THE ROYAL ENGINEERS JOURNAL.

Vol. X. No. 3. SEPTEMBER, 1909.

CONTENTS.

THE HELLIWELL
PATENT "PERFECTION" GLAZING.

ADVANTAGES.

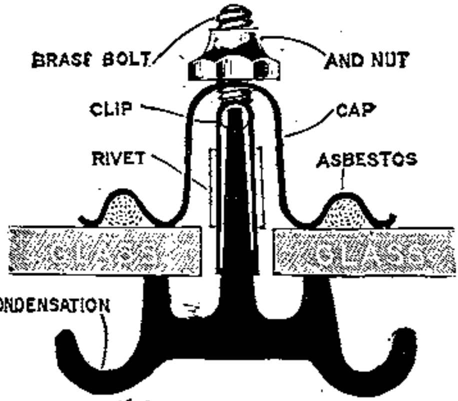
No Putty.
No Paint.

Guaranteed Water-tight and Dust Proof.

Easily Repaired.

Planks laid in Safety across Caps.

Steel Bars galvanized; and also entirely covered with Lead to prevent Corrosion.



"ORDINARY" BAR.
"Ordinary" Section.
BARS of different strengths, to carry up to 12ft. without Purlin.
CAPS in either Copper, Zinc, or Lead.

EXTENSIVELY USED BY

H.M. Government, for Barracks, Dock Sheds, Post Offices, Stores, etc.

All the leading Railway Companies.

Municipal Authorities, for Markets, Baths, Libraries, Art Galleries, Schools, etc.

Also for every kind of Glass Roofing.

Head Office and Works: **HELLIWELL & CO., Ltd.,**
London Office: 11, Victoria Street, Westminster, S.W. **BRIGHOUSE, YORKS.**

PATENT VULCANITE ROOFING

FOR

FLAT ROOFS, CONCRETE ROOFS
AND WOOD ROOFS.

ROOF TANKS

FOR

SWIMMING-BATHS, RESERVOIRS, BRIDGES.

EFFICIENT AND ECONOMICAL.

For Waterproofing Existing Faulty Concrete and Asphalte Roofs.

Will give with the movements of the building due to settlement, vibration, and expansion and contraction, and is guaranteed for long periods.

Special surfaces can be provided to the Vulcanite covering to meet any special requirements.

Full particulars on application to:—

VULCANITE, LIMITED, 118, Cannon St., London, E.C.
Laganvale, Belfast, and at MANCHESTER.

(Also Manufacturers of VULCANITE and BITUMEN Sheetings for the Sloping Roofs of Light Buildings, and for use as a Damp-proof Course).

CONTENTS.

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

1.—Working party in fours crossing the Bridge.

2.—A pony crossing.

3.—RAFTS OF RUSHES.—Bullock cart (weight, 1,360 lbs.) being ferried on 5 bundles of rushes.

FLOATING MATTRESS BRIDGES MADE OF RUSHES

A FLOATING MATTRESS BRIDGE.

COMMUNICATED BY THE COMMANDANT, 1ST (P.W.O.) SAPPERS AND MINERS.

THE following description of a floating bridge, made of rushes and reeds, may be of interest, especially to officers serving in India. The bridge is a very simple one to construct, requiring no skilled labour and very little material beyond the rushes. It should prove particularly useful in swampy country, where the streams are deep and sluggish, and where, although as a rule there are plenty of rushes growing on the banks, there is often a lack of timber suitable for ordinary bridges. The bridge in question was recently made by No. 1 Company, 1st (P.W.O.) S. & M., during its annual training under Capt. A. H. Cunningham, R.E., and was placed across the river Solani near Roorkee, at a site where it was 70′ wide, from 6′ to 10′ deep, the current being $1\frac{1}{4}$ miles an hour.

The bridge consisted of a number of bundles of rushes, each 10′ long by 1′ 6″ diameter, placed right across the river and touching each other. There was thus a continuous mattress of rushes from bank to bank floating on the water surface, and no waterway at all was left. The bundles were fastened to each other near their ends with lashings of grass rope passed through the wire ties which bound the rushes together, while each bundle was also fastened with grass rope to two 3″ hemp cables, which were stretched across the river 8′ apart, and lay on top of the row of bundles near their ends. The two cables were anchored to holdfasts on the banks, and kept the bridge from being swept downstream. *Photos* Nos. 1 and 2 give a good idea of the appearance when finished.

The rushes were cut $\frac{1}{2}$ mile from the river and tied into bundles 10′ long by 1′ 6″ diameter, with four ties, each of a single turn of No. 14 B.W.G. iron wire. They were carried to the river bank, and there lashed in pairs by three ties, each of two turns of wire, round both bundles, thus making small rafts; these rafts were then put in the water and taken to the bridge site, a mile downstream, by a crew of two men on each, provided with bamboos for poling. On arrival three or four of these rafts were tied side by side to form larger ones, and a bamboo was lashed across each end like a riband.

The large rafts were then floated into place under the two 3″ cables, beginning from one bank, and the cables lashed down to the bundles with grass rope passed through the wire ties. It was found that there was a gap large enough for a man's foot to slip into between each small raft and the next, so fascines $8' \times 6''$ diameter were laid on top of these gaps. The bridge was then ready for use, taking about 20 minutes to make.

The roadway was of course rather flexible, and undulated when men passed over, but it carried quite easily men in fours, crowded, and ponies walked over without difficulty. It could also be stiffened by lashing down long "bullies" (or poles) as ribands at each side, if the poles were available, while by laying long poles longitudinally as road-bearers across the bundles of rushes, with planks, hurdles, etc., over them, so that the weight was distributed across a length of the bridge, it would be possible to take carts across.

The weight of a bundle ($10' \times 1'$ $6''$ diameter) of "patera" rushes is 150 to 160 lbs., with a safe buoyancy of about 750 lbs. This size is a convenient one to handle on shore or in the water. After the bundles had been floating in the water four days they did not seem to be any less buoyant.

Only certain kinds of reeds and rushes are suited for such rafts and bridges. Most kinds and also most grasses are not buoyant enough, or else they get waterlogged quickly.

Two of the best kinds in Northern India are :—

(1). "*Typha latifolia*," known to natives of N. India as "patēra"; this is a greenish-brown flat-leaf rush, growing in water to about 12′ high.

(2). "*Cyperus alterifolius*," vernacular "tŭkta," a dark green round reed, about 5′ high.

The former is very common in "jhils" and swamps in India. It is also the best on the whole, as it is pliant and bears handling better than the latter, which, although more buoyant, is not only rarer but is also somewhat brittle. Both sorts are very buoyant, even when freshly cut, and do not waterlog. If dried first, rafts made of them will last four or five months in work.

Bundles of these rushes are also very convenient for ferrying. *Photo* 3 shows a cart weighing 17 maunds (1,360 lbs.) being ferried on five bundles ($10' \times 1\frac{1}{2}'$ diameter).

There are also two other kinds of grass very commonly found in "jhils," which are however of little use for rafts.

(3). "*Phragmites Roxburghii*."—Vernacular "nărkăll," or "năll," is a tall grass with hollow stem and feathery top; grows to 15′ and more—this is very heavy and soon gets waterlogged. This is the commonest "jhil" grass, and is very useful for fascines for roads, being stiff and strong.

(4). "*Cyperus papyrus*."—Vernacular "jill-mill," a flat-leaf bright green rush, or flag, about 4′ high. This soon gets waterlogged.

THE ENGINEERS WITH A DIVISION.

By CAPT. A. H. W. GRUBB, D.S.O., R.E.

1. THE Royal Engineers allotted to a division at war strength consist at present of:—

Headquarters,
2 field companies,
1 divisional telegraph company,

with a total establishment of:—

16 officers,
350 N.C.O.'s and men, dismounted,
129 N.C.O.'s and men, mounted,
32 vehicles, and
193 horses.

2. No provision has been made in its organization for a bridging train (35 yards of bridging material is carried by the two field companies), for balloons, or for search lights. With the present allotment in a division of three infantry brigades, three field artillery brigades (besides the howitzers and heavy artillery), and three field ambulances, it seems a natural arrangement to have three field companies, *i.e.*, an additional field company per division.

3. Again, now that the whole Army has been organized on a basis of divisions, it would seem advisable to organize the Engineers wherever possible on this divisional basis, and therefore to have a divisional organization for the existing balloon units (3), bridging trains (2), and search-light units, instead of keeping them as army troops or unallotted, as they now are.

4. To distribute each of the last three named as separate small units in a division would lead to many complications, even if the undoubted advantage of having these auxiliaries always with a division were obvious; and it is difficult to believe that the cost of equipping and maintaining in peace and war six separate bridging trains, six balloon companies, and six search-light companies for six divisions would be faced. It would probably be generally believed, by many officers as well as by civilians, that units bearing the name of balloon companies or search-light companies would only be useful when balloons or search lights were required, and would therefore be useless encumbrances to a force at other times.

5. To obviate this objection and yet provide these special units with each division, I submit that a third field company of the same

strength as the existing companies in dismounted men, but with a larger number of officers, mounted men, and horses, should be formed for each division, and that it should contain one section for bridging, one section for ballooning (36 men)—the balloon section—and one section for ordinary field company work or a base section. Each of these sections, like that of any ordinary field company, would be capable of performing any work generally falling within the duties of a field company, for which purpose it would have double tool carts with the usual tools. In addition, each section would be capable of performing the special work for which it is organized.

6. It appears to be quite feasible to keep up a company organized on these lines both in peace and war. In peace and war a necessary adjunct to this organization would be the provision of schools for the training of officers, N.C.O.'s, and men in their specialist duties, and to which the whole section should go every year for a portion of its annual specialist training.

7. The sections would have to be kept rather more strictly separate, both in peace and war, than those of other field companies, but the special section could, if necessary, be easily reinforced when required for special work by additional men or horses from the other sections.

The elasticity of the specialist sections, as regards numbers, conferred by this organization, would be a great advantage. In windy weather, for instance, the balloons would require additional help, and if the search lights were required at all regularly at night, additional men for reliefs would be essential. Again, in the event of a long bridge being required, the entire company could, if necessary, be employed on its construction.

8. To enable the company to take its place as a field company, it would be necessary to equip it with the usual double tool cart per section. It could then be employed in road mending, in improving communications, in water supply, and in camping arrangements. These double tool carts would be the only vehicles of the unit which would accompany the first line transport. The specialist vehicles would travel in rear with the ammunition columns, and would only be sent for and brought up to the front when required. It would be necessary for a small proportion of the men to travel with them, to look after them and their special plant.

9. The proposed specialist field company (see Appendix A), would be equipped with what is taken to be the minimum requirements of a division, viz.:—

100 yards of bridging material.

Stores for working one captive balloon, kites or a small dirigible airship.

Four large search lights (90 cms. each), with eight small ones (35 cms.) as alternative.

Bridging Section.—This would be as approved for a half bridging train by *Field Service Manual, 1908.*

The Army has two bridging trains carrying 200 yards of bridging material each. For the six companies 200 yards more would have to be provided.

Balloons.—One captive balloon and kites or a small dirigible balloon.

The Army has at present three balloon companies. These would have to be developed into six sections, or approximately double the existing strength.

Search Lights.—Four large search lights (90 cms. each), with eight small ones (35 cms.) as alternatives to two larger ones, are proposed.

The Army has at present one search-light company with six large lights and 10 small ones. It is an experimental unit and is unallotted. Eighteen new large search-light plants and 40 small lights would have to be provided.

10. Appendix A gives the war establishment which appears necessary. Eight officers are required as against six in the war establishment of the existing field company, and a great number of vehicles and horses are essential. The establishment provides for fully horsing the vehicles required; but it is now possible to count on mechanical draft for at least half of them. Engine drivers are required for search-light engines, and these could be employed on the mechanical tractors.

11. No alteration in the establishment of the existing field companies is proposed at present, but if it is found later that the two pontoon and one trestle wagon can be dispensed with, they could be attached to the bridging train of the specialist company.

12. It does not seem advisable to include any divisional telegraph units in this company. Their work is quite distinct and they must be directly under the divisional staff, whilst the proposed company would be directly under the Commanding Royal Engineer of the division.

13. The formation of the proposed companies from the existing organization does not present any great difficulties, and does not very appreciably increase the total establishment of the Corps.

At present regimental establishments provide for the following in peace:—

Three bridging trains.—Two with army troops, one unallotted.
Three balloon companies.—With army troops.
One search-light company.—Unallotted.
Three field companies.—Unallotted (one being disbanded).

With a total strength in dismounted N.C.O.'s and men of 517. It is proposed that these 10 separate units be formed into six specialist field companies, each with a war strength of eight officers and 157 dismounted N.C.O.'s and men; total, 48 officers and 942 N.C.O.'s and men.

The peace strength would conform to that of other field companies, viz.:—Four officers and 116 N.C.O.'s and men. Total, 24 officers and 696 N.C.O.'s and men.

14. In addition to this number, it would be necessary to have depôts or schools for ballooning and search lighting, and the strength both for war and peace is put as under:—

Balloon School.—Four officers and 40 N.C.O.'s and men.

Field Search-Light School.—Two officers and 20 N.C.O.'s and men.

These schools would be in charge of all experimental plant and would put all specialists through a first course of instruction, lasting nine months for ballooning and six months for search lighting.

15. For easy reference, Appendix B gives the approved war establishments of the existing field companies, bridging trains, and balloon companies. There is no approved war establishment for a search-light company, so the establishment recommended by the Committee on Search Lights, 1906–1907, in their report dated February 25th, 1907, is given.

The appendix also gives the peace strength of the existing specialist units and the field companies it is proposed to absorb.

16. The foregoing proposals give an organization which would comply with the conditions and necessities outlined in the first few paragraphs; but if there is any probability of a still further increase of establishment being approved, it would be preferable from many points of view to have three field companies with each division, in addition to a field specialist company and the divisional telegraph company.

17. This fourth company of specialist Royal Engineers should then consist of a headquarter section and a search-light section, with a war establishment of 7 officers, 93 rank and file dismounted, 46 vehicles, 279 horses, with 175 mounted N.C.O.'s and men, as given in detail in Appendix C, and it would not ordinarily carry tools or stores for pioneer or ordinary field company work.

18. The great objection to this fourth R.E. company per division is the large increase of establishment of dismounted men, and the consequent cost that it would necessitate.

In the first case, with the one additional field company per division, including its specialist sections for the six divisions of the field army, the total increase of establishment required would be:—

In peace—8 officers and 180 dismounted N.C.O.'s and men.

In war—7 officers and 254 N.C.O.'s and men.

In the second case, with three field companies per division and the divisional specialist company, the necessary increase of establishment to the corps would be :—

In peace—32 officers and 550 dismounted N.C.O.'s and men.

These are approximate figures, taking the peace strength of the new units as two-thirds the war strength.

In war—49 officers and 812 dismounted N.C.O.'s and men.

In addition to the above, the establishment required for the depôts or schools, both in peace and war, would be about 6 officers and 60 men.

19. In conclusion, the points it is desired to emphasize are :—

(1). The necessity of having more Engineers with a division.
(2). The necessity of having bridging material, balloons, and search lights with a division in peace and war.
(3). The undesirability of reducing the present war and peace establishments of existing field companies.
(4). The desirability of creating large units rather than a number of small ones.
(5). The importance of making it clear that specialist R.E. units can carry out in the field any ordinary field work usually allotted to the Engineers.

APPENDIX A.

PROPOSED WAR ESTABLISHMENT OF A SPECIALIST FIELD COMPANY, R.E. (ONE TO EACH DIVISION).

Detail.	Headquarter Section.		Field Company Section.		Bridging Train Section.		Balloon Section.		Search-Light Section.		Total.		Vehicles.	Horses.
	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.		
Major and Captain	2	—	—	—	—	—	—	—	—	—	2	—		
Subalterns	—	—	1	—	1	—	2	—	2	—	6	—		
Staff-Sergeants and Sergeants ...	2	2	—	1	4	1	1	1	1	1	8	6		
Snoeing and Carriage Smith ...	1	—	—	—	2	—	1	—	1	—	5	—		
Trumpeter and Bugler	1	1	—	—	—	—	—	—	—	—	1	1		
Corporals and 2nd Corporals ...	—	—	1	3	6	3	3	3	3	3	13	12		
Sappers	—	6	—	33	—	33	—	33	—	33	—	138		
Drivers	5	—	4	—	78	—	24	—	37	—	148	—		
Batmen	4	—	1	—	1	—	2	—	2	—	10	—		
Total	15	9	7	37	92	37	33	37	46	37	193	157	51	299
Vehicles	1		2		23		10		15		51			
Horses. Riding	8		2		17		8		8		43			
Horses. Draught	4		6		140		42		60		252			
Horses. Pack	—		1		1		1		1		4			
Total	12		9		158		51		69		299			

APPENDIX B.

WAR ESTABLISHMENTS, 1908–09.—ROYAL ENGINEERS.

	Officers.	Dismounted N.C.O.'s and Men.	Mounted N.C.O.'s and Men.	Total.	Vehicles.	Horses.	Remarks.
Field Company	6	157	49	212	12	71	
Balloon Company	3	31	31	65	9	50	
½ Bridging Train (right half)	3	12	106	121	23	167	
Recommended. Search-Light Company	5	85	83	173	21	136	Excluding water carts.

PRESENT PEACE ESTABLISHMENT OF THE FOLLOWING UNITS (SEE § AND REGIMENTAL ESTABLISHMENTS, 1908–09).

	Officers.	Dismounted N.C.O.'s and Men.	Mounted N.C.O.'s and Men.
3 Bridging Trains	—	21	3
3 Balloon Companies with Balloon School	8	99	38
1 Search-Light Company	3	49	39
3 Field Companies (4th, 55th, and 58th)	9	348	78
Total	20	517	158

APPENDIX C.

PROPOSED WAR ESTABLISHMENT OF A DIVISIONAL SPECIALIST COMPANY, R.E. (SPECIALISTS ONLY).

