's offensive in 1916 against this weakened army to show that, however gallantly it might fight in future, the Austro-Hungarian army was no longer to be regarded as a war-winning factor. It was Conrad who, as circumstances changed, was ever ready with a new plan; who, with a soldier's disinclination against political counsels, found himself constantly thwarted thereby, and his plans brought to nought.

Compression as in Vol. I is achieved by dealing with all proposals, plans, pros and cons, etc., as shortly as possible, and suppressing all mention of units below the division, and of all individuals, except in the footnotes. The latter, too, are laudably few, and mostly confined to giving the source (name of work, chapter or page) of a quotation, the name of an officer or a unit which won distinction in a particular fight, and a few details of remarkable engineering achievements, generally of river-crossings or of important railway movements.

F.A.I.

GORDON AT KHARTOUM.

By JOHN BUCHAN.

(Peter Davies. Price 5s.)

This is a short, readable and welcome book. Fifty years have passed since, in 1884, Gordon was "hemmed in" in Khartoum. There are very few still alive who knew Gordon personally. Even those interested at the time in the events of 1884–1885 are getting rather elderly. Dr. Bernard Allen's *Gordon in the Soudan*, published three years ago, is a book of research, invaluable to students, but too big for the general reader—so all admirers of Gordon will welcome a wide circulation for Mr. Buchan's book.

Mr. Buchan summarizes (pages 40–43) Gordon's six years in the Sudan (1874–79)—Gordon dreamt of a great African State, but (writes Mr. Buchan) "it was a thankless labour to make a civilized State out of the squalid towns, and the immense trackless hinterland, to enforce law and order with penny steamers and fever-ridden soldiers as brave as hares." After six years Gordon had to give in. The abdication of the Khedive Ismail, the intrigues of Egyptian officials, and finally failing health in a climate which killed off or invalided most Europeans, decided him to resign. Early in 1880 as he was leaving Egypt he said to a friend, "I am neither a Napoleon nor a Colbert; I do not profess to have been either a great ruler or a great financier; but I can say this—I have cut off the slave dealers in their strong-hold and I have made all my people love me."

Gordon had done wonders, but he was naturally disappointed at the six years' result. In March, 1880, he visited Brussels and explained to King Leopold his scheme to suppress slave trade in the Nile basin by attacking its source on the Congo. King Leopold approved. Gordon promised that whenever his services were required he would take on the job. On 15th October, 1883, King Leopold telegraphed to Gordon (then in Palestine) asking him to go to the Congo next spring. Gordon telegraphed to War Office for permission. Wolseley advised Hartington, "Looking at the fanatical character of the man and the chance of collision with French adventurers I think it very doubtful whether permission should be given."

The War Office refused permission asked by Gordon.

January 1st—Gordon arrives at Brussels and King Leopold is ready to form a trust fund to compensate Gordon if he resigns his commission.

January 7th—Gordon arrives Southampton and sends in his resignation to the War Office.

January 8th—Stead, the journalist, interviews Gordon.

January 9th—Stead's article published in *Pall Mall Gazette*.

January 10th—Wolseley recommends Gordon for the Sudan.

January 12th—Wolseley telegraphs Gordon to come and see him.

January 14th—Granville telegraphs to Gladstone (then confined to his room at Hawarden). "If Gordon says he believes he could by his personal influence excite the tribes to escort the Khartoum garrison and inhabitants to Suakim a little pressure on Baring might be advisable."

January 14th—Gladstone to Granville telegraphs approval.

January 14th—Granville to Baring telegraphs *No.* 28 asking further news as to "Retreat from Khartoum."

January 15th—Gordon calls at War Office. Gordon agrees to go to Suakim to report on military situation. On return will have permission to go to Congo. Gordon gives Wolseley notes of draft instructions. (For these notes in full, see Bernard Allen's *Gordon and the Soudan*, pages 221–222.)

January 15th—Granville to Baring telegraphs *No.* 28*A*.

Gordon ready to go to Suakim. His only object to report on situation.

January 15th—Granville to Gladstone sends copy of *No.* 28*A*.

January 16th—Gladstone to Granville approves *No.* 28*A*, but warns Granville

" We must be very careful in any instruction we give that Gordon does not shift " the centre of gravity as to political and military responsibility. In brief, if he " reports what should be done, he should not be the judge of *who* should do it, nor " ought he to commit us on that point by advice officially given."

January 16th—Baring to Granville telegraphs 10.30 a.m. (in reply to Granville's *No.* 28 of January 14th). " Send out at once qualified British Officer to go to " Khartoum with full powers civil and military to conduct the retreat."

January 16th—Baring to Granville telegraphs 11.15 a.m. (in reply to Granville's *No.* 28*A* of January 15th), " Gordon the best man if he will pledge himself to carry " out the policy of withdrawal as soon as possible."

January 16th—Gordon goes to Brussels to explain to King Leopold that his services are required in the Sudan for a short time. After that he can go to the Congo.

January 17th—Wolseley to Gordon 2 p.m. " Come to London by evening train."

January 18th—Gordon arrived London 6 a.m. Sees Wolseley and arranges to meet Cabinet Ministers in the afternoon.

January 19th—Gordon to Barnes, " Ministers said they were determined to " evacuate. Would I go and superintend it? I said 'Yes.'"

The ministers, especially Granville and Hartington, had altered Gordon's instructions from advisory to executive—Lord Crewe in his *Life of Rosebery*, Vol. 1, page 211, writes " In an ill-starred moment it was decided to send Gordon to carry through " the evacuation. Lord Wolseley's unstinted admiration and personal affection for " 'Charley Gordon' did more than anything else to impel Ministers to this hapless " decision."

And now for Gordon himself. How far, if at all, was he wrong? The answer can only be given by a careful study of Gordon's six years (1874–1879) in the Sudan. He knew the country and its inhabitants better than any other European. His pioneering in Equatoria, his settling the confusion in Darfur and other items read like romances. Gordon was unique. With his six years' experience and his constant success, the proposal to go to Khartoum and evacuate the garrisons must have been, to his mind, a very tiny job. He was confident of success in 1884.

The hidden snag in the path was that the Sudan from 1880 had gone from bad to worse. The Pashas were more and more incompetent. The Egyptian soldiers were " brave as hares," as in 1874-1879. The Sudanese were ready for rebellion and Abdullahi (known later as " the Khalifa ") was a real leader. According to the reminiscences of Zebeir (as told by Mr. H. C. Jackson in *Black Ivory and White*, 1913), Abdullahi tried to make Zebeir a " Mahdi," but Zebeir told him to shut up. At last in 1880 Abdullahi caught his " Mahdi," a " holy man " of some ten years' standing. The Mahdi had a gracious smile and his voice was a most musical organ—specially effective in its rhythmic roll of Arabic words. He became, in fact, a stage property for Abdullahi to promote rebellion. He had been a genuine ascetic. In the course of four years he deteriorated. He got puffed up both in mind and body and he died of luxury 22nd June, 1885, less than five months after the fall of Khartoum. Gordon, talking to Graham in Cairo, said " The rebellion in the Sudan had " little or no religious element in it. The Mahdi was a mere figure-head."

In three days, January 15th–18th, the apple-cart was upset—Wolseley pulled wires—Granville muddled—and at 8 p.m. off went Gordon happy and with a free hand to evacuate the garrisons the best way he could.

On 18th July, 1902 (18 years later), H.R.H the Duke of Cambridge, in unveiling a statue of Gordon, temporarily in Trafalgar Square, spoke as follows:—

" When I said good-bye to Gordon he had the conviction he would be perfectly " successful in the curious undertaking which he said he would face without anybody " to assist or help him."

Sir Samuel Baker, on January 1st, and Stead, the journalist, on January 8th, had boomed Gordon as *Deus ex machina*. Public opinion was delighted, and even

Gladstone, who had been misled by Granville, may have been calmed by Gordon's certitude, and have hoped for a peace without war.

The story of Gordon from January 19th, 1884, to January 26th, 1885, is divided by Mr. Buchan into five chapters:—

Jan. 1st to Jan. 18th	The Mission.
Jan. 19th to Feb. 11th	The Journey.
Feb. 12th to March 11th	The Forlorn Hope.
August 5th to Jan. 17th	The Race against Time.
Jan. 18th to Jan. 26th	The End.

On March 12th telegraphic communication with Khartoum ceased and Gordon wrote in his journal:

"It is most dispiriting to be in the position I am, if it was not good for me, when "I think that *when I left* (in 1880) I could say 'no man could lift his hand or foot "'in the land of the Soudan without me'—and now we cannot calculate on our "existence over 24 hours. The people are all against us, and what a power they "have; they need not fight but have merely to refuse to sell us their grain."

On September 24th Gordon hears of "Relief Expedition" and writes in some natural anger:

"I was relief expedition No. 1. I came up to extricate the garrisons and failed. "They are relief expedition No. 2. They come up to extricate the garrisons and "(I hope) will succeed. They do not come to extricate me. As for myself I could "make good my retreat at any moment if I wished. I am not the rescued lamb and "I will not be."

Gladstone is dealt with in "Dramatis Personæ" (pages 17–24) and in "Ironic Interlude" (pages 115–128). From 1881 till his death, 1898 (and long after), Majuba and Khartoum were, and still are, magnificent rocks for opponents of Gladstone to throw at his head. Mr. Buchan gives Gladstone great praise as "having as high courage as was ever possessed by an English statesman; "no man cultivated the masses more assiduously or feared them less . . . the "man himself a marvel and a mystery—a character far subtler and more "baffling than Disraeli's."

Defects are pointed out, such as "mind equipped like a Victorian dining room," "nothing of an artist," "little of a philosopher," "without the gift of style," "having a short range imagination," but such defects, even if correctly described, are not very weighty.

The proposal to send Gordon to report in an advisory, not executive, mission was made by Gordon and approved by Gladstone—but when Granville telegraphed to Baring on the evening of January 18th, he added that Gordon should "perform "such other duties as may be entrusted to him by the Egyptian Government through "Sir Evelyn Baring." This was a very "pregnant addendum," as Mr. Buchan notes. The mission of Gordon was changed from advisory into executive—Wolseley was probably the cause of the change, but it was Granville who made the muddle—Gladstone's approval of "advisory" was quite clear, but Gladstone was laid up and very likely was never informed how the mistake arose. Gordon's memoranda written on his journey from England to Egypt were telegraphed on to Baring. Gordon was made Governor-General and the fat was in the fire.

Gladstone and Gordon were both idealists. Both men walked and talked with God throughout their lives. They "followed the gleam" of duty as they understood it. They were both "men of action" in their different lines. In heaven they should be—perhaps are—accommodated in adjoining "mansions."

Baring (one of the four *dramatis personæ*), was the honest straightforward level-headed official returning to Egypt after three-and-a-half years in India—finding the Sudan had gone from bad to worse. He had reluctantly approved Gordon's mission

though highly dangerous. He supported Gordon's demand for Zebeir—so did Gladstone and Queen Victoria—an imposing trinity. In 1884–85 he was a good man struggling with adversity, but in the ensuing 24 years he became a great man who had raised Egypt from bankruptcy to prosperity.

D.A.M.

RECORDS OF THE SURVEY OF INDIA, VOL. XXV.

SURVEYS IN SWAT, CHITRAL AND GILGIT AND NEIGHBOURING TERRITORIES, FROM 1925 TO 1931.

By LIEUT.-COLONEL C. G. LEWIS, O.B.E., R.E.

Published by order of Brigadier H. J. Couchman, D.S.O., M.C., Surveyor-General of India.

(Price Rs. 1/8 or 2s. 6d.)

This is a report of survey operations at high altitudes. It contains much useful information regarding the countries named above, and the equipment and organization for the surveyor who proposes to visit high snow-clad peaks. Camp was established as high as 19,000 ft. in one attempt to reach a station 21,494 ft. Several stations at which observations were taken were well over 18,000, the highest being 18,860 ft.

H.L.C.

A SKETCH OF THE GEOGRAPHY AND GEOLOGY OF THE HIMALAYA MOUNTAINS AND TIBET.

By COLONEL S. G. BURRARD, R.E., F.R.S., Superintendent, Trigonometrical Surveys, and H. H. HAYDEN, B.A., F.G.S. (later Sir Henry Hayden, *Kt.*, C.S.I., C.I.E., F.R.S.), Superintendent, Geological Survey of India.

Revised by COLONEL SIR SIDNEY BURRARD, K.C.S.I., F.R.S., and A. M. HERON, D.SC., F.G.S., F.R.G.S., F.R.S.E., Superintendent, Geological Survey of India.

(Price Rs. 28 or £2 3s. 6d.)

To those interested in the study of Himalayan geography and geology this work will be indispensable. The first edition was published in 1907 and has now been revised after a lapse of 25 years, by one of the original authors, Sir Sidney Burrard—the other, Sir Henry Hayden, was unfortunately killed in an Alpine accident in 1923, but his place has been taken by Mr. A. M. Heron, of the Geological Survey of India.

During the years which have intervened between the two editions there has been a great deal of exploration in the Himalayas, so that from a topographical and geological point of view the area is far better known.

The following summary will give some idea of the general scope of this book.

The principal mountain peaks are classified, their heights are analysed; the origin of the mountain ranges and their alignment is discussed; precipitation and its influence on the height of the snow-line on both sides of the ranges; the Himalayan drainage basins, rivers and glaciers are described; seven chapters are devoted to the geology of the mountains and the complicated tectonic features.

Advances have been made in our knowledge of atmospheric refraction, which has enabled the heights of mountains to be determined with greater accuracy where the result depends on the observations of non-reciprocal angles, as they must do in the case of the great Himalayan peaks. But having eliminated as far as possible the effects of refraction there still remains the question whether mountain heights, not susceptible of spirit-levelling, should be reckoned above the spheroid or above the

geoid. Those interested will find a discussion on this subject to which Dr. de Graaff Hunter has devoted much attention.

A good deal of extra geological information has been acquired since the first edition, for instance the Everest Group was quite unknown in 1907, but has since been fairly well surveyed. Generally speaking, it has been found that, while granite rocks predominate, they do not play the exclusive part they are supposed to in the structure of highest parts of the mountains. The work is illustrated by numerous diagrams and cross-sections of the ranges, together with geological maps on which there are still blanks, notably Nepal.

H.L.C.

NOTES AND COMMENTS ON THE DARDANELLES CAMPAIGN.

By A. KEARSEY, D.S.O., O.B.E., *p.s.c.*, late Lieut.-Colonel, G.S.

(Gale & Polden, Aldershot. Price 4s. net.)

The author's heading to his work is sufficient to show that he only intends it to be a stepping-stone to a wider study of the campaign.

The book is written in an easy and very readable style, and yet it gives a succinct picture of the whole campaign. It should be a valuable help to officers in their studies.

Lieut.-Colonel Kearsey served in the Dardanelles; this is a qualification in itself; but the production of such brief, clear and well-balanced notes means that he must have supplemented his own experiences not only from a detailed study of all literature on the subject, but also from the personal experiences of others.

The spirit in which the book is written is refreshingly devoid of all acrimony; it can be summed up from the following extract:—

"However, there never has been and never will be perfection in military and other "plans—we all know that mortals cannot command success; they can only try to "deserve it."

C.D.M.

A HISTORY OF THE WORLD WAR.

By LIDDELL HART.

(Faber & Faber. Price 8s. 6d.)

This is really a revised edition of the author's *The Real War*, to which he has made additions as a result of further information published since the issue of his former work. The new book gives a very fair picture of the war, and is certainly the best short comprehensive history of the war as a whole.

Perhaps the author is still rather obsessed by his feelings against the Western Front and the Commanders there, and he seems, at times, to forget the comparative time factors of the German railways against British sea transport.

It would not be fair to comment on errors of omission, however important, in a condensed work of this nature; the book must be looked upon as a general picture from the author's own particular angle. As such it must be of real interest and value to the military student. To readers of the *R.E. Journal*, one of his statements given in this edition should be of interest:—

"The Western Front in 1914–1918 was pre-eminently an Engineer's war, yet "historians will be perplexed at the small part played by Engineers in its direction, "and the overweening influence of Cavalry and Infantry doctrine in the attempt to "solve the problem."

PROTECTION FROM AIR ATTACKS IN THE DESIGN AND LAY-OUT OF BUILDINGS.

(BAUTECHNISCHER LUFTSCHUTZ.)

By Dipl. Ing. Hans Schoszberger.

(Bauwelt-Verlag, Berlin, S.W. 68. Price 7·80 marks.)

The author, an engineer who has made a special study of this intricate subject, has written a book that deserves the careful attention of engineers and architects, and especially those who are engaged in town-planning schemes. In the preface he modestly calls the book a first attempt to originate the science of "air protection" in building and town-planning. The mere fact that he has consulted 315 books in compiling this volume is a proof of the thoroughness with which he has tackled the work.

After a brief reference to the connection that has existed from ancient times between war and building construction, Herr Schoszberger gives us his views on the next great war.

The war of the future will be decided in the air—and very rapidly. No country can hope to achieve victory without aerial preponderance. A decision will be arrived at, not in the encounter battle between the belligerent armies, but far back in the enemy's country by the destruction of whole cities from the air.

"Air protection"—to use the author's expression—does not mean concealment behind concrete blocks, nor a general "digging-in" underground. It means the abolition of back-to-back building and of slums in large towns, and the opening up of green spaces. It stands for the health and welfare of the people generally. It is in agreement with the "back to the land" policy, and encourages the development of garden cities. Its main object is to convince the enemy that bombing from the air is too costly a business to be worth while, and so to persuade him to abandon the attack.

There can be no complete protection without a large number of fighting planes, but the idea that a strong air force offers sufficient security pre-supposes that all countries are equally vulnerable. This is not the case. The most vulnerable countries are those with the densest population and the greatest number of large towns. England comes first, and Germany second, as the most vulnerable countries in Europe.

The writer divides buildings into four classes, in order of importance and size. The third class, which comprises most living houses, is by far the largest. In protecting them from air attack, the greatest economy is essential.

Attacks on towns can be carried out by the following methods: explosive bombs, incendiary bombs, gas bombs, and bacterial bombs.

No roof or floor can be made thick enough to keep out the heaviest explosive bombs. (A 1,000-kg. bomb will, in exploding on impact, penetrate 2·27 metres —about 7½ feet—of concrete.) Large bombs are, however, uneconomical; more damage can be done by an equivalent number of small bombs. The general principle to be adopted is not to attempt to keep big bombs out of a building, but to let them explode, offering as little resistance as possible.

For a building of any size, a steel framework with reinforced concrete panels offers the best solution. The panels should offer little resistance to an internal explosion, but should resist a blow from the outside. For cottages and small houses half-timber framing is suitable.

Incendiary bombs are very much lighter than explosive bombs. The best protection against them is to avoid the accumulation of inflammable material, and to have fire extinguishers handy.

Gas bombing will probably be one of the methods of attack adopted in future, but

not the most important one. Bacterial attacks are not likely to be attempted by any self-respecting nation.

A long chapter is devoted to the construction of shelters for occupation during an air attack. For gas attacks they should be as high as possible, but since the greatest danger comes from explosive and incendiary bombs, they will, in practice, usually be in cellars or basements, or else specially constructed underground. The roof should be strong enough to carry the weight of the overhead structure, if it should collapse.

The use of underground railways, as shelters, is mentioned. Some authorities are averse to it; on the other hand the regulations in Italy require underground railways and tunnels to be adapted for use as shelters in an emergency.

