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SIR CHARLES PASLEY.

III.

THE DEVELOPMENT OF THE PONTOON.

By MAJOR I. S. O. PLAYFAIR, D.S.O., M.C., R.E.

"The best of prophets of the future is the past."—*Byron.*

IN old military books the word "pontoon" was applied only to closed vessels or floats. It had, therefore, much the same meaning as it now has in civil engineering. Flat-bottomed boats which would now be called pontoons were almost always referred to as "bateaux." In the present article the word pontoon is used in its modern military sense.

The list of the various kinds of floating bridge expedients mentioned in military history is a formidable one. It might, perhaps, begin with the sectional boats carried by Semiramis about 2000 B.C. for crossing wide rivers during her expedition to India. What concerns us more immediately is the fact that the need for portable bridging arrangements came to be fully recognized during the seventeenth and eighteenth centuries, and each European nation adopted some form of "pontoon." Some were of wood, either bare, or covered with tin, copper, hide or sailcloth, As early as 1672 the French are said to have had a complete pontoon train, but what its establishment was we do not know. The tendency of the period was towards small pontoons, which had to be used rather close together, thus considerably obstructing the waterway. Such bridges were therefore very liable to damage by floating debris and by the force of the current. A marked exception to the series of small pontoons

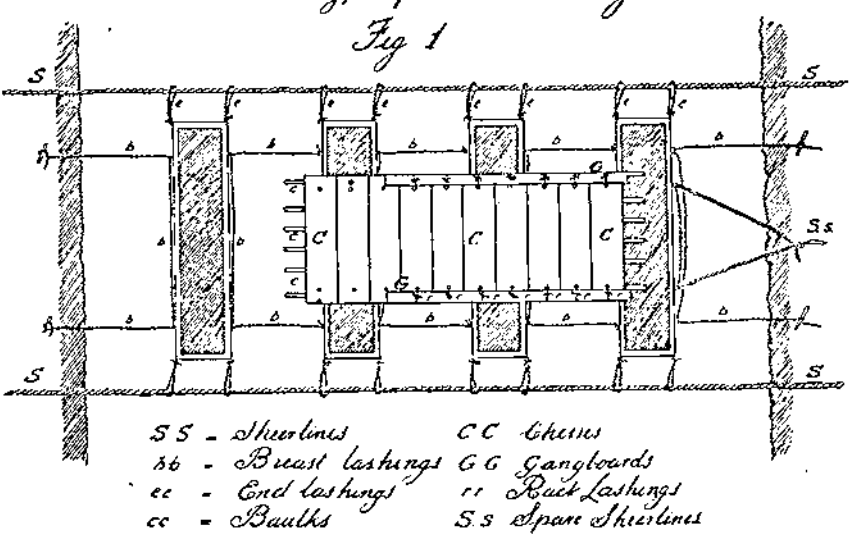
was the "Bateau Gribeauval," 36 feet long and weighing nearly two tons. Napoleon's bridge over the Danube in 1809 is said to have been supported on pontoons of this type, and, if this is true, his transport authorities must have had some anxious moments.

The conflicting requirements of adequate buoyancy and ease of transport resulted in the adoption of two sizes of pontoons, and at the beginning of the nineteenth century both the English and French had a small pontoon as "Advanced Guard" equipment and a larger one for general work. It is interesting to compare the need that is being felt to-day for a light form of floating bridge for the vehicles which require to cross at an early stage of an attack.

The pontoons used by the British in the Peninsular War were of wood covered with sheet tin. The two sizes were quite distinct; the spacing of the piers and the width of the roadway differed with each. (For particulars see the table on page 409 and Fig. 1.)

Peninsular type of Pontoon Bridge

Fig 1



PASLEY'S EXPERIMENTS.

In April, 1812, Sir Charles Pasley became the first Director of the Royal Engineer Establishment, now the S.M.E. He lost no time in investigating the whole subject of floating bridges, and realized at once the importance of conducting his experiments and training under service conditions. "When I first demanded pontoons," he wrote, "I could only obtain them on condition of making a pond on the low ground near St. Mary's Creek, on the left of Chatham Lines, lest some officers and men should be drowned in our pontoon practice,

if carried on in the Medway ; but having once got possession of them, I launched them into the river at once, and General Mann* pardoned my neglect in not making the pond." That he was justified in his policy there can be no doubt, for in his own words, " It was not till we took the old pontoons up to the Rochester Bridge that their entire uselessness and inefficiency in more rapid rivers became evident, for one of them, when moored below the arches for experiment, without either men or stores in it, was sucked head under water by the violence of the current, broke its cable, and drifted away and sank, though it had been moored on the same spot where an efficient bridge was afterwards formed with my new pontoons."

Pasley's lithographed MS. work, *Of Pontooning*, compiled in 1813, is a most thorough and painstaking summary of his survey of the whole question of floating bridges. It deals first with the trials of the large (Peninsular) pontoons and records the effect of various spacings, of different conditions of gunwale loading, details of lashings, superstructure, attachment of cables and breastlines, inter-pier bracing, the packing of carriages, etc., etc. Experiments were carried out to determine the effect of various forms of traffic and to study the behaviour of the piers in rough weather. Anchors, sheerlines, barrel piering, watermanship, and flying bridges all received attention, and most of the pontoon experiments were repeated with various kinds of boats and barges. Here is the account of the first operation of what we now call " swinging bridge " :—

" Of wheeling a Pontoon Bridge."

" We formed a bridge of 10 pontoons about 140 feet long, which was secured by 2 sheerlines and 4 anchors, two of which were thrown out above the bridge and two below it. We placed 4 men in each pontoon who by hauling on the sheerlines disengaged the bridge from the shore and moved it bodily further out into the river. We then hauled it back again near to the bank, but without touching it, and having made fast the adjoining end of the bridge to pickets on shore we untied all the end lashings, slacked the sheerlines and let go the cables. The bridge being thus perfectly loose except at one end it floated round with the current so as to perform a quarter of a circle, it then lay close to the bank and parallel to it."

The detachments required for forming a bridge of 12 pontoons were worked out in detail, and a note was added that this was the work of Lieut. Abbey, " who had charge of the pontooning during its most active period in the month of September, 1813."

A comparison is given of the British and French pontoons. Pasley considered that the French copper-covered type was more substantial, more durable, but more expensive and much heavier. He thought, however, that it was heavier than it need have been and pointed out

* The Inspector-General of Fortifications.

that a copper pontoon would have some market value after it was no longer fit for service. When, a few years later, he produced a design of his own, the covering was of sheet copper.

His Policy and Training.

In January, 1814, Pasley wrote to Col. Chapman, D.A.G., R.E. :—"You will recollect I was always a great advocate for the R.E. paying attention to the management of pontoons and to the study of military bridges. I foresaw that some time or other it was likely to become a very creditable and important duty and my conjecture has proved right. Elphinstone* writes to me that it has now become the most important duty in Wellington's Army and I am particularly glad it was thrown upon the Engineers in the army before the importance and respectability of it was generally understood. We have also reduced the art of forming bridges of casks to a system, and our plan (nothing equal or even similar to which is to be found in any book) is neither inferior to the pontoon bridge in strength or stability, but in some points superior. They, of course, will not sink if washed over by any violent effort of the current, and in mountain roads they may be transported on the backs of mules or horses. I choose in preference the 'butt,' a kind of cask most common in the Royal Navy. The officers and men are all exceedingly expert in all these operations, particularly the parties that went last from hence, or are now on the eve of going. For we are constantly improving our system of carrying on the duty. I have lately written several papers on the subject of pontoons, through Gen. Mann, requesting him to lay them before the Board. In the first place I have stated my opinion that tin is too perishable a material for pontoons, that it ought to be laid aside and copper pontoons constructed. I have requested the Board's authority to build one copper pontoon on trial, which I promise shall be sufficiently strong and yet not heavier than the present English large tin pontoons, to which I mean to make it exactly equal in point of size. I conceive that it may perhaps cost double in the first instance, but that it will last more than five times as long.

"As far as depends on me, all the officers and men who have been under my command are competent to the duty of pontoniers. There are now with Lord Wellington, 6 or 8 officers and at least 100 men, who have been trained according to our last improvements. The Company who went to Holland are still better. But the set of men who are now here, ready for service, just sufficient to form a company, are by far the best pontoniers of the whole, and every succeeding set will be equally perfect, for, as I mentioned in my last, our system has

* Lt.-Col. Howard Elphinstone, the C.R.E. of Wellington's army at the passage of the Adour.

now got to a much superior state than at first. I have from time to time regularly sent out to Lord Wellington's army an account of all our improvements and manœuvres in pontooning, first to poor Sir R. Fletcher,* afterwards to Burgoyne or Elphinstone.

"Floating bridges such as boats, pontoons, casks, etc., are the only kind suitable for general service. They and they alone are independent of depth of water, the nature of the bottom, and a hundred other circumstances which are never alike in any two rivers nor in the same river in any two places, or even at any two different periods. If you weigh this in your mind, I think you will agree with me as to the general principle. But if you suppose, what often happens in war, that the enemy has destroyed the arches of a permanent bridge, leaving the piers, then a good and light temporary bridge of carpentry will be a very useful thing and for the benefit of the service may be reduced to a system."

Realizing how valuable his experiences would be to the Army in the field, Pasley sent on the 9th of June, 1815, a memorandum to Lt.-Col. Carmichael Smyth, the Commanding Royal Engineer in Belgium, giving the suggested detailed distribution of a Company of Royal Sappers and Miners for pontoon bridging, "it having been considered the best by the officers who have practised that Duty in the current of the Medway."

Colleton's Buoys.

In 1814 Brevet-Major Colleton, Royal Staff Corps, afterwards Sir James Colleton, invented his "buoy" pontoon. To use his own words—"Having witnessed during the operations of the Army at Badajoz how liable the pontoon bridges were to destruction in a rapid stream, and having also seen how absolutely necessary it was to take up those bridges upon many occasions to save them from destruction at the very moment when the communications between both banks of a river were of the utmost importance, the idea suggested itself for substituting for the pontoons a totally different kind of boat which should be able to resist if not every stream, at least many that would be fatal to the pontoons."

The writer goes on to explain that it was not until April, 1815, that he was able to send a model to the Quartermaster-General in London. He claims that the advantages of his buoys "are more conspicuous when serving as flying bridge, in which situation they can be made to make head against a current that would undoubtedly swamp any pontoon; when travelling they are not so heavy as the pontoons and are calculated when formed into bridge to bear considerably greater weights without half the risk of being swamped.

* Sir Richard Fletcher was killed at the siege of San Sebastian in 1813, and Lt.-Col. Burgoyne was wounded.

Each was formed of two buoys of cylindric form in the middle and pointed at the ends. The two are strapt together by a frame which forms part of the carriage when it is travelling, and the gunwale of the boat when in the water. They are anchored near the points and offer scarcely any resistance to the stream, which upon striking the two points passes between, on either side, and over and above them."