Detail.	Headquarter Section.		Bridging Train.		Balloon School.		Search Light.		Total.		Vehicles.	Horses.
	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.	Mtd.	Dismtd.		
Major and Captain	2	—	—	—	—	—	—	—	2	—		
Subaltern	—	—	1	—	2	—	2	—	5	—		
Staff-Sergeants and Sergeants	2	2	4	—	1	1	1	1	8	4		
Shoeing and Carriage Smith	1	—	2	—	1	—	1	—	5	—		
Trumpeter and Bugler	1	1	—	—	—	—	—	—	1	1		
Corporals and 2nd Corporals	—	—	6	2	3	3	3	3	12	8		
Sappers	—	6	—	8	—	33	—	33	—	80		
Drivers	5	—	8	—	22	—	35	—	140	—		
Batmen	4	—	1	—	2	—	2	—	9	—		
Total	15	9	22	10	31	37	44	37	182	93	46	279
Vehicles	1		22		9		14		46			
Horses. { Riding	8		17		8		8		41			
Horses. { Draught	4		140		38		56		238			
Total	12		157		46		64		279			

NOTES ON FIELD EQUIPMENT OF ROYAL ENGINEERS.

By Lieut.-Colonel W. Baker Brown, R.E.

(*Continued from* R.E. Journal, *April*, 1908.)

DETAILS OF TECHNICAL EQUIPMENT.

I. Field Troop.—*Collapsible Boat Equipment.*—Two tri-partite boats, with superstructure for forming a raft, are carried on a special vehicle. The raft is intended for the transport of men, field guns, and light vehicles. Horses cannot be carried. The boats can be used separately, in swimming horses and transporting men, saddlery, etc.

Tools for Military Purposes.—Each section of a field troop carries, in the double tool cart, the following, which is approximately sufficient for one working party of about 20 N.C.O.'s and men :—

Axes, felling ...	10
Axes, hand ...	3
Axes, pick (heads 4½ lbs.) ...	15
Bars, crow (4′ 8″) ...	2
Hooks, bill ...	8
Saws, hand ...	4
Shovels ...	16
Spades ...	3
Sandbags ...	120

Telephones, etc.—Three portable telephone sets, with spare cells, cable, wire, and repairing apparatus, are carried with the Sappers, in light spring wagons, for tapping telegraph lines or making temporary repairs.

Artificers' Tools.—The quantities carried are reduced to the lowest possible, and if a force remains stationary for any time and much R.E. work has to be done, additional tools must be drawn from the

A.O.D. or obtained locally. A small set of carpenters' and other tools are carried with each section. The G.S. wagon of the unit, in addition to carpenters' and other tools, carries a forge and set of smiths' tools. A very small amount of fuel for the forge is also carried, and must be supplemented by local supplies. A small amount of consumable stores—nails, iron, steel, etc.—is carried, and should be supplemented from local sources.

Stores for Water Supply.—Each section carries on the double tool cart, a pump (lift and force to lift 60′) with hose, and for each pump a 600-gallon waterproof trough, with pickets and the necessary cordage, is carried in the G.S. wagon of the unit.

Explosives.—Each section carries about 140 lbs. of wet guncotton and dry primers, and both electrical and ignition appliances for firing charges. The electrical appliances include an exploder-dynamo, a length of D 15 cable, and detonators No. 13. The ignition appliances are No. 9 safety fuze, Vesuvian matches, and No. 8 detonators.

Signalling Stores.—Flags only are carried with each section, but heliographs and signalling lamps are with the G.S. wagon of the unit.

Survey Stores.—A small set of the usual military sketching and drawing instruments are carried with the G.S. wagon of the unit.

Packages.—Two Clarkson's chests are carried in the G.S. wagon of the unit for packing small stores. They can be used with the pack animals if necessary.

Pack Animals.—The normal loads for Nos. 1 and 2 horses are shown as consisting each of one rack of tools and one Clarkson's chest filled with consumable stores, etc. Nos. 3 and 4 horses each have two Clarkson's chests filled with explosives. No. 5 horse has one Clarkson's chest with tools, blocks, cordage, etc. Extra racks are carried in the double tool cart of each section.

II. FIELD COMPANY.—*Bridging Matériel.*—The amount carried is indicated by the notes to the Table of Transport (p. 8), *F.S. Manual.*

This is capable of use as under:—

(1). For a bridge of four bays, using five baulks to a bay, with three points of support (trestle or pontoon).

(2). For a bridge of three bays, using seven baulks to a bay, with two points of support.

(3). For extension of a bridge partly made by another unit, four complete bays with five baulks, or three complete bays with seven baulks.

(4). A trestle pier on each bank, with one raft of two pontoons.

Tools for Military Purposes.—Each section of a field company carries, in the double tool cart, the following, which is approximately sufficient for two working parties, each of about 20 N.C.O.'s and men :—

Axes	felling	8
	hand	5
	pick (heads, $4\frac{1}{2}$ lbs.)	18
	" (" 8 ")	4
Bars, crow (4′ 6″)		2
Hooks, bill		7
Saws, hand		5
Shovels		24
Spades		3
Sandbags		150

Stores for Water Supply.—Each section carries on the double tool cart, a pump (lift and force to lift 60′) with hose, and for each pump a 600-gallon waterproof trough, with pickets and the necessary cordage, is carried in the forage cart.

The Artificers' Tools, Explosives and Signalling and Survey Stores are the same as for the Field Troop, the Headquarters however carrying those stores, which in the case of the Field Troop are carried in the G.S. wagon.

Packages.—Two Clarkson's chests are carried in each forage cart for packing small stores. They can be used with the pack animals if necessary.

Pack Animals.—The normal load is shown as consisting of one rack of tools and one Clarkson's chest filled with explosives. Extra racks are carried in the headquarter wagon.

III. DIVISIONAL TELEGRAPH COMPANY.—(1). *Organization of Company.*—As shown by the "Note" to War Establishment, Section 2 A, *F.S. Manual,* a divisional telegraph company consists of three detachments. Each detachment consists of three mounted and five dismounted N.C.O.'s and men. The dismounted men include two operators, and are carried on the cable wagon. Each cable wagon is followed by a light spring wagon, carrying one operator. Six more dismounted men (including officers' second batmen) belong to the detachment; two of them can be carried--one on the cable wagon and one on the light spring wagon; the remainder march on foot. In addition there are :—

No. 1 Detachment—One officer's batman on spare horse.
No. 2 Detachment—One officer's batman on spare horse.
One C.S.M. (mounted).
One shoeing smith (mounted).
In each detachment—Two sappers (mounted).

(2). *Telegraph Stores Carried in Wagons.*—Each cable wagon carries 8 miles of cable, with materials and tools for crossings, etc., and two third-class offices, one for the starting point and one to accompany the wagon. Each light spring wagon carries 2 miles of cable and one third-class office, for use as required.

(3). *Third-Class Office.*—A third-class office consists of:—

Batteries, dry, O 6-cell		1
Boxes, tin, filled, plain stationery, Unit C		1
Flag, distinguishing, telegraph		1
Galvanometer { detector Q and I		1
Galvanometer { cases		1
Kettle, camp, oval, 12 quarts		1
Knives, clasp		1
Lantern, field telegraph		1
Mattocks, telegraph equipment		1
Pipes, earth		1
Pliers { side cutting	pairs	1
Pliers { cutters (spare)	pairs	2
Stamps, army telegraph { dating		1
Stamps, army telegraph { paid		1
Telegraph sets, vibrating, R.E.		1
Telephones { receivers, head		1
Telephones { ear cushions		1
Telephone sets { portable "D"		1
Telephone sets { cells, dry		1
Tents, complete D'abri		1
Tools, electricians', large	sets	1
Watches		1
Wire, electric, covered, C 23	yards	20

Telegraph sets, vibrating, R.E., consists of:—One vibrator, telegraph, with brass cover for coils; two adjusting pins; two dischargers, lighting bobbins (without screws); one long securing screw for dischargers; and plug quadruple. One telephone, hand,* C, Mark II., in case.

Telephone set, portable D, Mark I., includes:—Telephone with vibrating call, and telephone, hand, "D," in leather case, with sling. One dry cell for each set is provided separately.

Telephone set, portable D, Mark II., includes:—Telephone with vibrating call, telephone transmitter "D," with capsule, telephone receiver D, in leather case with sling. Two dry cells are provided separately.

(4). *Stationery.*—In addition to the box of stationery supplied to units for military use (which is carried in No. 3 light spring wagon),

* Pending provision of these, "Telephones, hand, A," are being used.

boxes of technical stationery are carried (Unit C). Each box is hermetically soldered round the bottom after the stationery has been packed inside. The method of opening is by stripping off the tin band forming the upper rim, an overlapping part of the band being left at each end of the box for that purpose. In "War" the boxes are thrown away after being emptied of their contents, but in "Peace" they are returned to the Army Ordnance Department for local repair and re-issue or disposal. The contents of the boxes are shown in mobilization store tables.

(5). *Artificers' Tools.—Carpenters.*—Chest 4 A, filled, one in light spring wagon No. 3.

Farriers.—Bags, tool, farriers', filled, one in light spring wagon No. 2.

Collarmakers.—Holdall, saddlers', one in light spring wagon No. 2.

(6). *Telegraph Tools.*—Each cable wagon carries tools for one working party. Soldering gear in carried in each light spring wagon, though there is only one pot per section.

IV. AIR-LINE TELEGRAPH COMPANY.—(1). *Organization.*—As shown by the "Note" to War Establishment, Section 2 A, *F.S. Manual*, an air-line telegraph company consists of a headquarter and three sections. Each section consists of two working detachments, operators for two second-class offices, and two mounted linemen. The section has four air-line wagons, each carrying 5 miles of air line complete, one second-class office (some of the batteries and stationery are in section G.S. wagon), and tools for one lineman. Two of the air-line wagons each carry tools for a working detachment. The section also has a cable wagon fully equipped with 8 miles of cable, and a G.S. wagon and a light wagon for spare stores, forage, rations, etc. The unit can therefore provide *matériel* for the erection of 60 miles of air line, 12 second-class offices, two third-class offices, and 8 miles of cable. The *personnel* can provide six air-line working parties, operators for 12 second-class offices, and linemen for 120 miles of air line. No *personnel* is separately provided for the cable.

(2). *Office Equipment.*—The following stores are shown in the two types of office:—

			2nd Class.	3rd Class.
Batteries, dry, "O"	6-cell	... ...	1	1
	10-cell	... ...	6	—
Bells, electric, battery, with case		... ...	1	—
Boxes, cash, G.S.		... ...	1	—
Boxes, stationery, tin, filled	japanned unit	A ...	1	—
		B ...	1	—
	plain unit	A ...	1	—
		B ...	5	—
		C ...	—	3

		2nd Class.	3rd Class.
Brushes, watchmakers'		1	—
Commutators, telegraph, 6-line		1	—
Flags, distinguishing, telegraph		1	1
Galvanometers, detector, Q and I, with case		1	1
Kettles, camp, oval, 12 quarts		1	1
Knives, clasp		1	1
Lanterns, field telegraph		1	1
Leather, chamois		1	—
Mattocks, telegraph equipment		—	1
Oil for instruments	pints	$0\frac{1}{4}$	—
Pipes, earth		1	1
Pliers { sidecutting, 3'	pairs	1	1
Pliers { cutters (spare)		2	2
Relays, telegraph, with case		1	—
Stamps, army telegraph { dating ...		1	1
Stamps, army telegraph { paid		1	1
Switches, single and duplex		1	—
Telegraph sets { simplex		1	—
Telegraph sets { vibrating, R.E.		1	1
Telephone { sets, portable, "D"		—	1
Telephone { cells		—	1
Telephone { receivers, head		—	1
Telephone { ear cushions		—	1
Tables, telegraph		1	—
Tents, complete { D'abri		—	1
Tents, complete { telegraph		1	—
Tools, electricians', large	sets	1	—
Watches		1	1
Wick, common	yards	1	$0\frac{1}{2}$
Wire, electric, covered, C 23		50	20

(3). A telegraph set, simplex, consists of:—Wood board, 15" × 15", with two wood reels for wire and fitted with galvanometer, single and duplex; instrument, telegraph, sounder, translating; relay telegraph, Mark II., key, double current; switch, single and duplex, four dischargers, lightning bobbin (two spare); and 48 yards of wire, electric, covered, A 3; in transport case.

A telegraph set, vibrating, R.E., consists of:—One vibrator, telegraph, with brass cover for coils; two adjusting pins, two dischargers, lightning bobbins (without screws); one long securing screw for dischargers; and plug quadruple. One telephone, hand, "C," Mark II.,* in case.

* Pending provision of these, "Telephones, hand, A," are being used.

A telephone set, portable "D," Mark I., consists of:—Telephone with vibrating call, and telephone, hand, "D," in leather case with sling. One dry cell for each set is provided separately.

A telephone set, portable "D," Mark II., consists of:—Telephone with vibrating call, telephone transmitter "D," with capsule, telephone receiver "D," in leather case with sling. Two dry cells are provided separately.

(4). *Linemen's Tools.*—A set of lineman's tools consist of the following:—

Apparatus, repairing, wire ...	...	2
Baskets, tool, leather handled	...	1
Drivers, screw, 9′ ...	...	1
Galvanometer, detector, Q and I, and case	...	1
Gimlets, spike, ¼″ ...	...	1
Hammers, claw, 28-oz. ...	...	1
Irons, soldering, tinman's small	...	1
Knives, clasp ...	...	1
Mallet, heel peg ...	...	1
Mattock, telegraph equipment	...	1
Pliers { sidecutting ...	pairs	1
Pliers { cutters (spare)	...	2
Rods, clearing, obstacle ...	...	1
Spanners, McMahon, 9″ ...	...	1
Telephone sets { portable, "D" ...	...	1
Telephone sets { cells, dry ...	...	1
Tools, electricians', small ...	sets	1

(5). *Stationery.*—The japanned boxes, with lock and key, are intended to hold stationery in use, from units A and B. The plain boxes, units A and B, to hold a full supply to replace. The japanned boxes are rendered watertight by strips of basil leather, secured to the inner side of the lid, and resting on the wired edge of the box. The plain boxes are hermetically soldered round the bottom after the stationery has been packed inside. The method of opening is by stripping off the tin band forming the upper rim, an overlapping part of the band being left at each end of the box for that purpose. In "War" the plain boxes are thrown away after being emptied of their contents, but in "Peace" they are to be returned to the Army Ordnance Department for local repair and re-issue or disposal. The contents of the boxes, units A, B, and C, are shown in mobilization store tables.

(6). *Artificers' Tools.*—Sets of carpenters', farriers', and saddlers' tools are carried in each of the section G.S. R.E. wagons. A forge and set of smiths' tools is carried in the headquarter G.S. R.E. wagon.

A set of telegraph mechanics' tools with spare parts and materials are included in the war outfit of an air-line telegraph company, but special provision has to be made for transport, as they are not included in the loads of vehicles given in Section 5B.

V. CABLE TELEGRAPH COMPANY.—(1). *Organization of Section.*—A cable company consists of a headquarters and four sections. Each section consists of two working detachments of three mounted and five dismounted non-commissioned officers and men each. The dismounted men include two operators, and are carried on the cable wagon. Each cable wagon is followed by a light wagon carrying one operator. Four more men without horses (including one batman) belong to the section, and are carried one on each cable wagon and one on each light spring wagon. In addition there are:—

1 shoeing smith (mounted).
1 batman (on subaltern's second horse).
3 sappers, linemen (mounted).

The headquarters consist of one working detachment organized as above, the company staff, six spare sappers (dismounted), three mounted linemen, and the spare drivers and horses. Owing to the necessity for carrying rations and ground sheets for these in the light spring wagon, it cannot be used to carry any men. The men without horses march.

(2). *Telegraph Stores Carried in Wagons.*—Each cable wagon carries 8 miles of cable, with material and tools for crossings, etc., and two third-class officers, one for the starting points and one to accompany the wagon. Each light spring wagon carries 2 miles of cable and one third-class office for use as required.

(3). *Third-Class Office.*—A third-class office consists of:—

Batteries, dry, O, 6-cell		1
Boxes, tin, filled, plain stationery, unit C...		3
Flags, distinguishing, telegraph		1
Galvanometers, detector, Q and I, with case		1
Kettles, camp, oval, 12 quarts		1
Knives, clasp...		1
Lanterns, field, telegraph		1
Mattocks, telegraph equipment		1
Pipes, earth		1
Pliers { side cutting	pairs	1
Pliers { cutters (spare)		2
Stamps, army telegraph { dating		1
Stamps, army telegraph { paid		1
Telegraph sets, vibrating, R.E.		1

Telephones { receivers, head	...	1
Telephones { ear cushions	...	1
Telephone sets { portable, "D"	...	1
Telephone sets { cells, dry	...	1
Tents, complete, D'abri	...	1
Tools, electricians', large	sets	1
Watches	...	1
Wick, common	yards	$0\frac{1}{2}$
Wire, electric, covered, C 23	yards	20

A telegraph set, vibrating, R.E., consists of:—One vibrator, telegraph, with brass cover for coils; two adjusting pins; two dischargers' lightning bobbins (without screws); one long securing screw for discharges; and plug quadruple. One telephone, hand,* C, Mark II., in case.

A telephone set, portable, "D," Mark I., consists of:—Telephone with vibrating call, and telephone, hand, D, in leather case with sling. One dry cell for each set is provided separately.

A telephone set, portable, "D," Mark II., consists of:—Telephone with vibrating call; telephone transmitter D with capsule; telephone receiver D, in leather case with sling. Two dry cells are provided separately.

(4). *Stationery.*—In addition to the box of stationery supplied to all units for military use (which is carried in No. 3 light wagon), 27 boxes of technical stationery are carried (Unit C). Each box is hermetically soldered round the bottom after the stationery has been packed inside. The method of opening is by stripping off the tin band forming the upper rim, an overlapping part of the band being left at each end of the box for that purpose. In "War" the boxes are thrown away after being emptied of their contents, but in "Peace" they are returned to the Army Ordnance Department for local repair and re-issue or disposal.

The contents of the boxes are shown in mobilization store tables.

(5). *Artificers' Tools.—Carpenters.*—Chest 4 A, filled, one per half-company, in light spring wagons 1 and 5.

Farriers.—Bags, tool, farriers', filled, one per section, in light spring wagons 1, 3, 5, and 7.

Collarmakers.—Holdalls, saddlers', one per section, in light spring wagons 1, 3, 5, and 7.

(6). *Telegraph Tools.*—Each cable wagon carries tools for one working party. Soldering gear is carried in each light spring wagon, though there is only one fire-pot per section.

* Pending provision of these, "Telephones, hand, A," are being used.