Camouflage, artificial fog, and dummy sites of towns (to be lit brilliantly at night) are referred to. In connection with camouflage, the following book is recommended for study: *Strategic Camouflage*, by Joseph Salomon, London, 1920.

As regards town-planning, many impracticable suggestions have been made. A star-shaped plan is bad, as it gives away the position of the most important buildings. The plan recommended is a rectangular one, laid out in parallel strips, a modification of what is known as the "Parkway System" in America.

This review may be closed by quoting the last two sentences of the book:—

"In the distant future we may possibly succeed by 'air protection' in reducing "aerial warfare against the civil population to an act of sheer folly, so that war "may again be restricted to land. If, in the meantime, we have succeeded in ensur- "ing a real, just peace between nations, a consummation that is devoutly to be "wished, the labours of constructive 'air protection' will not have been superfluous, "for, in order to secure their object, they will have helped to achieve what the well- "being and health of the people have long been demanding."

A.S.H.

ECHOES OF OLD WARS.

A MARTIAL ANTHOLOGY COMPILED BY COLONEL C. FIELD, R.M.L.I.

(Herbert Jenkins. Price, 10s. 6d.)

Shortly, as the publisher's cover describes it, this book is a collection of "Personal and unofficial letters and accounts of bygone battles, both by land and sea, by those who were there, 1513 to 1854."

The author's foreword, which refers to the "admiration of the brilliant qualities displayed in war" as "a powerful incentive to war," points out that while most published accounts of wars and battles were written retrospectively and give a general account of what happened, there exist certain accounts written at the time, and giving in each case an individual's impression, not of the whole, but of what the writer actually experienced. The compiler has collected from many sources accounts of this nature dealing with nearly 50 actions, from the siege of Terouenne in 1513 to the Battle of Inkerman in 1854. The actions described are fairly equally divided between the Services, and, while they include descriptions of many well-known fights, they also cover some of which few students of naval or military history will have any knowledge.

Apart from the interesting sidelights on warlike conditions at various epochs, and the indications of the atmosphere existing in the forces on these historic occasions, the letters and accounts show how little human nature has changed, and where adherence to the formal rules of literary composition of early days has been dispensed with, how little natural expression and opinion has altered. Naturally some terms have become obsolete, and for these the compiler, in excellent footnotes, has given an explanation. He has also given in the case of less well-known actions a short account of the circumstances in which each was fought.

Among the more interesting letters included in this anthology, are those of Ensign Henderson, 28th Foot, who relates how he supported Wolfe at Quebec when the General received his fatal wound, until he died; and of Serjeant Gullemard, of the French Army, who claims to have shot Nelson at Trafalgar. The authenticity of this last is, however, questioned. Another letter deserving special mention is that of Lieut. Basil Hall, R.N., on the Battle of Corunna as seen by a naval spectator ashore.

With such a wealth of material as is to be found in the Reports of the Historical Manuscripts Commission, Regimental Histories, and other published and unpublished records, the task of selection must have been difficult, and though those mentioned above perhaps deserve special attention, the whole collection is well chosen and full of interest. At the same time one must regret that no accounts are included of the great battles of the Marlburian wars, or, barring Seringapatam, of actions in the Indian wars, which have formed such a large part of the war experience of the British Army.

Altogether, from the experiences of the victim of the press gang, who writes to his wife—"When I left you hevens noes it was with an akin hart to be hauled from you by a gang of ruffins," to the description of the Commodore in a landing party, with his coat off, wearing a battered old straw hat, throwing stones at his lagging Turkish allies and adjuring them to "Bear a hand, messmates, shake a reef out of your trousers," the book is full of human and military interest and will well repay perusal.

R.P.P-W.

YEAR BOOK OF THE ROYAL ENGINEERS RIFLE ASSOCIATION.

In reviewing this publication it seems impossible to do better than to quote the following extract from an article written by *The Times* special correspondent at Bisley, on 23rd September, 1934:—"In a foreword to the *Year-book of the Royal* "*Engineers Rifle Association*, which has just been issued, Major-General W. G. S. "Dobbie, Commandant of the School of Military Engineering, and president of the "association, lays particular stress on the value of peepsight shooting under N.R.A. "rules, as well as shooting under the A.R.A. rules which govern most of the Corps' "competitions. He gives two reasons for asking officers and men to interest themselves in the peepsight. One is that the new rifle is fitted with an aperture sight, "and the other is that, as a scientific corps, he feels that the Sappers should be proficient in scientific means which tend towards finer and more accurate shooting. "The issue of the *Year-book of the Royal Engineers Rifle Association* is a new departure. The association has been reorganized in order to ensure a better representation "of the Corps at the Army and Imperial Meetings. There is a hint in the foreword "that in the near future the Royal Engineers may have a Central Meeting at Bisley, "and when this comes into being, all branches of the Services armed with the rifle "will be at Bisley at least once a year. The new year-book is particularly well got "up and is the best printed and arranged of the small collection of hand-books which "come into my possession each year. It gives full particulars of a large number of "attractive competitions, with generous prize-lists, and is a complete guide to the "rules and regulations governing all kinds of target shooting."

The foreword referred to by *The Times* correspondent should be read by all R.E. officers who wish to keep in touch with Corps activities in general, as well as those personally interested in target shooting.

It is to be hoped that the publication of this book will mark a new and better phase in Corps shooting. That a good beginning has been made is shown by the summary of results in 1933–34 given towards the end of the book.

F.I.P.G.

MAGAZINES.

THE MILITARY ENGINEER.

(*Journal of the Society of American Engineers.*)

(*July–August*, 1934.)—*The New Pontons in a River Crossing*, by C. K. Harding. A description of service tests carried out in 1933. The United States Army emerged from the World War to face the problem of providing floating-bridge equipment capable of carrying much heavier loads than those that could safely cross the 1869 bridges. By 1930 the Engineer Board had produced two types of ponton bridge—the Ponton Bridge 7½-ton (Model 1926) and the Heavy Ponton Bridge 23-ton (Model 1924). The former can be reinforced to carry 15 tons, so that the bridges available are 7½, 15 and 23 tons.

The tests described were with the 7½-ton equipment. The pontons are of aluminium and weigh 1,400 lb. The major items of the equipment are carried on four-wheel trailers, one of which takes a bay of bridge, *i.e.*, ponton, baulks and chesses. The tests showed that the most difficult phase in the use of the equipment arose over the handling of the material at the bridge site. Although 16–20 men could easily raise and carry the ponton for short distances, say, up to 100 feet, the effect of longer carries, broken ground and the uncertainties of darkness, was to enormously increase the time taken in the work. Reference to this difficulty is made in the Engineer Board Notes on p. 323, where it is stated that trials are to be made of a two-wheel trailer or " dolly " for handling the equipment.

H.W.H.

(*September–October*, 1934.)—This number contains three articles upon proposed American box-girder bridges.

The first includes the results of erection tests made with the experimental 100-ft. box girder, designed in 1929. The bridge is, generally speaking, a fairly close copy of our Large Box Girder, but the details have been considerably changed, without very obvious advantages. Instead of being connected by four cotter-pins, the sections are joined by fish-angles, involving 104 bolts per box. Furthermore, the heads of many of these bolts protrude from the upper and lower chords in such a way that large *wooden* rollers on runways are required for launching, and a rather clumsy method of attachment of the roadway has to be adopted. The bracing system of the girders has been changed, but this has given increased panel distances, with their increased secondary bending moments in the compression chords, during launching and under load. The bridge seems to take far longer than our L.B.G. to assemble, launch and deck. This design does not appear from the discussion which follows the report to be in any way acceptable to the American engineers as an equipment bridge, and further experiment is proceeding.

The second article is of a very general nature, and is apparently based upon experiences in military bridge design during the Great War, rather than upon the close study of recent developments. Some recent proposals are touched upon, but the author appears to favour the older types. Some of his statements are not entirely borne out by our own experiences. For instance, he dismisses pin-joints as " not practical," and stresses the occasional disadvantages of deck spans, without noting the fact that the box-girder types eliminate all floor system, and reduce the weight to be handled by launching gear. Among more recent advances, he suggests the

use of working stresses up to some 18 tons per square inch, apparently combined with welded connections. It is not clear how this can be accomplished with *our* present-day technique, as such stresses involve the use of heat-treated steels, affected by welding temperatures. A method of connecting girder sections by longitudinal high-tensile steel bolts is illustrated. These are run back along the chords for protection during transit, but, among other drawbacks, would seem to be far less robust and certain than our cotter-pins.

The third article includes a design for a two-girder, 100-ft. box-girder bridge, built entirely of light alloy. The design includes several unusual features, but these have already been partially investigated in this country, and practical difficulties have so far precluded their employment. Nothing appears in the drawings (as reproduced) to indicate proposals for surmounting these troubles. To take but one instance, the very tempting use of the top chords of the boxes for part of the roadway is a feature of the design. This, however, necessitates bolting additional metal panels between the girders, and it is not clear how the holes will be made to register, unless the girders are unusually straight, and are placed on their seatings with quite unusual accuracy. The bridge will not carry our heavy loads, and it is doubtful whether the metal decking is suitable for all types included in our medium classification.

The material proposed (alloy 27ST, of the Aluminium Co. of America) has a strength at yield point (0·2 per cent. set) of 50,000 lb., and a proposed working stress in tension of 22,000 lb. per square inch, with a weight per cubic foot of only 175 lb. Its corrosion resistance is said to be excellent, the coating proposed being—two coats aluminium paint over one coat of zinc chromate and iron oxide. The connections are by shop rivets, and by field bolts, over 1,000 of the latter being required in the bridge. The launching system proposed involves a 60-ft. derrick, and seems to have no great advantage over several others that would be possible with a girder of only just over four tons.

There can be no doubt that, for weight-saving purposes, light alloys can now be produced which have certain advantages over high-tensile steels for military girders. It is extremely difficult to make use of the full strength of the latter, without losing robustness in compression members, and nearly all members of sectional bridges must be designed as such. With light alloys, however, weight can be cut without the use of thin sections. The main objections still appear to be: high unit cost, war-time supply difficulties, and the impossibility of welding without affecting heat treatment.

The general impression gained from these articles is that the American military engineers are still undecided as to their bridging policy, and that although they are following up the possibilities of modern discoveries, they are very handicapped by lack of funds for experiment.

E.F.T.

RIVISTA DI ARTIGLIERIA E GENIO.

(*June*, 1934.)—1. *La cooperazione fra artiglierie.*

In this article, Colonel Merzari emphasizes the necessity for complete co-operation between divisional, corps and army artillery. It may be assumed that, with modern improvements, divisional artillery will have a range of 8 km., corps artillery of 12 to 15 km., army artillery of 15 to 20 km. Taking a normal divisional sector as 2·5 to 3 km., this means that a light group, in the centre of its divisional sector, can cover the front of the divisions to its right and left, and even further. Neither divisional nor corps artillery should be limited to its own particular front; the corps artillery commander must be able to concentrate the fire of the whole of his divisional and corps artillery on any desired target.

2. *Impiego di una compagnia aerostieri d'osservazione.*

Major Cappuccini has worked out the duties of a balloon observation company during an offensive carried out by a division in mountainous country.

A balloon company consists of the following :—Personnel : 6 officers and about 100 other ranks ; Material : One balloon, 3 parachutes, 4 machine-guns, 135 cylinders of hydrogen, etc. The transport consists of various kinds of motor vehicles.

The writer gives full particulars of the balloon and the method of working it, observation, communication, etc., and shows how the duties of the balloon company would fit in with this particular scheme.

3. *Note sull' impiego dell' artiglieria nella battaglia dall' Astico al mare.*

Major Raudino deals with the main characteristics of the employment of artillery in the battle of June, 1918.

The principle laid down by General Herr, of the French Army, as the result of the experience of Verdun, was that artillery should be echeloned out in depth. The original idea, that artillery should hold on to the most advanced positions, to the very last gasp, was recognized as suicidal. The normal position of artillery is behind the line of resistance. Guns should not normally fire from their battle position, but from other positions that are being constantly changed.

The writer compares the employment of the French artillery at the Battle of Matz on the French front with that of the Italian artillery at about the same time between the Astico and the sea.

4. *Nuovi orientamenti nella guerra terrestre.*

Lieut.-Colonel Infante makes a contribution to the study of motorization and mechanization as applied to the Italian Army. He touches briefly on the new armament and the new organization of infantry in foreign armies, referring especially to those of France, Germany, and Great Britain.

Coming to the question of motorization and mechanization, the writer refers to what has been done in Great Britain, France and Switzerland. He has made a special study of developments in England. He considers that Italy should not follow the lead of other nations blindly, but should take advantage of the experience they have gained, and the mistakes they have made, and consider the special nature of the country in which the Italian Army is likely to be called upon to operate.

At present, armoured cars and tanks are a branch of the infantry. The writer considers that they should be formed into a separate corps. The organization that he proposes to adopt, and the various types of tanks, armoured cars and other mechanical vehicles that he suggests introducing, are described in detail, but he also points out the importance of a fully trained personnel that will know how to make the most of the new conditions.

5. *Il mezzo ferroviario nella manovra.*

After a brief historical survey, Captain Paoli discusses the relative merits of railway and motor transport in war-time. Both were used to an enormous extent during the World War, but, however great the advantages of motor transport may be, it is clear that railways will always be essential. When motor transport is employed on a very large scale, it is severely handicapped by the huge quantities of road metal that must be carried in order to maintain the roads in working condition.

Considering a single line of railway 120 km. long, and the fact that a train can travel at three times the speed of motor-lorries in column, such a railway would have a carrying capacity equal to that of 10,000 motor-lorries.

The question affects Italy to a considerable extent. The country is handicapped by the absence of indigenous motor fuel or coal, but possesses ample hydro-electric power for its railways in the north. One source of weakness is the series of rivers that the frontier lines cross ; the bridges over these rivers being liable to destruction by aircraft. Hence the importance of a corps of efficient railway engineers to maintain and repair the railways in war-time.

6. *Circa l'infiammazione spontanea delle polvere infumi.*

Dr. Tonegutti, Chemical Inspector in the Italian Navy, records a number of experiments carried out to determine whether smokeless powders are liable to spontaneous combustion. Most of the experiments carried out gave negative results,

but an experiment carried out in 1928 showed that a sample of 6 kg. of cordite, mixed with 1 kg. of old cordite that had deteriorated by keeping, ignited spontaneously after a year. The temperature at no time exceeded 40° C., and the explosion occurred in the early morning. The author is of opinion that it is necessary to have a fairly large quantity of explosive for the experiment to succeed; he was unable to get the same result with a few strands of cordite.

(*July*, 1934.)—1. *Rinnovamento tattico.* Colonel Biondi-Morra.

Referring to the modifications introduced in the composition of the larger units, *i.e.*, army corps and divisions, and to the armament of the infantry, which now has stronger offensive possibilities, the writer lays stress on the changes that have been brought about in mobile warfare by the introduction of modern appliances for offence and defence.

2. *La scienza al servizio dell' esercito.* Lieut.-General Guasco.

In this study General Guasco draws attention to the value of visible and invisible radiations of light, in their application to military signalling and photography, and shows the progress made in apparatus for this purpose during the Fascist regime. He indicates what has already been done up to date, and the lines along which further progress can be made.

He deals, successively, with (1) tele-photographic, (2) photo-telegraphic, (3) photo-telephonic apparatus. With regard to the latter, there is a choice between using ultra-violet or infra-red rays: the writer points out the advantages to be gained by using infra-red rays.

3. *Il problema del carburante nella difesa nazionale.* Lieut.-General Pugnani.

Countries, such as Italy, that are unable to draw upon a national supply of oil, or of coal from which benzole can be extracted, are obliged to investigate every possible source of supply of a suitable substitute for petrol, such as alcohol.

One kg. of alcohol will produce 6,500 calories that can be utilized for work, as against 10,500 calories produced by one kg. of petrol.

The automobile section of the Italian Army has carried out a number of experiments with mixtures of alcohol and petrol to endeavour to find a suitable substitute for ordinary petrol. One of the most satisfactory substitutes found so far is known as "elcosina," which can be produced at a reasonable cost.

Attempts have been made to make the addition of methyl alcohol to petrol compulsory for motor fuel, but this fuel is not popular amongst motorists.

Beet molasses have been the main source of supply in the manufacture of alcohol; grape-skin dregs, cereals, and fruit pulp make up a smaller proportion, but the total production of alcohol is less than 3% of the amount of petrol used. The Government pays a bounty to encourage the manufacture of alcohol, out of the duty on petrol, its object being to increase the production of alcohol to 20% of the total amount of motor spirit used.

4. *Considerazioni sull' efficacia del tiro contro aerei.* By Brig.-General Faujas.

The writer points out the errors that can be made in preparing and carrying out fire against aircraft, and he draws certain conclusions from them. He has drawn up a table, in which, for distances of 3,000 m. to 10,000 m. inclusive, the percentage probability has been worked out of getting one of the four shells in a salvo from a four-gun battery to burst within 100 m. of the target, assuming a scale of ranges spaced 200 m. apart. From this table he draws conclusions regarding the efficacy of anti-aircraft fire. It is interesting to compare the results so obtained with the 3,000 rounds said to have been necessary to bring down an aeroplane during the World War.

5. *Il problema delle trasmissioni nelle grandi unità celeri.* By Major Cappuccini and Captain de Falco.

Having laid down certain principles on the influence of space and speed in battle, and on the strategy and tactics of the larger mobile units, the writers deal with the signal communication in such a unit. They describe the characteristics of the

different systems of communication, and express their views on the possibility of using existing telegraph or telephone systems in the sphere of operations, and the provision of suitable types of apparatus for signalling in mobile units.

6. *Il rifornimento delle munizioni di artiglieria nella divisione.* By Major Camera.

The importance of the supply of ammunition and the huge consumption of the latter in the Great War are well established facts.

The writer describes the system of supply of artillery ammunition in an infantry division. Batteries and divisional ammunition columns are provided with transport enabling them to carry one day's supply (250 rounds per gun). The method of keeping up the supply for different types of guns, when in action, is made clear by illustrations.

The writer ends by describing the maintenance of the supply of munitions in mobile warfare.

(*August-September*, 1934.)—1. *Le grande manovre del* 1934. By Colonel Biondi-Morra.

An account of the Italian Army manœuvres carried out in August, 1934, north of Florence. One of the problems connected with the manœuvres was the accumulation of a large amount of mechanical transport on very limited communications, another was the water supply in a district in which water was scarce.

2. *Metodo rapido per l'impianto del progetto di massima di una bocca da fuoco.* By Lieut.-Colonel Sacchi.

Ballistic calculations.

3. *Caso concreto di rifornimento idrico dei comandi reparti e servizi di una divisione operante.*

Lieut.-Colonel Biagioli has worked out a scheme for the water supply for a division operating in a hilly district where water is scarce. Water is required for men, animals and mechanical transport.

The sources of supply are: (1) a water supply main of 160 mm. diameter, that supplies neighbouring villages, (2) seven springs of varying yield, (3) two streams (for animals only). A daily ration of five litres (for cooking and drinking) are allowed per man, and 20 litres per animal. Water is stored, where required, in wooden zinc-lined boxes. A special apparatus for drilling holes in the main and tapping the supply is described in detail.

4. *Le posizioni dell' artiglieria durante la guerra* 1915-18. By Lieut.-Colonel Mazzei.

A collection of 28 interesting photographs of guns and howitzers, taken during the war, on the Italian front, showing different methods adopted for concealing and camouflaging the guns.