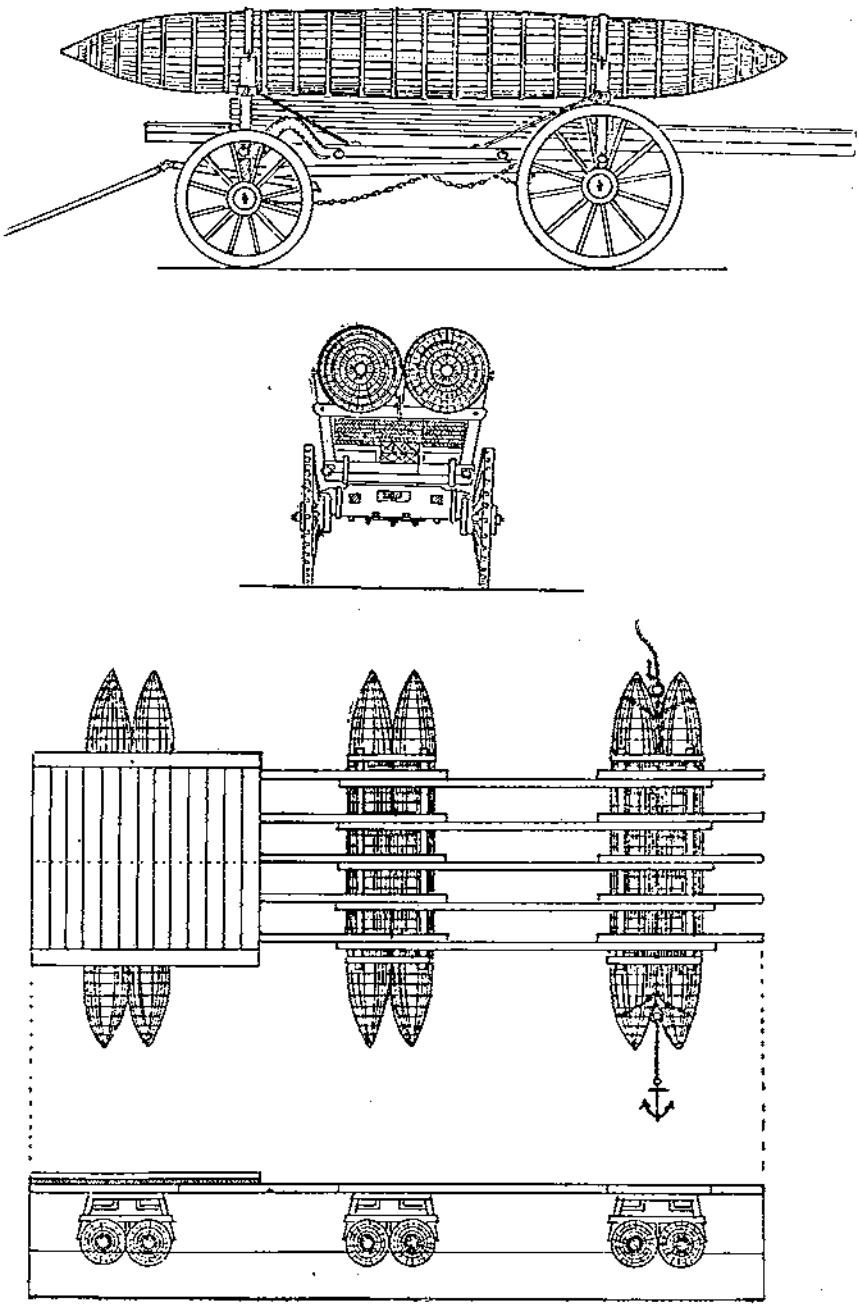
The buoys were divided by tin partitions into 8 watertight compartments, each of which could be pumped out independently. Fig. 2 shows the buoys on their carriages and in bridge.

Lieut. A. W. Robe, R.E., wrote to Pasley from Cambrai on 16th November, 1816, as follows :—

" My dear Sir. You will doubtless ere this have heard something of the Buoy Bridge invented by Sir Jas. Colleton of the Staff Corps intending to do away with the pontoons, but as you may not have had a description sufficient to give you a perfect idea of its construction so as to be enabled to judge of its merits and knowing myself how desirous you are of collecting every possible information tending to the good of the Service, from whatever indifferent channel it may be procured, I have been induced to make a few enquiries concerning this Bridge, and forward the result of them ; hoping that my endeavours to be of service to you and in consequence to the Corps will be sufficient apology for my intrusion, and if you are pleased I shall be well recompensed." One cannot help wondering whether the Director of the Engineer Establishment was dependent for his information upon such personal communications, or whether the Royal Staff Corps saw to it that he was fully, officially and immediately informed of all promising suggestions and developments as soon as they occurred.

After a long description of Colleton's buoys, Robe took the liberty of expressing his own opinions of them. He realized that Colleton had combined a comparatively high flotation with a low resistance, but that the design had certain defects, *e.g.*, difficulty in placing the baulks and great strain on them ; lack of elasticity ; likelihood of damage to the buoys on exposure to the sun by the opening of the staves ; liability to damage of the thin wood and the difficulty of repair. Robe then took the further (and entirely praiseworthy) liberty of making a suggestion of his own. It was that " the present pontoons might be rendered secure from swamping by applying a movable Tin Deck, made to fit close to the interior perimeter of the pontoon, by means of leather round the edge, as in a pump valve, and resting on a ledge a little below the top of the gunwales, there to be pinned down by a few iron pins going into small holes made in the gunwale level with the upper surface which if made entirely through would likewise serve as skupper holes. . . . The above suggestion to apply merely to the service of a flying bridge in which situation the Pontoons are most liable to swamp. With all their

Colletons Buoys
Fig. 2.



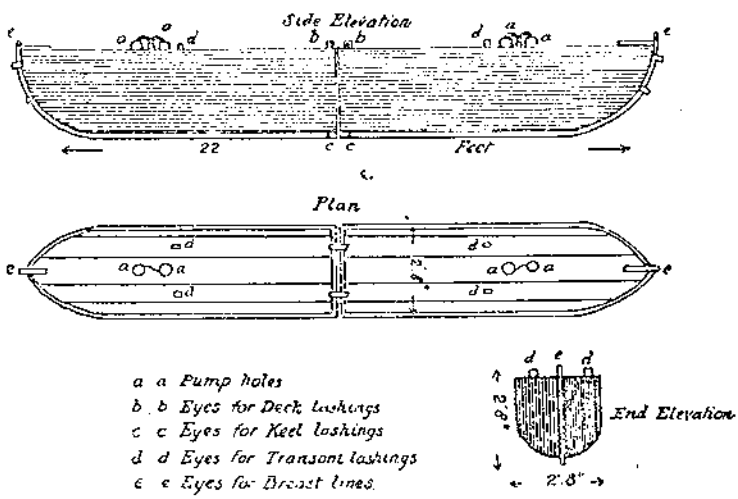
disadvantages, however, the pontoons I conceive still retain a superiority which any improvement in their shape or otherwise must render very decided."

Pasley was doubtless impressed by this idea, for in 1817 he produced his own design for a decked pontoon.

PASLEY'S DEMI-CANOES.

We have already seen that Pasley was aware of the merits of a copper covering for the hulls of pontoons, and in his new design he attempted to combine the advantages of a boat-shaped float with the submersible qualities of Colleton's Buoys. The idea was not entirely new, for, whether Pasley was aware of the fact or not, the

Pasleys Demi – Canoes
Fig 3.



proposal to use decked vessels had been put forward by a Lieutenant Hoyer of the Saxon Pontoniers in 1790.

Pasley decided upon a wooden frame covered with sheet copper, except over the deck, which was of wood. The unit was a "demi-canoe," two of which were lashed together stern to stern to form one floating pier. Each was again divided into two parts by a transverse bulkhead. (See Fig. 3.)

A manual entitled *Exercise of the new Decked Pontoons or Double Canoes, invented by Lieut.-Col. Pasley, R.E.*, was produced by

lithography at the Establishment for Field Instruction, Royal Engineers Department, Chatham, in 1823. It comprised some 70 pages of detail and instructions for handling and launching the pontoons, booming out, bringing up the stores, manœuvring and rowing, mooring, forming bridge, casting anchors, laying the superstructure, dismantling, and packing the carriages. Explanations were also given of rowing drill, sheering, forming double-chessed rafts for Heavy Artillery (viz., a 24 pdr. weighing 56 cwt.), embarking artillery by skidways and brows, forming bridge to take Heavy Artillery, and forming rafts for conveying troops. Knots, lashings, and full details of all the stores were also included, and the book ends with the following interesting remarks :—

Probable time of forming a bridge on Service.

" In forming a bridge on Service, the duty of each party consisting of 1 Non-Commissioned Officer and 6 men, according to the above exercise, would be as follows. First to dismount and unpack 2 Canoes with their stores, one after another, which may be done in 14 minutes ; secondly, to put together and launch one pontoon with its stores, which may be done in 16 minutes ; thirdly, to form their portion of the bridge, which may be done in 15 minutes ; total, 45 minutes. Hence if the river be favourable, and its banks of such a nature that all the pontoon carriages may be brought down and unpacked, and the pontoons launched simultaneously, there is no doubt but that a considerable bridge may be formed with the new pontoons by expert men, in very little more than three-quarters of an hour, after the order is given to dismount Canoes.

" When the banks are unfavourable, so that only a part of the carriages can be brought down to the river, and only a part of the pontoons launched at the same time, then a proportional delay will, of course, be occasioned by the necessity of doing successively what ought if possible to be done simultaneously. In most cases, however, by previously improving the banks, by employing Working Parties, in addition to the Pontooneers, to bring down the demi-canoes and stores with greater celerity from the carriages, when halted at some distance from the river ; and by other expedients which will naturally suggest themselves to an Intelligent Officer, the delay that would otherwise be occasioned by such difficulties, may be greatly diminished."

COMPARATIVE TESTS OF PASLEY'S AND COLLETON'S EQUIPMENTS.

Extract from Pasley's Diary for 1823.

" Sept. 6th. The D. of Clarence (afterwards William IV.) saw the pontoon practice.

"Sept. 8th. Saw the pontoon carriage trot past. In the evening exhibited the night telegraph which he highly approves.

"In September, 1824, a committee was appointed by the Duke of Wellington to examine new pontoons:

President: Lt.-Gen. Cuppage.
Members: Maj.-Gen. Millar.
Lt.-Col. Sir A. Frazer and Lt.-Col. Williamson, C.B. (all R.A.).
Col. Sir J. Carmichael Smyth, Bart.
Maj. Sir G. Hoste, K.C.B.
Bt. Maj. Rice Jones, R.E.

"The bridge of pontoons was put together in 11 minutes and taken to pieces in 7.

"The pontoons were rowed up to Rochester about 4 p.m. The Surveyor General of Ordnance, Sir Ulysses Burgh, and the Clerk of the Ordnance, Sir Henry Harding, also attended. H.R.H. D. of Clarence also came. Very rough weather, rain squalls, and half ebb tide.