VI. BRIDGING TRAIN.—(1). The bridging train is divided into two half trains, which are exactly similar, except for the extra baggage, rations, camp equipment, etc., in the right half for the headquarters of the train, which forms an additional part of it.

(2). *Bridging Material.*—The amount carried is indicated by the notes to the Table of Transport (pp. 8 and 13), *F.S. Manual.*

This is capable of use as follows :—

(*a*). Light bridge, capable of carrying infantry in file, 160 yards of floating and 40 yards of trestle bridge per half train.

(*b*). Medium bridge, capable of carrying infantry in fours, cavalry in half sections, field guns, or ordinary horsed wagons, 80 yards of floating and 20 yards of trestle bridge per half train.

(*c*). Heavy bridge, capable of carrying ox wagons, 60 yards of floating bridge and 20 yards of trestle bridge per half train.

(*d*). Special heavy bridge, double-chessed, with 10′ bays, capable of carrying the 60-pr. gun, 40 yards of floating bridge and 20 yards of trestle bridge per half train.

(*e*). Rafts, capable of carrying the light engine or trucks of the transport and supply park, with landing stages.

(3). *Artificers' Tools.*—Four sets of carpenters' tools, two ot saddlers', five of farriers', two of smiths', and two of shoemakers' are carried in the train.

VII. BALLOON COMPANY.—(1). *Organization.*—As shown by War Establishment a balloon company is capable of working one balloon, or one flight of kites.

(2). *Balloons.*—It carries in the field two balloons for work, besides smaller ones for signalling purposes and enough gas to fill a balloon twice. At the advanced depôt four more balloons are provided and six refills of gas.

(3). *Kites.*—A flight of kites consists of one pilot, one carrier, and one or more lifters. One set is carried in the field, and another set is kept at the advanced depôt.

(4). *Telephones.*—Telephonic communication is provided between balloons and earth by means of a light cable. Signalling gear is provided for communication with other units if necessary.

(5). *Tools.*—Carpenters', smiths' and shoemakers' tools are carried for the use of the unit only. No entrenching tools are carried beyond the wagon equipment.

RESERVE EQUIPMENT.—The present system of reserve of stores for the Army is based on the recommendations of a Committee presided over by Sir F. Mowatt in 1900, and the stores are often referred to as Mowatt Reserves. In addition to these, there has been in existence for about 20 years a special reserve of telegraph stores, based on the experience of various campaigns, which successfully provided for the requirements of the South African War. The Mowatt Committee laid down a general scale of 100 per cent. of the war equipment in the reserve for R.E. units. The whole of the lists of stores have now been reconsidered and rearranged under new heads, of which the following items affect Engineer services.

FOR SPECIAL EMERGENCIES AND TEMPORARY ADDITIONS TO FORCE.— * * * Item 12.—*Engineer equipment* for demolitions, water supply, entrenching, and siege requirements.

* * * * * *

MAINTENANCE OF THE ARMY IN THE FIELD.—Item 14.—General stores, including vehicles.

* * * * * *

The second of these (Item 14) is taken into the field by the Army Ordnance Dept., and used by them to meet demands from units to replenish equipment.

The amounts stored depend, firstly, on facility for purchase on mobilization being ordered; secondly, probable wear and tear when in use. For the Engineer portion, instead of the uniform scale of 100 per cent., different scales have been allotted to groups of stores; thus ordinary tools are stored to a scale considerably less than 100 per cent., technical stores are held on a larger scale than ordinary tools, and consumable stores, which have to be frequently renewed, on a scale considerably in excess of 100 per cent.

The reserve of telegraph stores is now included in this item, but as the field telegraph work of an army has to interchange a good deal with the work on the line of communications, all the telegraph stores not with units are kept together at Woolwich, and will be issued to the seat of war under the general direction of the Director of Army Telegraphs.

The stores in Item 12 are especially ear-marked for Engineer services, so that it will be one of the duties of the Chief Engineer of a force to advise the Army Ordnance Department what articles and quantities should be sent to the seat of war, also what additional articles should be provided.

All Commanding Royal Engineers of Divisions and their staff officers should also be acquainted with the general kinds of tools and stores held under this item, not only that they may find out what is available, but also that they may know what will have to be provided from other sources. Copies of the list of Mowatt are with the ordnance officers of commands.

The item is subdivided into separate heads for "Demolition," "Water Supply," "Entrenching and Siege." Under demolitions are stored a stock of the service explosives—dry and wet guncotton—with both ignition and electrical appliances, including a stock of instantaneous fuze, and bags, cylinder and mouthpieces for making up under-water charges.

The water supply stores include some 2,300-gallon waterproof tanks, 600-gallon troughs, several varieties of pumps—steam, borehole, deepwell, lift and force, and semi-rotary—also some Merryweather valiant pumps. Also some $1\frac{1}{4}''$ tube wells and 2 miles of $2\frac{1}{2}''$ light steel water main with couplings.

The entrenching and siege tools include a first supply of the usual entrenching tools, sandbags, and gabions. Also artificers' tools, miners' tools, and lifting tackle, including 6-ton differential tackles, $22\frac{1}{2}$-ton jacks, and various sizes of steel wire rope.

A PLEA FOR SINGLE-GUN BATTERIES IN COAST DEFENCE WORKS.

By Major C. R. Buckle, d.s.o., Royal Garrison Artillery.

It has long been the custom to build batteries with several guns in line. In the days of the 32-pounder we had our grand battery of 15 guns in line firing through embrasures; later we had heavy guns mounted in casemates in batteries of six or more guns; still later, several guns mounted in one battery *en barbette*, with large traverses between the guns. The area over which the guns could fire was restricted, not by their proximity to one another, but by the manner in which they were protected, *i.e.*, by embrasures, casemates, or traverses.

Batteries of the present day have their guns protected by shields, and are so mounted, that they would have an all-round arc of fire if it were not for the gun on either side of them. Yet we still adhere to the two or more gun type of battery. Is there any good reason for still adhering to this type, which limits the fire effect of our heavy and medium gun batteries, or is it simply an old custom which dies hard?

The design on paper, and the battery when completed may perhaps offer a more pleasing picture to the eye of the designer; but this is only attained at the expense of the efficiency of the battery.

Let us first consider the arc of fire of the guns. The coast defence battery is placed at a disadvantage in this respect compared with its adversary. A ship can alter course and place herself in such a position that she can bring a maximum number of her own guns to bear on her objective, whilst possibly her enemy can only bring a small number of his guns to bear on her. A field battery can change front or position to attain the same object. But in the coast defence battery the guns are chained to one spot; they can only revolve on their own pivots, and therefore, should the objective be on either flank, there is a loss of gun fire at once, since a gun cannot be efficiently fought whilst another gun of the same battery is firing within 30° of it. In the case of a 2-gun battery, each gun loses about 60° on one flank out of the 360° of the circle. In the case of a 3-gun battery, the centre gun loses 60° on each flank, *i.e.*, there is an arc of 120° which it cannot fire over; the flank guns each lose 60°. The single-gun battery is therefore an economy of guns and men; with five well-sighted single-gun batteries we can do the work of four 2-gun batteries.

The necessity of every gun having an all-round arc of fire is very much more important in these days of long-range fire than it used to be. Nowadays, coast-defence guns may have to fight landwards as well as seawards. At the Siege of Port Arthur the coast defence guns had to be dismounted and the batteries reconstructed to enable them to do so.

As regards the fighting efficiency of a battery, it is incomparably easier to fight a single-gun battery than it is a 2 or 3-gun battery. In the case of the more than 1-gun battery, difficulties arise in :—

(*a*). Determining which splash or hit is due to each gun when observing the fall of shots. This difficulty is increased in the case of medium guns, when two or more projectiles from each gun are in the air at the same time.

(*b*). Passing orders to a gun at a distance from the battery commander's post.

(*c*). Passing different corrections to each gun.

The difficulties attached to fighting a more than one 1-gun battery are so great that in practice we frequently find that a battery commander himself directs the fire of one gun only and delegates the direction of the other guns to his subordinates, who suffer from the disability of having no battery commander's post from which they can observe and direct their fire.

In the case of medium guns which are fought at night against torpedo craft, this delegation of fire direction becomes a necessity, since each gun has a different objective. If the objective be "blockers," the same delegation of fire direction will probably be a necessity on account of the number of ships which have to be fired on simultaneously. In the case of heavy guns, whenever the number of ships bombarding exceeds the number of batteries which can fire on these ships, certain batteries will have to engage more than one ship, for it is a cardinal principle that every ship whose fire is effective must be fired on continuously. If our adversary should decide upon a bombardment, he will not employ a single ship by itself for the operation. We may consider ourselves fortunate if we have one or two heavy guns to spare after allotting one gun to each ship. The heavy coast defence gun of to-day will require to be very well fought to keep down the fire of ten 12" guns.*

* The increase in the number of heavy guns in a battleship has made the destruction of a dockyard a more feasible undertaking than formerly. For supposing it requires 500 12" projectiles to seriously damage a dockyard, the fleet of five ships, each mounting four guns carrying a total of 2,000 rounds, could ill spare this amount of ammunition. The modern fleet of five ships however with 10 guns per ship carries 5,000 12" projectiles, and the loss of 500 will not be felt to the same extent. The improvement in propellants as regards their erosive effect on the bores of guns also helps to make a bombardment a less risky undertaking.

It not infrequently happens that the most suitable site for a battery has sufficient space for one gun only; under the present system of 2-gun batteries this site would be rejected in favour of one which has space for two guns, so that not only will the guns restrict each other's arc of fire, but the site selected will not be that which from the configuration of the ground gives the largest arc of fire.

In the improbable contingency of the enemy making our batteries the objective of his attack instead of the contents of the place which the batteries are designed to defend, the dispersion of the guns into single-gun batteries will of course considerably increase his difficulty in silencing the guns. Two single-gun batteries may cost rather more to construct than one 2-gun battery. They will also require about four additional men to man them.

As regards the expense in construction, it is a matter worthy of consideration whether in some cases a considerable saving might not be effected by substituting weather-proof buildings above ground for the present underground bombproof shelters. During a bombardment from the sea the *personnel* will be manning their guns, and therefore bombproof shelters will be of no use to them. Continuous bombardment from the land cannot well come upon us as a surprise; should it become probable, "dug-outs" might be constructed for the men to take shelter in when not fighting their guns. Possibly in some cases above ground iron buildings with large removable windows might take the place of our present underground shell and cartridge stores; the cost of construction would be less, the supply of ammunition to the guns might be simplified, and the risk of having our ammunition exploded by gun fire is not great. The case of each new battery ought however to be treated on its own merits; in some positions a battery is very much less likely to be bombarded than in others. When, by departing from the approved type of battery, money can be saved without impairing efficiency, we should not for a moment hesitate to do so.

Where then shall we find the best sites for our heavy and medium gun batteries? The requirements are:—

(*a*). An all-round arc of fire for every gun without interfering with the fire of any other gun.

(*b*). Height to facilitate observation of fire, range-finding, and laying.

(*c*). A forward position with regard to the place which the batteries are designed to defend, in order that the attacker may be kept at a safe distance.

Conditions (*a*) and (*b*) will usually be found on a ridge, hill-top, or spur. In the case of a spur with considerable height, it may be feasible to find two or more sites at heights differing by about 50'.

For administrative purposes, and also with a view to the replacement of casualties, it will be an advantage if the group of single-gun batteries, which are manned by the same unit, are within 600 or 800 yards of one another.

In conclusion, let us summarize the advantages and disadvantages of the single-gun battery.

ADVANTAGES.

(1). A maximum arc of fire for every gun, enabling every gun to engage the enemy.

(2). Facilities for observing fire.

(3). Simplification in the passing of corrections and orders.

(4). Simplification in the ammunition supply.

(5). Facilities for the distribution of fire.

DISADVANTAGES.

(1). Slight increase in cost of construction.

(2). Slight increase in the *personnel* required for manning the batteries.

Both these disadvantages are more apparent than real, when we can make five single-gun batteries do the work of four 2-gun batteries.

THE FYERS FAMILY.

By COL. ROBT. H. VETCH, C.B., LATE R.E.

THE origin of the family of Fyers, or Foyers, may possibly be traced to an illegitimate son of Hugh, third Lord Lovat, known as "Hutcheon Franchack," or "French Hugh," from his long residence in France. The third Lord Lovat was born before 1450 A.D., and it may be assumed that French Hugh was born towards the end of the 15th century. According to an *Historical Account of the Family of Frisel or Fraser*, by John Anderson, W.S., published in Edinburgh in 1825, French Hugh was the founder of the family of Foyers and of eighteen others in Stratherrick, a glen leading from Loch Ness in which are situated the falls of Foyers.

However this may be, the members of that branch of the Fyers family, which is so closely connected with the Corps and with the services generally, are undoubtedly descended from a Thomas Fyers (probably of one of the Stratherrick families), who was Overseer of the King's Works in Scotland in the middle of the 18th century.

Since I began to write this paper, the Secretary of the R.E. Institute has kindly allowed me to see two letters in the archives of the Institute which refer to a Thomas Fyers, and it was not an easy matter to decide whether this was the same man as the Overseer of the King's Works in Scotland.

One of these letters is as follows:—

To the RT. HON. AND HON. THE PRINCIPAL OFFICER OF H.M.'S ORDNANCE.
RT. HON. AND HON. GENTLEMEN,

I hope it will not be unacceptable that I take the liberty to recommend to your favour one Thomas Fyers, Foreman of the Carpenters at Fort William, for his diligence and activity in the works he was employed in there. But more particularly for his zeal and services to that Garrison during the late Rebellion: at the time that Fort was besieged by the Rebells, the Governor appointed him to act as Lieutenant to a Company of Militia of the townspeople taken in for the service of the garrison, which duty he discharged to the satisfaction of the Governour and rest of the officers, and was upon the command that sallied out upon the Rebells, and drove them from their Battery and spiked up their guns.

This Thomas Fyers served the late Mr. Mowbray, Master Carpenter, as Foreman to all the work he performed in the Highlands, both that which was done under the Direction of Capt. Romer* at Fort Augustus

* Capt. John Romer. See *Roll of Officers of the Corps of R.E.*, pp. 2 and 3.

and Fort George, and since at Fort William under me, and has always behaved himself faithfully and diligently.

As I know no other way than to your Honours to represent the merits of this man, I beg leave to recommend him to your favour and protection, and that if there is anything he can be employed in your service that you will be pleased to do it.

I am, with the greatest respect,
Rt. Hon. and Hon. Gentlemen,
Your most faithful and most obedient servant,
(Sd.) DUG. CAMPBELL.*

Office of Ordnance,
6th March, 1747.

The other letter is from Thomas Fyers himself, but to whom it was addressed is not stated. It was written from Edinburgh on the 22nd January, 1761, evidently to a superior officer. In it he says he has been ordered by Major Bramham† to report on some repairs to the roofs of the vaults, or casemates, in which the French prisoners were confined (presumably in Edinburgh Castle).

As I had been somewhat impressed by what I had read in the family and other records of the dignity and importance of the position of the Overseer of the King's Works in Scotland, I thought at first that the Thomas Fyers referred to in these two letters must be another man of the same name. In the family records Thomas Fyers is said to have been Chief Engineer in Scotland as well as Overseer of the King's Works, and in *The Patrician* of 1846 he is referred to as one "who for many years filled with credit the situation of Chief Engineer in Scotland, a highly responsible appointment, then connected with the civil branch of the Ordnance Department."

On further reflection however several considerations led me to the conclusion that the gallant militia lieutenant, who was foreman of carpenters at Fort William and distinguished himself in the sortie from that fort, as stated in the letter quoted above, must be the same man who was afterwards the Overseer of the King's Works in Scotland.

To begin with, there was no appointment of Chief Engineer in Scotland. Colonel, afterwards Lieut.-General, W. Skinner was Chief Engineer of Great Britain and was a very constant visitor to Scotland from the middle of the 18th century until his death in 1780. Then, on looking through the pay lists of the staff employed in the superintendence of the construction of Fort George (the large fort at Ardersier Point, on Inverness Firth, which cost some £200,000 and took from 1748 to 1770 to build, including additions), I found that foremen of carpenters, overseers, and draughtsmen were all upon the same footing, sometimes acting as one and sometimes as another.

* Major Dugal Campbell. See *Roll of Officers of the Corps of R.E.*, pp. 3 and 6.

† Major James Bramham, afterwards Major-General. See *Roll of Officers of the Corps of R.E.*, p. 6.

For instance, Charles Tarrant* was an overseer in 1750, and in 1753 appears in the pay lists as a draughtsman. We know that he became a Practitioner Engineer in December, 1755, Lieutenant (24th) in 1756, and Lieutenant of Engineers in 1759. Thomas Walker† was a similar case. He was an overseer and became a Captain of Engineers. There are other instances of foremen and overseers, evidently of good birth, who became officers in the Army. There is therefore no inherent improbability in the foreman of carpenters, so favourably recommended to the notice of the Board of Ordnance by Major Dugal Campbell, being nominated at a later date to the post of Overseer of the King's Works, which seems to have been a subordinate one, as regards military works, to the senior officer of Engineers in Scotland, and to have been of a civil character.

Moreover, it must be remembered that in those days the Scottish gentry of the highland glens led rough and hard lives, and the children of the small lairds had not many paths of life open to them. A foreman of carpenters implied much more then than it does now, and included a general knowledge of the building trades. A man who had superintended all the building work of the Government defence works of the "Chain" or "Line," as the great road from Fort William to Inverness was alternatively called, consisting of several forts and many military posts, might well have been selected for a more extended sphere of action. The name being the same, the dates fitting in, and the facts as I have stated, I think, in the absence of any evidence to the contrary, that my conclusion is justified.

THOMAS FYERS (1715—1784).

Thomas Fyers was born about 1715. He was therefore about 30 years of age when he took part in the defence of Fort William in the "forty-five." It is not precisely stated when he was appointed Overseer of the King's Works in Scotland, but from a reference to him in that position in a letter from the Chief Engineer of Great Britain to Sir George Ligonier in 1752, it may be assumed that it was about 1750.

Fyers was a man of large stature, standing, it is said, seven feet high, and broad in proportion, and his commanding presence attracted general attention as he walked the streets of Edinburgh. He occupied an official residence in the Castle, and enjoyed the reputation of being not only a clever professional man, but also a man of upright conduct and genial disposition.