5. *Della detonazione nei motori a scoppio e degli antidetonanti metallici.*

Lieut.-Colonel de Braud discusses the theory of "knocking" in motor fuels, and points out how the addition of certain substances will reduce the tendency to "knock." He describes the proposal made by Edgar in America to classify fuels by their "octane number," and explains what is meant by this. Lead tetra-ethyl appears to be the most efficacious substance for reducing "knocking."

In summing up, Colonel de Braud concludes that anti-knock fuels do not offer great advantages in ordinary motor-car engines, but that they are likely to be of considerable value in racing-car and aeroplane engines.

(*Technical Supplement. September*, 1934.)—1. *Sul calcolo dei coefficienti differenziali e degli elementi secondari occorrenti per il tiro.* By Lieut.-Colonel Bruno and Captain Cavicchioli.

2. *Contributo al calcolo dei ponti di circostanza.* By Major del Bello and Lieut. Betocchi.

Calculations for wooden bridges. The writers suggest certain modifications in the formulæ adopted in their previous article in September, 1933, to allow of the use of smaller sections for road-bearers.

3. *L'azione di un potente elletromagnete sulla traiettoria di un proiettile.* By Colonel Sacco.

4. *Sull' effetto dei proietti.* By Captains Cavicchioli and Ravelli.

5. *Studio sulla stabilità delle travicelle dei ponti in legno.*

Captain Palazzolo deals with the strength of wooden beams carrying two or more concentrated loads.

6. *Tavole di tiro controaerei.* By Lieut. Pellegrini.

A.S.H.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*July*, 1934.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. *Les pionniers-pontonniers-cyclistes au cours de la 2e sortie d'Anvers en Septembre* 1914.

Lieut. Gilmont gives an account of the attempts made by a pioneer company, hastily equipped with old bicycles on mobilization, to carry out demolitions on the Louvain-Tirlemont and Aerschot-Diest railways.

2. *Les opérations militaires à la frontière est de la province orientale pendant la guerre* 1914-18.

Lieut. Bayot gives us a second instalment of an account of operations carried out in the Belgian Congo in November and December, 1914, and January, 1915.

In November the Germans attempted to land on the Belgian bank of Lake Kivu, but were repulsed. In December operations took place along the Ruzizi river. By the end of the year the German forces had been driven completely out of Belgian territory, except for the island of Kwidjwi, and the Belgians were able to consider the question of an offensive in collaboration with the British.

On the 12th January, a small German force crossed the Ruzizi and attacked the Belgian post on the Luvungi river, but received a severe check, and the German commander, Captain Schimmer, was killed.

3. *Comment on franchit les grandes rivières.*

Major-General Piérard deals with the question of the disputed passage of a large river. The general principles to be observed are that a passage should be effected on as broad a front as possible, and that re-entering angles are the best places at which attempts should be made to cross.

Before any bridging can be thought of, a strong force must be ferried across the river, and must take up a position so far ahead that the enemy cannot shell the bridge-site.

Each boat, or raft, used for ferrying, will follow a triangular course, *i.e.*, from the starting point across the river and back, being towed up along the near bank the distance that the current has carried it downstream. Care must be taken not to allow the triangular courses followed by separate units to overlap, or there will be risks of collision in the dark. The writer discusses the relative merits of using single boats, boats coupled together in pairs, or rafts of two or three boats. Single boats, although handiest to manage, can only carry a limited number of men; rafts are awkward, but they are the only means of transporting material and animals.

Bridging is not dealt with in this article, except for the mention of the fact that bridges are required at several points. It is a matter for regret that, with short service in the Belgian Army, it will be difficult to train men properly for pontoon work.

4. *Aperçu sur la cavalerie allemande.*

Lieut. Dinjeart concludes his article in this number. In dealing with remounts, he points out that Germany mobilized 750 squadrons at the beginning of the war, and has now nearly as many horses available as it had in 1914.

He next discusses the training of officers and other ranks. Crossing rivers is a form of training on which special importance is laid. The tactical employment of cavalry and its duties in warfare are dealt with.

The writer concludes by quoting the opinion of General von Seeckt and others on the value of cavalry in future warfare. The official German opinion is that cavalry without some form of motorization is of indifferent value, but, from a tactical point of view, the horse is indispensable.

5. *Une levée de candidats sous-lieutenants en* 1813. By Major Couvreur.

After the disastrous campaign of 1812, Napoleon raised "Gardes d'honneur"; young men of good family who were expected to be fit for the rank of sub-lieutenant after a year's service.

This is an account of the 1st and 2nd Regiments of Gardes d'Honneur, of whom about a quarter were Belgians, up to the time of their taking part in the campaign of Saxony in 1813.

(*August*, 1934.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. *L'attaque de l'abri de Craonne en août* 1918, *par le* 1*er bataillon du* 4*e régiment de ligne.* By Lieut.-Colonel Bonnevie.

A carefully planned and well-executed attack on a portion of the German line, that resulted in 17 of the enemy being killed and 42 taken prisoners, at a comparatively trifling cost to the Belgian battalion that took part. The success was largely due to effective co-operation on the part of the artillery.

2. *Principes généraux d'organisation des troupes coloniales.* Lieut.-Colonel Jadot.

The employment of colonial troops in Europe during the Great War has brought up the question of the necessity for revising the organization of colonial armies. As far as Belgium is concerned, there is only one colony to be considered: the Belgian Congo. In a population of ten millions, the annual contingent to be raised is 2,808 (figures of 1933). Service is for seven years with the colours.

On enlistment, the native soldier is sent to one of three large camps of instruction for two years; for the rest of his service he serves with his battalion or special unit.

In the next part of the article the writer deals with the question of officers, and compares the system in force with those prevailing in the French Colonial Army and in the Indian Army in British India. At the end of his service with the colonial army, which may be from 12 to 18 years, the Belgian officer reverts to home service, and takes his place in the home army according to seniority. The writer discusses the pros and cons of changing the system to one on the lines of the French Colonial Army or the Indian Army.—(*To be continued.*)

3. *Transports par automobiles.* By Major Gilbert.

The writer works out a scheme in which a northern and southern army are in contact, and the Director of Army Transport of the northern army receives an order to arrange for the movement of two divisions by improvised motor transport to relieve two divisions already in the front line. The scheme is illustrated by a map and a series of tabulated statements.

4 and 5. *Emploi des mi. dans la défensive.* By Major Collard. *Cas d'emploi des mi. du deuxième échelon d'une position défensive.* By Lieut.-Colonel Mersch.

Major Collard discusses the employment of the machine-guns of an infantry division with two regiments in the front line: the machine-guns in the second echelon furnishing a barrage in front of the first echelon.

Lieut.-Colonel Mersch finds himself in agreement with Major Collard in most of his views, but he deals more fully with some points that, in his opinion, require further elucidation.

6. *Essais comparatifs de poste d'écoute de D.T.C.A.* By Lieut. Rosart.

A report of trials made in listening posts for the anti-aircraft service. In the first part the writer describes the amount of accuracy that can be obtained with the naked human ear in listening for aircraft. What he calls the "angle of hesitation" works out to 8°. With special apparatus the sound can be amplified and the angle of hesitation reduced.

In the second part of the article Lieut. Rosart describes a series of experiments

carried out with seven sets of apparatus to test their relative merits, and the results obtained.

(*September*, 1934.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. *Combat de Budingen. D.C. belge*, 18 *août* 1914. By Lieut.-Colonel Vicomte d'Ardoye.

An account of the defence of the bridge over the Gette at Budingen on the morning of the 18th August, 1914, by the 1st squadron of the 2nd Guides—subsequently reinforced by another squadron—against the infantry, supported by artillery, of the vanguard of Von Kluck's army. After a gallant defence, in which the Belgian cavalry suffered numerous casualties, the cavalry was obliged to fall back, their flank having been turned.

2. *Principes généraux d'organisation des troupes coloniales.*

In this second part, Lieut.-Colonel Jadot makes a careful study of the organization, effective strength, and cost of maintenance of the French colonial forces, the military forces of the British Empire, and the colonial forces in the Dutch East Indies.

The Belgian forces in the Congo State are not quite comparable with the colonial forces of the Great Powers. They are small, especially in comparison with the area of the country; the climate is trying to Europeans; Belgium has no navy, and the colonial dominion is 5,000 km. distant from the home land. On the other hand, the territory is compact, the natural communications are good, and are supplemented by a network of railways and roads. The cost of the colonial forces is debited to the colonial budget, but, owing to the economic crisis, the home government has taken over the military expenditure for a period of three years.

In summing up, the writer dwells on the importance of a nation studying its colonial problems, and including the defence of its colonies in its own scheme of defence.

3. *Le peloton en grand garde.*

Captain Vermandel works out a tactical scheme for a platoon, with the help of two maps.

4. *Considération sur la nouvelle instruction (française) pour les unités de mitrailleuses d'infanterie.*

Lieut.-Colonel Mersch deals with the more important points in the new French regulations of 1934 for Infantry Machine-gun Units, which supersede the provisional instructions of October, 1920.

A few interesting points about the French machine-gun are:—

The rate of fire is 400 to 500 shots a minute.

The practical rate of fire can attain 250 shots a minute.

The maximum range is about 4,300 metres.

Each company carries 6,000 rounds per machine-gun, a proportion of the cartridges having armour-piercing bullets. Fire against low-flying aircraft is allowed for, at ranges of less than 1,000 metres.

5. *Les armées françaises dans la grande guerre. Tome V. 1er volume.*

A review of a portion of the French official history of the war, from the preparation for the great offensive under General Joffre (November-December, 1916) to General Pétain's assumption of the command (15th May, 1917). Only a few of the outstanding events can be dealt with in such a brief review. In December, 1916, a change was made in the supreme command in France, General Joffre becoming technical adviser to Government, and General Nivelle succeeding him as Commander-in-Chief of the Armies of the N. and N.E. Nivelle made several changes in Joffre's plan for the offensive, his main object being to force a decision in 24 or 48 hours. In February the whole plan was upset by the Germans voluntarily withdrawing to the Hindenburg line. The object of this retirement was interpreted differently by the British and French: the British view being that an attempt would be made to cut them off from the Channel ports. The divergence of opinion led to an exchange of views between the Governments, and to the Compiègne conference. The offensive

was launched on the 16th April; the first four days failed to achieve the expected break-through. The plans were then modified, and the objectives limited. The losses in the great offensive between the 16th and 25th April became a subject of acrimonious discussion, the final figures being approximately 120,000 in killed, wounded, and missing.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*May-June*, 1934.)—1. *Les passages de la Meuse par les Allemands en août* 1914 *d'après le livre du Général Kōnigsdorfer.* By Major Metz.

This is a review of a portion of General Koenigsdorfer's book, *Beispiele von Flussübergängen*, which has been translated into French. The writer deals with three of the river crossings described in the book. These river operations, all on the Meuse, are those of the 3rd Army (General Hausen), of the 4th Army (Duke Albert of Wurtemberg), and the 5th Army (German Crown Prince). After describing each operation, General Koenigsdorfer criticizes it at length, points out the mistakes that were made, and makes suggestions for avoiding them in future.

Major Metz, who naturally disagrees with some of the statements made by an ex-enemy writer, thinks that there are valuable lessons to be learnt from the book. Some of the main points emphasized are: (1) the necessity for a pursuing force to prevent the enemy destroying all bridges behind him, (2) when the enemy is holding the opposite bank it is useless for an attacking force to try to capture an existing bridge, without effecting a passage by ferrying or other means at the same time, (3) a passage should be effected at numerous points, and, preferably, away from villages, (4) the insufficiency of bridging equipment in divisions and corps, and the necessity for army bridging equipment. With regard to the latter point, General Koenigsdorfer points out that at the beginning of the War a corps of two divisions only possessed 200 m. of bridging equipment, all told. The writer's comment is that the French possessed very much less.

In modern warfare the value of a river is greater than ever, as it is a complete obstacle to all forms of mechanical transport.

2. *Note sur un type de profilomètre.*

Captain Sillard has worked out a simple graph for calculating the areas of cross-sections of road and railway embankments. His "profilometer" avoids the use of a logarithmic scale or the use of a very large sheet of paper. The article explains ts use.

3. *Un nouveau procédé de revêtement de route.*

M. Deschamps describes a method of constructing road surfaces without going to the expense of a concrete road or a bituminous surface. He uses ordinary stone metal, well graded, broken to a 60–80 mm. ring, 13 cm. thick before rolling, mixed with a special binder known as "Pouzzolithe," which is added in the proportion of 350 to 400 kg. to 1 cb.m. of stone. "Pouzzolithe" is a preparation of French manufacture, a mixture of cement and artificial pozzuolana, to which a proportion of metallic oxide is added to accelerate the hardening. 35 to 40% of water may be added to it without the risk of washing the cement out of the aggregate.

The advantages claimed for this method are cheapness, rapidity of construction and waterproofness. The surface is hard-wearing, non-slippery, and has been used satisfactorily on a 1 in 8 gradient.

4. *Exercice sur la carte. Emploi du génie divisionnaire dans la défensive.*

A scheme for divisional engineers worked out with the aid of a map.

The commanding engineer (commandant du génie) is technical adviser to his

divisional commander in all engineering matters, and has under his orders the engineer battalion commander (commandant du bataillon) and the engineer park company. The battalion consists of two sapper companies, each under a captain, with four subalterns apiece.

The paper works out fully how the divisional commanding engineer would carry out the scheme that has been set.

(*July–August*, 1934.)—1. *Évasions.*

Major Nicollas gives an interesting and thrilling account of his escapes from a prisoner-of-war camp in Germany.

Captain Nicollas, as he then was, had been interned in the officers' prison camp at Reisen since the summer of 1917, and, having collected a suit of plain clothes, money, map and compass, decided to escape. He managed to get admitted to the hospital at Posen early in October, and, one evening, climbed the outer wall and got away. He travelled by train through Berlin, but when nearing the Dutch frontier, he was discovered, and eventually taken back to Reisen. From there he was transferred to the camp at Bütow. Here he and some other prisoners tunnelled from underneath the hut in which they were confined towards a cemetery just outside the prison wall. Unfortunately, when it was nearly completed, the tunnel was discovered, and the attempt was frustrated.

Captain Nicollas then adopted the more simple expedient of walking out through the front gate, past the sentry, who had just come on duty. The bluff succeeded. Having reached the railway station, he travelled, by train and bus, to Ahaus, near the Dutch frontier. Here he managed, by sheer bluff, to avoid capture, and got safely away into Holland, and thence to France. Some of his adventures were very thrilling, and his keen sense of humour must have been a great asset in trying circumstances.

2. *Notes sur les inondations.*

Lieut.-Colonel Rousseau works out the solution of the following problem. A valley, with abrupt sides, and a flat bottom about 300 metres wide, has a river flowing through it, 6 m. wide and 0·70 m. deep, with a daily discharge of 120,000 to 125,000 cb. m. It is required to make the valley impassable for tanks, on a front of 25 km.

To flood the whole valley is impracticable, as it would require the full discharge of the river for six weeks to obtain the required result.

The solution arrived at is to raise the level of the water in the river-bed itself to a minimum depth of 1·40 m. by a series of 25 dams, each 1·70 m. high. The necessary hydraulic calculations are given, also a set of calculations for submerged weirs.

3. *Le problème du chauffage des locaux par l'air conditionné.*

In the first part Captain Simon discusses the problem of heating (and cooling) buildings generally, and, in the latter part, he describes a heating installation provided in the "Henri Poincaré" amphitheatre in the École Polytechnique.

Experience shows that the best temperature for comfort in a living-room is 18° C (64·4° F.), with a 50% degree of humidity. The writer deals with the physical, chemical, and bacteriological purification of the air; then with its humidification and heating (in the winter), or cooling (in the summer), and, finally, with the movement of the air inside a building.

The systems adopted in the lecture-room at the École Polytechnique are described in detail.

4. *Exercice sur la carte.* (*Sapeurs de Chemin de fer.*)

A scheme set to the reserve engineer officers at the School of Versailles, involving demolition work on a large scale by railway engineers. A solution will be published in the next number.

A.S.H.

REVUE MILITAIRE SUISSE.

(*July*, 1934.)—1. *Réflexions sur la cavalerie: mes stages aux écoles de cavalerie allemande et italienne.*

Major de Muralt, of the General Staff, spent a period of attachment to the German and the Italian cavalry. He expresses his views on the future of cavalry. However much mechanization is introduced, the horse will never be completely ousted, but horsed and mechanized cavalry will continue to exist side by side. It is clear, from the number of cavalry regiments that Great Britain, France, Germany and Italy continue to maintain, that the horse is still looked upon as essential in war-time.

Major de Muralt describes in detail the various branches of the Cavalry School at Hanover, to which he was attached, the training of officers and men, and the schooling of remounts. Drag hunts take place twice a week during the autumn, and all officers are required to take part. He has nothing but praise for the school and the staff, and appreciation of the way he was received.

2. *Directive aux cadres de l'unité pour le C.R.*

Colonel Léderrey here gives a list of instructions for officers on the way to carry out a "repetition course," and of the points on which N.C.O's and men should be examined.

3. *La guerre chimique en campagne.* By S. de Stackelberg.

This article is continued from the June number.

Discussing chemical bombardment by artillery, the writer points out that toxic gas shells should not be used if the velocity of the wind exceeds 1·87 metres per second, nor tear gas if the velocity exceeds 2·21 metres per second. But, with an artillery bombardment, the direction of the wind is not as important as in the case of a cloud discharge. The best calibres for discharging gas shells are 120 and 150 mm.; 75-mm. shells only contain ½ litre of active liquid.

Projectors are rudimentary cannons one metre long and 137·6 mm. in diameter, firing at a constant elevation of 45°. The charges consist of little bags of powder, each bag corresponding to a range of 250 m., the maximum range being 1½ km. The projectors are grouped in batteries, and are fired electrically.

Seeing that many countries now give anti-gas instruction to their civil population, it is more than ever important that the Army should be fully instructed. The carrying and wearing of gas-masks on manœuvres is, by itself, worse than useless; the soldier should be taught to have a proper dread of gas. He should be subjected to regular gas attacks. The gas used should be irritating, but harmless. This would ensure the proper fitting of gas-masks, and the soldier would learn what to do, instinctively, in the case of a real gas attack.

(*August*, 1934.)—1. *La constitution organique du bataillon et son emploi en campagne.* By General Clément-Grandcourt.

General Clément-Grandcourt, of the French Army, expresses his views on the best organization and employment of a battalion under modern conditions. During the war he commanded, first, a battalion of Algerian "tirailleurs," next, a battalion of infantry of the line, and, lastly, a battalion of Chasseurs alpins.

Battalion organization was then in a state of transition. The first battalion consisted of four companies, all alike, with one machine-gun section; the second one had three companies of rifle-men, a company of machine-gunners, with eight machine-guns and two 37-mm. pieces, besides staff and signallers. The third battalion had four companies of rifle-men, a company of machine-gunners with 12 machine-guns, and a company of specialists.

General Clément-Grandcourt is decidedly in favour of the last arrangement, with four interchangeable companies of rifle-men, even though it gives the C.O. six separate units under his command. But he considers that the best arrangement of all is to

have an automatic rifle that can be converted into a machine-gun by attaching it to a portable tripod. He would give each of the four companies of rifle-men 12 to 16 of these weapons, and then add a fifth company group, consisting of signallers, pioneers, large-bore machine-guns, two pieces of small calibre, and two mortars.