"Sept. 9th. Go to Crown Inn at 11 a.m. and meet the Committee. Bring them to the Gun Wharf. The 6 pontoons in one sub-division, 2 with a 12 pdr. limber in a second sub-division. Pass up towards Rochester at half past twelve. One Sub-division goes inside, the other outside the bathing house. Form a bridge on the Rochester side near the end of that reach. Limber up gun and moor it above on the bridge. Dismantled and formed bridge at Rochester. Two of Colleton's double buoys moored on opposite side. One has a 6 pdr. dismounted on board. At 4 o'clock the Duke of Clarence arrives. Committee inspect bridge. It is dismantled. The pontoons descend current, run on shore near Brindley Yard. Take everything to pieces and ashore from rafts. Vast numbers of spectators. The whole done beautifully by the 6th Co. There had been a great review in the morning. Evening—a dinner at our Mess. D. of Clarence, Sir H. Torrens, Lord Torrington, Sir H. Montressor and C.-in-C.

"Sept. 10th. At nine meet the Committee at the Gun Wharf. Show them my pontoon carriage. They approve it. Take, on a raft of three canoes, one large, two small, a 24 pdr. on its travelling carriage. Land and re-embark it at the Hard opposite the Marine Barracks. On two canoes take an 18 pdr. on a ship-carriage, 50 cwt. Offer to land it. They are satisfied. Land 20 R. and F. in heavy marching order either standing or sitting. Colleton with his three canoes tries to take on board the 24 pdr. and carriage. They will only bear the gun alone, 49 cwt. They are pressed. Offer to land the gun and carriage on 4 of his canoes.

Declined. It would crack them as they are only $\frac{5}{8}$ inch thick. Dine at Fusiliers and meet the D. of Clarence."

In Sept., 1825, a fresh trial of pontoons took place before a Committee in the presence of the Duke of Wellington. In addition to Pasley's pontoons there were new designs by Sir James Colleton of the Royal Staff Corps and others by Major Blanshard, R.E. The test took place in bad weather and at the place where the river raced on the ebb tide through the piers of old Rochester Bridge. The exhibition of skill in this rapid river was such that the Duke recognized, once and for all, the wisdom of selecting so difficult a position. There had previously been a proposal to move the Establishment to Woolwich. Pasley wrote in his diary, "The Duke sees one of my rafts moored in the river below the bridge and goes off in great good humour, says that the pontoon exercise shall be carried on at Chatham."

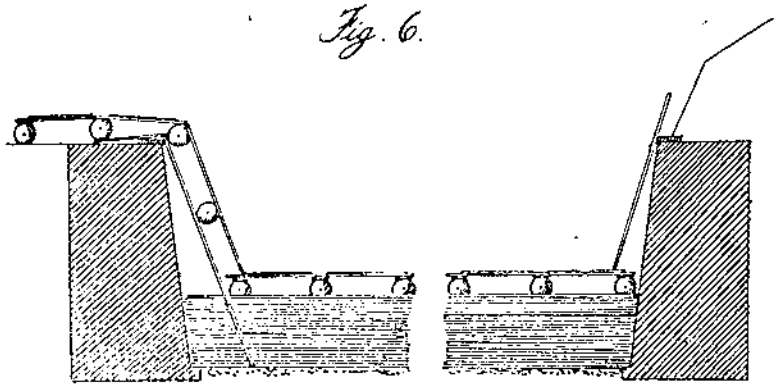
At the wish of the Duke of Clarence, Pasley wrote to him on 3rd Dec. 1825:

"I was honoured by Your R. Highness's note expressing a desire to know the result of the late trials of the new pontoons in the presence of the Duke of Wellington. I have delayed writing in reply to this query, from the circumstance of the report of the Committee upon this subject not yet being made known, and in expectation of soon having the Duke's decision. But we have not yet been put in possession of this information, and, in the meantime, I feared that longer delay might appear neglect. My system was arranged with all its details with little change or alteration subsequently, early in 1819. The other gentlemen, Sir James Colleton and Major Blanshard, whose present plans were certainly not digested at that period, have therefore endeavoured to surpass me in lightness. I do not think they will get the better of me in efficiency. Sir James Colleton's pontoon is of wood. The last pattern is rather complex, but was a beautiful piece of workmanship. I do not conceive, however, that wood is a proper material for general service. Maj. Blanshard's pontoon is of tin. Mine is a wooden frame covered with copper, which is the heaviest material of the whole, but the most durable, and the least liable to decay or corrosion, or to serious injury. Maj. Blanshard has proposed two bridges, one a pontoon for general service, which comes in competition with my pontoon, the other an occasional bridge for infantry and field pieces only. The latter is one of the most ingenious things I ever saw. A number of men in proportion to the length of the bridge can put it together on dry land and can carry it bodily to the bank of a river and push it across. He even managed to get it down one of the counter-scarp walls of the 'Lines' here, and made a bridge across one of the ditches at high water,

and scaled the opposite wall. This, although difficult, or impracticable when the enemy are on the alert, shows in the strongest light the powers of the bridge." (See Fig. 6.)

Blanshards Infantry Bridge launched across a wet ditch

Fig. 6.



The Duke of Clarence wrote in reply :—

"Bushy House, Dec. 4th, 1825.

"Dear Sir,

In answer to yours of the 3rd inst. from Chatham, I shall be anxious to hear from you the result of the report of the Committee before the Duke of Wellington. I believe Sir James Colleton to be a man of science, and so he ought to be from the situation he holds in the King's Service. I never heard before of Major Blanshard, but by your letter he must be an intelligent and clever man. I think your statement of your own pontoons and of those of the two gentlemen very fair and I make no doubt very correct. I will thank you to inform me of the report when made public, and ever believe me,

Yrs sincerely, William."

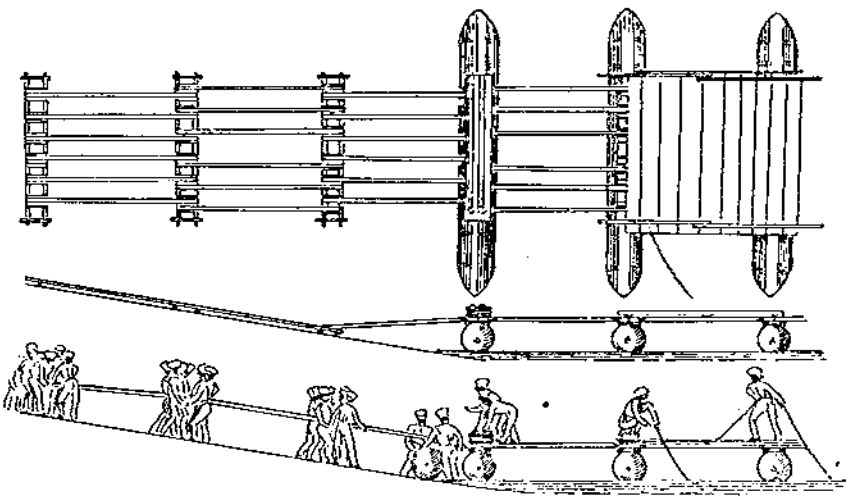
BLANSHARD'S PONTOONS.

Although Pasley preferred his own design, Blanshard's large pontoon proved to be a serious rival. It was a cylindrical float of tin with hemispherical ends, rather similar in general appearance to Colleton's. The framework was of "wheels" of tin tubes formed on a hollow axle which extended along the whole length. The pon-

toon was divided into 9 watertight compartments, and was provided externally with stout iron rings at each end and 4 rows of sunk handles, to which the saddles and baulks were lashed. (Figs. 4 and 5.)

Blanshard's Pontoons—"Booming out"

Fig 4.

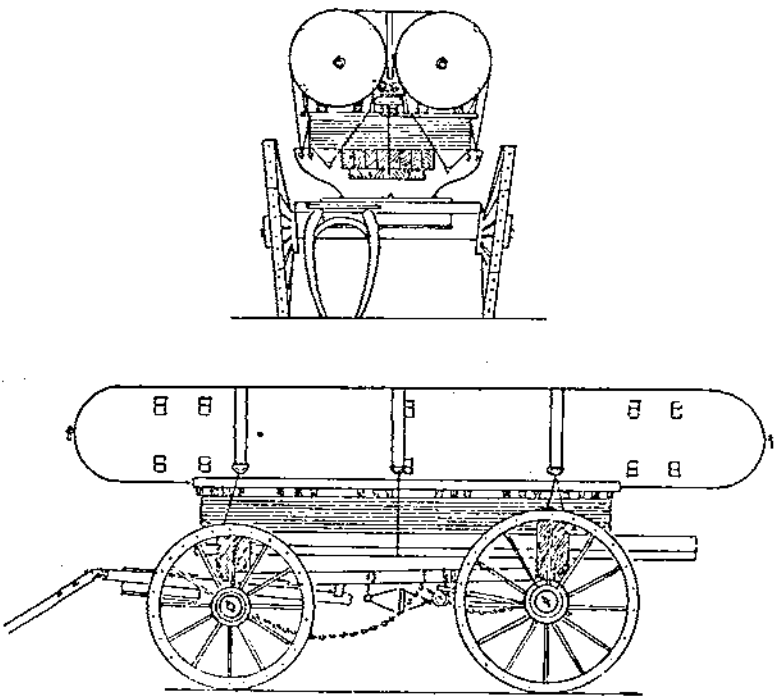


In spite of Pasley's belief in the boat-shaped pier as against the cylindrical float, Blanshard's pontoon was introduced into the Service in 1836, and an *Exercise of the New Pontoons, Lt.-Col. Blanshard's pattern*, was issued.

Brig.-General George W. Cullum, of the Corps of Engineers, U.S. Army, in his "System of Military Bridges, 1836," sums up the disadvantages of the British Bridge Equipage in the following terms:—"It is unprovided with trestles and abutment materials. The metallic cylinders, with conical or parabolical ends, are more expensive than wooden pontoons; cannot be readily repaired in the field when bruised, broken or perforated by shot; afford no stowage place for small stores; are bulky and inconvenient for shipment; require long wagons to transport them in campaign; have no stability separately, and have to be formed into rafts, not easily navigated, for the conveyance of troops and materials; are unsuited for bridging broad streams; catch and afford lodgment for drift, of which, when half immersed, they cannot free themselves; and, if heavily loaded, are operated upon unfavourably by waves, swells and strong currents."

Carriage of Blanshard's Pontoons.

Fig 5.



PASLEY'S LATER ACTIVITIES.

Sir Charles Pasley left Chatham at the end of 1841, but he maintained close touch with his old Establishment, and kept up the greatest interest in all engineering developments. He paid frequent visits to witness trials and experiments, many of which took place at his instigation. His demi-canoes were for a long time standard equipment in India, but were not often used, as boats were usually available locally.