On the 27th December, 1750, he married Elizabeth, daughter of

* Lieut. Charles Tarrant. See *Roll of Officers of the Corps of R.E.*, pp. 3 and 6.

† Capt. Thomas Walker. See *Roll of Officers of the Corps of R.E.*, pp 5 and 7.

the Rev. Alexander Falconer of Ferintosh, in the parish of Urquhart, Cromarty. Falconer, like Fyers, was a big man, for he was known as "Alister More," which is the Gaelic for Big Alexander. He had previously been minister of Ardersier in Inverness-shire, and had two sons, one of whom was Fort Major at Fort Augustus.

By his marriage with Elizabeth Falconer, Fyers had a family of nine children—four sons and five daughters—and became the progenitor of many officers distinguished in the Services, including at least nine officers of the Corps. He died in Edinburgh on 17th June, 1784. His widow survived him over 30 years, living in a house he had bought in Prince's Street, which, it is said, afterwards became the New Club.

CHILDREN OF THOMAS FYERS.

The Fyers girls were all married in due course. One of them, Alexandrina, born in 1757, to the Rev. James Reid, minister of Kinglassie, Fife. She became the mother of a very able and well-known officer of the Corps, Major-General Sir William Reid, G.C.M.G., K.C.B., F.R.S., who was Governor successively of the Bermudas, the Windward Islands of the West Indies, and of Malta. He was the author of *The Law of Storms.* He married Sarah, daughter of J. Bolland, Esq., M.P., and had six daughters: Lucy, died unmarried; Maria, married Capt. Edward George Hore, R.N.; Sophia, married Colonel E. G. Hallewell, 20th Foot, who was some time Commandant of the Royal Military College at Sandhurst; Elizabeth, married the Rev. Charles G. Gambier, only son of the Admiral; Charlotte, married Field Marshal Sir Neville Chamberlain, G.C.B.; and Grace, married Capt. Basil S. de R. Hall, R.N., the well-known explorer.

And here I may mention that it is mainly to Sir William Reid's daughter, the late Lady Chamberlain, that I am indebted for information about the Fyers family. When I was writing a memoir of her father for *The Dictionary of National Biography* some 13 years ago, she kindly sent over to Dublin to me all the papers she had about the family, and gave me permission to transcribe anything I wished and to make any use I liked of the information. At that time I hoped to write a memoir of Lieut.-General William Fyers, eldest son of Thomas Fyers, for the Supplement to the *Dictionary*, which was then advanced to letter "R," but the editor was so pressed for space in the supplement that many names of officers of the Corps had to be omitted and among them that of Fyers.

Of the four sons of Thomas Fyers three survived to manhood. William, the eldest, who became a lieutenant-general and a colonel commandant of the Corps, had a large family, and it is about him and his family that this paper is mainly concerned.

Thomas, the third son, born in 1767, became Treasurer of Malta, and died there unmarried in 1815, the same year as his mother died.

MAJOR-GEN. PETER FYERS, C.B., COLONEL COMMANDANT, R.A.

Peter, the youngest son, was born in Edinburgh Castle in 1769. On the breaking out of the war with France he obtained a commission as 2nd Lieutenant in the Royal Artillery on the 24th April, 1793, without going to the Royal Military Academy. He served during the campaign of 1794–5 in Holland, and was employed on board bomb-ships against the coast of France in 1796, and again in the two following years on various small expeditions. He was promoted Captain-Lieutenant in July, 1799. In 1801 he went with a detachment of Royal Artillery, which accompanied the fleet under Admiral Sir Hyde Parke, to attack the Northern Confederation. Sir Hyde appointed him Acting Engineer to the Force, but at the Battle of Copenhagen under Lord Nelson on 2nd April he acted as senior officer of artillery. As a captain he again served under Lord Nelson, who had been appointed to command the defence flotilla on the S.E. coast in July of the same year, and was with him in his expedition to burn the French flotilla in Boulogne Harbour. He was wounded on this occasion, and Lord Nelson spoke highly of his conduct in his despatch. Thenceforth the great Admiral honoured him with his friendship and confidence.

In 1807 he took part in Lord Cathcart's operations in Denmark, and at the Siege of Copenhagen was aide-de-camp to Sir Thomas Blomefield, who commanded the Royal Artillery. He also served in the Walcheren expedition and at the Siege of Flushing in 1809. In the campaign of 1813–14 in the Netherlands he greatly distinguished himself under General Sir Thomas Graham (afterwards Lord Lynedoch) in the operations against Antwerp. At the action of Merxem, near that city on the 13th January, 1814, when the 78th Highlanders advanced to drive the French out of the village, he himself laid a gun that silenced a battery of several guns of the enemy which were threatening the flank of the Highlanders. He took part in the bombardment of Antwerp and the French fleet in February, and in the assault of Bergen op Zoom on the 8th March, when he scaled the rampart and turned the guns of one of the bastions on the town. For these services performed under the eye of the General he was thanked in general orders and received the Companionship of the Order of the Bath.

On his promotion on the 20th December, 1814, to the regimental rank of Lieutenant-Colonel, he was obliged to return home to take up the command of the Rocket Brigade, to which he had been appointed on promotion; and so to his lifelong regret he missed Waterloo. After holding his command for 10 years he retired as a Major-General. When William IV. came to the throne he showed General Fyers marked attention, having met him on service. Peter Fyers was an able draughtsman, and his views of Arnheim, in Gelderland, of Copenhagen, of Cronsburg Castle, and of the Castle of Nimeguen, on the river Waal, were engraved and published in the early years of the 19th century. He married an elder sister of the wife of his nephew, Sir William Reid, Frances, daughter of J. Bolland, Esq., M.P., by whom he had four children, three sons and a daughter. Two of his sons were in the Service and will be noticed later. Major-General Peter Fyers was made a Colonel Commandant of the regiment on 14th June, 1845, and died at Old Charlton, near Woolwich, on 17th May, 1846.

LIEUT.-GENERAL WILLIAM FYERS, COLONEL COMMANDANT, R.E.

William Fyers, the eldest son of the Overseer of the King's Works in Scotland, was born at Inverness on the 6th January, 1753. In order that he might become a military engineer, he was entered as a draughtsman at the Tower of London as soon as he was old enough, and after a few years of preparation there, was appointed Practitioner Engineer and Ensign in November, 1773, when he was nearly 21 years of age.

He began his military duties at Portsmouth, where for some twelve months he was employed on the new defences, and was afterwards moved to Plymouth, where his duties were of a similar kind.

In 1775, Fyers was ordered to America to join the army under Major-General the Hon. William Howe, at Boston, Massachusetts. The precise date of his sailing for America is not given, but as Howe only succeeded General Thomas Gage in the chief command on the 10th October, 1775, it must have been near the close of the year when Fyers joined the army. In an official statement of the distribution of officers of Royal Engineers in North America in the Spring of 1776, Fyers, who was promoted to be 2nd Lieutenant on the 17th January, 1776, is shown with the 3rd Brigade at Boston; the 1st Brigade was in Virginia and the 2nd in Canada. The names of the officers of Engineers serving in the 3rd Brigade are given as follows:—

Capt. Montresor, Chief Engineer.
" Archibald Robertson.
Lieut. Thomas Hartcup.
" Henry Haldane.
" Andrew Durnford.
" William Fyers.
" James Straton.

On Howe's withdrawal from Boston to Halifax, Nova Scotia, in March, 1776, Fyers accompanied the army and sailed with it again from Halifax in June for Staton Island. Here Howe's force was augmented by troops from home brought in the British squadron by his brother, the admiral, and also by the return of the joint expedition under Major-General Henry Clinton and Admiral Sir Peter Parker from its unsuccessful attack on Charleston.

When all was ready a landing near Utrecht on Long Island was effected on the 22nd August, and Fyers took part in the battle of the 27th of that month, when Howe by a masterly turning movement carried the strong position held by the Americans in front of Brooklyn Heights. Fyers also took part in the capture of New York City on the 15th September. After the defeat of Washington in the engagement at White Plains on the 28th October, and the capture of Fort Washington and 3,000 prisoners of war on the 16th November, Fyers crossed the Hudson with Lord Cornwallis in pursuit of Washington. The crossing was above Fort Lee, which Washington was obliged to evacuate in haste. So close indeed was the pursuit that Washington was leaving Newark as the British advanced guard entered the town. From Newark Cornwallis pursued Washington across New Jersey to the Delaware River, and had he not been stopped by Howe might have occupied Philadelphia. But Howe was a Whig, and his mission was not to put down the rebellion with ruthless pertinacity, but rather to allow a loophole by which an ultimate settlement and a reconciliation could be effected. No soldier can succeed if he treats war in such a manner. The army went into winter quarters in December, 1776, and Fyers returned to the main body of the army under Howe, whose troops were disposed in and around New York. Fyers was quartered some 8 or 9 miles from the city, but although the winter was one of great gaiety in New York, he does not appear to have taken much part in it. He rode in occasionally on duty and to attend Divine Service on Sundays. Nevertheless he met his fate in New York. Whether it was during this or a later winter during the war is not stated, probably it was in 1777. The young lady was a Miss Anne Wanton, about whom there will be more to say later on.

Fyers accompanied Sir William Howe's expedition, which left New York on the 24th July, 1777, 18,000 strong, and, after keeping the Americans in suspense as to its destination, finally entered Chesapeake Bay on the 21st August. The landing took place on the Elk River, and Howe marched on Philadelphia on the 8th September. Fyers took part in the Battle of Brandywine on the 11th, when Howe, again by a flanking movement, defeated Washington, and he was also present at the capture of Philadelphia on the 26th September. He remained at Philadelphia until its evacuation the following year.

The Engineers had plenty of work to do at Philadelphia. The Americans endeavoured in every way to obstruct the river below the city, and thus prevent supplies reaching the city by water. Batteries were thrown up on the Pennsylvanian side to oppose the American works on the other side. Later a line of redoubts was constructed between the Delaware and Schuylkill Rivers for the protection of the city, which elsewhere was surrounded by the waters of these rivers.

In the spring of 1778 came the news of the treaty of the Americans with France. The surrender of Burgoyne at Saratoga in the previous autumn, due to Howe's want of support, had raised considerable resentment against him, and his resignation was now accepted. Sir Henry Clinton succeeded him in the chief command. In view of the French alliance he decided to evacuate Philadelphia and concentrate his force in New York, where by systematic raids he hoped to wear down the enemy. Philadelphia was evacuated on the 18th June.

Fyers was with the army in the notable march through New Jersey to Sandy Hook, where the fleet lay in readiness to receive it, and he landed with the army in New York on the 6th July, 1778. We next hear of the young engineer in the spring of the following year. He had been promoted from 2nd Lieutenant to Lieutenant on 7th May, 1778, before leaving Philadelphia.

Washington had taken great pains to protect the strategic position at West Point on the Hudson River. The King's Ferry crossing was the principal channel of communication between the Eastern and the Middle and Southern States. West Point itself, where the Americans had their chief magazines and stores, was well defended, and strong posts had been constructed lower down the river at Stony Point on the right bank, and at Verplanck Point opposite, to guard the entrance to the highlands and protect the approach to the key position. Clinton determined to capture these posts.

A force was organized in two columns, one under Major-General Vaughan and the other under Major-General Pattison, Clinton commanding the whole in person. Capt. Mercer and Lieut. Fyers were the Engineer officers detailed to accompany Pattison's column. The columns left Long Island, where they had assembled, on the 29th May, 1779, and proceeded up the Hudson. Pattison's column attacked Stony Point. An official report says: "While the Artillery were dragging the guns up the heights two batteries were in course of erection on the summit of a difficult rock. These were completed with so much expedition that by 5 o'clock next morning (2nd June) the batteries opened fire with a 10″ mortar, an 8″ howitzer, and two 12-pr. guns." The attacks on both posts were successful, and the Engineer officers received due credit. The garrison of Stony Point consisted of 1 captain, 3 lieutenants, 1 surgeon, and 70 men, of which 1 officer and 3 men were killed, while the British loss was *nil*.

The Commander-in-Chief decided to hold the two posts. They were therefore strengthened, especially Stony Point, which commanded the other side. British garrisons were placed in both posts, and Clinton encamped his force further down the river at Phillipsburg.

"For the first time during the war," says a recent American historian of the war, "the British controlled the lower reach of the Hudson River, and Americans coming from the south through New Jersey were obliged to make a detour of 90 miles through the mountains to cross the Hudson and enter New England." General Pattison, in a letter dated the 9th June, 1779, gives credit to the Engineers for the rapid way they had prepared new defences to receive their armament. He writes as follows:—

"Stony Point . . . is exceedingly strong from its several commanding heights, and being almost insular by means of a swamp and creek from the river, is very inaccessible, but the Commander-in-Chief, having determined to retain the post and render it as strong as possible, gave orders for batteries to be erected on several eminences. Working parties were immediately employed under the direction of the Engineers, Capt. Mercer and Lieut. Fyers, and so much diligence has been used that there are already seven fascine batteries nearly completed. The guns intended for these works are two 24-prs., two 18-prs., four 12-prs., six 6-prs., one 3-pr., one 10″ mortar, one 8″ howitzer, two Royal mortars, and two Coehorn mortars, and the platforms will be ready to receive them in a very few days."

About a month later the American General Wayne, with a force of 1,200 men, surprised the garrison of Stony Point by a night attack, and captured the work by assault. Sixty-three of the garrison were killed and the rest surrendered. The Americans lost 15 killed. A simultaneous attack, to have been made by the American General Howe, on Verplanck Point, was unsuccessful, as he was himself attacked in rear by the British and had to retreat. Stony Point, although thus surprised, was only held for a few days, "as it could not be held in the face of Clinton's energy."

In the autumn of 1779, anticipating a combined French and American attack upon New York, Clinton withdrew the garrison from Rhode Island and brought it with the loyalist inhabitants to Long Island, while he kept his Engineer officers busily employed in strengthening the defences of New York. On the failure of the allies before Savannah on the 9th October, Clinton decided to conduct an expedition in person to South Carolina. He pushed forward the strengthening of the New York defences, so that he might be able to leave the city with a small garrison. By the middle of December the works were completed, and having celebrated Christmas Day in the old fashion, he sailed from New York on the day following with 8,000 men for Savannah, as a place of rendezvous for an attack on Charleston.

Fyers accompanied the expedition. The storms of an unusually stormy winter delayed the fleet, several transports and victualling ships were lost, and it was not until the 26th February, 1780, that Clinton appeared before Charleston. The place was invested, but it was the 9th April before the British fleet, under Admiral Arbuthnot, could enter the harbour to take part in the bombardment. The first parallel was finished the following day. By the time the third parallel was finished and the wet ditch had been tapped and the water drained off, a heavy bombardment dismounted most of the guns of the besieged, and on the 13th May the place surrendered; 6,000 prisoners and 400 guns were taken, with a British loss of 79 killed and 189 wounded.

In June Clinton left Lord Cornwallis with 4,000 men in charge of South Carolina and returned to New York. Fyers accompanied him, and remained under Clinton's command for the remainder of the war either at New York or in the neighbourhood. At the beginning of the following year, 1781, Fyers married Miss Anne Wanton. Some account of this young lady and her family is given by one of her daughters.*

"My mother's ancestors," she says, "were Quakers of the name of Walton, who emigrated to North America during one of the early persecutions of that sect. They were wealthy, and made large purchases of land at Boston, Rhode Island, and New York. As the family ceased to be Quakers and became members of the Church of England, it may be worth while to mention the circumstances that led to the change.

"During the reign of Queen Anne Rhode Island was much infested by pirates, who were emboldened in their lawless attacks on the settlers because they knew that owing to their religious convictions the Quakers were unlikely to oppose or molest them by armed force. A merchant vessel could scarcely approach the harbour but it was seized by these marauders, who put the crews to death and fitted out the captured vessel to add to the pirate fleet.

"This state of affairs had continued for some time, when two spirited young men, John and William Walton, determined to put a stop to these outrages. They bought a small vessel, hired a crew of brave men, whom they armed, and then sailed to meet the enemy. The crew were concealed below, the brothers Walton alone remaining on deck. As they expected, it was not long before a pirate craft bore down upon them, believing it had got an easy prey. The pirates ran alongside and, having no thought of resistance, were about to board the Waltons' vessel. But at this moment the brothers gave the signal, their armed crew rushed up on deck, killed the pirate captain, and, springing on to the deck of the pirate vessel, mastered the crew, many of whom were below and were completely taken by surprise. The Waltons carried their prize triumphantly into harbour, where they were received with acclamation by the people, who were astonished beyond measure at the success of their daring enterprise.

"But the elders of the sect looked upon the incident with very different eyes. A council was convened, at which it was decided that the Walton

* Sarah Fyers, who married Lieut. (afterwards Major-General) Cornelius Mann, R.E. Her discursive MS. was in possession of her niece, Sabine Anne (daughter of her sister, Charlotte Young), who married Capt. John Jervois Tucker, of Trematon Castle, Cornwall, and a copy of the MS. was made by Lady Chamberlain.

brothers had transgressed the tenets of the Society of Friends by shedding man's blood, and they were cast out of the Society.

"Indignant at the ingratitude of their co-religionists, the brothers joined the Episcopal Church. The news of the gallant capture of the pirate vessel reached the Mother country, and eventually came to the ears of the Queen. To show Her Majesty's appreciation of the brave deed, Queen Anne sent to each of the Walton brothers a large silver punch bowl, on which was engraved a history of the exploit.

"My grandmother, Anne I think was her Christian name, a sister of these Walton brothers, married a very rich and estimable man, who bore the rather peculiar name of Wanton. They left two sons and two daughters, who were consigned to the guardianship of their uncle, William Walton, Governor of New York. I don't know what became of the elder son; the younger, Joseph, a very amiable youth, was killed by a kick from a horse. The elder daughter married; the younger continued to reside in her uncle's family."

This last paragraph in the lady's MS. has given me some trouble. Firstly, Miss Wanton, who married Lieut. Fyers, and was the mother of Miss Sarah Fyers, the writer of the MS., was born in 1754, and it is difficult to understand how her mother could have been the sister of the valiant brothers of Queen Anne's reign. Secondly, I cannot trace that there was any Governor of New York of the name of Walton. Probably the MS. was compiled from family tradition, and some confusion arose between the somewhat similar names of Walton and Wanton. These names were well known both in Rhode Island and New York. At the time of the Revolution the Governor of Rhode Island was Joseph Wanton, and his father, William Wanton, had also been a governor of the province before him; while at New York at this time a William Walton occupied the important office of President of the Chamber of Commerce, and lived in a well-known house in Pearl Street, New York, called Walton House, afterwards occupied by a representative of the family who was a British admiral, Rear-Admiral Jacob Walton, R.N., who died there in 1844, aged 77 years.