2. *Réflexions sur la cavalerie.*

Major de Muralt continues his article and here describes the Italian School of Cavalry at Pignerolo, near Turin. There is also a branch school, subordinate to the Pignerolo School, at Tor di Quinto, outside Rome. The main course is for cavalry second-lieutenants who have just passed out of the Military Academy at Modena, and lasts nine months, at the end of which the young officers go through a supplementary course at Tor di Quinto.

About 600 remounts are kept at the school, of which about half are of Italian stock, the remainder thoroughbreds or foreign. In training the horses, great importance is attached to jumping, from the very beginning.

A snaffle bridle with nose-band and martingale is regulation, except when working with the troop, when a " Pelham " bit is used, of a kind that is very distantly related to the " instrument of torture " used in the Swiss cavalry. Major Muralt thinks that there is a great deal worth copying from the Italian cavalry.

3. *La guerre chimique en campagne.* By S. de Stackelberg.

In this third article on gas warfare, the writer produces statistics to show that most of the gas casualties during the war were due either to masks not being fitted properly, or to their being put on too late, or removed too soon.

He next gives a list of the requirements that should be fulfilled in a gas mask, both of the filtering and of the isolating type. Quite a number of gas-masks exist, of different varieties, but none actually fulfils all the conditions.

We then come to the precautions to be adopted in a gas attack, the alert, alarm, and other signals, and, finally, to the precautions to be taken during a chemical bombardment.

(*September*, 1934.)—1. *Deux corps de cavalerie à la bataille de la Marne* (6 *au* 9 *septembre* 1914).

Colonel Poudret writes a review of a book with the above title by Lieut.-Colonel Pugens on the action of two German cavalry corps, commanded, respectively, by von Richthofen and von der Marwitz, which, during the most critical period early in the war, filled the gap between the 1st Army under von Kluck and the 2nd Army under von Bülow, and prevented the Allies from breaking through on the Marne.

Lieut.-Colonel Pugens comes to the conclusion that, in spite of numerous errors of execution, the two cavalry corps fulfilled their duty of delaying the allied armies. They successfully covered the extraordinary reverse movement which the 1st German Army audaciously carried out in broad daylight; they amused and deceived the hesitating Allies; they compelled the whole British Army, Conneau's cavalry corps, and the left wing of the 5th French Army to lose three days in reaching the Marne; and, in spite of the serious mistake that allowed the Marne bridges to fall intact into the hands of the Allies, they covered the retirement of the German right wing, and saved the 1st Army from disaster.

2. *Réflexions sur la cavalerie.*

Major de Muralt concludes his article in a third instalment. He continues the account of his experiences in Italy. The general principles of cavalry instruction in Italy are to train riders and horses to move and fight on every sort of ground and in the specially difficult conditions of modern warfare; everything that is not absolutely essential is purposely excluded. The main principle is to allow the horse the maximum freedom in his natural movements. A comparison is made between the Italian seat and that laid down in the German training manual. The Italian cavalryman rides with comparatively short stirrups, the feet right home in the stirrups, and the body slightly inclined forwards.

The writer describes the course of instruction that the Italian officers go through at the finishing school at Tor di Quinto, for which he has nothing but praise.

In concluding his article, Major de Muralt makes a comparison between cavalry instruction in Germany and Italy and that in Switzerland. Apart from a difference in conditions, it is impossible to get, in the short time available for training in Switzerland, the same results as in the other two countries.

A.S.H.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*July*, 1934.)—As it is twenty years since the heir to the Austro-Hungarian throne, the Archduke Franz Ferdinand, was assassinated in Sarajevo, the *M.M.* starts this number with a portrait of the Archduke and a character-sketch of him by Glaise-Horstenau, the keeper of the State Archive.

The Archduke, in his capacity as Inspector-General of all the armed forces of the Austro-Hungarian Empire, had found it necessary, on June 28th, 1914, to visit the capital of Bosnia, although he was perfectly aware of the Bosnian hatred of their Austrian rulers, and hence of the risk he was running. Whatever the causes of the Great War were, the spark which set it off was the Archduke's murder. Glaise-Horstenau hence looks upon him as the first to die a soldier's death among the millions who were to fall in the succeeding years. His soldierhood may have been less in evidence than that of his imperial uncle. He more often appeared in plain clothes than the Emperor did, but he was at heart hardly less of a soldier, and certainly not in his recognition of the role of decisive importance played by the armed forces in the life of every state, and especially among the various nationalities which went to make up the Habsburg Empire. Very early he recognized that Austro-Hungary's armed forces could only exist when they rose superior to nationality, and were kept clear of the lines of increasing cleavage between the different peoples of the Empire; and he was only 31 when he wrote to the C.-in-C., from a sick leave in Switzerland, very strongly to this effect, opposing a territorial system which had been adopted with the idea of facilitating mobilization, and recommending that the soldier should be placed out of reach of all national and socialist agitation. His undeniable dislike of the Hungarians was certainly not unconnected with the Hungarian policy directed against the unity of the Austro-Hungarian army. To Cardinal Kopp about the year 1900 he said that he considered that the most essential bulwarks of the Empire were the German language, the ruling dynasty, and the Roman Catholic religion.

For the preservation of the German language, as uniting the whole army, he laboured, and against Hungarian separatist plans he fought, being instrumental in the issue of an Army Order directed against such by Chlopy in 1903. Two war-ministers who were too ready to give way to Hungarian demands he had removed, and when Auffenberg's title was changed from Imperial War-minister to War-minister *tout simple* he threatened if any more was given away to appear in Vienna "only in a top-hat." To the stand he put up against this movement and to the way in which he handled the Czech regiments which gave trouble during the Balkan crisis of 1912-13 Austro-Hungary is indebted for the fact that there was no sort of trouble during the great mobilization of 1914. No greater honour could have been paid by the army to their Inspector-General who had already passed away.

The Influence of Sea-Power on the Great War, by Lieutenant Handel-Mazzetti, late Imperial Austro-Hungarian Navy. The author treats his subjects under the following headings:—(1) The significance of the Sea to the Powers which took part in the war. That all the Great Powers engaged in the war were dependent upon their external trade and their imports from overseas is shown very clearly by the trade-figures for 1913 here given, in millions of marks, of each of the three countries of the Triple Alliance and of the three countries of the Entente. Hence blockade brought

to the Central Powers, but also to Russia, economic collapse and the tragedy of exhaustion; while the command of the sea allowed the Western Powers to draw upon the resources of the rest of the world. The longer the war lasted the more heavily would this have weighed to the advantage of Germany's enemies. Command of the sea would have made Germany victorious in 1914.

(2) Sea-power and Policy. Not only the belligerents, but also the neutrals, as far as they lay on the sea and were dependent upon it, came under the ban of sea-power. Neutral powers opened up their resources, and were pressed into the war against the Central Powers. The part played by the United States is the best example of this.

(3) The Struggle for the Command of the Sea. This is dealt with under three sub-heads, (*a*) the sea-battle which did not take place; (*b*) the sea blockade, and (*c*) the cruiser and submarine warfare.

As regards the first-named the author points out that a victorious sea-battle would have been for Germany of an importance greater out of all proportion than for Great Britain. England had command of the sea without it, Germany could only obtain this command by fighting. The Germans preferred to keep their fleet as a "fleet in being" to risking a decision which would have meant the end of the beaten fleet. It is, however, obvious that a defeat for England would have been followed by far graver consequences than a defeat for Germany, which was not in all respects dependent upon the sea. The Germans should therefore have risked the great sea-battle, and that they did not do so Lieut. Mazzetti attributes to the fact, that at the moment when the German Grand Fleet was required, its creator, Admiral von Tirpitz, who knew exactly what he had created the fleet for, was no longer naval commander-in-chief. "This was perhaps the gravest of all the mistakes committed on the German side!" This statement needs amplification. Admiral von Tirpitz, while he was C.-in-C., was not allowed to risk the fleet. When nearly two years after war broke out the eagerly desired sea-battle came, the result exceeded all German expectations. In spite of a British superiority of two to one, the result was a German victory tactically, but not strategically, and still less politically. The battle was uncompleted, the British and German fleets resumed each its role as a "fleet in being," and henceforward acted only as a backbone to other methods of fighting, more economic than military, the blockade on one side and submarine warfare on the other.

Writing of (*b*) and (*c*) the author states that by 1918 the war had become only a race between these two methods to see which could bring about first the collapse of its adversary. That the race was won by the Entente was partly due to the fact that submarine activity had been adopted too late.

(4) The Influence of Sea-Power on the Warfare on Land.

(5) The Victory of Sea-Power over Land-Power. To speak thus of a victory of sea-power, when it never came to a decisive battle at sea, may at the first sight appear as an exaggeration. Nevertheless this is the state of affairs which the end of the Great War disclosed. It is true that certain events on land also played a considerable part, above all the battle of the Marne, but we must not forget that it was only the command of the sea which made it possible for the British Army to appear on the German right wing and thus to weaken that very wing of which von Schlieffen had written, "But make ye me the right wing strong!" It was the command of the sea which made possible the saving of the Serbian Army (*vide The R.E. Journal*, September, 1932, p. 567, and December, 1933, p. 699), the hunger-blockade of the Central Powers, the provisioning and supply of all the enemy nations, the dragooning of neutrals and the influencing of world opinion. Sea-power was certainly less militarily to be felt, and more economically and politically, but this only increased its value at a time when all nations, owing to their complicated economic structure, are dependent upon world-economics, and in which the gaining over of the neutrals is of the greatest importance. The Great War developed from a purely military campaign

to an economic war of a hitherto hardly known intensity in which all civil populations were involved. In such a war that group of nations must in the end be victorious which actually holds command of the sea. The conquest of this command, incorporated in the British fleet, alone could have made a difference in the result.

Irresistibly one is drawn to an historic parallel, the Napoleonic wars. While Napoleon was winning his brilliant victories at Austerlitz, Jena and Auerstedt, and finally, after Aspern, at Wagram, his fate had long since been decided on the sea at Trafalgar. He conquered himself to death, while he could no longer reach his most implacable foe, England. The two blows he directed against that country, the expedition to Egypt and the attempted Channel crossing from Calais, were defeated in the sea-fights off Alexandria and Cadiz.

The 52nd Infantry Regiment in the Battle of Stanislau, 6th–8th July, 1917. A first instalment of this article gives a clear picture of the troops, their dispositions and circumstances in a trench-warfare position, preparatory to being attacked. The writer's object is to describe the details of a fight as the best means of conveying a correct recognition of the state of affairs, and a true appreciation of the significance and consequences of those generally sudden impressions which the changing phases of the fight make upon the troops and upon their leaders who are on the spot. Theoretically this sort of thing can hardly be illustrated, but an actual example, the author hopes, may call forth in the reader the necessary understanding.—(*To be continued.*)

Thoughts about the Degree of Effectiveness of Machine-gun Fire, by Major Däniker, Swiss Army. The writer is the *Jane* of small arms, as knowledgeable in his own department as Major Heigl is about tanks. He has, in addition to his many articles describing various small arms, made in book form two excursions into the theory of musketry (*vide The R.E. Journal*, June, 1934, p. 352) and his considerations in this article on the theory of m.g. fire will be of interest to m.g. commanders, whose business it is to produce such fire effectively, and also to the field sapper, who too often finds it thrilling.

As a result of the introduction of new weapons and tactical methods, the targets of the modern battlefield have now assumed an order of dispersion which compels m.g's to adopt traversing-fire both in depth and breadth to a far greater extent than hitherto. This places the whole question of the efficiency of m.g. fire in a new light. It must now cease to be regarded theoretically as little more than a much improved form of volley-firing.

In 1879 in the Afghan War the indifferent shooting of our troops impressed a young R.E. officer to such an extent that, having made up his mind that a remedy could only be found in an application to practice of the theory of musketry, he set about to make a thorough investigation of the latter, which materialized later in a text-book.

In those days of volley-firing the conditions of hitting were studied, and a recognition of the applicability of the theory of probability placed the result of these investigations upon a secure basis. One accepted as established a "beaten" zone, or rectangle upon the ground which included all hits, and a "zone of effective fire," nucleus or *noyau de dispersion*, which enclosed 75% of all hits; this latter being a smaller rectangle occupying about the middle of the beaten zone. It is relevant to the matter now in hand to notice that the decrease in density of hits was regarded as existing only in one direction, viz., depth, and not in breadth. For this there were two reasons, viz., that fire aimed at one fixed point is easier of control as regards direction than as regards elevation, and that in any case lateral dispersion is relatively small (*e.g.*, the dimensions of a well-known "beaten zone" are taken as 120 yards long, and only 14 feet broad).

If fire has nowadays to be distributed in breadth against broad targets the distribution of hits in breadth assumes quite a different character from their distribution in breadth when the fire is concentrated, *i.e.*, aimed at one point. Hits, except at the extreme edges of the zones, will be distributed so regularly that the idea of the existence of a "zone of effective fire" cannot arise.

If then the efficiency of fire is to be judged at all, it becomes necessary to seek some other basis upon which to work, and Major Däniker's suggestion is that the best way is to associate the different classifications of fire with definite degrees of efficiency, measured in percentages of loss they might be expected to inflict. Omitting for the moment barrage, he classifies m.g. fire as "destructive," "holding-down" and "harassing." It would be a mistake to attempt to identify these three descriptions of m.g. fire with our own classifications of rapid, normal and slow. They correspond neither tactically, nor as regards rate of fire.

"Destructive" fire is defined as that which brings about a hit on one target in every two, *i.e.*, which would cause the enemy troops exposed to it 50% of losses, the assumption being that the infliction of a 50% loss would put ordinary troops out of action, they would at any rate for the time being be "destroyed." The time-factor obviously enters into this, since the losses must be caused during the time the target is exposed.

"Holding-down" fire is that which forces the enemy to take cover and to keep it. It should be able to cause 15% losses per minute on lying targets. This is about the equivalent of causing 50% losses on standing (advancing) targets, which is the same result as achieved by "destructive" fire, so its density must be the same, *i.e.*, with the same number of guns its rate of fire must be the same.

"Harassing" fire is any rate of fire which does not rise to the intensity of the foregoing.

"Barrage" fire needs no definition. When an m.g. barrage is laid down its density should be such as to cause troops 50% of loss in the time they take to pass through it.

Using the figures assumed and normal rates of fire, the author then works out examples at various targets and ranges to determine the degree of efficiency of fire attained, or alternatively, given the description of fire it is desired to apply, how many m.g's are necessary.

The whole article is worthy of consideration, not only as containing many good points, but as treating the subject from a different standpoint to ours, as witness the designation of the various kinds of fire, not from the firer's point of view and that by rate only, as rapid, normal or slow, but by their intended effect upon the enemy. Further, because the country which alone among European powers seriously studied the machine-gun question for many years (in fact up to the South African War) was Switzerland.

Air-Reconnaissance and Ground Strategy. This article consists mainly of extracts from General Armengaud's *La reconnaissance de l'ennemi par l'armée de l'air et la manœuvre stratégique des armées de terre*, which appeared in the April, 1934, number of the *Revue militaire française*. As regards the value to a nation's military air forces of having well-developed civil aviation, the reviewer, Major-General Schäfer, adds some instances of the use of civil passenger aeroplanes for military purposes. He states that they have been used with complete success in recent manœuvres both in France and in Italy for intercommunication between separate columns and head-quarters; and points out as specially suitable for this sort of work the auto-giro, a type already to be found in the British Air Force, and invaluable for mountain-warfare. A further advantage of possessing well-developed civil aviation is that it can be drawn upon by military aviation for the supply of pilots. Several thousand of these have in England received training with the R.A.F.

The speeds of modern postal aeroplanes make them suitable for use on military communications, *e.g.*, the German Postal 'plane He-70, which has flown at 365 km. per hour. Holland and the United States have also postal aeroplanes in this class.

Austria and Prussia. The firm of Herder of Vienna and Freiburg im Breisgau is bringing out in thirty volumes a *History of the Leading Nations*, and Colonel Heller here congratulates the publishers on the happy thought of omitting any account of the long struggle for supremacy between the two great German powers, and of giving us instead, combined in one volume, separate accounts of the development of each.

Volume XV of the series contains *The Development of Austro-Hungary to a Great Power*, by Dr. Hantsch, and *The Rise of Brandenburg-Prussia, 1640 to 1815*, by Dr. Braubach: price, 8 marks 50 in paper covers. By this method and arrangement the two authors have contributed to provide the only basis upon which the contrast between Austria and Prussia is understandable, and upon which the possibility and the limitations of German unification can be measured. It becomes clear how with the differing ideals of these powers the present tension became inevitable: one begins perhaps to see a way in which that tension might be relaxed.

(*August, 1934.*)—*Twenty Years Ago.* Major-General Steinitz, in 1914 the Director of the Mobilization Department in the Austro-Hungarian Ministry of War, writes the first of a series of contributions to the history of the outbreak of the World War.

It would almost appear as if 20 years was an insufficient period of time to elapse before reminiscences of this sort are published. Certainly the indiscretions committed are not few. In the first place we are informed that Austro-Hungary's attitude in 1914 to the happenings in the Balkans was "forced upon" her. This might, of course, mean no more than that the Archduke's murder compelled Austria to send to Serbia an ultimatum couched in such terms as to be unacceptable within the short time allowed for an answer. As it stands, however, it will certainly be understood by some as denying that the ultimatum was a purely Austrian affair and that Germany played no other part than that of standing by her friend.

In the middle of May, 1914, in order to facilitate the return to the colours, in the event of mobilization, of the large numbers of Austro-Hungarian subjects, who happened to be living in Germany, the heads of the Mobilization and Railways branches at the War Office went from Vienna to Berlin to talk the matter over. General Steinitz's subsequent report on the proceedings unfortunately fell into the hands of a socialist paper, which used it as evidence of war-guilt. This no soldier, knowing what plans and for what eventualities must be worked out in peace, would concede: but for the same reason he would acquit of evil intent those representatives of the British and French War Offices who, before August, 1914, worked out what would happen should Great Britain ever decide to send her Expeditionary Force across the Channel. In the matter of re-patriation Germany took her part of the proceedings much more seriously than Austria, so that when the crowds of Austrian subjects came pouring over the frontier on mobilization, both accommodation and provisions were lacking.

Somewhat naïve is the confession that, in order to avoid the appearance of a war-like threat to Serbia, both the C.G.S. and the War-minister went on leave. The Director of Mobilization himself followed suit, but this must have been carrying things too far, as the latter was recalled from Bavaria on July 17th.

That on the occasion of General Steinitz's visit to Berlin a toast was drunk at lunch to the hope that the arrangements just concluded might be put to a real test should perhaps not be taken too seriously, but it is at least evidence that the toast of "Der Tag" was not a British invention.

Sea-power Questions are World-power Questions. The author, Lieut. Handel-Mazzetti, late Austrian Navy, adds one more to the series of admirable articles he has written on naval policy. Much that he says is worth repetition even to islanders, who, served by a marine-minded Press, read, hear and think more about the sea and its significance than the dwellers on the Continent for whom these articles were written.

Before treating of his subject under sub-heads the author gives us his definitions. Sea-power and imperialism are two inseparables, each unthinkable without the other. Sea-power is that which strives for command of the sea. The latter means command of communications by sea, of shipping and of the cables, and with these things a decisive influence upon the formation of public opinion, and finally the possibility of carrying out a colonial policy according to one's own ideas. Hence sea-power does not first become effective only when war comes, as a strong army does. It is the

fundamental condition for a successful world-wide *peace* strategy. It is the foundation of success in international politics and in world economics.