Writing to Col. Sandham on May 23rd, 1856, he says :—

" Having occasion to go to the India House, the Assistant Military Secretary congratulated me upon the Pasley Canoes having been finally established as the Standard Pontoon in India, not in opposition

to Blanshard's, which were sent out to be tried in competition with mine in 1826, because from both having been tried in salt water near Bombay, his tin cylinders were corroded into rust and dust, and no trace of them was to be found, so that mine were adopted at once, and others built on the same lines by the Bombay Engineers, the efficiency of which was proved in a remarkable manner in the Winter of 1838–39 in the passage of a branch of the Indus by the Bombay contingent of Sir John Keane's Army over a bridge of 6 rafts which a troop of Horse Artillery crossed at full gallop. Afterwards a bridge of 14 rafts constructed and organized by Officers of the same Presidency was made over to the Bengal Engineers, and was extremely useful in the passage of the Sutlej after the battle of Sobraon." He goes on to give details of a few proposed alterations to the canoes and superstructure in order to deal with 32-pdr. guns and 13-inch land mortars. He still had great faith in his canoes and had a new raft made by a London firm with the view of getting it re-introduced into the Service. "If it should be honoured by the approval of you and your Staff," he wrote in 1858, "in preference not only to Blanshard's, but to the many other competing schemes, the War Department of Government will pay for them; if not, the expense will not ruin me."

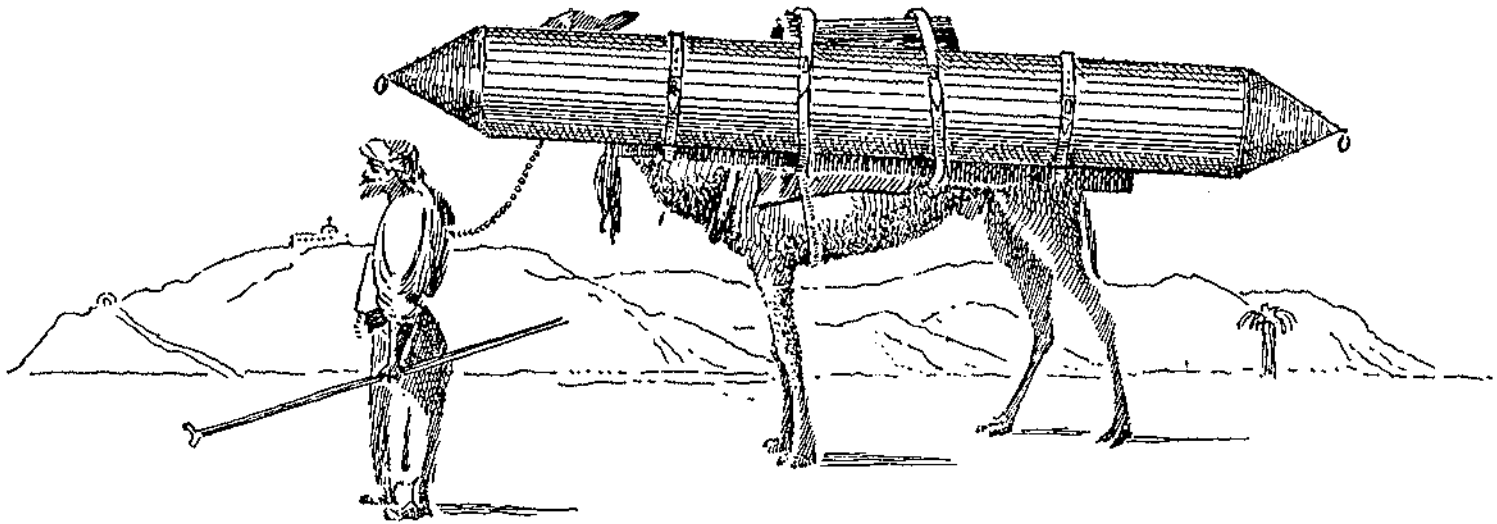
A few months later Sir John Burgoyne, the I.G.F., wrote in the course of a letter to Col. Sandham:—"Pasley is very impatient about his pontoons and it is difficult to keep him quiet. He seemed to think that a report could be made at once, and he wanted to go down on Friday and meet the Committee, but I have told him that you certainly will require some time, particularly as there is a new competitor in the field—Captain Fowke. . . . I cannot help thinking that the pontoons are not well advanced as a mechanical contrivance, that there are defects in them all, and I expect some day that we shall be enlightened by some brilliant invention that will be an improvement on them all."

That was 73 years ago. The assault bridge has since been rediscovered and bears a strong resemblance to its forerunner—Blanshard's Infantry Bridge. Captain Fowke's proposal took the form of a canvas-covered collapsible boat, and now (in 1931) we hear a good deal about canvas-covered collapsible boats.

Last but not least, the present Service Pontoons are decked-in, and are used in pairs fastened stern to stern—as were Pasley's.

À tout Seigneur tout honneur.

Fig 7.



Syrian Camel loaded with 2 of Blanshard's small pontoons and 2 saddles. weight 2 cwt 1 qr, without the Pack Saddle.

COMPARATIVE TABLE OF PONTOONS.

(Only one example of each type is given; there were, of course, frequent alterations of the sizes and weights.)

	Large Peninsular type.	Colleton's Buoy Pontoon.	Pasley's Demi-Canoe.	Blanshard's Large Pontoon.	Blanshard's Infantry Bridge Pontoon.
Length	21 ft. at gunwale. 17 ft. at bottom.	21′	11′	24′ 6″	15′ 5″
Width or Diameter	4′ 10″	2′ 5″	2′ 8″	2′ 8″	1′ 7″
Weight	1300 lb. (See Note 1)	660 lb.	400 lb.	560 lb.	140 lb.
Baulks	Six; 22′ 8″ x 5″ x 4″	?	Six	Six; 14′ 2″ x 4½″ x 3″	Six; 6′ 4″ x 3″ x 1½″
Chesses	12′ x 8″ x 1½″ in panels of 4.	?	"Common Chesses"	11′ 5″ x 8″ x 1½″ in panels of 3.	8′ x 1′ 4″ x ⅞″
Usual spacing of piers (*c* to *c*) ...	(*a*) Open order 14′. (*b*) Close order 9′.	15′ (2 pontoons side by side per pier).	(See Note 3.)	(*a*) Open order 12′ 6″ (*b*) Close order 8′ 4″	5′ 4″
Carriage	1 Pontoon and 1 bay on a 12-cwt. carriage. Total 36 cwt.	2 Pontoons and 1 bay on a 4-wheeled carriage.	2 demi-canoes and 1 bay on a 12-cwt. carriage. Total 32 cwt.	2 Pontoons and 2 bays in one 4-wheeled 13-cwt. carriage. Total 44 cwt.	5 bays on 1 carriage. Total 26 cwt.
Capacity ...	(See Note 2.)	Probably Infantry in fours.	Inf. in fours, Cav. "Two deep" and medium 12-pdr. field pieces limbered up, all at common order. Heavy Artillery at close order.	Inf., Cav. and Fd. Arty. at open order. Heavy Arty. at close order.	Inf. 3 abreast. A field piece "with care."

NOTE 1.—"For loading and unloading the pontoons from their carriage 24 men barely are sufficient. 30 men can carry a pontoon with the greatest ease."—(Pasley, "Of Pontooning.")

NOTE 2.—"At close order the Pontoons, 12 in number, were laid at the distance of 5′ 6″ apart. An iron 24 pdr. weighing 49 cwt. was drawn over by men on a sling cart. Some of the pontoons sunk 20 inches. The average sinkage was 15½ inches. The chesses creaked very much but on examination neither they nor the baulks were injured. This is a decisive proof of the strength of the English Pontoon bridge. 70 men marching over sank the bridge on an average 14 inches. At open order 12 feet with double bearings 100 men in marching over four deep sank the bridge 20 inches on an average."—("Pontoon Exercises.")

NOTE 3.—(*a*) Close order; 3 canoes per raft; length of bridge per canoe 6 ft. 4 in. (*b*) Common order; 2 canoes per raft; length of bridge per canoe 10 ft. 11 in. (*c*) Open order; 2 canoes per raft; length of bridge per canoe up to 12 ft. 3 in.

MECHANIZATION AND DIVISIONAL ENGINEERS

(continued).

By

BREVET LIEUT.-COLONEL N. T. FITZPATRICK, D.S.O., M.C., *p.s.c.*, R.E.

PART II.—BRIDGING.

I.—INTRODUCTION.

MECHANIZATION, combined with the introduction of the greater loads of to-day, has led to many changes being made in the bridging equipment which Divisional Engineers will normally handle, but a certain amount of finality has, however, been arrived at in this matter now. The situation at present is that Field Companies are to carry no bridging equipment of any kind. The bridging equipment actually held within a division will consist possibly of a few bays of trestle or light girder equipment, some folding boat equipment, and perhaps some kapok, all to be carried in the Field Park Company, whilst the standard consuta pontoon equipment is to be concentrated in non-divisional units called " Pontoon Bridge Parks."

The design of the various natures of bridging in a Field Park Company, as described above, is practically settled and it is proposed to give in this article a short account of the recent developments in these matters. Also, as there has been a proposal to introduce a new type of bridging in the shape of the light box girder into Field Park Companies, a few notes will be added on the use of this equipment, which is still in the experimental stage.

As regards the Pontoon Bridge Park, here the equipment is now to all intents and purposes a sealed pattern, and the outstanding problem with which we have had to deal in this connection has been the question of putting all the equipment satisfactorily on to mechanical transport. An account will accordingly be given of the various loading trials carried out, together with the proposals for the transportation of the standard equipment.

Finally, for the benefit of those who may not be *au fait* with the new service bridging gear, a few photographs are added showing consuta equipment in use.

II.—Kapok Bridging.

Kapok equipment was originally provided for the express purpose of enabling infantry to cross river obstacles in the face of opposition. It is essential that equipment for use in these circumstances should be simple and sure in its action, and the greater the adaptability of such equipment, the more useful it is likely to be for bridging operations under fire.

It was felt that the existing pattern of Kapok equipment, in spite of various improvements, was still unsatisfactory in many respects, particularly on account of its finicky duck-board fastenings, which are apt to cause difficulties in the handling of this gear under service conditions.

A considerable advance has, however, recently been made in the attachment of the duck-board to the saddle. The old removable pin type of transom is done away with and replaced by fixed transoms on each float, and the duck-board runners are fitted with a simple drop bolt to engage with the fixed transoms.

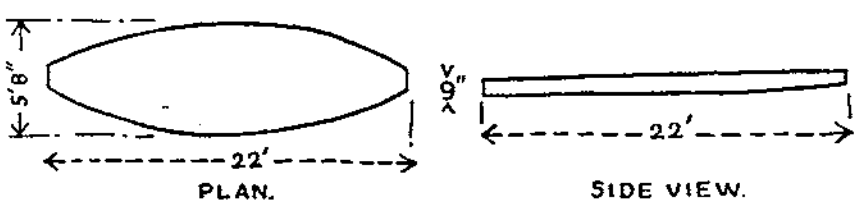
Experiments with the new arrangement, Photo 1, have proved successful in many respects. The procedure of assembling the bridge has become simpler, quicker and more certain, and the equipment has also turned out to be considerably steadier in actual bridge.