After consulting American histories and biographies, which it must be admitted are very puzzling, I am inclined to think that this paragraph of the MS. might be brought into line by the following reconstruction:—

"My *great*-grandmother, a sister of the Walton brothers, married William Wanton, of Rhode Island, afterwards Governor of the Province. Their son, Joseph Wanton, the last Royal Governor of Rhode Island, was my grandfather. He left two sons and two daughters. The elder son, William, went to St. John's, New Brunswick, where he was Collector of Customs for many years, and died there in 1816. The younger son, Joseph, may have been the Colonel Joseph Wanton who commanded a regiment under General Prescott, which had been locally raised at Rhode Island, and who accompanied the British troops to New York when

Rhode Island was evacuated, and died there. The younger of the two sisters confided to the guardianship of her *cousin*, Mr. William Walton, President of the Chamber of Commerce of New York, was my mother."

The MS. account continues :—

"During the War of Independence many Americans wished to buy the estates that had fallen to the orphans from both father and mother's sides, and their guardian would have sold the properties on their account, but that the would-be purchasers would only pay for them in 'assignats,' or what was called 'Congress money.' To this Mr. Walton would not listen. 'Old England,' he said, 'was sure to gain the day, and then Congress money would be so much waste paper.' Thus the orphans at the end of the war lost their estates, and got no equivalent.

"Mr. Walton's family consisted of his wife, a very handsome daughter, who, having been educated in England, was more accomplished than the usual run of young ladies of those days, and his niece (? cousin), my mother, Anne Wanton, who was also a remarkably pretty woman. These two young ladies were among the belles of New York. Mr. Walton lived in a handsome house and in good style, and from the position he held it may easily be imagined that his house was the resort of all that was distinguished in society, both civilian and military. I have heard my mother recall a long list of names of persons she was acquainted with in those days who afterwards became celebrated.

"My mother was born in New Jersey on the 17th March, 1754, and was therefore 21 years old when the war began in 1775. She had many offers of marriage, which she declined, and her acquaintance with my father came about in an odd way. On returning from church one Sunday, the cousins asked one of their visitors, General Trotter, if he could tell them the name of the young officer with the very white hands who was so constant in attendance at church. They had not seen his face; he was so attentive to the service, and leant his head on his hand. 'That,' said General Trotter, 'must be Mr. Fyers; he is called "the Good Engineer"; he rides 9 miles every Sunday to attend church service.' 'Oh!' said the ladies, 'do bring him to see us if he should come to New York again. We should like of all things to be acquainted with him.' Accordingly General Trotter brought him to Walton House, and on further acquaintance Mr. Fyers was found to merit all the good that was said of him. He was soon captivated by the beauty and sprightliness of Miss Anne Wanton; they became engaged, and in course of time were married. The marriage was solemnized by the Rev. —. Moore, at New York, on the 4th January, 1781, in the presence of a large circle of friends. The bride was given away by Mr. Walton, and was attended by his daughter and other maids, while the bridegroom was supported by three of his brother officers—Major Archibald Robertson,* Major Alexander Mercer,† and Capt. William Parker,‡ of the Royal Engineers."

* Afterwards Lieut.-General. Died 1820.
† Afterwards General. Died 1816.
‡ Died 1793.

On the 20th January, 1783, preliminaries of peace were signed, but it was not till the following November that New York was evacuated on the ratification of the treaty. In the meantime Sir Henry Clinton had returned to England and had been succeeded in the chief command by Sir Guy Carleton. When the evacuation of New York took place Sir Guy sent Fyers to Halifax, Nova Scotia, for special duty there under Major-General Campbell. Fyers had now two children, a girl, Elizabeth, born at New York in November, 1781, and a son, Thomas, born in the same city on the 6th January, 1783, and it is recorded that the girl's godparents were Lady Douglas, Major Robertson, and Mrs. Parker, while the boy's were Lieut.-Colonels Robert Morse* and James Moncrieff,† and Mrs. Morrison.‡ Fyers was ordered home in the autumn of the year 1784, the year his father died, and while on leave in London another daughter was born on the 2nd December. She was christened Sarah, and her godparents were Mrs. Thomson, Mrs. Holloway,§ and Lieut.-Colonel William Spry.‖ This is the daughter who wrote the MS. from which I have quoted. Of her arrival in the world she says :—

"At the end of the year 1784 my parents were staying in London in Edward Street, Portman Square, and on the 2nd December I first drew breath there, indeed, my drawing breath was for some time a doubtful affair, I am told, as I was all but stillborn, and it was not without difficulty I was made to live, but there was work for me to do."

On the expiration of his leave of absence Lieut. Fyers was ordered to Gosport. At the time he found himself in a rather embarrassing financial position. He had married a lady of considerable fortune, but after the close of the war she was deprived of the greater part of her private means. The American Government had confiscated her landed property, our Government having made no provision in the terms of peace for the protection of their loyal American adherents.

Unfortunately the sad case of the American loyalists is by no means a solitary instance of the neglect of this country on the termination of hostilities to take adequate steps to protect those who had supported them in time of stress and danger. Too often have such persons found when the crisis had passed and they had ceased to be of use that their loyalty and services were forgotten, and they were left to make the best terms they could get from their recent opponents.

Want of diplomatic action at the end of the American War on

* Afterwards General, Colonel Commandant, R.E., Inspector-General of Fortifications. Died 1818.

† Killed at Hondchoote, near Dunkirk, 1793.

‡ Wife of General George Morrison, who died in 1799.

§ Wife of Lieut. (afterwards Major-General Sir) Charles Holloway.

‖ Afterwards Lieut.-General. Died in 1802.

behalf of the loyalists was, perhaps, in some degree to be excused, because it could hardly have been conceived possible that a civilized people like the Americans, having won their cause, would have been so small-minded and unwise as to confiscate deliberately and as a matter of policy the estates of those of their own countrymen who had been actively opposed to them in the struggle, and so not only alienate them permanently, but injure the inoffensive women and children dependent upon them.

Yet so it was, and when Fyers went to Gosport with his wife and three children, still smarting under the confiscation of his wife's American estates, another blow awaited him. He was called upon to refund certain pay and allowances he had drawn while serving in America, which had been disallowed by the Treasury.

His daughter thus refers to the time at Gosport :—

"My sisters Charlotte* and Eliza† were born there, and a trying event befell the family. It seems that the agent to the Corps had issued a higher rate of pay to some of the officers in America than he was authorized to do, and the mistake was not discovered until some years had passed, when all were called upon to refund the amount overdrawn. This demand caused much consternation among the officers concerned, and especially to those of small private means. This was my dear father's case. In answer to his application to be allowed to refund the overdraw by instalments he was informed that in consideration of his good service he would be allowed to spread it over a year."

By rigid economy Fyers pulled through, and his daughter records that the time passed happily and peacefully with them, her mother's cheerful disposition making all bright.

* Charlotte, born in 1786. Married Vice-Admiral James Young, of Barton End, Gloucestershire.

† Elizabeth Lydia, born in 1788. Married Major-General the Hon. W. H. Gardner, R.A., third son of the first Baron Gardner.

(*To be continued*).

MEASUREMENT OF THE SEMLIKI BASE:
WITH
SOME NOTES ON INVAR WIRES.

By CAPT. E. M. JACK, R.E.

A JOINT British and Belgian report on the work of the measurement of the 30th Meridian Arc in the Uganda Protectorate will shortly be published. In the meantime an account of that part which deals with base measurement may be of interest to R.E. officers, especially as the above-mentioned report will probably not be seen by many of them.

That part of the 30th arc which lies in or adjacent to the Uganda Protectorate, between latitude 1° 10′ N. and 1° 10′ S., was surveyed in 1908–9. A base $16\frac{1}{2}$ kilometres in length was measured on the eastern side of the Semliki Valley.

Site.—A site was looked for whose terminals would be about 200′ above the intervening ground. The nearest approach to this that could be found was one in which the ground varied from 65′ near the centre to a maximum of 150′ in other parts, below the ray between the terminals. The ground surface was nearly all that could be desired, the only serious obstacle being a marsh some 700 metres long where crossed. The water in this was rather over knee deep; the bottom rough, but on the whole firm. Work through this section was slow, and great care was necessary to avoid accidents; but the results obtained were equal to those of any other section.

Terminals.—The terminal at the north end, Makoga, was a gently rising spur, which required very little work to fit it for its purpose. The southern terminal, Kibuku, was steep and rocky. It gave some trouble, as towers of rock and earth had to be built to carry the tripods for the six last reaches.

Clearing.—A certain amount of clearing work was done at the end of July, but clearing proper began with a large party and accurate alignment on 4th August, and was finished on the 19th. A path 6′ wide was cut through the grass, which was mostly medium to very thick. In one part a thin wood was crossed, and in another a ramp had to be cut through what was probably an ancient margin of Lake Albert. The time taken is given below. Aligning was done with the 10″ theodolite on to helios after the first 2 miles. Aligning posts, about 15′ high, with the upper half covered with white cloth, were put up at about every half mile.

Apparatus.—A full description of the apparatus used, with an account of the preparation and testing of Invar wires, will be found in the pamphlet "Les Nouveaux Appareils pour la Mesure Rapide des Bases Geodesiques," by M. Ch. Ed. Guillaume, of the Bureau International des Poids et Mesures, Sèvres. For the benefit of those who have no previous knowledge, the following short description is given :—

The operation of base measurement consists in the measurement of the distances between a succession of movable points, the forward point of each reach becoming the rear point in the next, and so on. As the measurement advances the points left behind are carried to the front and re-aligned. The movable points consist of tripods, with adjustable heads, fitted with foot-screws for levelling, and capable of a small movement in a horizontal plane. The actual point to which the measurement is taken is a fine cross-cut line on the head of a small vertical pillar. The wire is slung on straining trestles, fitted with pulleys on ball bearings, over which pass cords with weights of 10 kilogrammes attached.

Aligning and placing tripods is done by a forward party, which carries a gauge wire for setting the tripods at the correct distance apart, and a small aligning telescope, fitting on to the upright pillar of the tripod-head, and by means of which each successive tripod is aligned accurately between that last fixed and the distant mark. A small levelling telescope is also provided, which fits on to a special pillar on the tripod-head, and by means of which the difference in level between two tripods can be determined.

The wires are of Invar steel, diameter 1·7 millimetre, and fitted at each end with a scale of triangular section, one edge (along which the scale of 80 millimetres is engraved) being in prolongation of the axis of the wire; the length of each wire from zero to zero of the scales being 24 metres.

Standardization.—For purposes of comparison a test base was laid out 120 metres long, the terminals being formed of iron rails 4′ 6″ long, concreted vertically into the ground with 2′ projecting. The tops of these were filed smooth, and a cross-cut marked with a needle. Comparisons between the three field and the three reference wires were made by measuring this base four times (first and fourth with reference, second and third with field wires). Three such comparisons were made before beginning base measurement; three between the forward and return measures; and three after the base measurement was finished.

During the measurement—when it was found that one of the field wires was giving varying results—comparisons were made on a single bay formed by two tripods. The bay was measured five times, the second and fourth being with the field, and the remainder with the reference wires.

Organization.—The party was organized on the lines laid down by M. Guillaume in his pamphlet, as follows:—The two N.C.O.'s, Lance-Corpls. Jones and Page, formed the forward party, and did the setting out and aligning; M. Dehalu, Mr. McCaw, and Capt. Jack took turn about in keeping the record and reading the wires; and Capt. Wangermée did all levelling. Sikhs were employed at first to set the straining trestles, but these falling ill with one accord, the work was done by Swahili porters, who, on the whole, did it very well. One porter was detailed to each tripod, which he had to carry forward when finished with. The two wires were slung one below the other on swivel hooks fastened to two bamboos, which were carried vertically by two porters. A thermometer was tied to each pole between the two wires. This method of carrying the wires, where more than one is used, is probably the best. They are carried without strain and are easily detached and replaced. It would be an improvement to fasten the hooks to the poles with small spiral springs.

Measurement.—The base was divided into sections of about 1 kilometre (usually 42 reaches). The procedure on the outward measure was as follows:—Work was started from the terminal of the previous day's measurement. On reaching the 42nd bay, if the ground was firm and good, the aligning party drove a 2′ iron peg into the ground, and went straight ahead, aligning tripods for the next section. If the ground was unfavourable, they went on for a few reaches before driving the peg. The observing party filed the top of the peg smooth, made a longitudinal groove and fine cross-cut, completed the measurement of the section, and went on with the next. The peg was covered with vaseline and a small cage built round it. On the return measure it was the same, except that there was no preparation of the pegs, and any excess or defect on an exact number of reaches had to be measured with the 8-metre tape.

In this connection it may be remarked that there appears to be no necessity for "transferring" the terminal point to the head of the tripod. Whether done by plumb-bob or theodolite, or even by a special instrument, transference gives room for error; whereas it is perfectly simple to measure direct to the terminal mark. The wire is attached at the terminal end to a spring-balance (merely to save jars), which is fastened to a stick or pole, the point of which is driven a few inches into the ground. The other end of the wire is slung as usual over the straining trestle. The shifting of the scale for the readings is done by the man holding the pole, without removing the point. It is necessary of course to measure the difference of level between the tripod head and the terminal. This is done with a level and staff in a few minutes, and when everything is in working order should be completed by the time the observers come up.

With regard to the observing, each bay was measured with two wires, and three readings taken on each wire, a fourth being taken if the range was as great as 0·3 millimetre. This number of readings appears to be ample; a fourth reading was the exception. When carrying out comparisons however, three readings were taken if the range did not exceed 0·15 millimetre, one more if the range was 0·2 millimetre, and five readings if the range exceeded 0·2 millimetre.

One tripod was always left standing in rear until the bay in front had been finished. After intervals for meals the bay last measured was re-measured, and if there had been any serious discrepancy between the two measures, the bay in rear would also have been re-measured; but this was never found necessary.

The recorder, besides noting the readings of the two thermometers fixed to the wire poles, also took that of a swing thermometer, or it would be more accurate to say that he did this until all the swing thermometers were broken. The recorder kept the tot (*i.e.*, the summation of the scale readings) going the whole time, so that it was always possible to know how much in excess or defect of an exact number of bays we were. We were also by this means always able to avoid measuring a short piece with the tape, in our case an important matter, as the tape did not arrive until we were more than half-way through the base. The levelling as above-mentioned was done by one officer, and the results kept in a separate book.

On the end sections, or in any part where the slope was steep, the pillars of the tripod heads were arranged at right angles to the slope, instead of vertically, as usual on approximately level ground. On steep slopes all levelling was done with level and staff.

Speed.—On the Semliki Base there was never a chance of developing anything like the full capacity for speed possible with the Guillaume apparatus. In the first place, there were only six tripods, and this number is not enough. To guard against accident, one tripod must be left untouched in rear until the bay in front is finished; and it would be better to leave two. With six tripods there was therefore no room for elasticity, and when the whole party was thoroughly expert the observers continually pressed on the aligners, and had to wait for them. The minimum number of tripods for proper working is nine, and it would be better to have ten. Again, on the return measure, one observer was unfortunately taken ill, and for the remainder of the time both reading and recording had to be shared by the other two, work which proved very trying after a time.

The usual day's work was two sections of 42 reaches, or a total of 2,016 metres. This took from daybreak to 3 p.m., with two intervals of about an hour each for breakfast and lunch, and works out at 288 metres per hour for actual measurement; but it should be noted that this includes everything from start to finish, *i.e.*, delays for reasons given above, getting out wires and returning them, fixing terminals, etc. For a complete bay, *i.e.*, from first reading at one to first reading at the next, the time was usually 3 to $3\frac{1}{2}$ minutes, which represents a speed of 411 to 480 metres per hour. M. Guillaume mentions in his pamphlet a speed of 1 kilometre an hour, but I do not think that this can include extras as above, nor measuring with two wires, and the measurement would be of course made by European assistants only. With nine tripods and a full *personnel* we would have been able, I think, to measure 3 kilometres, or over 2 miles, a day.

Field Calculations.—By keeping the tot going all the time, the recording book was ready to be handed to another observer for checking almost as soon as work was finished. This latter observer also entered up temperature corrections. The leveller got out his level corrections, which were checked by an observer, and it was usually possible, within a few hours of finishing measurement for the day, to arrive at the length of the section. In the return measure this length had to be compared with that of the first measure, to see whether it was necessary to measure the section a third time. The limit of difference allowable between first and second measures was adopted as $4\sqrt{K}$. millimetres, K being the length of the section in kilometres.

The form for recording readings, etc., as given in M. Guillaume's pamphlet, in which each bay is made the subject of a separate sum, seems rather cumbersome. A considerable amount of labour is saved by dealing with each wire as being of its standardized length—*i.e.*, the length given to it by field standardization, and by treating everything above as a correction, *i.e.*, for readings, temperature, level. So that the length of a section was obtained thus: n reaches $\times\, l$ (length of wire) $\pm\, \Sigma$ readings $\pm\, \Sigma$ temperature corrections $-\, \Sigma$ level corrections. As in the following example, taken from the book. The level correction is not included here, being the same for both wires, and taken from the level book.

Section IX.—42 *Reaches.*

	ms. mms.	ms. mms.
Wire 119:—	$42 \times (24 - 1{\cdot}738)$	$= 42 \times 24 - (42 \times 1{\cdot}738 + 01{\cdot}63 + 12{\cdot}71)$
		$= 42 \times 24 - 58{\cdot}66$
Wire 121:—	$42 \times (24 - 2{\cdot}016)$	$= 42 \times 24 - (42 \times 2{\cdot}016 + 11{\cdot}99 + 12{\cdot}71)$
		$= 42 \times 24 - 59{\cdot}97$
Mean	$42 \times 24 - 59{\cdot}32$.	

The record was kept in small notebooks in the form given below.