The sub-heads treat of:—(1) Sea-power in general; (2) Economic imperialism; (3) The struggle for space for surplus population; (4) The naval interests of the Great Powers; (5) Conflicting interests; (6) Armament and disarmament.

Lieut. Handel-Mazzetti's conclusion is that not only can we not speak of any diminution or bridging-over of the surfaces which give rise to friction between the Powers, but that it is precisely in the matter of marine interests that the questions have become more complicated than ever before, and this through aggravation of the conflicting interests of the Powers both economically, and as regards colonization. In the 15 years since peace was signed there have formed among the "Conqueror" States matters for conflict in no way less than those of pre-war days. These circumstances show that, nowadays more than ever hitherto, world policy and world economics govern the entire way of thinking of the Great Powers, and that the concerns of the Lesser Powers are only inconsiderable portions of the large complexes of questions which embrace oceans and continents. The fate of mankind will not be decided so much upon the historical battlefield, known as Europe, as upon the oceans of the world.

The 52nd Infantry Regiment in the Battle of Stanislau, 6th–8th July, 1917 (continued). The writer, the O.C. 1/52, modestly concealing his identity by calling himself merely "One who took part," here gives a detailed account of the three days' fighting as experienced by his own battalion. The narrative is easily followed with the aid of four maps. It shows above all—and this appears to have been the writer's intention—how good troops well led are equal to even most difficult situations, how they can adapt themselves to sudden changes in the fight, and how their training asserts itself, and they almost instinctively do the right thing.

The 1st Bn., 52nd Regt., during three days of very heavy fighting, mostly spent under drum-fire, and getting their meals either with difficulty or not at all, (*a*) on their own initiative organized against and threw out a Russian attack which had penetrated 400 metres beyond their front line, then restored and re-organized the original front line, (*b*) changed front 90°, facing N.E. instead of S.E., and prevented the Russians, who had overrun the Austrian regiment on their left to a depth of two kilometres, from extending the width of the breach they had made.

This latter achievement had a wide-reaching strategic result. Both of these feats were accomplished without reinforcements, and without any specific orders having arrived from Regimental (*Anglice*, Brigade) Headquarters.

Cromwell's Soldiers' Councils. A book bearing this title has been written by Professor Pasukanis, President (or Presidial member) of the Communistic Academy in Moscow, who justifies the choice of his theme by saying that the experiences of the Russian revolutions of 1905 and 1917 have brought about a new conception of known historical facts which makes them of significance for the present age. Those who in the recent revolutions in Germany or in Austria have had experience of Soldiers' Councils will agree; but Colonel Heller here points out that Professor Pasukanis is an out-and-out Marxist, and an uncompromising champion of the materialistic conception of history. As such he considers that class differences are the sole cause of all revolutions, and hence of the English Revolution. Colonel Heller's own standpoint is that our knowledge of the historical development of nations can be furthered only in a conception of history which takes both idealistic and materialistic account of movements and events, and which is free of national influence and national pressure of any kind, being animated alone by the desire for objective truth. Thus, to confute Professor Pasukanis' "arbitrary and untenable interpretation" he writes a sketch of England in the middle of the seventeenth century which brings into prominence the religious ideas and conflicts of the time. Of the strength and determination displayed by Cromwell in dealing with the Army at Newmarket and its demands, and of the way he eliminated the Adjutators, Colonel Heller writes with praise.

(*September*, 1934.)—*The July Occurrences and the Federal Army*. The editor, General Ratzenhofer, rises worthily to the occasion. Only six months had passed since Austria, and especially Vienna, was shaken in a manner up to then almost unknown, by the February revolution. The State, once the rebellion was crushed, set to work immediately to build upon new foundations, and to ensure for all its citizens better conditions. The Federal Army hoped at last for a little quiet, and with the conclusion of the almost daily calls to assist in keeping peace and order, to be able to devote itself to its own tasks and duties. But it was not to be for long. On the 25th July, about mid-day, a *coup de main* was carried out against the Austrian Government by entirely new methods. The signal for a general uprising of dissatisfied and rebellious elements throughout Austria was given, after violent possession had been taken of the Vienna Broadcasting Station, by a false announcement that the Government had resigned and a new Chancellor had been appointed. At the same time five lorries apparently filled with soldiers and police arrived at the Government offices in the historic Ballplatz. The occupants, 144 in all, including one disguised as a major and one as a captain, overpowered the unsuspecting guard, and imprisoned in their offices at the pistol-point the Chancellor and two other ministers who happened to be in the building.

Both the Government buildings and the Central Broadcasting Station were quickly surrounded by two battalions of troops hastily summoned by telephone. This prevented any more trouble from outside. The chief care of those who opened up negotiations with the rebels was to prevent bloodshed within the buildings which had been seized, and to obtain re-possession without the necessity of storming. Finally towards evening the rebels, seeing that the hoped-for rising throughout the country had failed them, and that the new Chancellor had not materialized, surrendered on promise of safe-conduct out of the country. This promise was itself conditional upon the rebels having caused no bloodshed. Unfortunately it then transpired that they had killed the Chancellor.

Meanwhile trouble had also started in the provinces. Although the signal broadcast from Vienna for the greater part failed of its purpose, in portions of Styria and of Carinthia it was obeyed, and police-stations, Government offices and railway stations were occupied by armed rebels who in many cases took hostages. Troops were hurried to the spot from the nearest garrisons. In some cases their arrival was sufficient to restore order even on the night of July 25th, but elsewhere the rebels fought all day before surrendering, while in the worst cases it took three days' fighting to reduce their strongholds or to round them up.

It is interesting to note the entirely different nature of the tasks which devolved on the Government forces in the two revolutions. In February:—Fighting in the streets of a great town, attacks upon strong modern buildings, situated at commanding points, suitable and militarily equipped for defence. In July:—Fighting in woods and open country, wide flanking movements, house-to-house fighting in scattered country villages.

The total casualties were, killed and wounded: Regular Army, 21 (including two field officers) and 37 (including four officers); Police: 19 and 19; Auxiliary Corps, 61 and 180—total of Government forces, 101 and 236. The rebels lost 123 killed, about 360 wounded, and about 2,000 who escaped over the frontier to Jugo-Slavia. A few of the rebels were also executed.

One of the measures of General Vaugoin, during his long period of 12 years as War-minister, with the idea of improving the Federal Army which he had created, was the identifying of its units with those of the old Austro-Hungarian Army in order to preserve tradition. It now appears as if by its perfect discipline and gallantry in two revolutions, that of the Social-Democrats in February, and that of the National-Socialists in July, the little Federal Army has in the best fashion set about creating its own tradition.

Field-Marshal von Hindenburg, by Major-General Schäfer. The late President

of the German Republic and former Commander-in-Chief of the German Army in the field receives a short obituary notice. An outstanding feature of his career seems to be that at the age of nineteen he saw his first war-service in the victorious Prussian Army at Königgrätz, a piece of good fortune for a young officer, to be followed only four years later by his taking part in the costly but successful attack of the Prussian Guards at St. Privat. Thus when Lieut. von Hindenburg came to join the Staff College he had already taken part in two campaigns in addition to having been Adjutant in a Guards battalion—a brilliant start in a military career. The course of his activities, military and political, from 1914 onward is well known.

General Schäfer concludes:—von Hindenburg followed from Frederick through Blücher to Moltke a row of popular commanders, all of whom brought to their fatherland final victory. To him this last gift was denied. Nevertheless he kept the love and the greatest respect of the German people to the end.

The Opposed Crossing of the San in May, 1915, by Major-General Hess. After General Mackensen with the 11th German Army had broken through the Russian front in Western Galicia at Gorlice on the 2nd May, 1915, the combined Austro-Hungarian and German advance reached 14 days later the obstacle of the San, 125 km. from their original front line. The direction of advance was N.E., and brought the VIth A.H. Corps to Jaroslaw, behind which lay a loop of the river 1½ km. broad and 1¼ km. deep. The San was here 100 to 120 metres broad, and crossed by a road-bridge at Jaroslaw and a railway-bridge four km. away, both of which the Russians subsequently destroyed.

On the afternoon of the 16th May the VIth Corps had the difficult decision to make, whether the troops who had been fighting and marching for a fortnight without a pause, could be called upon, in spite of their exhaustion and diminished numbers, to make a supreme effort and force a crossing against the strong Russian rearguards, or whether, having gained the security of the river front, they should not be granted at least one night and one day to recuperate. Both divisions in the Corps were for the latter alternative, although the Corps had already got its four pontoon-trains well forward in readiness. Here, however, a new factor took a hand. On the left of the VIth Corps was the Prussian Guards Corps, as the right-hand Corps of the 11th German Army, the prime movers of the whole enterprise. In two days' fighting the Guards had captured Jaroslaw and driven the Russians over the river. They had three brigadiers killed in doing so, and took 4,000 prisoners. They now announced their intention of crossing the San that same night, and, working their pontoon-wagons through the narrow streets of the town, got them close to the river unobserved. At 5 p.m. they started ferrying the infantry, at 6 p.m. they started a pontoon bridge. The VIth Corps felt itself constrained to follow suit, and by 10 p.m. five of its battalions were supporting the five battalions of the Guard Corps, who, having formed bridgehead, were now being heavily counter-attacked. The pioneers and sappers of the two divisions in five days and nights in addition to trans-shipping troops, built and maintained mostly under fire two pontoon bridges and four trestle bridges, including procuring the material for the latter.

Infantry of To-morrow. General Schilhawsky writes of Capt. Liddell Hart's recent book:—This is the most arresting treatment which has appeared recently about the infantry's mode of fighting. The author tackles all problems, and holds the reader by his logical and stimulating trains of thought. This study, which is written in fluent style, must be recommended to all officers—not only to those of the infantry—to read and form their own judgment upon. Since many of this British officer's views are the same as those held in the Austrian Army, and since we must also come to a conclusion how we are best to withstand a combat with modern infantry equipped with mechanized heavy weapons, this book deserves our thorough consideration.

New Means of Communication in the Infantry.—From an article by Lieut.-Colonel Micheletta and G. Rossoni in the *Rivista di Fanteria*, March, 1934, it appears that the

following novelties have been introduced into the Italian Army for forward communications:—A new light-weight telephone, M.33, weighing 3·8 kilos, with arrangement for use when gas-masks are on; a new carrier and drum, which leaves both hands free while the cable is paying out; a new type of cable for short lines, of which the drum takes 600 metres instead of 200 metres as heretofore; a new 45-mm. signalling lamp, day range 4 km., night range 10 km., weight 9·6 kilos, run by 120 hours ever-ready cells; new combined W/T and R/T sets for working from Brigade down to companies, completely secret, weight 16 kilos, man-pack, usable on the march, 56 hours' dry cells, three wave-lengths per brigade, minimum ranges, R/T 6 km., W/T 12 km.

A phototelephony set is also promised. Whether this works R/T on a beam of light and selenium-cell receiver, or whether, *lucus a non lucendo*, it has reference to Marconi's recent successes with R/T on directed beams of very short waves outside the spectrum remains to be seen.

The Marne Drama. The Case of Moltke and Hentsch, by General Ludendorff. The deeper-lying causes of the result of the battle of the Marne, so fatal to Germany, are disclosed by this pamphlet. Colonel Moltke was under "occult influences," while Colonel Hentsch was probably a Freemason! The "miracle of the Marne" was, therefore, like other miracles, supernatural.

F.A.I.

WEHR UND WAFFEN.

(*July*, 1934.)—*Thoughts about the New Artillery Training Manuals.* Lieut.-General Marx continues his notes, pointing out ambiguities, and even apparent contradictions. His remarks on the drawing up of regulations in general are to the purpose:—Regulations which have to stand for years are so important that each word that they contain must be checked over before the regulation receives its final form. This cannot be done without a certain amount of "splitting hairs." We have to reckon with senior officers, who like sticking to the strict letter of a manual—and such superiors are even very useful. It is on account of them that we must pay special attention that in regulations there is no sentence which can lead to doubts and disagreements.

Motorization and its Effect on the Conduct of War. The editor himself has collected from all available sources information concerning the state and progress of motorization in foreign armies, which are unrestricted by the Treaty of Versailles in their development, and publishes it here for the benefit of the German Army, which in this respect is far behind the others. As regards definitions he calls mechanized formations motorized, and motorized troops as "on lorries." The first army motorization was pre-war and consisted in the formation of M.T. Supply and Ammunition Columns. The first large-scale use of M.T. for moving troops is the historic case when in September, 1914, the Governor of Paris, General Galliéni, used taxi-cabs for sending reinforcements to General Manoury, who was engaged with the German right wing. After this motorization scored many triumphs, for it was the M.T. columns, which kept the defenders uninterruptedly supplied with fresh strength, troops, weapons and masses of ammunition, which were the cause of the successful defence of Verdun, in the Somme battle, in the battles in Flanders, and against the German 1918 break-through.

General Schwarte finds himself constrained to admit in advance that the ideal case for all armies would naturally be the complete motorization of all units. Expense alone would be sufficient to prohibit this, but there are several other good reasons, which compel us to rest content with what is attainable. That being settled, it is for us to make what is attainable as perfect as possible.

Considering only the leading unrestricted nations the present state of motorization, takjng the arms in turn, is:—The infantry for a long time after the war remained

untouched. Then Great Britain, France, Italy and to some extent the U.S.A. introduced M.T. for regimental transport. Great Britain, which has always led in motorization, then started to free the overburdened infantryman of his load and to carry it after him on lorries. Hence resulted improved marching performances, shortened length of columns, the formation more mobile and handier. The saving in drivers was also considerable. The vehicles used were chiefly cross-country six-wheelers, and in the first line ordinary trade 1½-tonners. The next step was the equipping of staffs and signals with cross-country cars and motor-cycles, and finally the provision of small caterpillars for carrying the heavy infantry weapons, m.g's, t.m's and infantry guns. France has gone one step farther in incorporating in the rifle-company small tanks. Italy, Czechia, the United States and, it is believed, also Russia, are doing the same experimentally.

The partial motorization of infantry brigades gave satisfaction and has now become universal. The next step was for special purposes to provide more mobile brigades. Again Great Britain was the pacemaker, followed by France and the United States. The completely motorized brigade can travel fabulous distances and thus apply complete surprise with the full fire-power of the infantry brigade. It has, however, the disadvantages of all troops carried in non-fighting vehicles, viz., generally the tactical situation compels early de-bussing and a loss of much of the time gained; the vehicles are very vulnerable; ground-reconnaissance and security, even with armoured-cars, are incomplete. Consequently in 1932 France and Italy started trials of sending troops on to the battlefield in armoured vehicles. This is well within the reach of modern technics. All nations possess to-day some completely motorized infantry brigades, while France has even such divisions.

As regards field artillery, France, Belgium, the U.S.A., Czechia and Poland either carry the guns on lorries, or on special low well-sprung trailers. For cross-country work they need also dragons, and a further complication is that the latter, not being suitable for roadwork, have also to be carried on lorries until required. The tactical disadvantages and the clumsiness of this method led Great Britain, and latterly also the United States, to a new solution. The gun is now attached direct to its tractor, which is either a six-wheeler lorry, or a four-wheeler tractor, or a light and very fast caterpillar. The French in the 1934 manœuvres are trying the third method. If considered necessary the gun-wheels may be rubber-tyred, in which case for firing the axles are raised by means of folding segment-pieces which keep the tyres off the ground.

The ideal vehicle is the automobile caterpillar gun-carriage, but on account of expense it is but sparingly provided. Generally it is found only with A.A. artillery and tanks accompanying artillery.

France heads the list as regards the motorization of light artillery with about 60 completely motorized field batteries and 30 more special batteries on motor-carriages. Countries like Czechia, Poland and Belgium, which are on friendly terms with France, are well provided with fully motorized light batteries. Some distance behind follow Great Britain, the U.S.A. and Italy.

As regards heavy howitzers and the guns of the medium artillery, owing to weight these are not as a rule loaded upon, or towed by ordinary M.T. Only France and Czechia, as with light artillery, carry guns and caterpillars on special M.T. Nearly all the other countries prefer four-wheel tractors or caterpillar tractors. Especially remarkable is the fact that in England the unarmoured chassis of the light tank is used as a dragon. This solution has distinct advantages in the matter of mass-production. At the head of the motorization of medium artillery stands Italy with 66 such batteries, followed by Great Britain, France, Czechia, U.S.A. and Belgium. The United States alone have 4·8-in. guns and 6·2-in. howitzers on self-propelled carriages.

With heavy artillery we come to a province where the great weights necessitate load-distribution. Almost exclusively special vehicles are used, and these are

generally four-wheel or caterpillar tractors. It is interesting that England in 31 heavy batteries uses a four-wheel tractor bearing a strong resemblance to the German pre-war Krupp-Daimler. Italy is again first with 48 batteries, France, Great Britain and Czechia come next averaging over 30 batteries apiece; then, far behind, Poland and the U.S.A.—(*To be continued.*)

A.A. Defence in a Nation armed without Restriction. The vast development of the air-arm since the Great War has given rise to a school, of which the Italian General Douhet may be taken as a representative, which teaches that future wars will be decided exclusively in the air. The conditions, technical and material, for such are certainly present, especially against a Germany, deprived of "all and every" protection. In future warfare we shall have no time for mobilization as in 1914. Speed, surprise, and strength of blow are the characteristics of air-power. To be able to escape this deadly peril we must begin by realizing its possibilities beforehand. There will unfortunately be no lines of communication, and no home country. Everything will lie open to a powerful air-fleet under leadership with a clear and well-defined plan. A.A. defence troops of the near future will thus acquire the significance of a main arm. The article then considers in turn the three essential parts of A.A. defence, bombers, fighters and A.A. artillery.

Trinitrotoluol or Pentaryt? The importance of the explosive Penta-erythrit-tetranitrate, deriving as it does from home-products, coal, air and water, through formaldehyde and acetaldehyde, has been pointed out by Lieut.-Colonel Justrow before (*vide The R.E. Journal*, December, 1933, p. 694). A Swiss scientist, Dr. Stettbacher, has now, both in the periodical *Nitrocellulose* and in a pamphlet *Pentrinit and Hexonit*, taken up the cudgels for Pentaryt against T.N.T. Lieut.-Col. Justrow, while admitting the claims for Pentaryt's explosive powers, still considers it for artillery purposes inferior to T.N.T., although superior to the latter both in detonation-velocity and in heat generated, and to be recommended for mining, for engineer demolitions, for aerial bombs, for torpedoes, submarine mines, and especially for charges fired on wrecks. Incidentally is mentioned the world's "most powerful explosive of to-day." This is an amine, tri-methyl and tri-nitro, viz.: $N(CH_3)_3$ $(NO_2)_3$. It is called hexogen, or in its phlegmatized form hexonit, and like pentaryt it is too sensitive to blows to be able to replace T.N.T. for artillery purposes.

A new Panorama Camera for taking Films. R. Leonhardt describes a recent production of the Zeiss-Aerotopograph Coy., Jena.

International Automobile and Motor-cycle Exhibition, Berlin, 1934. This instalment deals with motor-cycles, which judging by the number of visitors this year were a great success. The exhibits ranged from an ordinary bicycle, with a 65-c.cm. F. and S. engine built in, to a B.M.W. of 33 H.P. costing £166. The article contains a dozen good photographs and sketches, and among other novelties praises the Arnal waterproof carburettor of British origin.