Kapok equipment, however, continues to be one that can only be used in streams of moderate width and current, it has little adaptability and can only be used as a light bridge, just carrying infantry in single file when spaced out.

Something more adaptable and capable of carrying heavier loads is evidently required, and experiments carried out during the last two years have shown that Folding Boats have many advantages and possibilities for the initial work in bridgehead operations.

III.—Folding Boats for Assault Ferrying.

The dimensions of the military model of the new Folding Boat are as follows :—



This boat, with its weight of 850 lb., forms a 10-men carry. It opens out, literally, in a matter of seconds, from the flat affair shown in the diagrams above, to form the boat shown in Photograph 3. The net buoyancy with 6" freeboard is 3·6 tons. The boats can be

used either as single boat ferries each carrying 25 armed men, or as two boat rafts for 3-ton or 4-ton loads according to the actual ferrying arrangements, or as bridges for 4½-ton loads.

The accompanying photographs show the equipment in action. Whilst cavalry are making their way round a flank and crossing streams by methods such as those shown in Photograph 2, the leading waves of infantry would be passed over by Folding Boats ferries as shown in Photograph 3.

In some particular circumstances, such as the passage of small canals, the use of Folding Boats for ferrying may appear somewhat tedious, but for the passage of rivers of any size and current, it is thought that Kapok bridging will be impracticable, and that ferrying in some form or another will be essential.

As matters now stand, our only service ferry boat is the consuta pontoon, but as this equipment was designed for heavier loads, it is unsuitable for assault ferry work and Photograph 4 illustrates the awkwardness of the pontoon pier in these conditions. Besides obvious disadvantages, each consuta pier requires nearly four times the man-carriers required for a Folding Boat, whilst the resulting passenger-carrying capacity of a pier is little more than that of a single Folding Boat.

Considerations of visibility are also on the side of the Folding Boat, which can be stowed away in a very small space, whilst each pontoon takes a considerable amount of hiding.

As regards transport, a single pontoon pier requires a medium lorry and trailer, whilst two Folding Boats, together with raft superstructure, can be packed on a single 30-cwt. Morris " Carrimore " or on one G.S. trailer.

As regards seaworthiness, the Folding Boat is remarkably good both in the way she rides and in the way she steers, and, with the large deck space available, there appears no reason against these boats being made capable of ferrying loads such as pack mules.

To sum up, on such experience as we have gained to date with this new means of ferrying, it is thought that Folding Boats possess many possibilities and are well worth extensive field trials.

IV.—Assault Rafting.

As soon as ferrying is well under weigh during the course of bridgehead operations, it will then be necessary to push over close support weapons at the earliest opportunity, and a handy and effective method of assault rafting is the next requirement.

With our present equipment the lightest available raft is the one which is made up of consuta equipment as shown in Photograph 5. This will carry loads up to 4½ tons, but for the same reasons as those already given in the preceding paragraph, the consuta pontoon is

also unsuitable for assault rafting, and a satisfactory alternative is not an easy thing to find. One turns to Kapok and discovers that it takes 16 floats to make a raft to carry 1½ tons, whilst 28 floats are required to deal with 3-ton loads. The essential requirement for assault rafting is to have a handy type of equipment in which all loads to be taken up to the stream form reasonable carries for a small party, and construction at the river's edge must be simple and rapid. Lieut.-Colonel Martel designed a 28-float raft which could be very quickly launched, but the lorry carrying this raft had to be backed right up to the water's edge, where the launching party numbered 20. In 1929, we designed Kapok Raft II to take 1½-ton loads. In this case the biggest carry, which consisted of the piers, required only 8 men, and construction on the river-bank took 12 men 10 minutes. Both solutions have their disadvantages, and owing to the consuta light raft being held unsuitable, it is proposed to turn now to see how a Folding Boat raft meets requirements. A series of photographs illustrates this equipment in use. Photo No. 6 shows a raft nearing completion, the sapper party required for construction being 16. The time required for construction depends on the length of the carry from vehicle to stream, but, with vehicles drawn fairly close to the river-bank, construction should not take more than 5 minutes. Loading and unloading go very smoothly, the raft can either be rowed or warped to and fro, and the whole arrangement seems a practical proposal for bridgehead operations.

Photo 7 shows a Carden Loyd loaded aboard, 25 cwt. plus the weight of the men, and the amount of free board is noteworthy. Photo 8 shows the Carden Loyd being unloaded, and Photo 9 is of the 3·7 howitzer which the Carden Loyd was towing. The rafting illustrated took place at " C " Crossing on the R. Avon, where the stream is only a few feet wide, but as a matter of interest, times were kept of the round trip workings and the average on most exercises came to 1 minute per round trip.

Photograph 10 shows the two-boat raft loaded with an empty light 6-wheeler, weighing 2½ tons, and again the amount of free board is noteworthy.

The 4½-ton Folding Boat raft, and also the Folding Boat bridge, have not as yet come to Bulford, so we cannot speak from any personal experience, but recent *Summaries of Engineer Information* contain some interesting data in this connection.

To sum up further on the use of Folding Boats as rafts, etc., as well as for ferrying, this whole equipment appears to promise many noteworthy advantages in handiness, adaptability and serviceability; it seems just the type of equipment that might well be used in Field Park Companies, the Kapok equipment being relegated possibly to the Pontoon Bridge Park, where it would be available for issue in particular circumstances.

V.—TRESTLE EQUIPMENT IN FIELD PARK COMPANIES AND PROPOSALS REGARDING LIGHT BOX GIRDER EQUIPMENT.

The trestle equipment carried in the present establishment of a Field Park Company, amounts to 3 bays, 63 feet, of medium bridge, or two bays of heavy bridge.

This trestle equipment is admirable for ordinary bridging in conjunction with pontoons, but trestle work itself is admittedly awkward and as trestles can only be used over gaps of limited depth, a few trestles by themselves can hardly be held to constitute the ideal bridging equipment to provide for the immediate requirements of a Division. It was thought that experiments should be carried out with a view to providing something more handy and adaptable, and with this end in view Lieut.-Colonel Martel, in 1928, started a series of experiments with a new Light Box Girder.

The Light Box Girder Bridge Set comprises two built-up girders, each of four 16-ft. sections, together with its own decking, and the normal bridge is capable of carrying 9 tons over a 60-ft. gap. Each set includes the apparatus for launching both by launching noses or by derrick, the whole affair loads on to 3 medium lorries, the working party is 42 men, and an average time to launch with launching noses is half an hour from arrival at site.

The Mark I set was put together during the latter part of 1928, and was tried out fairly extensively in the field in 1929. After the '29 manœuvres, this set was taken over by E.B.E. Christchurch for detailed tests, from which a Mark II set emerged and became ready for trial in the field in December, 1930. As a result of the latter trials, a final specification for a Mark III of this pattern has been prepared, and it is understood that mass production of this equipment could now be put in hand whenever necessary.

Some of the many advantages claimed for the Light Box Girder are apparent from the series of photographs attached.

As regards portability, Photos 11 and 12 show how each of the pair of girders, together with launching apparatus, fits on to a single medium lorry, whilst all the decking goes on to a third lorry, a picture of which can be seen in the background of the photographs of the Folding Boats.

The foregoing pictures illustrate the Mark I girders, carried as they were during the 1929 manœuvres, on lorries with special roller fittings. The girder thus loaded, travelled and worked admirably, but it was considered that one could not count on special bodies, or much in the way of special fittings, and in consequence the tests with the Mark II in December, 1930, were carried out with ordinary bodies for transport. We found that girders and decking could be loaded on to any 3 medium lorry bodies; a simple end roller, fitted in lieu of a tailboard, would help greatly in loading and unloading.

As regards launching, Photo 13 of the Mark I is a typical example illustrating the ease of launching with the launching nose method and Photo 14 shows the Mark I taking traffic.

It was found that the Light Box Girder can be combined with trestle equipment, a possibility which on occasions might prove to be most useful.

The general conclusion we arrived at in the matter, is that Light Box Girder equipment should prove most serviceable for a Field Park Company to carry, to meet the needs of a Division.

VI.—Transport of the Standard Equipment in the Pontoon Bridge Park.

The Pontoon Bridge Park has been in existence for some time under a variety of names. The introduction of heavier bridging gear, combined with the greater speed with which it can now be moved owing to mechanization, inevitably did away with the *petits paquets* of bridging which used to be held by Field Companies, and led to the pooling of such resources in units of a higher formation. It is to be noted that the Pontoon Bridge Park is now a unit without even a corps prefix; normally we might expect to find one such unit allotted to each corps, but in situations such as September, 1914, one can see G.H.Q. attaching the majority of all available bridging equipment to one particular part of the line.

Under present arrangements, the Park is a R.A.S.C. unit with 2 Sapper Subalterns and a few Sapper O.R.s attached. Whether the Sapper element is sufficient to handle the equipment and whether the Sapper tail will wag the R.A.S.C. dog, are matters on which there may be various opinions. These questions will, however, work themselves out, and are not going to be discussed in this article, and it is now proposed to give some notes on the transportation of this equipment.

As is generally known, all the bridging of the Park is put together in " units," of which there are 25 pontoon units, 11 trestle, 6 odd bay, 6 conversion units floating, 6 conversion units trestle and 2 cut bay units. The pontoon unit comprises 2 pontoons, together with all the gear and superstructure for one bay of medium bridge, the trestle unit contains all the gear for one bay of trestle bridging and the conversion units supply the etceteras required to turn medium into heavy bridge. The total possibilities of the Park consist of some 500 ft. of heavy, or 800 ft. of medium bridge.

This equipment having been decided upon and " sealed," the 17th Field Company, with its bridging vehicles attached, has had the task of working out how the gear was actually to be carried.

Transport in this case was to consist of medium 6-wheelers, which take 3 tons, and G.S. 3-ton trailers. The gear in the various units

had been made up in 3-ton loads, except in the case of the pontoon units, which weighed 3·7 tons. Thus the loading of the pontoon unit on to a medium lorry and trailer, and the loading of the remaining units on to single medium lorries, were practical proposals as far as weights were concerned. Our task lay in going into questions of bulk and seeing how the gear was actually to be carried, bearing in mind the necessity of a certain degree of cross-country capacity for each unit.

The first to be tackled was the Pontoon Unit. This unit consisting of a medium lorry and trailer, is a bulky affair and the unloading space available at a bridge site is usually restricted. In consequence, the original loading provided for the maximum amount of equipment being placed on the trailer and the minimum on the lorry, the theory being that the latter would quickly unload, unhook and drive away, to leave at site the trailers to be unloaded subsequently as required.