No. of Reach.	Tripods.*	Wire.	Temp.†	Fore.	Back.	Difference. F – B.	Mean.	Summation. 119	Summation. 121	Corrections to Summation. 119	Corrections to Summation. 121	Temp. Correction.‡	Notes (*not in original*).
								− 175·51	− 170·97	—	− 0·03	+ 0·72	Totals brought forward.
13	4—5	119	F. 18·7	551 237 580	414 100 443	+ 13·7 ·7 ·7	+ 13·70	− 161·81					
		121	(6) 19·3 (7) 22·0	176 663 329	034 523 188	+ 14·2 ·0 ·1	+ 14·10	—	− 156·87			+ 0·10	* Tripods were numbered as an additional precaution. † F. is the frond or swing thermometer. (6) and (7) the two attached.
14	5—6	119	F. 20·0	173 521 205	017 366 051	+ 15·6 ·5 ·4	+ 15·50	− 146·31					
		121	(6) 19·0 (7) 21·4	443 681 208	283 523 049	+ 16·0 5·8 5·9	+ 15·90	—	− 140·97			+ 0·09	‡ Temp. coeff. for these two wires was the same.
15	6 1	119	F. 19·3	380 137 583 289	430 188 632 340	− 5·0 ·1 4·9·1 ·1	5·02 − 5·07	− 151·38	—	+ 0·05			*Corrections to Summation.*
		121	(6) 19·1 (7) 22·0	110 448 634	156 495 680	− 4·6 ·7 ·6	− 4·63	—	− 145·60			+ 0·10	Corrections to errors in addition, meaning, etc., are entered in these columns and not carried through the work.
16	1—2	119	F. 22·1	406 653 202	265 512 060	+ 14·1 ·1 ·2	+ 14·13	− 137·25					
		121	(6) 20·0 (7) 23·8	396 686 398	250 542 254	+ 14·6 ·4 ·4	+ 14·47	—	− 131·13			+ 0·13	
										+ 0·05	+ 0·03	+ 1·14	Totals carried forward.

Tables.—Tables are supplied in the French pamphlet for (1), corrections for difference of level; (2), secondary corrections for deformation of catenary; the argument in these tables being the tangent of the angle of slope as given directly by the scale in the small levelling telescope. The use of a level and staff for the terminal reaches of a section, and for steeper slopes than the small telescope could read to, necessitated the construction of tables giving the necessary corrections, in which the argument was expressed as difference of level in feet. Again, though the levelling telescope gives the true tangent of the angle of slope whatever be the length of the bay, the table supplied only gives the true horizontal correction when the bay equals 24 metres exactly. The correction is of course small, but not negligible. Further, to obtain the true mean height of the base, and for other reasons, it was necessary to keep a record of the difference in height of the section terminals. Tables were constructed for these purposes, and will be published in the joint report.

Results.—The following results are preliminary only, and subject to modification.

The figures under the head of "Measures" below are the corrections in millimetres to the total number of reaches in each section × 24 metres.

Section.	No. of Reaches.	Measures.				Difference 1st—2nd, *or*, Mean of 1st and 3rd—2nd.
		1st.	2nd.	3rd.	Mean.	
I.	43	−1760·05	−1750·80	—	−1755·42·	−9·25
II.	47	−128·24	−126·75	—	−127·49·	−1·49
III.	42	−741·52	−744·50	—	−743·01	+2·98
IV.	42	−224·51	−219·13	−219·37	−221·00·	−2·81
V.	42	−158·91	−159·38	—	−159·14·	+0·47
VI.	42	−157·50	−153·00	−153·52	−154·67·	−2·51
VII.	42	−120·30	−122·40	—	−121·35	+2·10
VIII.	42	−108·62	−107·82	—	−108·22	−0·80
IX.	42	−133·55	−131·49	—	−132·52	−2·06
X.	42	−93·51	−92·01	—	−92·76	−1·50
XI.	39	−99·32	−102·04	—	−100·68	+2·72
XII.*	42	−103·07	−107·43	−105·43	−105·31	+3·18
XIII.	42	−125·77	−126·97	—	−126·37	+1·20
XIV.	42	−120·29	−119·53	—	−119·91	−0·76
XV.	49	−125·15	−126·96	—	−126·05·	+1·81
XVI.†	49	[−1804·82]	−1775·43	−1782·52	−1778·97·	−7·09
XVII.‡	—	+3881·60	+3881·77	+3881·43	+3881·60	+0·25
	689	−2097·68	−2083·87	—	−2091·30	−13·56

* Marsh section.

† 1st measure not included; considered unreliable on account of weather conditions and other reasons.

‡ 1st and 2nd with common steel tape; 3rd, with Invar.

	Ms.
689 reaches of 24 ms.	= 16,536·00000
Σ corrections	− 2·09130
Length of base on Semliki Plain	16,533·90870
Assuming height of base above M.S.L. to be 645 ms., reduction to S.L. gives about	1·67688
Length of base on geodetic surface	16,532·23181

(Log = 4·2183315).

The discrepancy between mean of 1st and 3rd measures and the 2nd is—

13·56 mms. = 1 in 1,219000.

The P.E. (of measurement only) is—

4·83 mms. = 1 in 3,423000.

TIME AND COST.

Preliminary Work.

	Men.	Days.
Clearing and alignment	40	21
Preparing southern terminal slope	6	7
" northern " "	70	14
Cutting ramp, Section III.	20	4
Making test base	4	1
Total men and days	1,946	

Measurement.

Personnel ... ... 6 Europeans, reduced to 5 after 7th Sept. 18 Natives.*

Time ... ... 38 days.

In the following, for preliminary work, the cost of the men actually employed is taken; for the measurement it is assumed that the whole expedition was employed, as was practically the case.

For purposes of comparison, the Belgian officers are estimated at the same rate of pay and equipment of porters as British officers; but this cost did not of course fall on British funds.

Preliminary Work.

	£	£
Europeans...	61½	
Natives (with food)	35½	97

Measurement.

	£	£
Europeans...	264	
Natives† (with food)	137	401
		498

= £50 a mile, nearly.

In addition to the above there is the cost of the apparatus, as follows:—

	£
3 wires and all apparatus brought out by A.C.B.C. ...	100
3 wires, tape, etc., brought out for arc measurement...	40
Transport, etc., say	10
	£150

* On the measurement; others were employed shifting camps, etc.

† 100 Swahilis, 60 Ba-toro, 12 boys.

Notes.

Elevated Terminals.—There can be little doubt as to the advantage of elevated terminals to a base line. The principal source of error in base extension is due to triangle errors, these being in turn due to the fact that the rays of the first triangles are necessarily close to the ground. To get the required elevation and to get clear of the intervening ground, it is necessary to measure up more or less steep slopes.

Jaderin considered 1 in 8 the steepest slope advisable. The Guillaume telescope reads to a maximum slope of $\frac{1}{10}$ with the ordinary wire; with the long-arm wire one can read to a greater slope, but it is questionable whether steep slopes can be determined with sufficient accuracy with this telescope. On the Semliki Base we measured a maximum difference of level of 15′, or a slope of $\frac{1}{5 \cdot 2}$, and a number of others approaching this.

Unfortunately, I cannot point to the results of our terminal sections as justifying our confidence that slopes up to $\frac{1}{4}$ or $\frac{1}{5}$ can be measured with the highest accuracy. On the other hand, there were obvious reasons why our results did not come up to the standard we expected. The officer in charge of the levelling had not had previous experience of this work, and was further handicapped by the fact that the level at his disposal was too small, and in several respects faulty in construction, so that it was almost impossible to do precise levelling with it.

In measuring up steep slopes the whole thing depends on levelling, the measuring itself being as easy as on level ground. The correction to obtain the true horizontal projection increasing very rapidly with increase of slope, very accurate levelling becomes of the highest importance. With proper instruments this should present no difficulty, and had we been able, when measuring the base, to use the first-class level which was lent to us later by Capt. Stevenson, R.E., we should most probably have obtained the highest results.

Apparatus.—The apparatus used was that designed by M. Guillaume, and described in his pamphlet, and was constructed by J. Carpentier, of Paris. It is in nearly every respect perfectly adapted for its purpose. The tripods stand in the most remarkable way, showing no perceptible movement after hours in a tropical sun. The cases, as supplied, are not strong enough for use in the tropics; most of them fell to pieces during work on the Semliki. The springs which hold down the foot-screws of the tripod heads are also too weak. They are made of brass, and would be better of steel.* The levelling telescope is a very neat and handy little instrument, but it is questionable if it is accurate

* In the latest pattern these springs are made of steel.

enough for precise work. It is small, and the level attached to it is hardly delicate enough to ensure that the telescope is always brought to exactly the same position. This question is referred to again under the head of Levelling.

Field Standardization.—It has been usual to lay down a test base with a standard bar for the purpose of comparing and giving a value to the field wires. M. Guillaume, placing entire reliance on Invar wires, considers it enough to compare the field wires with the reference wires on a bay formed with a pair of ordinary measuring tripods. On the Semliki Base we had no standard bar, the reference wires taking its place, and a value being given to the test base by them. Had our field wires not behaved eccentrically, this comparison on the test base would probably have been enough; but when one of them began to show unequal behaviour, we carried out several comparisons on a bay of two tripods. This method has some great advantages. It takes a very short time in itself, which is a good thing both for the observers and for the comparison. It can be done without any delay, such as would be involved in returning to the test base, and at any time when the behaviour of a wire appears to call for re-standardization, and the steadiness of the tripods makes the result very reliable. In the absence of a standard bar, it is probable that this method is sufficient in itself.

Levelling.—Mention has been made above of the importance of levelling, and it has been suggested that the "levelling telescope" can hardly be accurate enough for precise work on account of its small size and that of the attached level. The results of the record of vertical heights kept by us show that something is wanting. By far the greater part of the levelling was done with this telescope, and though some of the fault may have lain with the big level, it is reasonable to suppose that the majority of it was due to the levelling telescope. The difference of height between the terminal pegs of a section obtained during the forward measure differed from that on the return by an average of 0·1 metre (this is excluding the terminal sections, where the level and staff were principally used), and throughout these same sections the total difference of height obtained on the forward measurement differed from that on the return by 0·4 metres.

On other bases levelling has been done with level and staff only. On those measured in Northern Rhodesia on the 30th Meridian, the level was set up to one side of the base, and the staff placed successively on all the tripods in position at the time. Given a good instrument, carefully adjusted for collimation error, differences of level can be obtained thus with a high degree of accuracy and a little loss of time, and though it would perhaps be convenient to have one man told off for this work entirely, this is by no means essential.

On the Semliki Base we used the levelling telescope on all normal ground, and the level and staff for terminal reaches and steep slopes. For work of this kind a good large level should be taken, say a 14″ Cooke, one light 10′ staff, and one 5′, both with a circular spirit level attached near the bottom end. It would be convenient if the staves were divided in metres, tenths, and hundredths, with a scale on the opposite side divided in some arbitrary manner, say into sevenths and seventieths. As a check reading, the staff is simply turned round, and not upside down.

Invar Wires.—The steel alloy known as Invar, and Invar wires themselves, have now been subjected to a long series of exhaustive tests, extending over many years, at the "Bureau International." Invar wires are being used at the present time all over the world for the purpose of base and other measurements.

Of the six wires used by us, four gave absolutely consistent and reliable results. The fifth appeared inconsistent, but I now hear from M. Guillaume that on re-standardization an error has been discovered in the formula for its coefficient of expansion; when rectified it is expected that this wire will prove to be in harmony with the others. The sixth however gave trouble. It was one of the three taken out in 1907 by the Boundary Commission, and from the outset appeared to have a different value to that given to it at Paris. On the Semliki Base this same wire gave variable results, and was considered untrustworthy.

In the criticisms which have been directed against the use of wires (as compared with tapes), the danger of twisting has been somewhat insisted upon. This danger is, I think, exaggerated. Any twist would probably be very noticeable long before it was serious enough to affect the length of the wire. The rolling and unrolling of the wires on the drum is an absolutely simple matter.

On the other hand, there can be little doubt that Invar wires as constructed are very fragile, and it would appear to be a matter for consideration whether it would not be worth while to increase their sectional area. An increase of diameter of, say, 50 per cent. would more than double their strength, probably without impairing any of their advantages as wires, while at the same time giving them a factor of safety which would relieve observers of a good deal of anxiety when using them with unskilled assistants.

Lastly, it should be noted, especially by those who have occasion to order these wires, that Invar is by no means always "invariable." The coefficient of expansion is different for every batch of the alloy turned out, and it should be particularly specified that wires supplied should have as low a coefficient of expansion as possible. For this reason it is advisable to place orders early, otherwise one has to take what one can get.

For example, the six wires used on the Semliki Base had the following actual expansions per 1° C.:—

			Mm.		Millionth.
168, 174	...	...	·0025		0·10
176	...	...	·01	equivalent to	0·41
119, 120, 121	...	...	·02		0·82

Compared with the expansion of ordinary steel, which is some 6·25 millionths, even that of the last wires appears small. But the whole point of using Invar is that the question of temperature shall be rendered unimportant, and when the expansion is near one-millionth per degree centigrade, the question of temperature is by no means unimportant.

TRANSCRIPT.

AERIAL NAVIGATION AND THE WRIGHT AEROPLANE.

From the *Rivista di Artiglieria e Genio* of April, 1909.

Until the year 1896 we advocated, in this Review, aerial navigation by means of heavier-than-air machines, which, though based on the flight of birds, would be modified by mechanical means so as to make up for the instinct with which the bird itself is endowed.

A balloon can always be sure of alighting slowly, provided that it does not catch fire or is not struck by lightning. The lifting power of the gas is always a good guarantee, whereas a machine, without this to rely upon, falls like a dead body to the ground, if suddenly arrested in flight.

If a flying machine has its motor paralyzed, it can glide slowly to earth with its planes sustaining it like a parachute, provided that the aviator keeps his head and is sufficiently expert, and also that the planes themselves are not damaged. In the same way as a good pilot in bad weather may often succeed in bringing a damaged ship into port, the aerial pilot may bring a damaged aeroplane safely to the ground.

The number of those who favour the dirigible balloon has increased during the last century, and many models have been experimented with. Amongst others are those of Blanchard in 1789, of General Meusnier in 1784, of Zambecazi in 1804, of Giffard in 1852 and 1855, Dupuy de Lorne in 1872, Tissandier in 1883, Capt. Renard in 1884 (la France), Count de Schio in 1905 (Italy), and Santos Dumont, who proclaimed in his book, *Dans l'Air*, that the gas dirigible is the flying machine of the future. And towards the end of 1905 the dirigible balloon designed and constructed by the engineer Julliot, and by the energy and munificence of the brothers Lebaudy—from whom it takes its name—performed marvels at Toul, showing itself obedient to the rudder and safe in the hands of the pilot Juchmés.

Whilst France rang with pæans of praise at the astonishing results obtained with the Lebaudy dirigible, there came a wonderful report from America. The brothers Orville and Wilbur Wright, manufacturers of bicycles at Dayton (Ohio), had carried out evolutions in the air with an aeroplane of their design and construction, furnished with a motor of 16-H.P.

This rumour gave a fresh impetus to those who favoured the heavier-than-air machines, and even Santos Dumont abandoned his principles by constructing a helicopter and studying an aeroplane.

A number of aviators, especially in France, sought to imitate the brothers Wright, but only Farman and Delagrange succeeded in competing with Wright and in disputing with him the dominion of the air. The apparatus of all three was somewhat similar, being based on a cellular system, with motors varying from 25-H.P. (Wright) to 100-H.P. (Farman). The aeroplanes themselves are made as light as possible, the frames being covered with fine canvas and consisting of two superposed horizontal planes.

The brothers Wright employed from the commencement (1900) an apparatus with superposed wings, and experimented with it from 1900 to 1903. On the 17th December, 1903, they experimented with a machine fitted with a motor of 16-H.P., and succeeded in remaining in the air for 59 secs., travelling 260 ms. against a wind of a velocity of 32 kms. per hour. In 1904 more than a hundred flights were made at Dayton with a second aeroplane and motor, with which they were able to accomplish closed circuits and some variable courses, ranging up to 40 kms.

In these trials the Wrights sought to eliminate any difficulties that might arise by modifying the parts of the machine affected. Afterwards they made new trials for courses of short duration in 1905, keeping secret the working and details of their machine.

Towards the end of September, 1905, the aeroplane could be directed with a certain security and stability, and being improved upon from time to time, was able to make flights with the results shown in the following table :—

Dates.	Distance Travelled. Metres.	Time.	Cause of Stoppage.
26th September................	17,961	18 mins. 9 secs.	Deficiency of fuel.
29th ,, ...	19,570	19 ,, 55 ,,	,, ,,
30th ,, ...	Not measured	17 ,, 15 ,,	Heating of the motor.
3rd October	24,535	25 ,, 5 ,,	,, ,,
4th ,, ...	33,456	33 ,, 17 ,,	,, ,,
5th ,, ...	38,956	38 ,, 3 ,,	Deficiency of fuel.

The last table shows a result of a velocity of more than 61 kms. per hour.

The machine used weighed 420 kgs., including the aviator, and a motor of 16-H.P. at first, and 25-H.P. afterwards. The distance travelled was measured with a Richard anemometer attached to the machine and verified by land when possible. The time was measured with accurate chronometers.

In February, 1908, the American Minister of War ordered a competition in the construction of aeroplanes under the following conditions :—

"The machine to be sustained in the air by dynamical means without the employment of gas.

"It should be able to carry two men, or about 160 kgs. of weight, with a sufficiency of fuel to run 200 kms. at an average velocity of 64 kms. per hour (40 miles) in calm weather.

"The price of purchase will be increased 10 per cent. for each mile (1,609 ms.) exceeding the above velocity per hour, and diminished in the same degree for each mile less than the above, provided that the average velocity is not less than 58 kms.

"The velocity will be measured above a closed course of 16 kms., the machine remaining in the air for an hour without touching the earth.

"To facilitate its use the machine should be transportable, and it should be possible to put it together and to ascend in less than an hour."

The conditions were somewhat onerous, but in spite of this there were 41 competitors, among whom were Scott of Chicago, price 25,000 lire (5,000 dollars); Heming of New York, price 100,000 lire; the brothers Wright of Dayton (Ohio), price 125,000 lire.

Orville Wright took part in the trials at Fort Meyer, commencing with short flights, so as to show the perfect working of the aeroplane, while Wilbur Wright made his trials at Le Mans, in France.