Signals in Foreign Armies, their Development and Organization. In peace-time no one had been able to make a complete picture of what immense demands modern warfare would make upon the Signal Service. The truth of this dictum is borne out by a comparison of the strengths of Signal troops of different armies in the last year before the war with those they now possess. Large increases are to be found not only among the nations which took part, but also among neutrals. The comparison by countries is as follows, what is shown in brackets being either the proportion of present Signals strength to that of 20 years ago, or where these are not known, the proportion of Signal units now existing to the number of units existing in 1913. In many cases there has been an increase in the total strength of the army, which has to be discounted.

Greece (double); Spain (175%: still belong to the Engineers); Portugal (more than double); Holland (nearly 150%); Switzerland (nearly four times); Japan (more than 2½ times); U.S.A. (double); Italy (six times: still belong to the Engineers);

Rumania (a greater percentage than corresponding increase in the army); France (four times).

The extraordinary high provision of Signal units in the French Army is considered specially instructive, and it is given here in detail as a pattern for modern armies.

Enemies as Human Beings. Major Baron Villiez praises a book with this title by a Swiss writer, Eugen Wyler, who has collected from German, French, English and Italian sources soldiers' war-stories which show their respective enemies in a good light. Baron Villiez wishes to carry on the good work. His address is Freiburg im Breisgau, Ludwigstrasse 41.

Infantry of To-morrow. Lieut.-General Schwarte writes of the translation of Capt. Liddell Hart's book into German, which he considers has been quite well done, that it leads to a carefully thought-out proposal of special importance. Even if one does not follow this officer to his wide-reaching conclusions, they are in many ways convincing and worthy of being thought out and utilized.

(*August*, 1934.)—*Reichspresident Field-marshal von Hindenburg's Legacy to the Armed Forces.* "The armed forces of Germany bear upon their shoulders the inheritance of a glorious past, which compels them to their duty. The spirit which once raised Germany to a proud and great position, still points out to them the way clearly and surely. Numbers alone do not decide. It is always the inflexible will which in the end shapes the destiny of peoples and nations. Firmly united in devotion and obedience the army and navy are a symbol of the national will to defence. May the armed forces ever go their way in strength and honour as guarantees of a strong German future!"

This message has been captured as a gramophone record to serve as a document for succeeding generations of soldiers.

Motorization and its Effect on the Conduct of War (continued). After dealing with the present tank position in the leading countries, General Schwarte treats of the two clearly divided schools of thought. To the complete army-motorization, or mechanization, school belong Great Britain, Russia, and latterly Poland; while the United States, which formerly belonged to this school, has since 1932 adopted less extreme views. An interesting reason for Great Britain's attitude is given. "England, regarding this development as inevitable and no longer judging the question by whether these revolutionary changes are desirable or not, takes the point of view that a repetition of the Great War and its method of fighting would wreck our whole civilization. It is believed in that country that through the mechanization of armies such a struggle, lasting for years and causing enormous destruction of values, can be avoided. Only mechanized forces can win back the mobility necessary for a decision." There are also other reasons why Great Britain, as opposed to other European Great Powers, leans towards these views. As an island, thanks to its huge fleet, it is unattackable. Besides that, it returned immediately after the war to its traditional small professional army, which consists of first-class soldiers and has in the colonies plenty of opportunities of gaining practical experience of war. It is precisely of this opportunity of trying out new weapons and new methods of fighting that it is hard to over-estimate the value. No peace practices can equal it. One more reason, and that a most weighty one, is that Britain possesses a highly developed armament-industry, which, in keen competition with those of France and Italy, finds itself compelled, by considerations of exports, continually to create better and more modern equipment. The second school of thought consists of France, the majority of the powers which are on friendly terms with France, and Italy. As he did with Great Britain's views the writer traces and explains France's attitude. In general he points out that all nations unrestricted in their armament by the Treaty of Versailles have realized the truth that although to-day as ever it is the spirit which decides in war, that spirit must be *with* the machine and not without it. Enthusiasm and determination must not be allowed to fail because weapons are inadequate.

Peace-training and War-experience. General Marx's reminiscences start at Longwy

in August, 1914, where he was a battery commander in action in mobile warfare for the first time. He shows with wonderful memory and with much humour the mistakes he made, some new ones of his own, but mostly due to peace training. General Marx is evidently what an Austrian general said of Sir Ian Hamilton, after reading his "Scrapbook," *ein Gott-begabter Mensch*. One of his amusing stories relates to his feelings when, the young battery commander having just gone into action for the first time, and while the battery's first shells were bursting, a telephone message came, announced by the trumpeter as follows:—"Sir, the Sergeant-major says he's watered now and shall he feed away?"

The International Automobile and Motor-cycle Exhibition, Berlin, 1934. Deals this month with accessories and makes a few general remarks. Accessories showed good progress, especially in materials and quality. At the head of the light metal industry stand the Electrometal Coy. of Stuttgart and Schmidt and Co. of Neckarsulm. These two firms supply nearly all the pistons in Germany. Much attention was paid to tyres, which show quite new profiles, as a result of designing for cross-country purposes. The Delbag air-filter containing no loose material is recommended for military purposes. The Solex Regulator-carburettor is a further development of the carburettor with automatic starting arrangement, which, however, prevents the engine from exceeding a certain number of revs. It thus replaces the centrifugal regulator and avoids moving parts. Air-cooling has gained in interest. The Krupp and Phänomen air-cooled engines showed their superiority again in the Harz three-day trials as in those in the winter at Oberstauffen. Gas-generators of the most varied kinds have come much into the foreground.

The Laws of Dispersion as the Basis of the Theory of Gunnery. Investigations of dispersion for guns and trench-mortars by Captain Schneider, ballistic expert in the Ordnance Department of the German War Office.

Bombers and Bombs according to French, English and American Views. Consists of quotations and extracts from Sir F. Maurice, the *Revue des Forces Aériennes* and *U.S. Air Services*; also of arithmetical examples for arriving at the number of bombers requisite for a given task; for all of which a quotation from Marshal Foch may serve as a text:—"Soldiers always think that the next war will be on the lines of the last one. This has never been the case, and it never will be. Obviously one of the great factors in the next war will be the aeroplane. The possibilities of air-attacks on a grand scale are almost immeasurable. . . . The bomber may thus be decisive."

(*September, 1934.*)—*The Departure Errors of a Projectile due to the Motion of a Ship.* The effects upon gunnery results caused by a ship's rolling and pitching are here investigated mathematically by Dr. Hanert of the Naval College, Mürwik. The value of the article for military purposes lies in the fact that firing from tanks or aeroplanes can be investigated on similar lines.

Climatic Correction by Shooting. What in musketry is known as the "error of the day," *i.e.*, the correction of range necessary to allow for the effect of wind, temperature and pressure on the flight of the bullet is arrived at in the case of artillery by observed artillery fire at a known range. Major Böttticher here takes exception to a paragraph in H.Dv.142, "Field Meteorological Service," which lays down what is to be done when the fire cannot be observed. He suggests instead that a climatic correction be obtained for another target of known range, where the fire can be observed, and then altered proportionately for the range of the target at which fire cannot be observed.

Attacks by Low-flying Aeroplanes and how to Guard Against Them. This article is written for the artillery, but it concerns equally all those who march in columns, or who are sometimes even more susceptible to attack by low-flying aeroplanes because they are fixed to one spot, *e.g.*, in bridge-building. The chief way of avoiding the panic such as the Germans claim to have caused among the British in 1918, when the latter were engaged in crossing the Somme by the bridges near Brie and St. Christ,

is for the troops to have full confidence in their ability to deal with low-flying aeroplanes. The answer to the menace is that the troops must be able to look after themselves, and this is best achieved by the regimental issue of a proportion of suitable small-calibre weapons. For this purpose the *Field Artillery Journal* says that Browning automatic-rifles, fired from the shoulder, are twice as effective as machine-guns. The Italians, as well as the Americans, have adopted this solution, and issued their gunners with a number of automatics.

Reconnaissance is essential, or the time for action will be much restricted. Reconnaissance-parties should be put out both ahead of and behind the column. A good signal is a smoke-bomb, rising nearly 30 feet from the ground.

Advantages of Observation from the Ground. Agrees with the proposals (*vide R.E. Journal*, June, 1934, p. 353) of the writer on *Observation of Fire at the Longest Ranges*. Not the youngest, but the best officer of the battery, should be chosen to observe. F.O.O's in addition to all their training and qualification must be thrusters. The writer attributes all the successful break-through battles to the precarious communication by land-line having been kept going, so that F.O.O's could direct and correct the artillery fire. In future warfare the F.O.O's must be sent forward in armoured cross-country vehicles with R/T, so that there shall be that security of communication with the battery, which the German artillery so bitterly lacked in the Great War.

Experiences of the Driving Marathon, 1934. Major Bieringer, of the Cavalry School, gives none of the results of these trials for two- and four-horse teams, but notes on training, the best type of horse, driving, forage, harness, care of vehicles, shoeing and officers accompanying under instruction. The objects of the Marathon are given as increasing the understanding of all arms for good driving, long-rein and from the saddle, and giving valuable experience for the increasing of march and draught performances. Quite apart from the results achieved under this head, the level of horsemastership attained seems very high, since the casualties were *nil*.

Liquid Amber as Protection for Metals. The *Kölnische Zeitung* claims that a Berlin chemist, Ernst Krause, who entered in a prize competition instituted by the National Prussian Mining Coy., has succeeded by a cold process in making a solution of amber, hitherto obtainable only in the liquid state by melting at about 300°C. This amber solution when applied to a metallic surface evaporates, leaving the thinnest of coatings, which combines very quickly with the surface metal, affording a waterproof protection, superior to that of any known lacquer.

F.A.I.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*February*, 1934.)—*Pioneers and Infantry in Mobile Warfare.* This article brings out clearly how much the Pioneers of the German Army, unlike the divisional Engineers, who carry out the corresponding duties in the British Army, are regarded as a glorified form of infantry. In accordance with German F.S. Regulations they march with the advance guard. Further, as up to the Great War the allowance of Pioneers was only one company to an infantry division, and it was considered undesirable to break it up, the Pioneers had to be prepared to suffer losses which might affect their ability to perform their own tasks. It was indeed possible to aim at Pioneers not being put in as infantry without a special reason. Since, however, the support of the infantry with all attainable means—hence also with the infantry fighting strength of the Pioneers—is the chief aim and object of the co-operation of the other arms, these losses of the Pioneers must be reckoned with. The Pioneers not only increase the fighting strength of the foremost infantry by the work they perform, but also by being themselves completely trained as infantry.

The Training of an Engineer Company. Owing to the many duties of the Engineer

arm, this training has always had to be carried out against the handicap of insufficient time; and so it will always have to be. Now and again attempts are made by specialization to simplify engineer training in general, and to intensify it in its branches. The general utility engineer, as opposed to the specialist, must, however, be accepted at any rate for the present. Owing to its many-sidedness, his training can be successful only if it is carried out on the best lines. Some fundamental points are:—(1) The Coy. Commander's most important task is the training of his officers and N.C.O's, upon whom the efficiency of the company will depend. (2) Owing to the fact that engineer-recruits have the trained intelligence of tradesmen, indoor instruction plays a more important part with engineers than with any other arm. It is one of the best ways of saving time in individual training and in preparation for unit-training. In winter and in bad weather one hour daily, or even more, of really live indoor instruction will repay itself handsomely later on. (3) A well thought-out scheme of training is essential, so that, when for a certain time special instruction is being given in one branch, the state of training in other branches is maintained and does not start going back. This means changing from one subject to another at short intervals. (4) In arranging a programme the mistake is sometimes made of giving to different subjects almost equal periods of instruction or training, without paying respect to their degree of importance or their degree of difficulty. Only careful grading can guard against this. (5) Often a company, which has been well trained in all branches of its work, is found to fail when it is tested under field service conditions. The cause of this is generally that its training has been too much confined to the barrack square and to the vicinity of barracks. A certain amount of the work must always be done farther afield. (6) The shortness of the time available for training is most felt in those units in which the first quarter of the training year, viz., from October to December, has not been completely utilized.

Engineer Training of all Arms. Amongst the most neglected branches of peace-training is the engineer training of all arms. We ignore not only the war experiences of other nations, but also our own. Certainly since the Russo-Japanese War, and strictly since the Boer War, it has been clear to every observer that rifle and spade have become of equal importance to the fighting man; or, in other words, that field fortification is an essential part of the conduct of battle. Insufficient attention was, however, paid to this teaching, with the result that the costly experience of the Great War was necessary to drive the lesson home once more. Similarly the Great War made abundantly clear that the provision of simple barricades must be carried out by the fighting troops themselves. This is the more necessary now since the advent of motorization. Thus, the erection of simple barricades, like the provision of entrenchments for the infantry, is no longer an Engineer task, but work to be carried out by the troops themselves with no assistance other than that of the regimental pioneers. All troops when halted or resting must be able to protect themselves against cavalry, motor-cycle or cyclist patrols by means of simple barricades. The trained pioneers of the different arms must be able to erect barricades of a more elaborate nature.

In field fortification, while the troops themselves provide fire positions, cover and simple obstacles, the regimental pioneers should be able to provide shelters, obstacles requiring more skilled labour, and O.P's of every kind. They must be able to organize drainage, to put up screens, and to undertake repairs to ways and bridges.

A very important branch of engineer training for all arms is that which will enable them to cross streams and small rivers. Here the object of training must be that every unit should be in the position under simple circumstances of being able to convey itself together with its fighting vehicles across a stream, either in boats and ferries, or by means of self-constructed bridges, from footbridges up to bridges to take infantry in fours. It is all-important to establish precisely what in this case constitutes "simple circumstances." These may be taken as obtaining, as regards current strength when the current is flowing up to two feet per second; as regards

breadth, up to 40 metres broad for bridges taking infantry in fours and light vehicles; as regards depth, when insufficient floating supports are available; *i.e.*, when firm supports have to be built, the limit of depth is 2½ metres. "Simple" circumstances can, however, easily be extended beyond the limitations named. This would be the case when material is available of such nature as to permit the building of a bridge from bank to bank without intermediate support, or when heavy ferry-boats built to carry wagons are available. In such circumstances the fighting troops may be expected to provide, without engineer assistance, bridges capable of taking heavy vehicles up to armoured cars.

The underlying idea of the training of the regimental pioneer should be to make him as independent as possible of the Engineers, so as to set the latter free for their own important tasks.

Orders or Instructions? In order to bring out the difference between these two means of expressing the leader's will, a situation is chosen in this article, viz., the crossing of a river in the face of the enemy, by a mixed brigade, to which a field company has been allotted for the purpose. An example is then given of the orders which would be issued verbally by the O.C. Field Coy. to one of his section-commanders for the move forward of his section by night to a position of readiness. The latter is to be ready at 3 a.m. to move forward, under brigade orders, from the position of readiness with four pontoon-wagons, preparatory to forming, under the cover of an island, two four-ton rafts for ferrying across the vehicles of the brigade and of light artillery, as part of the general crossing.

Alternatively we are given the "instructions" which might be issued instead of "orders" for the same operation. The writer analyses and compares, and then definitely expresses his preference in this instance for "orders."

Finally he emphasizes the importance of training all subordinate leaders in giving orders correctly. The clear and simple language in which orders should be given is often difficult to attain. Engineer officers and N.C.O's must be masters of both methods, and that entails being masters of the language in which orders and instructions are couched. This mastery demands self-discipline, both in thought and word. When it has been gained, and when officers and N.C.O's have been called upon constantly to give orders, as emergency arises, they will attain the degree of skill which can do justice to every situation quickly, while expressing themselves without any possibility of being misunderstood.

Anti-Aircraft Defence and Camouflage of River-crossings. In river-crossings all movement on the water, the actual building of a bridge, and the crossing by troops are three things which can hardly escape observation by the enemy's aircraft, except under the cover of darkness, mist, rain or storm; but even prior to this, the failure of a crossing may have been determined by unskilful concealment of the approaches to the site, or of the assembly of materials or personnel. The actual crossing by the troops is best protected by superiority in the air, and by adequate A.A. defence on the spot. Where this superiority and the requisite strength of A.A. defence are not present, and the necessary assistance is not received from bad weather conditions, the crossing of the river must take place almost entirely in the dark. Under such circumstances it will hardly be possible to keep a bridge going by day, let alone to use it for the passage of troops. Concealment of the crossing by artificial smoke screen is of little use, since experience has shown that the smoke attracts the attention of hostile aircraft. This disadvantage outweighs the smoke-screen's chief value, which is that it blinds hostile ground observation. It has other disadvantages in that it hinders one's own troop movements, observation and weapon-effect. Possibly its best use will be to direct the enemy's attention to feigned crossings.

In the case of opposed crossings, whenever the tactical situation permits, ferrying must be carried out in the dark, starting preferably in the dusk. The same applies to bridge-building, and the bridge itself should be completed in time to allow of the majority of the troops crossing before daylight.

The essential conditions of success for all crossings which are obliged to take place in daylight have already been indicated. They are strong active air protection, efficient A.A. defence, good march discipline and good camouflage. For A.A. defence to be successful it must be provided with its own observation service. For this purpose a writer in the *Militär Wochenblatt* suggests the addition to the headquarters of every infantry brigade of one serjeant, 14 men, and eight motor-cycles with sidecars. For a pioneer battalion (the equivalent of our own divisional engineers) he recommends the addition of an aeroplane observation section, which would furnish one dropping and picking-up station for aeroplane messages and would include three pairs of air observers; total, one officer, nine men, and five motor-cycles with sidecars.

An observation service of this nature is specially important for all motorized formations, since they have to reckon not only with bombers, but also with m.g. attacks by low-flying aeroplanes. Bridging equipment on the march is therefore particularly likely to be interfered with, and the results might be disastrous.

In modern armies there will be available for the defence of bridges, units of fighter aeroplanes and independent formations of A.A. artillery and m.g's. The A.A. units alone could not guard against torpedo-bombers swooping at enormous speed at a bridge, since they may not get more than 40 seconds in which to act, from the time the 'plane is first sighted. Hence fighters are an essential part of the defence, but it is unlikely that they will be available except while building is actually in progress, or while troops are in transit. The scale of provision of the A.A. defence would be, say, one 7·5-cm. battery to protect two bridges not more than 8 km. apart, with m.g's placed on both banks in the longitudinal axis of the bridge, since the torpedo-bomber will enfilade the bridge in his dive.

Further, the troops will naturally protect themselves while crossing in the same manner as they have been trained to do on the march. It is the protection afforded by the machine-guns of the troops, which use the bridge, which offers the chief prospect of success against low-flying aeroplanes and torpedo-bombers.