Loading trials according to this idea were proceeded with and were fairly successful. The loading worked well in many ways, but in the course of time it became apparent that for efficient haulage, the lorry had too little weight and the trailer too much, and the loading had to be completely reconsidered.

The fully loaded Medium Guy lorry weighs in all $7\frac{1}{2}$ tons, and the vehicle is designed to have 6 tons on the back axle and $1\frac{1}{2}$ tons on the front axle ; the component parts of the pontoon unit were to be made to conform as far as possible with the foregoing, both as regards distribution between lorry and trailer as well as in lorry axle loads. At the same time various other factors had to be borne in mind, and one of the most important was the adherence to the general loading rule that there should be no overhang past a line at 45 degrees to the horizontal and tangential to the back wheels.

Various systems of loading were tried out, the superstructure of the lorry had to be considerably re-designed to meet the new requirements, and construction in company shops (with generous help from establishments like the E.B.E.), loading trials, roads tests, cross-country trials, reports, demonstrations for W.O. representatives, co-operation with design department at Woolwich, and complications of " forward " and " rear " control lorries, combined to make the job a lengthy affair.

Our part in connection with the pontoon unit was, however, finally completed in December, 1930, and this unit now stands as seen in Photos 15 and 16.

The loading trials of the remaining vehicles commenced early in 1930, and as the trestle units form the second most important item of the Park, this vehicle will be the next to be described.

A considerable amount of thought was devoted to the loading of this unit, as a suitable place had to be found in this case for the transport

of all eleven long road-bearers which go to make up each trestle unit. It was evident that some form of special superstructure would be necessary, but in order to reduce the number of different special superstructures to a minimum, we decided finally to try and make the lorry superstructure of the pontoon unit also carry the trestle equipment.

From the commencement, we found this guess was a good one. Loading went happily, cross-country powers seemed quite good, and the trestle unit as seen in Photo 17 was accordingly dispatched on its running trials. All went well whilst on the roads, but across country a considerable amount of bumping was set up at the forward ends of road bearers, and on examination of the chassis after 500 miles, we found a permanent set of 1 inch in each of the side members.

In view of this, re-loading was essential, and of various alternatives, the one finally adopted for recommendation is that shown in Photo 18, the bearers being secured in the position by a pin passing through holes bored in the web of each girder.

The odd bay unit caused little trouble. In this case all the smaller stores fitted comfortably into an ordinary medium personnel body and the only problem lay in finding a suitable method of carrying the 7 road bearers and 2 ribands which are included in this unit.

Photo 19 shows the first solution, which behaved well in the initial tests. Objections were, however, raised to a preponderance of load on the front axle. Trials showed that in this case it was impossible to obtain a loading which conformed exactly with the data mentioned about distribution of load and at the same time was correct as regards overhang. A compromise has, however, been arrived at, and a loading as shown in Photo 20 has now gone forward as our proposal in this matter.

Regarding the conversion units, it was thought that these units, with their compound joists, would prove awkward items, but in both cases an amazingly simple solution was arrived at by putting the equipment on to the simplest of flat bodies.

Photo 21 shows the conversion unit floating and Photo 22 illustrates the conversion unit trestle.

The manhandling of heavy compound joists is an important consideration and flat bodies give the best facilities in this respect and admit of easy loading and unloading.

The photographs show these units in the exact state in which they were put through their cross-country trials, no lashings of any kind were used, and the whole unit was held together admirably by the forces of " stickion."

The cut bay stores obviously pack without difficulty into medium lorries, and in consequence no loading trials were done for this unit.

Photo 23 is given to show how questions of the sizes of the loads may cause difficulties in making any considerable alterations to the order of march of Pontoon Park units. It will normally be the case that speed in construction will depend on units arriving at site in a particular order, and these units being what they are on the road, one would be well advised to make sure they start off in the proper order for the final approach march.

A few notes on the transport of motor boats will conclude the work done in the loading trials of the Pontoon Bridge Park.

As far as the writer knows, it has now been decided that all Pontoon Bridge Parks are to be equipped with motor boats to help with rafting and anchor work.

Various models have been tried out, the biggest being some 27 ft. long. Photo 24 shows how even this model can be accommodated on a normal G.S. Trailer, and Photo 13 of Part I of this article (*R.E. Journal*, June, 1931) illustrates how simply one can launch these boats with the assistance of a medium derrick lorry.

VII.—Examples of Bridging with Standard Equipment.

The following few photographs illustrate the various methods of using consuta equipment.

To deal firstly with ferrying and rafting.

Photo 4 has already shown consuta piers in use as infantry ferry boats, and in Photograph 5 we have seen the light consuta raft which will take 4½ tons. As regards medium rafts, Photo 25 shows such a raft in action and Photo 26 shows a landing stage for this type of work.

Photo 27 shows the heavy raft which is capable of taking loads up to 16 tons. This picture gives a correct general idea of a heavy raft work but too great attention should not be paid to the detail, as the photograph in question was taken during an inter-company competition, when special arrangements were permissible.

To come finally to ordinary bridging, Photo 28 shows booming out, Photo 29 shows light bridge work (the second pontoon at each pier moored alongside for convenience), and Photo 30 shows the motor boat assisting to form bridge from rafts.

Of trestle work Photo 31 gives an idea of the new trestle, which by itself will carry both medium and heavy loads.

In conclusion, Photo 32 illustrates that most spectacular of all bridging operations—swinging bridge.

Photo 1.

Photo 2.

Photo 3.

Photo 4.

Mechanisation & Divisional Engineers 1-4.

Photo 5.

Photo 6

Photo 7.

Photo 8.

Mechanisation & Div Engineers 5-8

Photo 9.

Photo 10.

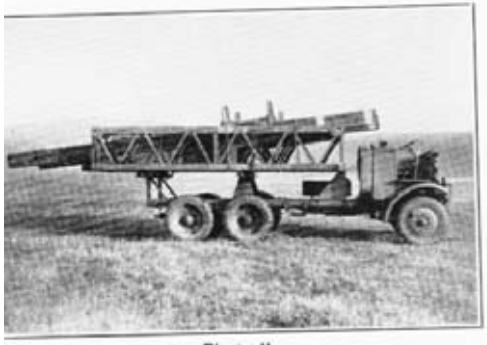


Photo 11.

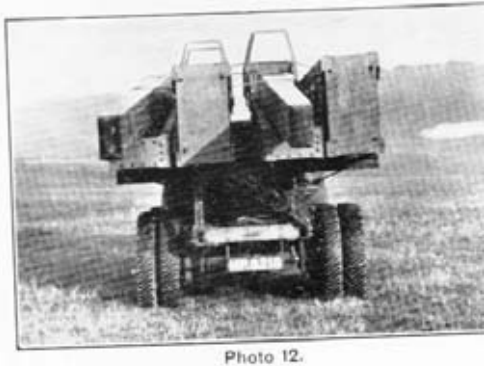


Photo 12.

Mechanisation & Div Engineers 9-12

Photo 13.

Photo 14

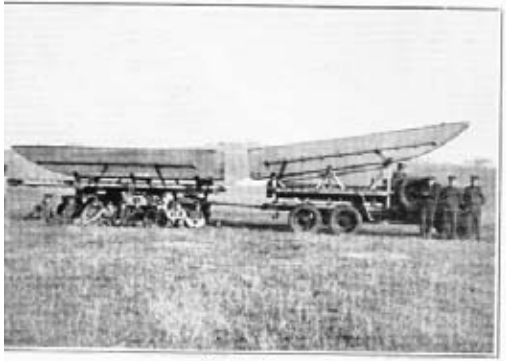


Photo 15.

Photo 16.

Mechanisation & Div Engineers 13-16

Photo 17.

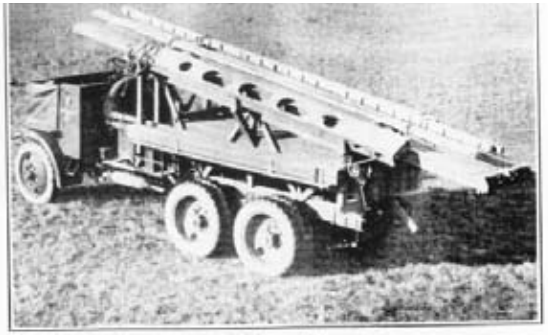


Photo 18.

Photo 19.

Photo 20.

Mechanisation & Div Engineers 17-20

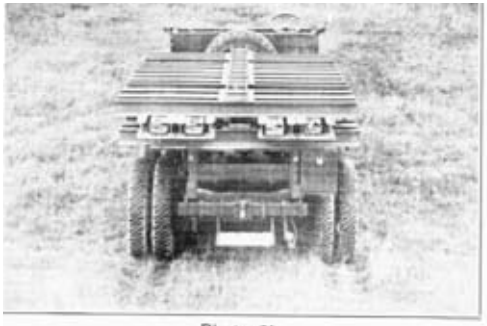


Photo 21.

Photo 22.

Photo 23.

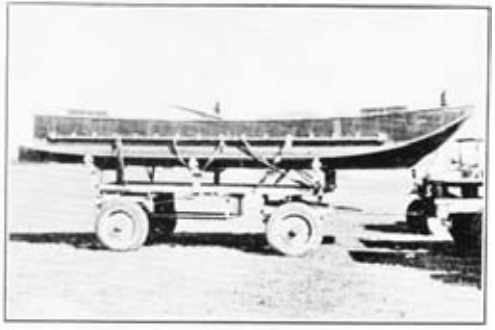


Photo 24.

Mechanisation & Div Engineers 21-24.

Photo 25.

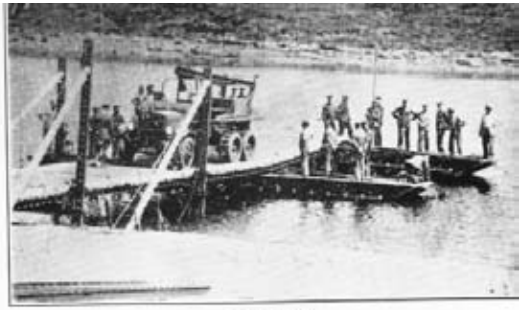


Photo 26.

Photo 27.

Photo 28.

Mechanisation & Div Engineers 25-28.

Photo 29.

Photo 31.

Photo 30.

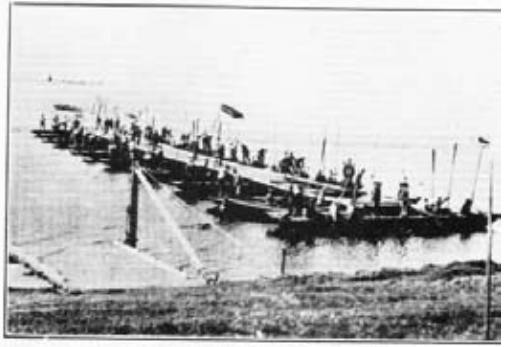


Photo 32.

Mechanisation & Div Engineers 29-32.