Orville Wright performed the following flights at Fort Meyer:—

9th September, 1908:—	57 mins. 28 secs.
9th ,, ,,	1 hr. 3 mins. 15 secs. at about 45 ms. above the ground; distance flown, 63·9 kms.
9th ,, ,,	5 mins. 38 secs. In the aeroplane were O. Wright and F. P. Lahm; 6·4 kms.
10th ,, ,,	1 hr. 5 mins. 52 secs.; 19·3 kms. (retarded by the wind).
11th ,, ,,	1 hr. 10 mins. 50 secs.; greatest height above ground, 60 ms.
12th ,, ,,	1 hr. 15 mins. 25 secs.; record of distance, time, and height.
12th ,, ,,	9 mins. 6 secs.; record for aeroplane carrying two persons.

It seemed certain that the Wright aeroplane would easily win the prize for the competition, having surpassed the prescribed velocity and time, but on the 17th September the trials were cut short by an unfortunate accident, in which Orville Wright broke his left leg and two ribs, whilst Lieut. Thomas Selfridge, who accompanied him, was killed by the fall. The accident seems to have been caused by the use of a screw propeller of too large a diameter.

While the aeroplane was in full flight the screw fouled the ligatures of the rudder. A sharp and unexpected roll of the machine immediately resulted, disturbing its equilibrium and precipitating it to the ground.

After this unfortunate accident Wilbur Wright modified the propeller and other parts of the mechanism of his aeroplane and accomplished great successes in France, winning honours and prizes in the face of rivalry, jealousy, and distrust.

During his trials he recognized that it was not necessary to use a motor of great power, having made an ascent with a 25-H.P. motor when carrying a weight of 450 kgs., viz., a passenger and 50 kgs. of benzine.

The motor used by Wright had not any speciality, being of the same type as that used in automobiles. He used four cylinders lined with aluminium, water circulation 108 mms. in diameter, automatic valves, the usual method of ascent, automatic lubrification with circulation of oil produced from a pump.

The admirable speciality of this machine consisted in the torsion of the wings, which increased or diminished the angle of incidence according to the direction of the movements. The machine could be inclined and could fly like a bird, and it could be raised or lowered with ease and with perfect lateral equilibrium. After introducing several improvements in his machine, on the 10th September, 1908, he effected a flight under the best conditions, lasting 21 mins. $43\frac{2}{5}$ secs., with a velocity of 60 kms. per hour, not however surpassing his brother, who remained in the air for 1 hr. 15 mins.; nor exceeding the French record held by Delagrange of 29 mins. $55\frac{4}{5}$ secs. (8th September in calm weather).

On the 21st September W. Wright gained the record for time and distance by a flight of 66·6 kms. in 1 hr. 31 mins. $25\frac{4}{5}$ secs., while he still had a good reserve of benzine and the machine in the best condition. On the 25th September he made three flights in the same day, in the last one having a passenger for 9 mins. 11 secs. On the 28th September he first of all went up alone, and remained in the air 1 hr. 7 mins. 24 secs., and afterwards, with Paul Tissandier and De Lambert, made other flights, the first of 11 mins. 35 secs., and the second 7 mins.

On the 30th September W. Wright won the prize of 5,000 francs of the Aero Club of France, having flown 42 kms. in 43 mins. on the 29th September, and 34 kms. in 35 mins. 36 secs. on the following day.

The victory of W. Wright was crowned by a good report of the condition of his brother, who was making satisfactory progress towards recovery at Washington, and who had obtained from the American War Minister an extension of nine months for the trials before mentioned.

EDWARD T. THACKERAY.

REVIEWS.

HYDRAULIC TABLES AND DIAGRAMS FOR PRACTICAL ENGINEERS.

By Capt. A. ff. Garrett, R.E.

In this work, ingenious, practical, and clear, Capt. Garrett has added to his already high reputation as a scientific engineer, and he has earned the gratitude of many, not so much in the Army as in civil life, who have to design waterworks of all kinds.

The letterpress is clear and concise. It omits the discussion of fundamental principles, as these are certainly already known to those who are likely to use the work, but it gives in tabular form all information about units of area, volume, length, discharge, and pressure. A chapter is devoted to the subject of orifices, and the velocities at various heads for orifices of certain forms are given in tabular form, likely to be extremely useful to the engineer who may have to decide half-a-dozen times in the course of his morning's work the size of an outlet to discharge a given quantity.

Next comes a chapter on weirs of various forms. This is a matter on which there is much difference of opinion. Capt. Garrett does not commit himself to any predilection for the V notch over the rectangular, but gives tables of discharge of right-angled V notches and diagrams for weirs, both with a free fall and when "drowned."

As a rule the formulæ for such discharges deal with sharp-crested weirs only. But in actual practice the weir crest has to be made of some definite breadth, a fact which has a retarding effect on the discharge. Again in any flowing canal the velocity of approach must be practically considered, and although this is not ignored in recent formulæ, it complicates the calculation, which is already somewhat troublesome. Capt. Garrett's ingenious diagrams enable all these complications to be read off easily.

Possibly in some future edition the author may be able to give diagrams for V notches, or trapezoidal notches, with tip falls, such as are largely used on canals in North India, and which have given excellent results with varied depths of water.

The sixth chapter deals with the flow of water in pipes, asphalted, incrusted, and riveted. Attention is drawn to the most recent of the many formulæ dealing with frictional resistance, viz., that of Professor Unwin, which however differs only slightly in its practical results from the more widely known formula of Fanning. Diagrams based on Unwin's formula give in a graphic and most ingenious manner the velocity, discharge, and head per thousand feet for pipes of various diameters, under various conditions. There is also a very neat diagram giving the thickness and weight of cast-iron pipes of various diameters, and the head which may be reckoned safe at each thickness.

Chapter VII. deals with a subject little touched upon by the irrigation engineer, but most useful to a municipal surveyor, viz., the dimensions of sewers of various shapes. Diagrams based on Kutter's formula with the coefficient for glazed pipes in good condition, or for ashlar or well-laid brickwork, are given for sewers of different varieties and flowing just full. By means of coefficients given in tabular form, the discharge and velocity at varying depths are derived from the diagrams by a very simple calculation.

Chapter VIII. deals with the most difficult problem of all—the discharge in open channels, with the four variable factors of discharge and velocity, bed width, depth of water, and slope of bed. If any three of these are given, the fourth can be found from Capt. Garrett's diagrams, or if only two are given (such as the discharge and the bed slope), an almost infinite variety of values of the other two may be found to satisfy the conditions.

The diagrams are extraordinarily ingenious. With the aid of them the engineer who is working out, perhaps under great difficulties and under high pressure for time, the bed widths and depths of channels for various slopes and discharges, can do so by simple inspection, and can choose among several solutions the one that suits best the local conditions. It is also possible to see whether the decision will be affected by the "critical velocity," *i.e.*, that which will just carry silt in suspension without depositing it. The diagrams may also be used to ascertain the values of the important coefficient N in Bagin's formula in any doubtful case, and by utilizing the diagrams in connection with tabular statements, trapezoidal channels of various side slopes can easily be designed.

The admirable and most ingenious book contains in small compass a mass of practical information useful to all hydraulic engineers, but especially to irrigation officers. The writer can only say that if he had had a book of this sort on his office table when on works in India, many a weary calculation would have been saved and possibly many mistakes avoided.

G. K. SCOTT-MONCRIEFF.

THE BOARD OF TRADE RAILWAY CONFERENCE.

(Blue Book, Col. 4677, 1909. Price 1s. 5d.).

This report is important to those concerned in railway matters, and in view of the present movement towards state-ownership it is interesting to everyone. The Conference was constituted in February last year to discuss some of the more important questions which have been raised between railway companies and traders; both sides were represented.

Of the disputed questions, an agreement was come to on the following :—

(1). A form of procedure for settling disputes that should be simple than that of the Railway and Canal Commission.

(2). That companies should have the power to restore rates temporarily reduced.

(3). With regard to "owner's risk" rates, the companies agreed to somewhat modify their attitude, and in certain cases to accept liability for "gross negligence" as well as for "wilful misconduct."

(4). A model private siding agreement was drawn up.

(5). A similar agreement for working of private owners' wagons.

(6). A procedure by which companies may acquire land. The present statutory powers involve needless expense; the average paid-up capital, £56,000 per mile of open line, so much in excess of the average in other countries, is attributed to this.

(7). The question of railway amalgamations, combinations, and working agreements was widely discussed, and a number of reports are printed giving the views of twelve members of the Conference; the subject is returned to, on the historical and legal aspects, at the end of the book. No agreement was arrived at.

Enquiries were made into the system of working foreign railways; the Blue Book contains the report of the two investigators sent to Germany, and other reports may be expected. The enquiries deal with :—

(A). The financial conditions under which privately-owned railways passed into the possession of the State.

(B). The control Government now exercises over the railways still in private hands.

(C). The composition, function, and actual working of the Advisory Councils.

(D). The extent and effect of competition with private-owned and Government lines.

(E). The rates systems.

And various other questions—liability for loss, private sidings speed, workmen's trains, demurrage, etc.; in fact, the extent of the enquiry was exceedingly wide.

The following is an abstract of the more interesting points dealt with, lack of space preventing the consideration of more than a few.

In Germany the privately-owned lines were purchased by degrees and at prices governed by the market quotations; legal powers existed for purchasing at other and sometimes lower terms, but these were ignored. A start was made in 1872 and the process is not yet complete.

The financial results can be judged by the interest earned in capital. In 1882 the State-owned capital was 4,379 million marks (the mark is about a shilling), and the earnings were 5·22 per cent.; in 1906 the capital had increased to 9,500 million marks, and the earnings were 7·48 per cent.

The capital cost per mile averages £21,469 (compare with the above-quoted £56,000 on English railways), and there are 35,400 kilometres (22,000 miles) now open. The low cost is partly due to lighter construction charges, low platforms, and the absence of over-bridges. The taxation is local and only £46 per mile; on the other hand, the railway administration is compelled to run postal services at a loss, and to fix rates from a standpoint other than mere revenue earning.

The control of the railway is through the Minister of Public Works, a permanent salaried official. He has extensive administrative and spending power, subject of course to the annual Parliamentary estimates. There are in addition various supervisory authorities and an annual General Conference.

For executive control the Prussian railway system is divided into 21 districts, each with its President and Staff. To determine rates the District President is assisted by a local Advisory Council, with members nominated by the Chambers of Commerce; similarly there is a General Advisory Council to assist the Minister. These councils can exercise considerable moral pressure and their recommendations are generally followed; but they have no executive power. From a railway point of view, they are useful because, through them, the railway is able to point out technical difficulties to the trade, and to shift on to other shoulders a certain amount of responsibility.

The tariff system is based on kilometric rates, which may be either "normal" or "exceptional." The normal rates are either per ton in wagon loads or per ton as piece goods. The wagon-load rate is for 5-ton or 10-ton wagons, and is cheaper than the piece-goods rate; it leads to a good deal of discontent, because the railway administration is often unable to provide trucks with suitable capacity. The monopoly of single ownership has in fact resulted in scarce rolling stock, or, as the railway would probably put it, economically-used rolling stock. Regulations impose demurrage after a much shorter time than in England—generally from 12 to 24 hours, but sometimes as little as six are allowed—and economy of working is obtained by giving an ample time allowance for rail transit, thereby ensuring full train loads. (In England the railway as a rule makes no guarantee; but in Germany the maximum transit periods are for "fast" goods 1 day + 1 day for each 300 kilometres, and for "slow" goods about double; and for delay they pay compensation on a fixed scale).

The piece-goods rate may be for either "general class" or "special tariff" goods, and for "fast" or "slow" services; it diminishes as the distance increases. As an example:—"General class" goods for slow services would be charged 11 pfennigs per kilometre (2¼d. a mile) per ton for from 1 to 50 kilometres, and 6 pfennigs if over 500 kilometres. For "fast" services the charge would be double. Terminal charges, 1 to 4 pfennigs a ton, are additional. "Special tariff" goods travel cheaper.

The "exceptional" rates have been getting more and more common, and now apply to nearly $\frac{2}{3}$ of the whole quantity. They are *reduced* rates, intended:—

(1). To advance internal industries.
(2). To assist native products in export.
(3). To support industries against imports.
(4). To support the railway against sea or other competitive transport.

They are complicated, as might be expected. For instance, 21 kilometre-ton rates are given for the same description of iron and steel goods, the differences depending solely on origin and destination. Again, the ordinary rate between Cologne and Hamburg for iron plates, railway locomotives, is 1·61 marks per ton; the export rate is only ·56 marks.

No direct comparison has been made with English rates, but a list of "iron and steel" rates is given from which one can be made.

The German rates for "iron and steel special Tariff I.," corresponding to our "iron and steel Class C," are "normally" 4·5 pfennigs per ton per kilometre between 100 and 200 kilometres, and "exceptionally" 2·8 or even less. These are equivalent to about ·9d. and ·56d. per ton per mile respectively for a distance between 62 and 124 miles. There is an additional charge of 1s. 3d. a ton for "terminals," and probably 5s. 6d. would be paid for cartage. Over a distance of 82 miles, as from Rugby to London, the German rate for rail transit would be "normally" 6s. 1d., and "exceptionally" 3s. 10d., or adding the charges for terminals and cartage, 12s. 10d. and 10s. 7d. respectively. In England the rate for this journey is 12s. 3d., including terminals and cartage; there might be an "exceptional" rate as well, but in England they are less common, less extensive in amount, and are only put on to assist the railway against competition. There is not much to be said for either on the score of simplicity.

Agriculture is more favoured in Germany; for instance, to Portsmouth from London the charge for potatoes would be 3s. 4d. a ton instead of 11s. 3d. In Germany there are no rates such as ours which include loading and unloading, collection and delivery; and the agents performing these services are independent of the railway administration. A large trader does his own work, but the usual thing is to leave it to one of the "spediteur" companies; they charge from 2·50 to 3 marks per ton for collecting and delivering near a town.

The "spediteur" serves a useful purpose in addition as a forwarding agent. The complications of tariffs require expert knowledge, and merchants generally entrust the whole business to the "spediteur"; he not only looks out the best routes and tariffs, but is often able to combine goods from different senders and obtain a cheaper wagon-load rate than would be possible with separate parcels. This is to the advantage of railway merchant and "spediteur" alike; we in England have something of the same sort of thing in the transit stores now commonly found at big junctions, but the inducements and facilities are less.

More than half the Blue Book (90 pages) is taken up with this account of the German State Railways.

R. H. CUNNINGTON.

THE TIMES' HISTORY OF THE WAR IN SOUTH AFRICA.

VOLS. VI. AND VII. (THE LAST OF THE SERIES).

Part I. deals with the work of reconstruction during and after the war, with a brief survey of political events down to the spring of the present year.

In Part II. are described the measures necessitated from the commencement of hostilities to place the whole army in the field, equipping and maintaining every branch.

A mass of information has been carefully collated with regard to Sea Transport, Railway Work, Supply and Transport, Medical Services, Ordnance and Artillery, etc. The various branches of Engineer work throughout the whole theatre of operations are referred to and the increasing importance of the Engineer in war is insisted upon.

The value of the "Fourth Arm"—the Engineers—is emphasized, and attention drawn to the "danger of our forgetting how entirely dependent armies now are on their engineers."

It is satisfactory to note how highly the actual work done by the Corps is always referred to. On p. 333 we read that "some of the duties performed were conspicuous and obvious, but more were comparatively obscure, though none the less important because they lacked excitement and notice. An immense amount was done by the Engineers—Regular, Volunteer, and Civil—and no duties during the campaign were better or more conscientiously carried out."

Again on p. 338, . . . "the longer the war went on the more fully was the usefulness of the fieldwork of the Engineers realized. Divisional or column commanders who had never commanded Engineers, or at most only on manœuvres, at first hardly appreciated them or knew how to make use of them. . . . At the end of the war there was a continual demand for Engineers. . . . The conclusions most obvious from the experiences of the war were the need for a larger proportion of field Engineers to other troops and for having a larger number of the Engineers mounted."

More recent experience from the Russo-Japanese War adds yet another conclusion, namely, the necessity of having a sufficiency of Engineer units trained for siege work, regarded but a few years before as likely to be obsolete.

Last but not least in importance, a chapter has been devoted to Finance.

Useful lessons of the war are deduced under the respective subheads in the several chapters.

Much has been done in reorganization of late years to fill the gaps, but many may still ask whether, *as a nation*, we have really taken the lessons of recent war to heart, and even now done enough to meet the future needs of an army which cannot be anything but Imperial, if the Empire is to stand?

The illustrations are confined to portraits of individuals—both military and civil—who took a prominent part in the campaign.

The Index of the series is contained in a separately bound volume, which is numbered VII.

The editor, L. S. Amery, deserves the thanks of the general public and congratulations on the completion of a nine years' toil. His work is a classic.

AN INTRODUCTION TO MILITARY GEOGRAPHY.

By BRIG.-GENERAL E. S. MAY, C.B., C.M.G.—(Hugh Rees, Ltd., 119, Pall Mall. 8s. 6d. net).

This book of some 250 pages is divided into 13 chapters, dealing in turn with Artificial and Natural Frontiers; Some European Frontiers; The Influence of Geographical Features in Operations; The Sea in Relation to Operations of War; Lines of Communication; Canals and Waterways; Strategical Railways in Process of Construction; and chapters on Persia, Afghanistan and the N.W. Frontier of India, Abyssinia and Manchuria.

In an introductory chapter Colonel May gives various reasons why officers should study geography, pointing out its influence on war both as regards the resources, weather, lines of communication, etc., of the country in which operations are to take place, and recalling how lack of knowledge in the military geography of South Africa lead to increased difficulties in the operations there.

The whole book is extremely interesting, is full of well-chosen examples emphasizing the various points referred to, and contains as well numerous maps, each carefully chosen to illustrate some special lesson.

The strategical railways in progress of construction include those of the Balkan Peninsula, the Baghdad Railway, the Damascus-Hedjaz Railway, the Amur Railway, and the Northern Nigeria Railway.

The two chapters on Persia and Afghanistan and the N.W. Frontier of India are of particular interest to Sappers, as so many of the Corps have been employed at different times in these regions.

Finally, three interesting appendices are given, consisting of the terms of the Convention of the United Kingdom and Russia relating to Persia, Afghanistan, and Thibet; the Anglo-Japanese Agreement; and the record of a unique achievement of cavalry and horse artillery rendered possible by climatic conditions in 1795.

Also Received.