Engine-power on the Water. The object of this article is to investigate the engine-power question for pontoons and motor-boats for bridging and ferrying. Military requirements are harder to fulfil than those of, say for comparison, the sporting motor-boat, whether the latter has a built-in engine, or an outboard motor. The military motor-boat must be capable of being loaded upon a vehicle, which must itself in almost any country be capable of reaching the river-bank. There is often in launching pontoons little or no choice of the spot. They have to be launched where there is no landing-place, where the current is swift, and often they have to start off with a heavy load. There are also difficulties when they have to be brought upstream to form bridges. Hence the demand arises that for bridging purposes engines must work well and reliably at any depth and with any current, and must be ready to start at any time. With outboard motors this means that their position must be capable of quick adjustment according to the depth of immersion of the pontoon. They must be robust, and light enough to be carried over long distances. Further requirements of the military motor-boat are that it must be handy, robust and not easily capsized. Its draught must be shallow for landing; it must have good tractive power for towing against the stream, and good speed when not towing. A considerable increase of drive for slow speeds is obtained by running the propeller inside a funnel, which can be made oval so as to increase the size of the mouth. At the narrowest point, where the propeller is, the water is pressed together and thus stops the propeller from sucking in air, a common fault causing loss of power when propellers work too near the surface. A swimming engine has also been made, but it is too heavy for military purposes and cannot be taken apart for transport like an ordinary outboard engine, which breaks up into vertical steering-pillar, with propeller attached, and the engine itself. A grave military limitation is that the size of propeller is determined not by the power necessary to drive the pontoon and not by

the required speed, but by considerations of protection from damage. The best protection, apart from that afforded by the propeller-protecting ring, is that by means of a lever the propeller can be very quickly lifted; a degree of dependence on the human factor which is hardly satisfactory. From this fact, and from the description here given of the best outboard-engines like those of Johnson (U.S.A.) and Laros (Italy) it appears that in the matter of engine-power for military bridging the field is still open.

Landing on Open Coast. Describes, with photographs and a sketch, landing on an open coast from the buoying of the 2-metre line parallel to the shore, where the rafts and boats containing the infantry are cast off by the tugs and left to their own resources to get ashore, to the method of working the horse-boats, for which steel hawsers are bent between large buoys and shore-anchors. The article is evidently written for the young soldier, as it cleverly brings out the fun of the whole proceeding. As it, nevertheless, goes into the minutest detail in narrative form it forms a good example of "drill without tears."

That one company of engineers in calm water built a pier 100 metres long, with a 20-metre broad pier-head, in 12 hours, while another company could achieve only half this amount in three days of rough weather, shows how easily a rough sea can cause landing operations to fail.

Emergency Bridges. Some good photographs show:—

(1) An 8-ton road bridge, 60 metres long, on 4 crib pillars, protected by ice-breakers. The road-bearers are R.S. joists. The whole was built in 11 working days of 2 shifts, one 12-hour and one 8-hour; each shift consisting of 1 N.C.O. and 6 O.R. of engineers, with 30 regimental pioneers.

(2) A footbridge to take men in file and led horses. The roadway is carried on the tie-beams of 2 king-post trusses, with a top sill as distance piece between the heads of the king-posts.

(3) A strutted footbridge, for men in single file, on a mountain path.

(4) A landing stage is being approached by a pontoon raft ferry. The former has a drawbridge, held up by levers, ready to engage the ferry. This it does by means of two cross-baulks made fast to the underside of the drawbridge, which have sufficient space between them to admit a similar cross baulk fastened on the deck of the ferry.

Rafts for Light Loads out of Improvised Material. It nearly always happens that in practising river-crossings rafting is done with equipment that has been prepared beforehand. We must be quite clear in our minds that in war this will not suffice. The provision of floats and light rafting material is on so small a scale that rafts will often have to be improvised. Especially patrols and reconnoitring parties will often have to find their own means of getting across rivers. Improvised rafts for this purpose must be simple and quickly made, light to carry and easy to paddle.

There is a wealth of possibilities in this direction, and keenness should be stimulated among the troops in discovering means of getting themselves across rivers, and also in acquiring skill in the making of such improvisations. Chericheff's Cossacks swam the Elbe in 1813 and towed the whole of their baggage and booty across in willow-baskets which they had made. The chief points to be observed are: (1) The simpler, the better; (2) all materials must be as light as possible, so as to keep down the weight of the raft itself; (3) the centre of gravity of the load must be kept as low as possible; (4) the raft must not offer to the current too great a resistance owing to the way it is constructed.

The article gives a large number of examples with sketches. The materials include round timbers and bundles of twigs; two barrels with outrigger; four barrels with planks; petrol-tins and boards; petrol-tins bound together in threes in a triangular framework of branches; wagon-covers filled with twigs, straw, shavings or hay; two filled wagon covers, with branches and boards; forage sacks; troughs and wash-tubs. Most of these rafts take four men a quarter of an hour to make. A raft of

two wagon-covers suitably stuffed will carry two men and a light m.g., but it will not last more than half an hour.

The Crossing of the Szczara. Tells the story of the attempts made by General von Woyrsch's army to cross the Szczara in the face of determined resistance, and endeavours to deduce therefrom why the Germans and Austrians lost three valuable days in crossing. The deductions are :—

(1) The technical difficulty of the crossing lay not so much in the breadth (40 to 50 metres) and depth (2 metres) of the stream, as in the swampy nature of the river-bed (1 to 2 km. broad) and its flooding by the Russians. Tactically the difficulty lay in the lack of cover in the broad river-bed, and the suitability for defence of the river line through the heavily wooded nature of the opposite bank.

(2) In all three cases in which serious attempts to cross the river were made, ferrying occurred at one spot only and not, as laid down, on a broad front. This was due to shortage, both of pontoons and of Engineer personnel. The result was that the Russians were able to concentrate their artillery fire on these places, and to delay the crossings as much as 24 hours.

(3) The artillery was insufficient to protect the crossings, only six field and a few heavy batteries per division. Such shortage of artillery, bridging equipment and engineers at once suggests that the divisions should have done no more than demonstrate while a Corps crossing was provided.

(4) Until his artillery has been got across the river, the attacker, even with equal strength in numbers and weapons, is far inferior to the defender. Hence the attacker is in a particularly dangerous position, especially when a number of his divisions either cannot effect a crossing, or think that they cannot do so. At the Szczara eight divisions should have crossed, but only three of them made serious attempts. Five divisions were quite idle; for, although in every case their artillery was in action, artillery fire at a river line does not constitute a serious demonstration. Nor indeed do lines of skirmishers directed against it across the open. The only thing that makes the defender really believe himself threatened is seeing bridging in progress. The fewer the places selected where a crossing is really intended, the more points of demonstration should be chosen where preparations for bridging are put in hand so seriously as to deceive. Only thus can a greater number of the enemy be bound to the task of watching the river than the attacker uses in demonstrating.

(5) The failure to cross at the town of Slonim is in accordance with experience, both on the eastern and western fronts, that, owing to the ease with which the defender can conceal his machine-guns, river-crossings at towns mostly fail.

(6) In September, 1915, it was not yet a general practice to have air photographs of river sectors taken before an attempted passage. According to present practice, air photographs would have been taken on the afternoon of the 13th September, before even the Russian rearguards had crossed. These photographs would have been in the hands of the commanders by mid-day on the 14th, would have reduced materially the time necessary for all reconnaissances, and the line of the river would have been forced by ferrying the same night, before the defence had time to consolidate, as it did two days later. In a very pressing situation three days would thus have been saved.

(7) At the first ferrying over all equipment is to be carried, and there should be no vehicles at the river-bank. Thus, a place should be chosen for ferrying which is tactically and technically favourable, and where engineers and infantry can just manage to move and work, not a place where roads and paths lead to the river, and which is therefore likely to be shot up.

(8) Bridges, on the other hand, especially those for heavy loads, must always be where there are roads, even though it involves a detour. This obviates the laying of corduroy roads, which is always a lengthy process.

From a War-Diary. At Chauny in April, 1918, the French destroyed before retirement six bridges over the Crozat Canal, the Oise, and the St. Lazare Canal. The

extracts here given show the works executed by a German pioneer battalion with four divisional bridging trains (and one trench mortar company) attached, to make good the deficiency.

Among other articles in this number are *Ferrying and Bridging Equipment in Foreign Armies*, which contains three photographs from *The R.E. Journal* and a comparative table of pontoon equipment data in the British, French, Italian and American armies: *French Views*, a simple exposition of the French ideas of the phases of a bridging operation, taken from an article by Lieut. Thonnard in the *Bulletin Belge des Sciences Militaires; Civil Tasks of American Engineer Officers*, from the *Army, Navy and Air Force Gazette; The Repair of a Broken Dyke*, with photographs; and other accounts of good work done by the troops of a breakdown nature.

(*May*, 1934.)—*Engineers for the Front Line*. Based upon an historical retrospect, a plea is here made out for more engineers in the battle-front, in order to overcome the greater strength of the defence due to advances in technics.

The Training of an Engineer Company (continued). The well-known difficulties peculiar to the training of an Engineer Company arise from the wide range of the Engineer's duties; the obligation upon the Engineer to adapt himself to changing tactical situations; the thorough training necessary for all parts of the company, each of which must be capable of acting independently; and the necessity of maintaining the standard of tactical and technical individual training. As regards the last-named point, the danger of neglecting to maintain the standard of individual training is common to all arms, but with the Engineers it is specially great. Even in peace-time the lives of others may depend on the Engineers' efficiency and reliability.

It is a matter of experience that on account of these special difficulties the direct transition in an engineer company from individual training to "free" engineer exercises is not to be recommended. By "free" exercises is meant exercises, based upon a war situation, the course of which depends essentially upon the decisions of the O.C., and can to a certain extent be influenced by the conducting staff. Further, it will often be noticed that engineer companies have difficulty in finding an early moment for changing over to field exercises. A frequent cause of this delay is anxiety about discontinuing individual training. The time occupied in individual training is allowed to drag on, and it happens that the thorough training of the company is hardly possible in the time remaining. If the most is to be got out of individual training in limited time, it becomes necessary under this heading to practise only the really essential. It is precisely in engineer training that there are many details of individual training which can be practised later when unit training is on. The preliminary condition for this is, of course, a clear training plan. One means of leading from individual training to "free" engineer exercises is that furnished by schemes. The requirements which schemes should fulfil are to: (1) Maintain and improve the standard of individual training within the framework of the unit, *i.e.*, in the successive training of group, section and company; (2) show how the unit acts in definite situations, and how its separate parts co-operate (*Note*—The introduction of examples of this sort is immensely important: the omission of such is a principal source of defects in unit training, or even of its complete failure); (3) train the separate parts of the unit according to plan, the preliminary condition of which is to preserve in all distributions the tactical units. Hence (*a*) choose quite simple situations, as typical as possible, by means of which fundamental principles can be illustrated. Do not undertake too much; otherwise one either does not finish, or the work is scamped. Practise clearly defined phases with careful calculation of time. At first the schemes will run a prescribed course, but, as a higher standard of training is reached, one leads gradually to the "free" exercise; (*b*) make a careful reconnaissance in the field, and technical preparations of such a kind that as much as possible can be carried out practically, and nothing, or very little, has to be assumed; (*c*) make known the nature and purpose of the forthcoming exercise, and its intended course to officers and N.C.O's at the sand-table. The giving of orders and method of

reporting will then be practised, also officers and N.C.O's can be trained in adapting themselves to changes in the situation; (4) have all working-parties at the sand table for an explanation on similar lines. It will deal with the situation (only a few sentences, but which everyone must know), object and intended course of the exercise, and tasks of the sections and parties; (5) carry out the exercise itself in clearly defined phases, *e.g.*, (*a*) preparation for advance march, and arrangements for ground and air security, (*b*) dispatch of reconnaissance personnel, (*c*) preparation of tools and material appropriate to the nature of the task as ordered, (*d*) the carrying out of the advance march, (*e*) dispatch of the different parties to their respective tasks, (*f*) tactical and technical execution of the latter; (6) discuss the exercise after completion, both on the ground and in barracks. In order to check the state of individual training and also to supervise the execution of the work, umpires should invariably be appointed, one with the O.C. Company, and one with each section and group. These umpires will intervene at once when they see anything done wrong. They have also authority to have any particular job repeated. After the exercise they will be called upon to discuss freely any errors they have noticed before the whole company, preferably in barracks. It is their duty also to bring forward instances of good work, worthy of recognition. This system of mutual education has proved of extraordinary value.

An Exercise in Blocking. An exercise is here set and solved with a map showing the work executed and a table of labour, time and materials. Regarding blocks in general the writer states that, when exercises are held with troops, blocks should always be actually carried out. Blocks which are only indicated give the troops a false picture. If one has on account of the expense (damage to fields, hire of teams and lorries, cost of explosives, etc.) to give up the actual construction of a block, then it is better to leave the troops out also, and treat the whole as a T.E.W.T. The preliminary work before such an exercise in blocking takes much time. Authorities and private owners have to be dealt with, and this is best done by personal interview, and not by writing. The object is to make possible the creation of blocks within the practice area. Only the railway is inviolate. It is difficult to get the use of metalled roads. The local authorities should be approached to close the road in question to traffic, after due announcement in the Press, during the period of the exercise. When a bridge is to be taken as having been destroyed, a reproduction should be made close by, of at least the essential parts, and this should be destroyed under service conditions in the course of the exercise.

Mechanical Tools for Blocking Purposes. The advent of tanks and armoured cars has brought with it fresh tasks for the military engineer. The speed of these vehicles, which enables them fully to utilize surprise, and their invulnerability to infantry weapons, necessitate the rapid provision against them of blocks by means of felled trees, stake-obstacles, inundations, etc., and also the closing of defiles. Hence most modern armies have adopted mechanical tools for blocking against hostile A.F.V's. The choice of such tools requires great care owing to the limitation of space in tool transport. The tools chosen must combine light weight with as wide a range of use as possible. They can hardly be simple enough to work. They must be quick to assemble, reliable in service, and insensitive to weather. The nature of drive which answers these requirements best is that of electricity, which has already proved its suitability for rough employment, like mining. It is, however, not suitable for tools which have to be moved about too much from place to place, if the tool must be accompanied by its source of energy. Electrically-driven tools requiring to be worked too far apart for a common supply necessitate a number of small engine-driven generators, and hence considerable weight. A typical case in which electrical drive would be entirely suitable is the building of a large bridge, where many tools are required to work simultaneously fairly close together, or where electricity is required for other purposes like lighting and heating. Compressed air also requires an engine and its special machine, the compressor. When compressed air has to be distributed

to a number of small tools this method is even considerably less economical than that of electricity, only two to three boring-hammers or boring-machines being workable thereby against ten electrically-driven hand borers, given the same weight of installation, 300 kilos. Compressed air will be used chiefly for jobs like stone-boring, for which it is specially suitable.

For these reasons the mechanical tools now being adopted by modern armies for blocking against A.F.V's, contain each its own source of energy. The power-saw for felling trees is directly driven by its own small engine, as simple and reliable as that of a motor-cycle. It consists in its latest development of a blade round which an endless chain revolves, carrying the teeth with it. The chain does its return journey inside the cut, so that wedging behind the blade is necessary when the saw gets well in. Saw and two-stroke engine are built together. This instrument after many improvements has now become well established in forestry. It is satisfactory as regards performance, reliability and simplicity, and its weight of only 30 kilos permits of its being lifted breast-high, so that high stumps can be left to strengthen abattis. A further advantage of this saw is that it has an alternative position for sawing vertically, and is therefore suitable for removing felled trees, or for cutting them into required lengths, and into planks.

Comparing motor-driven saw performances with hand sawing, pines 60 cm. thick can be sawn through in 55 seconds against 8 minutes; and in general the times are four to eight times better. This is as regards cutting only. When it comes to compare felling times there are other factors which reduce the mechanical saw's advantage, especially if the job is a small one. Generally speaking, the machine does considerably more than can be done by hand, and its superiority is most marked when the work is continuous. With hard woods, like oak, times may be only three to three-and-a-half times as fast as hand-sawing, owing to the teeth getting blunt and the chain sticking.

Further development of the power-saw will be directed less towards increased performance, and more towards diminution of noise of the two-stroke engine, improved durability of the saw-chain, and general handiness and reliability of the whole machine. Especially as regards sawing power, much will be gained through the progressive improvement of tool-steel.

For the maintenance of the saw appropriate sharpening and setting tools have been developed. Its employment should be extended to the sawing of tree-trunks longitudinally for baulks and beams, and chesses, and for scantlings for shelters.

The suitability of compressed air for stone-boring makes it, in combination with explosives, very suitable for tasks of blocking which involve the demolition of stone or concrete buildings of every sort. Such buildings are of great importance for blocking roads, as they are nearly always to be found close to bridges and defiles which the enemy cannot avoid.

For the compression of air there are various mobile arrangements of different makes on the market, which, apart from the heaviest types, are mostly suitable for military purposes as they stand, requiring at most pneumatic tyres and strengthening of carriage. The most usual type is a two-cylinder four-stroke engine with a two-cylinder compressor, built upon a common crankshaft case. Later types have a four-cylinder engine, petrol or Diesel, separate from the compressor. Recently rotary compressors have been produced, so perfectly reliable as to be of military importance where the lightest weights are obligatory, *e.g.*, in mountain warfare. In order to drive simultaneously three to four medium-sized pneumatic boring hammers it will generally be sufficient to provide a plant with suction of two to three cubic metres per minute, and compressing to five to six atmospheres.

The compressed air tool, the boring hammer, is primarily intended for making round holes to a great depth in stone and concrete in which charges are to be placed. With pneumatic drive several yards of such a hole can be bored in a few minutes, additional lengths of rod being inserted quickly, while the use of hollow rods permits the

compressed air to expel so much of the spoil as to eliminate the long delays otherwise necessary for cleaning the bore-hole. As in future concrete bridges are built more and more instead of iron bridges, these mechanical borers will gain in value.

Compressed air is not only the best drive for borers, but also for another type of hammer, with shattering effect, which is suitable either for breaking up masonry altogether or for the making of mine-chambers in abutments and piers or under roads. As with the power saw, here also special machines have been devised so as to keep the hammers in use without the constant attention of a superior blacksmith.

Since armies will not be able in future to dispense with the use of compressed air for the tasks indicated, it will be as well to investigate to what further tasks this form of drive can be usefully applied. Ramming, as on bridges, dams, anti-tank stake obstacles, etc., is one of these, and may well be taken over from the steam-ram. The pneumatic ram saves time and has an adjustable blow. For tasks in which the effect of a blow is not required, small rotary pneumatic borers have been made which are in handiness and light weight even superior to electric hand borers.

From the foregoing examples it may be accepted that the engineer for his battle-tasks will in future have power tools placed increasingly at his disposal.

The remainder of this number contains in addition to the articles already mentioned (*vide R.E. Journal*, September, 1934, p. 504) :—*Bridge-demolitions in the Great War*, three pairs of photographs on the well-known instructional principle of "wrong" and "right," showing how different types of bridge should not and should be demolished; *The Blocking of Lakes; The Bridge at Porzecze*, a war-memory of the repair of a sunken pontoon bridge; *The Effect of Aerial Bombs on Road-bridges; Gas in Foreign Armies for Blocking; Removal of Ice-floes by Explosives;* and *Strategic Demolitions in Foreign Armies*, which quotes chiefly from Generals Normand, Bailles and Le Hénaff, from Capt. Grimsdale in the *R.U.S.I. Journal* and from the *Règlement sur la manœuvre et l'emploi du génie.*

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*August*, 1934.) This number opens with a short article by General Paul Azan, with the title "Albert 1er en 1914," showing how well entitled to military renown King Albert proved himself to be. His cool judgment and firm purpose stood his country—and the Allies—in good stead all through the war, but especially during 1914. The decisions to oppose the German invasion of Belgium, to fall back to the Yser line, and to reject the proposals of his staff for a further retreat on October 26th were due to the King. His share in the great struggle is not likely to be forgotten.