A SUBALTERN IN THE INDIAN MUTINY.

Containing some letters of Lieutenant Edward Talbot Thackeray, Bengal Engineers, afterwards Colonel Sir E. T. Thackeray, V.C., K.C.B., R.E. (1836–1927).*

Edited by BREVET COLONEL C. B. THACKERAY, D.S.O. (*late Lieutenant-Colonel, R.A.*).

V.—LUCKNOW AND BAREILLY—THE LAST PHASE.—(NINTH LETTER.)

THE last number brought Lieutenant Thackeray's narrative since Delhi down to the assembly of the Engineer Brigade, early in February, 1858, near General Outram's Headquarters three miles south of Lucknow, preparatory to the advance upon the city. Troops were arriving fast from England, and the main army was now concentrating under Sir Colin Campbell, the Commander-in-Chief.

Lucknow played a part in the Mutiny only less vital, and far more prolonged, than Delhi. It is a stirring story, on which to a great extent the course of the Mutiny pivots. An outline of the somewhat complicated sequence of events leading up to the capture may be helpful. The operations can be divided into five phases.

(*i*) *The Defence of the Residency.* Under the firm but sympathetic rule of Sir Henry Lawrence the outbreak of revolt at the capital of Oudh was delayed for seven weeks. It was precipitated by the reverse at Chinhat, for which he was himself partly responsible. He was mortally wounded on 2nd July, and was succeeded by Brigadier Inglis. The little garrison of about 800 English, soldiers and civilians, and as many loyal Indians, with some 500 women and children, was invested in the precincts of the Residency (the famous Baillie Guard), and conducted an heroic defence until the 25th September.

(*ii*) *The First Relief* (so-called; really only a reinforcement). General Havelock captured Cawnpore on 17th July, a few hours

* This account of the capture of Lucknow and Bareilly is based on Sir E. Thackeray's *Two Indian Campaigns* (published in 1896 by the R.E. Institute), *verbatim* extracts being marked [E.T.T.]. The writer was always, even in private, almost too scrupulously careful to avoid adverse comment, no matter how deserved, on individual officers under, or with whom, he served. Anything in the nature of criticism must be ascribed to other sources.—C.B.T.

too late to save the surviving women and children from massacre. But after a brilliant campaign, in which he won nine engagements, his force, decimated by casualties and cholera, was too weak to advance to the relief of the Residency, and had to await reinforcements. With them arrived Sir James Outram, his senior, who chivalrously waived his rank, that Havelock might have the credit of relieving Lucknow. The force, some 3,000 strong, fought its way with heavy losses through the city, and joined the beleaguered garrison on 25th September. But the force under Outram, who now assumed command, was not strong enough to fight its way out again, encumbered with the wounded, and the women and children; and the reinforced garrison was itself compelled to remain on the defensive within the Residency enclosure, and adjoining buildings.

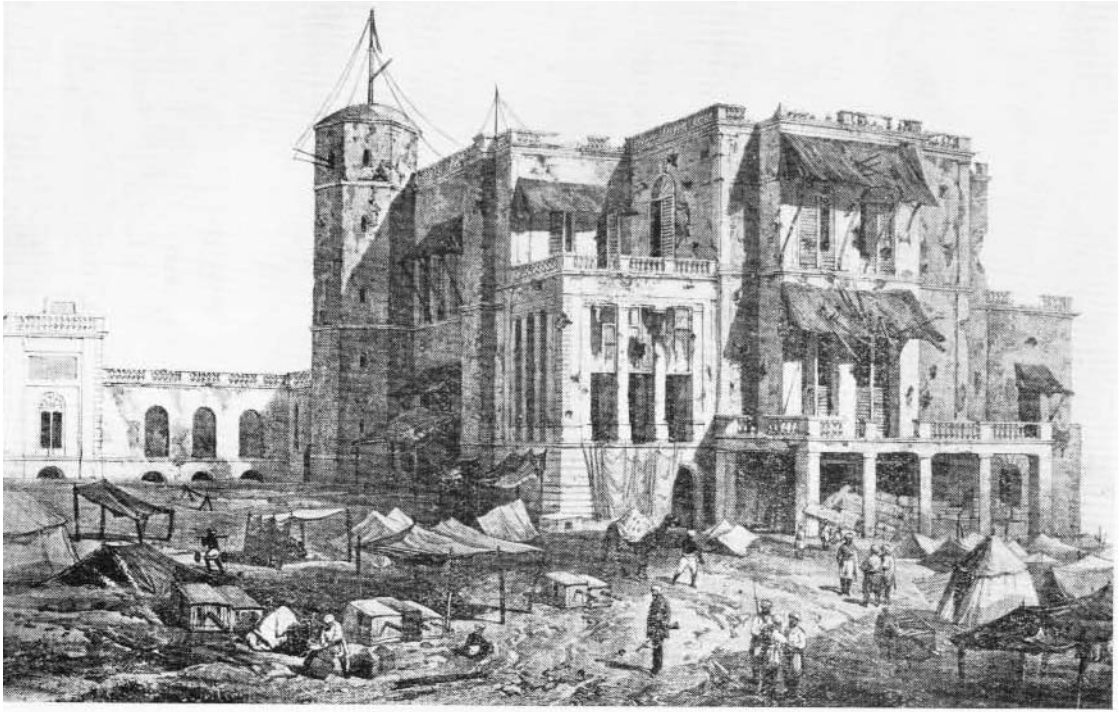
(*iii*) *The Second Relief.* In November, Sir Colin Campbell, having collected a Relief Force numbering about 3,400 men, marched against Lucknow, and after desperate house-to-house fighting joined hands with Outram and Havelock. The historic meeting of the three generals took place on 17th November. The two generals from the Residency with their staff officers had to cross a fire-swept zone to reach the Commander-in-Chief, and several of them were hit, among them Colonel Robert Napier, of the Engineers, Outram's Chief of the Staff. Campbell decided that his army was insufficient to hold Lucknow, and contented himself with evacuating the women and children and garrison. This was skilfully effected without loss, and at midnight of the 22nd November the city was abandoned to the rebels, to be reduced at a later stage. The next day, his last duty done, Havelock died, worn out by toil and privation.

(*iv*) *Outram at the Alam Bagh.* From this date until March, 1858, General Outram was left threatening Lucknow, with about 4,000 men at the Alam Bagh (an observatory standing in large grounds), his orders being to harass the enemy and keep open communications, a duty which he and his First Division carried out most gallantly.

(*v*) *The Capture of Lucknow*, by Sir Colin Campbell. It is at this point that the present account may be resumed.

Brigadier Robert Napier, Bengal Engineers, having recovered from his wound, was appointed to the command of the Engineer Brigade. As already mentioned, the post of Chief Engineer to an army engaged in the attack of fortified places was in those days second to none in importance. Sir Colin Campbell had already decided, on his recommendation, that the operation required 20,000 men, and should be made on the east, accompanied by a flank movement on the north, across the River Goomtee, to take the enemy in reverse. The city of Lucknow being upwards of 20 miles in circumference, it was utterly impossible to attempt an investment or a siege under ordinary conditions.

The Residency, before the siege



The Residency, Lucknow, at the end of the Siege.

The Residency, after the siege.

General Outram, with his 4,000 at the Alam Bagh, had been faced with a most difficult double task. For three months he had had to hold an enemy numbering in all some 120,000, half being armed but untrained levies, with all the resources of Lucknow at their disposal, and his division was constantly engaged. In addition to this, he was called upon to provide large escorts and convoys for the main army, as it began to assemble. Though latterly, after some severe handling, the enemy demonstrations did little harm, the menace of a serious attack was always present. The denuded troops had little rest, and when not on piquet or outpost, were on escort duty. General Outram became very justifiably irritated with Army H.Q.

Bluff old Sir Colin was a hard-hitting, if over-cautious commander, but neither he nor his academic Chief of the Staff, Sir William Mansfield (afterwards Lord Sandhurst), his exact antithesis in character, were inspired leaders. The men loved the hearty and irascible old Highlander, who had been one of themselves, and called him *Old Khubardar* (Hindustani,—"Ca' Canny"). The concentration into position for the final operations was a slow business, not completed until the beginning of March, after which the attack and capture of Lucknow only occupied fifteen days. From first to last it was the much-tried Outram and his veteran First Division who bore the brunt of the hard work and hard knocks.* Those who had been in the thick of it from the start felt that the fresh troops from England took more of the credit than they merited, and eventually walked off with an undue share of the honours. The battered and tattered young warriors of Delhi in the Engineer Brigade, now reinforced by two companies of Royal Engineers,† found the new

* The name of Major Olpherts (known as "Hell-Fire Dick"—afterwards General Sir W. Olpherts, V.C., G.C.B.) cannot be omitted in any mention of this Division. He was with Outram in every action from the first Relief until Lucknow fell, and commanded a Horse Artillery Battery throughout.

† The Brigade consisted of the 4th and 23rd Companies R.E., "C" Company Madras Sappers and Miners, the Bengal Sappers, and 700 Punjabis and Sikhs, "very useful men" who acted as pioneers. The following is a list of the officers. Subsequent ranks are given in brackets. Those present at Delhi, or at the Defence or Reliefs of Lucknow, are marked (*D.*), (*L.*) respectively.

Brigadier in Command.—R. Napier, Bengal Engineers (Field Marshal Lord Napier of Magdala, G.C.B., Col. Comdt. R.E.) (*L.*).

Royal Engineers.—Lieut.-Colonel H. Harness (Maj.-Gen., K.C.B., Col. Comdt.). Commanding R.E., Major Lothian Nicholson (Gen., K.C.B., Col. Comdt.), commanding 4th Company. Captains A. J. Clerke (killed at Lucknow), commanding 23rd Company; F. E. Cox (Maj.-Gen.), Adjutant; Bt. Major Wilbraham Lennox (*L.*) (Gen., V.C., K.C.B.); F. E. B. Beaumont (Col.). Lieutenants P. H. Scratchley (Maj.-Gen., K.C.B.); E. D. Malcolm (Col., C.B.); G. D. Pritchard (Lt.-Gen., C.B.); C. E. Wynne (died at Lucknow, 1858); Harrison, R. (now General Sir Richard Harrison, G.C.B., C.M.G., senior Col. Comdt., the last survivor); Swetenham, G. (Major); Keith, W. (Col.).

Bengal Engineers.—Captain (Bt. Maj.) Alexander Taylor (*D.*) (Gen., G.C.B., Col. Comdt. R.E.), commanding Indian Engineers. Captains H. W. Gulliver (*D.*) (Lt.-Gen.), commanding Punjab Pioneers; F. R. Maunsell (*D.*) (Gen., K.C.B., Col. Comdt.), commanding Bengal Sappers. Lieutenants J. A. Champain (*D.*) (Col., K.C.M.G.), Adjutant. Captains J. F. Tennant (*D.*) (Lt.-Gen., C.I.E., F.R.S.); J. St. J. Hovenden (*D.*) (Lt.-Col.); E. P. Brownlow (killed at Lucknow); R. Young (Maj.-Gen.); G. Hutchinson (Maj.-Gen., C.B., C.S.I.); G. E. Watson (Lt.-Col.). Lieutenants and 2nd-

arrivals, with their smart uniforms and side whiskers, some of them wearing Crimean medals, a little inclined to give themselves airs. They themselves looked upon the capture of Lucknow as a pleasant picnic, compared with all that they had been through. The operation from first to last only took three weeks, with a loss of only 735 killed and wounded.