STRATEGY OF THE RUSSO-JAPANESE WAR.

By BREVET MAJOR W. D. BIRD, D.S.O.—(Hugh Rees, Ltd., 119, Pall Mall. 4s. 6d. net).

NOTICES OF MAGAZINES.

ELECTRICIAN.

July 2nd, 1909.

INCANDESCENT LAMPS.—Mention is made of 16-C.P., 210-volt, 25-watt lamps made by the Stearn Electric Lamp Company. The consumption of energy is higher than that of most metallic filament lamps (1·6 watts per C.P., as against 1·1), but the bulbs are small and the filament is more robust. No figures are to hand as to life. The lamps will be on the market in two months' time.

ELECTRIFICATION OF BADEN STATE RAILWAYS.—Brief description is given of the electric locos. It was decided to utilize existing rolling stock and construct locos. with six driving wheels coupled. Two single-phase commutator motors drive the coupling bar by means of connecting rods inclined to horizontal at an angle of 60°.

WIRELESS TELEGRAPHY.—Illustrations are given of various portions of Telefunken apparatus described in *Electrician* of 18th June, 1909.

RADIO-TELEGRAPHY.—Continuation of Professor Fleming's lecture to the Royal Institution. Oscillation detectors dealt with in some detail.

ELECTRICAL DEVICE FOR SOLVING EQUATIONS, ETC., is described, which is said to find even imaginary roots of numerical equations correct to within 1 per cent. For full description see papers of Physical Society.

ELECTROLYTIC DISINFECTOR for laundries or hospitals is described briefly. They are largely used in German hospitals.

July 9th, 1909.

ELECTRIC TRACTION.—Articles by Mr. Dawson are continued, No. XVI. dealing with collectors for overhead conductors.

RADIO-TELEGRAPHY.—Conclusion of Fleming's lecture.

PURIFICATION OF RIVER WATER BY OZONE.—For purifying water which has been contaminated by sewage, ozone is now being used in many places. In Paris Siemens Halske ozonizers are in use. The process takes 133 electrical units per million gallons of water treated, but further plant is to be installed, taking 315 units per million gallons. The results obtained are said to be satisfactory.

Metallic Filament Lamps.—Other lamps by Ediswan of lower candle-power and with smaller-sized bulbs are mentioned.

July 16th, 1909.

"Flicker" Type Photometers.—Doubt is thrown on the accuracy of candle-power of metallic filament lamps when measured by this instrument. This type appears to make the C.P. 6 per cent. too low.

Alternators for Wireless Telegraphy.—Description of an alternator for 100,000 cycles per second, as developed by Fessenden for wireless telegraphy. It has an output of 2 kw. at 110 volts, and runs at 20,000 r.p.m. The revolving disc which contains the field magnet system is made of chrome nickel steel with an elastic limit of nearly 100 tons per square inch.

Electric Traction.—A continuation of Dawson's articles, dealing with overhead collectors.

Electricity Supply of Chicago.—The chief points of interest are:—

(1). The plant is modern, the oldest part dating to end of 1903.
(2). The enormous size of the undertaking.
(3). It is an excellent example of the relative spaces taken by boilers and prime movers of modern design.
(4). The fact that 14,000-kw. generators are to be installed.

Street Lighting in Continental Towns.—Report of a deputation from the Corporation of London which has been abroad recently. The practice in many continental towns is reported. The general conclusions are:—

(1). Where possible streets should be lighted by means of centrally hung lamps with lowering gear.
(2). Open spaces should be lighted by lamps upon standards, and fitted with lowering gear.
(3). High-pressure incandescent gas lamps with inverted burners should be adopted as illuminants. Where gas is impracticable, electricity with arc lamps should be installed.

The "Graetzin" high-pressure lamp is described. A 4,000-C.P. lamp gives about 50-C.P. per cubic foot of gas—it is not stated if this is result of experiment or maker's claim. The mantles are renewed every nine days.

July 23rd, 1909.

Electric Traction.—Article XVII. deals with the feeders and feeder system.

Electricity Supply of Chicago.—Part II.—The staff required is detailed. With modern plant this is very small.

ANTENNÆ FOR WIRELESS TELEGRAPHY.—The different forms found in practice are discussed. Those which are directional, *i.e.*, receive or send better in one direction than another, are detailed. The best forms of earths are also mentioned.

SHORT DISTANCE RAILWAYS.—Notice of 1,200-volt continuous current equipment.

An account of another electro-magnetic method of solving algebraical equations is contained in this number.

A. E. DAVIDSON.

JOURNAL DES SCIENCES MILITAIRES.

July 1st, 1909.

FRENCH MANŒUVRES, 1908.—The opening article is on the French manœuvres of 1908, written by a Russian staff officer. Having just previously been at the German manœuvres in Alsace Lorraine, he compares the two, and on the whole considers the German manœuvres to be the more practical. Although they only lasted four days as against the French nine, operations in the latter ceased each day at noon and practically did not recommence till next morning. This of course was striking at the chief end of manœuvres—their resemblance to real warfare. Theoretically they were supposed to recommence at sunset, but no attempt was ever made by either side to operate in the evening. This was no doubt due to the habit of always sleeping in a cantonment. Another mistake was that the troops always knew where the director of the manœuvres would be, and operations were involuntarily keener at this place.

On one side a cavalry corps on the German model was formed. It was only moderately successful. Its operations were marked by slowness, indecision, and lack of adaptability. A detachment was sent to seize a bridge, but finding it unoccupied passed over and left no garrison. On its return it found that the bridge had been seized by hostile infantry, which could not be forced.

The chief difference between French and German tactics is that the Germans invariably try to take the offensive, and turn one or both flanks, whilst the French insist on keeping their forces concentrated, and thus generally get indecisive results.

THE COMBINATION OF ARTILLERY AND INFANTRY.—This article is continued. For small forces such as a mixed brigade it is considered that artillery is unnecessary with the advanced guard. The main body will not be very far behind, and if needed by the advanced guard, a battery can soon cover the distance. Though it is laid down that artillery which is at all exposed should have a special infantry escort told off, this is by no means always done. Even when there is an escort, it is not under the orders of the artillery. A group of guns requires a company (200 men) or even two, but for a battery one section of 70 men should be enough.

Infantry attacking artillery should make for its flanks and rear. The horses, drivers, wagons, and limbers, are the objective. Artillery should fire, not on its own most important enemy, but on the enemy which is most troublesome to the army in general, whether it be the hostile artillery or the hostile infantry.

The knowledge possessed by artillery officers of the tactics of other arms is not of itself a sufficient basis for the necessary co-operation. How this combination is to be attained should be clearly laid down by regulation.

War.—A new book on "War" has been lately published by General Kessler. It is of course based mainly on the Russo-Japanese War. The review points out the entirely opposite "lessons" deduced by various people. Some think that this campaign was full of them, others hold that nothing new came out that had not already been foreseen by theorists. For instance, the French General Staff has made no important modifications in the latest edition of its "Conduct of War." General Kessler considers that superiority of fire should no longer be sought for, as it is manœuvring alone that gives victory. To manœuvre with ease, extended fronts and open order become necessary. This should be in favour of the French national characteristics, of bravery, intelligence, initiative, and independence, as opposed to the German strength, which lies in order, discipline, and cohesion. Some may doubt whether the German and Frenchman are really so different as is generally believed; but whether or not this is so, the national trainings are such as to accentuate the differences. It is true that many of the Revolutionary volunteers were by no means willing soldiers, but there must have been a large number of true patriots whose zeal and example stimulated the others to the great deeds they performed. To this is due the change of tactics of the time of the Revolution from the solid masses of former years. These masses were to prevent the desertion of the unwilling levies. The Revolutionaries however did not need such means, as patriotism and sentiment kept them from deserting. It is suggested that the supposed heavy losses in 18th century battles were really due to the wholesale desertions which took place as soon as the *serre-files* failed to exercise their usual pressure.

Promotion of Officers.—"A Colonel" writes on the promotion of officers. His three main points are that (1) promotion is almost entirely considered, and therefore awarded, as a recompense; (2), too much attention is paid to years and not enough to fitness; (3), too much attention is paid to distributing promotion evenly between the various army corps.

(1). In any promotion list the officers who are actually training the troops are passed over in favour of the staff, influential persons, and those who have passed good exams. The promotion list might be ticked off in the same way as prizes are awarded at a school—prize for memory, prize for recitation, prize for politeness, etc. No blame is to be attached to officers who try for these special billets, as it is the only way to get on. But promotion should be given instead to the men who have the gift of command. Each captain has enough responsibility to show whether or not he is fitted for promotion, and this should depend on the way in which he carries out his duties as captain. The same rule should also hold in the field; mere bravery should be rewarded by the Legion of Honour, never by promotion of an unfit man.

(2). A man is no older than he feels. Why retire excellent officers, perfectly fit in every way, because they happen to have lived a certain number of years, while others, who are quite useless, are allowed to remain on the active list because they are younger in years.

No doubt the scheme would be an excellent one if it could be carried out, but it is difficult to judge in many cases the fitness of a man. As regards the promotion, it would be almost impossible to ignore army corps, without raising bad feeling.

H. L. WOODHOUSE.

LE BULLETIN.

March 31st, 1909.

IMPERIAL GERMAN MANŒUVRES, 1908.—Carrier pigeons, carried in baskets strapped on the back, were used by cavalry. Special attention was paid to methods of communication, central communicating posts being formed, provided with motor cyclists.

April 15th, 1909.

FRENCH ARMY ESTIMATES, 1909.—The article includes a comparison of the French and German systems of promotion of officers.

COMPOSITION OF ORDERS IN LARGE UNITS describes the French system of supply for an army in the face of the enemy. Portions of supply and ammunition columns and field hospitals (corresponding to our tent division, field ambulance) are linked up to form an *échelon de combat*, which follows immediately behind the main body, and in front of all second line transport.

May 15th, 1909.

FRENCH ARMY ESTIMATES, 1909 (*continued*).—The question of the replacement of horse-drawn by motor-driven transport is discussed. It is noted that the only steps hitherto taken have been in the direction of replacing the transport between the railhead and supply columns, whereas it is more important to secure greater mobility in the supply columns themselves. By next spring each of the four fortresses on the east frontier will have its dirigible balloon. Dirigible stations are ready at Verdun and Belfort, and those at Toul and Epinal are under construction.

FRENCH GRAND MANŒUVRES, 1908.—An account is given of the supply arrangements by motor transport between the railhead and advanced depôts.

May 31st, 1909.

FRENCH GRAND MANŒUVRES, 1908 (*continued*).—The special instructions given to the umpires are of interest. They include several conventions with regard to the counting value of troops, thus :—

Infantry on the defensive, entrenched = four times actual strength.
Infantry on the offensive, advancing by rushes = three times actual strength.

Of two bodies of infantry, both supported by artillery, that alone whose artillery is the stronger is considered as supported by artillery.

FOREIGN MILITARY INTELLIGENCE.—*The Present State of Aeronautics in Germany*.—At the end of the present year there will be four Zeppelin, four Parseval, and three Gross dirigibles in Germany. A school of aeronautics is to be formed at Friedrichshafey for technical instruction in aerial navigation.

'E.R.'

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

February, 1909.

MILITARY NEWS FROM VARIOUS COUNTRIES.—*Austria*.—The field artillery were re-armed on the 5th January, 1909, with a new 8-centimetre, 1905, field gun. The fortress troops have been reorganized by the Army Order of the 18th January, 1909. The fortress artillery now consists of 19 battalions (72 companies) arranged in six regiments, of which four have two battalions and two have three, and five independent battalions. A fortress balloon section and an electric lighting detachment are attached to each regiment or independent battalion. A fortress artillery company has 4 officers and 99 men, and a fortress balloon section 1 officer and 19 men.

The two first Austro-Hungarian military balloons, designed by Dr. Raymond Nimführ, an Austrian aeronaut, are in process of construction. The smaller will have a capacity of 1,500 cubic metres, and is intended to assist tactical reconnaissance; the larger, with a cubic content of 3,500 metres, is to be used for strategical reconnaissance. Mechanical draught is to be used by all field balloon detachments.

Belgium.—The construction of 11 forts and 12 redoubts, the new advanced line of the Antwerp defences, will be started on the 27th February, 1909. The cost of this undertaking will be 13½ million francs, and it will take 3 years and 3 months to complete.

Germany.—It is rumoured that the War Office intend to lend their heavy motor vehicles to private firms. The drivers, who are soldiers of the experimental section of the line-of-communication troops, will accompany the vehicles, and as the latter will be lent chiefly to agricultural firms, it is hoped that they will acquire a better knowledge of their cars than they could get if the latter were used for purely military purposes. The firms will only have to pay the cost of upkeep of the vehicles.

The garrison of Metz possesses an automobile ice safe for the distribution of meat to the various units in the station.

Practice against captive balloons is to be carried out in the spring of 1909, in the bay of Dantzig, by guns on special mountings. Last year's practice showed that projectiles from field guns and howitzers cannot hit balloons at a greater altitude than 1,200 metres; hence the new experimental carriages.

An experimental wireless telegraph station has been built at Göttingen. The masts are 85 metres high and weigh 6,000 kilogrammes. Similar stations may be erected at Cologne and Konigsberg.

United States.—The regular army increased in 1908 by 19,168 men, but is still 9,558 below the authorized establishment. The percentage of desertions has fallen from 7·4 in 1906 and 5·6 in 1907 to 4·6 in 1908.

The methods of teaching horsemanship in vogue in the French Army are to be taught at the U.S.A. cavalry school of Fort Riley (Kansas).

Italy.—The following are the principal points of the third report of the Royal Commission of Enquiry on the Army:—

(1). The administration of the army requires simplifying and decentralizing.

(2). The army corps commanders should take parts in the schemes of the Army Council and of the National Defence Committee.

(3). The strength of infantry companies, which at certain times of the year falls as low as 50, should be fixed permanently at 96 of all ranks.

(4). The strength of a squadron should be 130, the number of squadrons per regiment five instead of six, and the number of regiments would thus be increased from 24 to 29, and a new division of independent cavalry could be created.

(5). The peace establishment of a field artillery battery should be 90 men, 60 horses, and 4 guns, with an increase to 6 guns when on war footing. Horse artillery, 4 guns per battery. Mountain artillery, 6 guns. The raising of a new regiment of mountain artillery of 12 batteries is recommended.

(6). The changes recommended in the Corps of Engineers are:—

(*a*). The creation of a pontoon regiment, so as to relieve the pioneers of this duty.

(*b*). To transform the railway detachment into a regiment with three sections.

(*c*). To make the specialist section independent, *i.e.*, hand over wireless telegraphy to the telegraphists, and take away the automobile section from the railways and attach it to the specialists.

(*d*). The raising of an independent detachment of engineers for Sardinia, consisting of one pioneer and one telegraph company.

The Commission next proposes to deal with the education and promotion of officers.

A. H. Scott.

THE RAILWAY ENGINEER.

April, 1909.

Reinforced Concrete Sleepers in America.—These have been tried by several of the railway companies, and have been found to be infinitely more lasting than timber. Those used by the Lake Shore and Michigan Southern Railway are made of lengths of old flange rails inverted and set in concrete. The running rail is clipped down to the sleeper, the clips being held down by nuts screwed on to the threaded ends of U-shaped straps running underneath the sleeper.

The sleepers weigh 400 lbs. complete. It is found that they form too rigid a bed for high-speed trains, but that they are excellent for slow speeds and for sidings, where they last a lifetime. The inverted flange rail protects them from being broken by the wheels of derailed trains.

Another form of sleeper is used on the Elgin, Joliet, and Eastern Railway. It is composed of two scrap boiler tubes, 2¼″ in diameter, slotted through at either end, a stiff sheet of wire being passed through the slot and the whole wrapped round with chicken fence wire, which binds the concrete together and prevents it from separating should the sleeper become cracked.

It was found that 20 per cent. of the sleepers thus made failed in use under the rail, and that 5 per cent. were broken by derailments. On this account the design was slightly modified. A pressed steel box was placed round each sleeper with a 2″ piece of wooden packing on top of the box, the rail being held down as described by U-straps and clip-washers.

It is thought that the failure of the sleepers mentioned above was largely due to their being made of inferior material and under insufficient pressure during manufacture. The cost worked out at 6s. per sleeper.

Another form of sleeper is in use in connection with the line from the Chicago and N.W. Railway to the Sioux City Stockyards Company. It is cross-shaped, one cross being placed under each rail and the pair being connected together by a tie. Each cross has an area of 4 square feet. Eighty-ton engines, drawing trains of 50 or 60 cars, pass over several times daily, and as the line is laid over an old marsh which is liable to be flooded in wet weather, the test is additionally severe. After seasoning for 18 months, the blocks are capable of resisting a blow of 30,000 lbs. per square inch.

The same material is now being used on some of the Pennsylvania lines for telegraph poles and signal standards.

AUTOMATIC TICKET PRINTING MACHINE.—This machine, which is called the Regina Automatic Ticket Printing Machine, is engaging the attention of railway managers, and will shortly be manufactured in this country at Birmingham, where a factory is being built for the purpose.

Present methods of issuing tickets leave much to be desired, as they are both troublesome and expensive in operation. At big stations many hundreds of tickets have to be pigeon-holed, and to avoid all chance of their running short, excessive quantities have to be kept printed and in store. To safeguard against fraud, these have to be checked frequently, while the daily stocktaking and balancing is a wearisome operation, which sometimes takes as long as three hours to carry out.

The new apparatus consists of a table between 3′ and 4′ in length, whereon are tabulated the names of the different stations, space being provided for about 2,000 different names. A sliding carriage works, at the will of the operator, backwards and forwards over the length of this table. When a ticket is asked for a blank card is placed in the sliding carriage, which the operator slides along, opposite the name of the station required. The operator then presses a small lever at the right-hand end of the table; this prints the blank ticket in duplicate, with the station of departure and destination, date, route, luggage, district, class, price, and number. One of the tickets thus printed is handed to the passenger, while the other is retained as a record.

These machines have been in use in Cologne Central Station, and have been found so satisfactory that an order for more of them at a cost of £30,000 has been given by the State Railways. They are very compact and are made in various sizes, the cost varying from £100 to £350, according to size.

Besides issuing railway tickets, machines made on the same principle can be used for all similar purposes, such as theatres, places of amusement, steamboats, etc.

A. J. SWINTON.