Lieut.-Colonel Lançon contributes the first instalment of a long article, "Les dernières étapes de la Pacification dans le Grand Atlas Marocain." This describes the operations south of the Meknes region in 1931–1933. Meknes (or Mequinez) lies some 50 miles S.W. of Fez. Operations for mobile columns were also continuously carried out in other regions of the Atlas, for the pacification, if slow, is thorough. The columns were carefully organized, and operated from bases well equipped for the purpose, at Tamalout and Bou Draa. Aeroplane hangars at the latter base were within easy reach of the scene of operations. Details are given of the various columns, usually three working together, but the general sketch-map provided is anything but clear. The French versions of the names are so different from those on English maps, that the operations cannot be very easily followed topographically, but the narrative is clear and provides interesting reading. The French have had a long experience of this kind of desert warfare. Their methods of dealing with it keep pace with modern weapons. The reader is, perhaps, struck with the rather imposing array of force against such comparatively slight resistance, but if the forces are available, it is the best economy to make short work of the campaigns.

An article entitled "Le Sens du Terrain et la Géographie Militaire," by Captain Thoumin, has its first instalment in this number. The gist of the author's meaning is the importance of the real study of ground, and the difficulty of locating on maps the exact crest lines, heads of ravines or changes of slope on a hill-side, as compared with the facility in identifying a road junction or a bridge. In other words, it is not a difficult matter to interpret the plan, but quite another matter to realize the profile. The subject is, of course, developed farther than this. The author enlarges upon the importance of the study of ground from topographical, geographical and geological points of view: skill in all these directions can only be acquired by practice. In the opening stages of a campaign it will still be of vital importance for commanders to study the ground. In these days of aerial reconnaissance, rapidly moving transport, and wholesale destruction of superficial features, a clear personal view of the ground is apt to be set aside, but no leader, whatever his rank, can afford to neglect it.

A most interesting article entitled "La Bataille de Galicie en 1914," by General Golovine, is begun this month. The author describes the great Russian move against the Austrians at the outbreak of the war as an encounter battle with a frontage of 350 kilometres (about 220 miles). The opening battle of a campaign is always of great interest, because both sides deploy their forces in accordance with the preconceived plans prevailing up to the war. They work on their experiences of the past. In this case, the opposing forces were almost equal. The troops had been carefully trained and were the pick of their respective armies.

The Russian South-Western Group of four armies was to defeat the Austro-Hungarian Armies in Galicia and endeavour to envelop them. The plan required either a great superiority in quality and technique, or a great numerical preponderance. As the Russians had no reason to suppose that their troops were superior to the Austro-Hungarians in the former respects, it behoved their staff to ensure that they had the necessary numerical superiority. But the exceptional slowness of the Russian mobilization entirely prevented this. While the Austro-Hungarians were expected to have from 43 to 47 infantry divisions in Galicia by the fifteenth day of mobilization, the Russian plan only provided for 38½ divisions available on that front by the twenty-fifth day. Clearly, therefore, the task given to the South-Western Group was impossible to achieve. By the terms of her alliance with France, Russia was under obligation to attract to her own front as many as possible of the German forces. She could do this in two ways: by direct action against Germany, or by proceeding against the Austro-Hungarians in Galicia, and aiming at their total destruction. With four Austro-Hungarian Armies on that front, Russia could not make a direct offensive against Berlin, but by attacking the enemy in Galicia, she would force Germany to withdraw large forces from France; by attacking in East Prussia she would not necessarily oblige Germany to do this.

The plans of campaign on both sides were upset at the beginning. Owing to Russia's slow mobilization, she could not bring the necessary weight of numbers into action in time to envelop the Austrians. She prepared four armies for the operations in Galicia—the 3rd, 4th, 5th and 8th—forming the South-Western Group under General Ivanoff. The Austrians also had four armies—the 1st, 2nd, 3rd and 4th—but Conrad had ordered the 2nd Army to the Serbian front, where he hoped to obtain a decisive success before the Russians were ready. The Russians, in response to the urgent calls from France, loyally started before they were ready, and Conrad found himself obliged to hastily recall his 2nd Army from Serbia and re-direct it to Galicia. This Army was in the midst of its move southwards, and in order to avoid dire confusion in the transport arrangements, the troops had to be sent down to Serbia, and then back to Galicia. This delayed the Austrian plan, but Ivanoff was not quick enough to take advantage of it. In spite of the fact that in Galicia the Austrians had only 38½ divisions ready to start, instead of the 46 of the original plan, the Russians were taken by surprise. Their plan for the envelopment of the Austrians required that their wings should be strong and the centre weak, but Ivanoff arranged

the reverse. The Austrians, moreover, concentrated their 1st and 4th Armies much farther west than was expected. The upshot was, the Russian right wing (4th Army) was heavily attacked by superior numbers before its neighbours were ready to assist it. Several cavalry encounters took place along the wide front before the armies clashed, and these were mainly to the advantage of the Russians. In spite of this cavalry work, the Russian Headquarters did not realize the westward shifting of the Austrian dispositions until 22nd August. Ivanoff was then ordered to modify the direction of march of his 4th and 5th Armies. But it was too late. On 23rd August the battle of Galicia began. The Russian 4th Army attacked Dankl's (1st) Army, but was defeated and driven back. Ivanoff attempted to counter this by a flank attack with the 5th Army; at the same time, he altered the march of his 3rd Army so that it would strike at the rear of the Austrians sooner than its original march would have allowed. The 3rd Army Commander (Russki) did not, however, obey these orders; he persisted in continuing to direct his troops towards Lemberg, and then at the critical moment informed Ivanoff that he intended to suspend his offensive for two or three days in order to reconnoitre the Lemberg fortifications. Ivanoff consented; but the Grand Duke Nicholas at once intervened, and ordered the 3rd and 8th Armies to be pushed vigorously forward. The 8th Army (Brussiloff) was doing its best to hurry on and take its part, but owing to the changed situation, it found itself farther from the scene of action than it had supposed. Thus the battle opened unfavourably for the Russians.

The article gives a clear description of these operations; the sketch maps are helpful, but might be much better.

(*September*, 1934.) General Golovine's article, "La Bataille de Galicie en 1914," is concluded in this number. He describes the Russian recovery, the skilful use of reinforcements sent by the Grand Duke Nicholas, and the subsequent rout of the Austrians. The French General Staff were urging the Russians to make a direct threat against Berlin by way of Posen, in addition to the thrust into East Prussia, and the Russians were collecting a 9th and a 10th Army in Poland for this purpose. But the Grand Duke Nicholas, who had only been appointed Commander-in-Chief at the outbreak of war, and had been kept in the dark as to the evolution of the war plans up to that point, considered that it would be impossible to strike at Berlin before gaining a decisive victory over the Austrians in Galicia. When, therefore, he found Ivanoff's Group in difficulties, he directed first the XVIIIth Corps, and then the Guard Corps, which were to form the 9th Army, to reinforce Ivanoff's right flank. To counter these reinforcements, the German Corps of Von Woyrsch was hurrying down to help the Austrians, but its march was successfully delayed by the Russian Cavalry Corps under Novikoff.

The Russian 4th Army (Evert) was continuing the fight on the outskirts of Lublin, waiting for the arrival of the 9th Army. The Austrian 1st Army (Dankl) with Kummer's Detachment, was attacking Evert, but the Detachment was decisively beaten by the Russian XVIIIth Corps, newly-arrived. Under this defeat, Dankl turned his attention to Evert's left flank, which he tried to envelop by thrusting forward into the gap between Evert and the 5th Army (Plehve). But this attempt also failed, owing to the fact that Dankl's right flank Corps had already been deflected to help Auffenberg (4th Army), and there was delay in changing its ground. This delay helped the Russian 5th Army, which was being roughly handled by Auffenberg at Tomaczow. Plehve managed to disengage, and, with Ivanoff's concurrence, retired during the night of 31st August/1st September. This gave the Austrians the impression of a considerable victory, which deceived Conrad and adversely affected his subsequent decisions.

There was now a very wide gap between the Russian 5th and 3rd Armies, but Conrad had nothing left to throw into it.

On the 31st August the news of Samsonoff's rout in the north impelled the Russian G.Q.G. to urge Ivanoff to seek a decisive victory without delay. Ivanoff (or, rather,

his Chief of Staff, Alexieff, who was the active spirit in the South-Western Group) responded by shifting the Guard Corps and the IIIrd Caucasian Corps across to Evert's left flank, in order to attack the Austrian forces which had broken through between the 4th and 5th Armies. He extricated the 5th Army in order to re-form it for an attack against the flank of the forces attacking Evert.

Meanwhile, on the Russian left wing, the 3rd and 8th Armies were meeting with success in the battle of the Gnila Lipa (August 29th–30th). Unaware, owing to the good cavalry work of Brussiloff's Army, of the near presence of the Russian 8th Army, Conrad made dispositions for attacking Russki's 3rd Army, which, as we have seen, had suspended its advance to reconnoitre Lemberg. Russki succeeded in driving back the left flank of the Austrian 3rd Army (Boroevitch), while Brussiloff's right-hand Corps struck at its right flank, and at the same time, severely defeated the newly-arrived Austrian 2nd Army (Boehm-Ermolli). Conrad could not yet bring himself to give up Lemberg, and ordered the 2nd and 3rd Armies to give battle afresh on the line Lemberg-Mikolajeff. But by 1st September, the Austrian 3rd Army was exhausted, and could no longer hold its positions round Lemberg. Conrad ordered a further retirement of his right-wing armies (2nd and 3rd). By 2nd September the whole strategic position was reversed; the Russians had a 50% superiority on their northern wing, while the Austrians had three armies against two on the southern wing. Heavy fighting followed for the next six days. The decisive manœuvre was made by Plehve's Army, which launched four Corps against the rear of the Austrian 4th and 3rd Armies while the latter were heavily engaged with Russki and Brussiloff.

Finally, Conrad was forced to order a general retreat to the River San, where a strong position had been prepared in peace-time, but the Russian cavalry in pursuit did not allow the Austrians time to rally, and Conrad was obliged to retire farther still, behind the Wisloka, losing 100,000 prisoners and 300 guns.

The battle is of great interest throughout, and these articles give a very good outline of it.

The article " Les Dernières Étapes de la Pacification dans le Grand Atlas Marocain," by Lieut.-Colonel Lançon, is continued. It is copiously provided with sketch-maps, which are either over-elaborately burdened, or are too sketchy to be of much assistance in illustrating the text. The operations described are those of the 1932 campaign, lasting from May to September. The mobile columns acted very much as described in the previous article. The French methods in this form of warfare are based on their long experience, not exceeded now by our own.

The article is chiefly of interest when read as a whole.

Capitaine Thoumin finishes his article " Le Sens du Terrain et la Géographie Militaire," which is accompanied by two very clear reproductions from the French 1/80,000 military map. The author shows how a great deal of unexpected information can be deduced from a systematic study of ground, and in the two distinctly different examples given he shows much skill in analysing the features on the system he advocated in his first instalment. It is an article of considerable interest to the military engineer.

The fourth article in this number is an account of the Battle of Zama, translated from Liddell Hart's *Scipio Africanus* by Capitaine Lageix. As the book is well known there is no need to describe this French excerpt from it.

W.H.K.

THE INDIAN FORESTER.

(*July, August* and *September*, 1934.)—The July number is full of meat. A brief article on the subject of the timber trade between India and the U.K. makes interesting reading. Again, a suggestion for piling sleepers in such a way as to shade the ends, and so to reduce end splits, might be tried out in R.E. parks. The method involves no additional expense, and the use of no extraneous material, and incidentally would circumvent the ingenious form of theft described by Ole Luk Oie in

When Dog Eats Dog. Statistics in connection therewith may be of interest; from the photos and diagrams, it would appear that 100 sleepers are stacked in a heap one sleeper wide by rather more than one sleeper long, by 5′ 5″ high.

While on the subject of sleepers, mention may be made of two other short articles in this number, one on the use and durability of treated sleepers, and the other on air-seasoning experiments.

" Useful Hints on Forest Bridges " contains some valuable wrinkles; " log Irish bridges " simply made, provided logs are available, and effective, as well as a bamboo suspension bridge, practicable, however, only where suitable trees exist as piers.

In this and the September numbers Sir Sidney Burrard's " Sketch of the Geography and Geology of the Himalaya Mountains " comes in for a very favourable review.

In the August number is a brief article, illustrated by photos, of wooden staging employed in erecting the Ava railway bridge over the Irrawaddy; unfortunately, the description is all too brief, dealing almost entirely with the specification and dimensions of the timber used—*kanyin* or *gurjan* (Dipterocarpus turbinatus) and *in* or *eng* (Dipterocarpus tuberculatus), which were available in 12″ by 12″ sizes up to 60-foot lengths. The staging consisted of triple trestles, the total height of which is not given, though comparison with the only human figure in the photo indicates a total height of not less than 60 feet. The paucity of detail from our point of view is greatly to be regretted, as the problem must have been very similar to that of the reconstruction of a railway bridge damaged by enemy action.

" Radius cutting " as a method of seasoning logs in the same number describes a successful way of preventing splitting along medullary rays of certain hard woods.

The editorial notes transcribe part of a speech of H.R.H. the Prince of Wales to the Empire Forestry Association, commenting on the short-sighted policy of retrenchment in government forestry. There are, he said, 2,300,000 square miles of forest in the Empire, and only 1,500 forest officers to administer this vast extent. This works out, we may notice, to one officer to an area about the size of Kent !

The Presidential address to the Indian Science Congress in 1934 is quoted at some length, chiefly in connection with the deplorable absence of a river physics laboratory, similar to those in the U.S.A. No mention is, however, made of experiments carried out in the College of Engineering at Poona, where, from small-scale models of river-beds, it is possible to estimate with great accuracy the extent of flooding likely to be caused by a proposed barrage or other obstruction in the bed of a river.

The September number begins with a bitter wail on the subject of retrenchments in the service in Burma, by the abolition of many posts on the directing staff. " Why not abolish the General Staff of the Army, and let every Colonel make his own plan of battle? " writes the Editor. Many R.E. officers have been up against a similar problem. Much the same theme occurs in the next article on " Forest History," a plea for continuity of policy in forest management.

In lighter vein is " A Census in Tigerland," the author of which, by arranging for the watching of every water-hole in his division (in the S.W. of Bengal), estimated the tiger population at one per 3·6 square miles.

" Indian Forest Statistics " interests more than the statistician. More than 30% of the total land area of India and Burma is classified as forest. The estimated annual increment of timber in this area is 289,000,000 cu. ft. Primary forest industries—though it must be difficult to assess what are such industries—absorb 7,600,000 of the inhabitants, while the total value of forest products, raw and manufactured, is in the neighbourhood of ten crores of rupees, say £8,000,000.

Lastly, there is an extract from a paper on Indian earthquakes by Sir Edwin Pascoe, late Director-General of the Geological Survey of India, which must be specially commended for the very lucid way in which it explains the origin of recent earthquakes in India.

F.C.M.

CORRESPONDENCE.

UNIFORMS OF THE CORPS OF ROYAL ENGINEERS.

To the Editor, *The R.E. Journal.*

DEAR SIR,

Colonel Kealy's otherwise authoritative article on R.E. uniforms which appeared in *The R.E. Journal* for June of this year, should, to make it complete, have a note added on the practice, for which there is considerable evidence, of wearing red coats (at any rate when off duty) between 1782 and 1812, during some of which time it is known that the regulations prescribed a blue coat.

The authority quoted by Colonel Kealy for the change in 1812 from blue to red is a letter from Captain Nicholas dated 2-4-1812. Colonel Kealy adds, " Nicholas died of wounds received at the assault of Badajoz on 6th April and never lived to wear the scarlet coat and to enjoy the brevet rank which he was given posthumously : yet in the portrait given in *Porter* he is shown as wearing a red coat."

It would seem a fair assumption that the wearing of red coats was at any rate winked at at some previous time during Captain Nicholas' service.

This is not an isolated instance of a Sapper in a red coat before 1812.

I have a red-coated miniature of Lieut. Edward Le Breton, R.E., who served in the expedition to the Low Countries in 1799 (*Porter*, Vol. I, p. 222) and died of yellow fever in Jamaica in 1802.

In 1930 I had some correspondence with the greatest living authority on the Peninsular Army, Sir Charles Oman.

His letter is perhaps of sufficient interest to be printed in full.

Yours faithfully,
E. P. LE BRETON,
Lieut.-Colonel, R.E. (retd.).

Loders,
26-8-34.

Frewin Hall, Oxford.
14-10-30.

DEAR COLONEL LE BRETON,

The whole affair about the colour of the R.E. coat is very puzzling. I have come upon one note of colour since I had your last.

" Diary of Lieut. Rice Jones, R.E., April 3, 1809.

Thomar, 3 April, 1809. We were the only English officers they had seen. From our uniform being like the French we were sometimes taken for officers of that nation."

Therefore in April, 1809, Jones was obviously wearing *blue*, or he could not have been mistaken for a Frenchman.

Yet every coloured portrait of a Peninsula R.E. officer that I know puts him in red, and so do the coloured engravings in Beamish and Hamilton-Smith! Were all the portraits taken after 1812, or before (say) 1808? The document you enclose (and which I return) is evidently of 1812, a consequence of Wellington's vigorous demand for Sappers and Miners, which was duly attended to.

Believe me,
Yours sincerely,
C. W. C. OMAN.

"AIR, SEA AND LAND IN BURMA."

To the Editor, *The R.E. Journal.*

Survey of India,
Quetta,
26th September, 1934.

DEAR SIR,

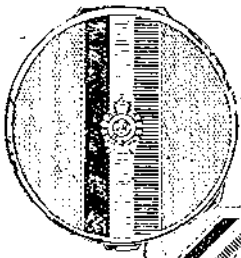
I read the above article by Captain Wyatt in the September *R.E. Journal* with much interest.

I don't quite know, however, why he should complain of the "paucity of maps" in the country south of Mergui, as there are modern (post-war) one-inch maps of the whole of that coast line and of many of the islands. I don't know about the present day charts, as during the course of the survey it was found, when comparing the work of the land surveyor with the chart, that a five-fathom line ran over a hill 100 feet high; and it wasn't a mud vulcano. But little matters like this were soon amicably adjusted.

The Marble Rocks were also visited, landed on, and surveyed. While after twelve years my camera still bears traces of the mud of one lagoon alongside which it was dropped when photographing the lagoon from inside.

I must have been luckier in my tide, as we got in, standing up in quite a large sampan, over half an hour each side of low water. One of my companions on that occasion was a charming Burman, who was being taken under the personal supervision of the D.S.P. to cool his heels at Victoria Point during the time of the Prince of Wales's visit to Rangoon.

Yours truly,
T. M. M. PENNEY, *Major.*



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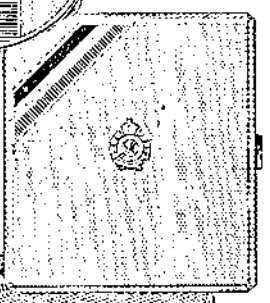

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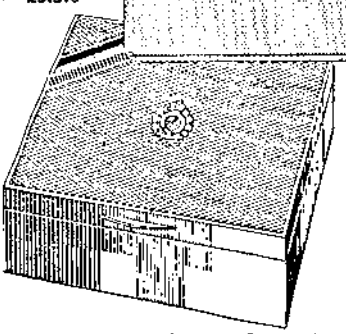

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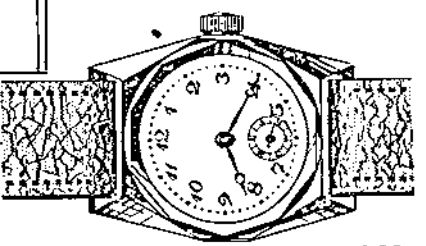

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