The fall of Delhi in September, though a turning point in the campaign, had not had the immediately decisive effect that had been expected. On the contrary, it had released tens of thousands of rebel soldiers, who flocked to Lucknow and other centres of disaffection. Fortunately they lacked sound leadership, and early in 1858 it was evident that the insurgents had lost heart. At Lucknow, the efforts of the Queen Mother, "the best man of the lot," as Outram styled her, were of no avail. Their cavalry would prance about out of range, and perform the most dashing evolutions, whilst imposing masses of infantry manœuvred in their rear. If they ventured near enough, a few round shot would disperse them. When a more serious attack was made it was not pressed home, though Thackeray relates that the leader of one attack, a Hindu fanatic attired as the Monkey God, fell mortally wounded into the hands of a piquet, who treated him as a mascot and did their best to save his life.* He states that the Intelligence Department was well served, and the daily news was given to the camp in what was known as *The Court Journal*. On one occasion it was reported that the mutineers had planned a grand assault. The troops were formed up in readiness. The numerous generals established themselves at a respectable distance in rear, and awaited developments. But nothing happened. The commanding officers being sent for, explained that

Lieutenants A. M. Lang (*D.* and *L.*) (Col.); W. F. Fulford (died 1858); H. A. L. Carnegie (*D.*); E. T. Thackeray (*D.*) (Col., D.C., K.C.B., died 1927, the last survivor of the B.E.); J. G. Forbes (*D.*) (Col.); C. N. Judge (Lt.-Col.); R. G. Smyth (Col.).

Madras Engineers.—Captains R. H. Sankey (Lt.-Gen., K.C.B.); C. Scott (killed 1858). Lieut. W. H. Burton (Col.).

Lieut. J. J. McLeod Innes (*L.*) (Lt.-Gen., V.C., C.B., F.R.S.), Bengal Engineers, to whom the successful defence of the Lucknow Residency was largely due, was present with the Force under General Franks.

Lieutenants Cape, Baggage Master (killed), and Nuthall, Indian Army, were attached for duty.

* Sir Richard Harrison, who was among the newly-joined R.E. subalterns at Lucknow, and is now the last survivor in the Corps, gives an interesting account of the campaign in his *Fifty Years in the British Army* (1908). It states that this attack was made all along the line by some 27,000 rebels. They always used the English words of command, their bands urged them on with British airs, and they retired to the strains of *God Save the Queen*. Sir Richard says that he was "much struck with the luxury and magnificence of Indian campaigning, the size of the tents, the number of servants and amount of transport. As a junior lieutenant I had two horses, ten servants, and three camels for my personal baggage." But in contrast to this Sir Richard speaks of the Spartan discipline of the two old Engineer commanders, Napier and Harness, neither of whom seemed to require rest or food, and expected the same of their officers, when occasion demanded.

Five years later Richard Harrison was best man at the wedding of Edward Thackeray from William Makepeace Thackeray's new house in Kensington Palace Gardens. A chance meeting in the park the day before the ceremony reminded the bridegroom that he had forgotten to provide himself with this necessary support.

General Sir Richard Harrison, G.C.B., C.M.G., Colonel Commandant, R.E.
(As Inspector-General of Fortifications, November, 1902.)

General Sir Richard Harrison. GCB, CMB, Colonel Commandant, RE.

they would rather die fighting than be hanged for cowardice, but they must first have their pay. It does not appear that the attack materialized.

The main army, under the Commander-in-Chief, commenced its advance on the 2nd March, and on the 5th, General Outram began his turning movement against the enemy's left and rear, north of the River Goomtee, across which the sappers threw a bridge of casks. Never had so powerful a British army been seen in India—some 20,000 cavalry and infantry, with 134 guns and mortars, reinforced by General Franks' column of 3,600 men, and a siege train of 22 heavy pieces.

The rebel garrison had constructed three strong lines of defence to a depth of about two miles. The Dilkusha (a royal country house and park) and the outlying suburbs and buildings were quickly seized with little loss. Cavalry and horse artillery galloped forward in pursuit, a gallant sight with their glittering helmets and caparisons, scarlet and blue and yellow uniforms, lances and sabres flashing. On the 11th, the 93rd Highlanders and 4th Punjab Rifles stormed the Begum Kothi (Queen's Palace). Cannon raked the streets, sometimes mounted on the roofs of the houses. Bullets flew from every loopholed and barricaded door and window. But the Palace was rushed, and the mutineers were hunted from room to room. In the central court alone 800 were slain. It was here that the renowned Hodson, of Hodson's Horse, was mortally wounded. The fame of this incomparable leader of irregular cavalry and Chief Intelligence Officer has been assailed by attacks on his honour. His reconnaisances scoured the countryside, and he was known as the "eyes of the army." Sir Edward Thackeray always championed his cause, and the fact remains that, from the Commander-in-Chief to the junior officers, men of the most unimpeachable integrity numbered him among their personal friends, and counted his death an irreparable loss to the army and the nation—"equal to the loss of a division of troops," said Sir Colin. The case against him, on several scores, remains "not proven." It were better, in the light of his great services, to let it sink into oblivion.

On the 11th, our ally from Nepal, Jung Bahadur, with his 9,000 Gurkhas, joined the army. Sir Colin even somewhat delayed the operations to allow him a ceremonious entry, and give his army a fuller share in the coming victory. To have done otherwise might have offended the potentate—as though one were to sit down to dinner before the arrival of the principal guest. Lord Roberts has described the state visit, the General in full dress uniform, but quite eclipsed by his Nepalese *confrère's* gorgeous attire and blaze of jewels. Both were embarrassed, and were hardly seated when, to Sir Colin's obvious relief, news was brought of the storming of the Begum Kothi, which gave him an excuse for hurrying away. The bearer of the

news was a young sapper officer, Lieut. (now Sir Richard) Harrison.

On the 12th, 13th and 14th further advance was made by breaching the walls from house to house. The Engineers, 10th Foot, 90th Highlanders and Brasyer's Sikhs were foremost in these hand-to-hand conflicts. The third line had now been turned, and the remaining strong points were stormed and fell. By the morning of the 15th, Lucknow was virtually in our hands.

But the bonds of discipline now broke down, and British soldiers and Sikhs, laughing at the threats and entreaties of their officers, gave themselves up to the sack of the places they had stormed. Huge fires were kindled and plunder that they could not carry away was flung into the flames. They juggled with handfuls of gold mohur pieces, as though they were ha'pence. Thackeray's last letter gives a glimpse of these scenes of pillage. This insensate carnival of victory was in those days the soldier's hereditary reward, claimed by him for the hazards of hardships, wounds and death. It may, however, be said for them that women and children were invariably well treated.

NINTH AND LAST LETTER.
(Extract.)

To his brother (?)

CAMP LUCKNOW.
March 24th, 1858.

****

I have, thank God, again passed through a siege (though nothing like Delhi in danger or duration) without a scratch and am in very good health.

Harris Dick* came to our camp one day and dined with me and slept in my tent ; he was looking as well and jolly as possible.

There are such thousands of troops here and scattered over the City and miles of ground that the chances are against seeing anyone. On the 11th February I joined the Engineer Brigade at Jellalabad, about three miles from here, we remained there until the 2nd March, preparing siege material. The C.-in-C. collected his force at a place called Bumteerah, about nine miles from this.

On the 23rd February, the enemy attacked our position at Alumbagh in great force and were driven back, losing four guns and many men killed. On the 28th (I am not certain about dates) the Chief, without any previous warning, moved his force right up to Bumteerah, passing our (the Engineer) Camp at Jellalabad, and right on to Dilkoosha, which is a large house which was held by the enemy. It was a fine sight to see regiment after regiment of Highlanders

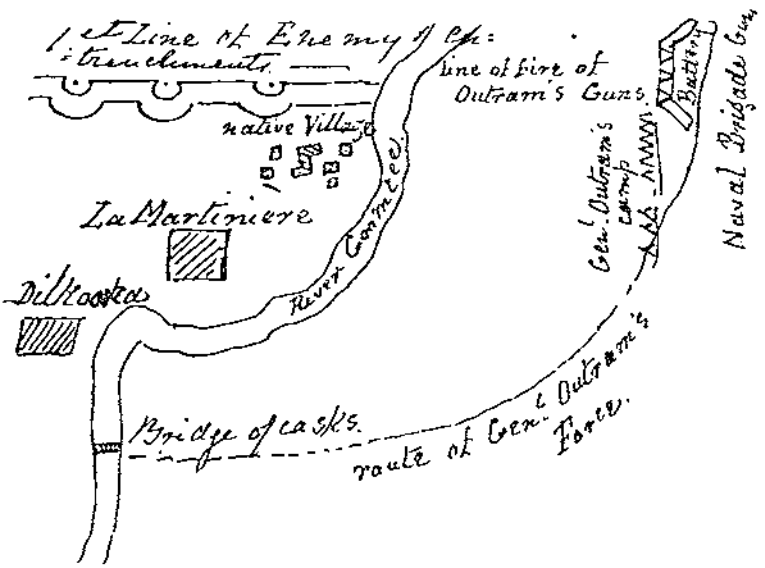
* Harris Dick, of the Queen's Bays, was the writer's cousin. James Tennant, R.E., mentioned later, married Dick's sister.

and Infantry march past and two regiments of European Cavalry. The enemy were completely taken by surprise and abandoned the Dilkoosha, leaving one gun. This was without any loss on our side. On the 2nd March the Engineer Brigade moved down to Bibiapore, a large house about 500 yards from the Dilkoosha and close to the River Goomtee. Our Brigade is very large. Brigadier Napier of our Corps commands us. . . . From the top of the house at Bibiapore, we got our first view of Lucknow. You could see the Martinière, an enormous building which has been used as a college, about a quarter of a mile from the Dilkoosha. We could see the enemy's first line of entrenchments looking very formidable and were told as a consolation that they had two more with ramparts twice as thick, and ditches twice as deep, one behind the other. We were told that every house and street was loopholed and we found it true. The quantity of labour they had expended was enormous. Streets a mile long had every house loopholed and guns pointing up many of them.

The bridges were all mined. Poor Capt. Clerke and Lieut. Brownlow of our Corps, with 17 men and a number of Sikhs, were blown up by the explosion of 10 carts of powder that the rebels had drawn across the road. Fifteen, with poor Clerke and E. P. Brownlow, died that night. Major (Alex) Taylor severely wounded, but doing well. On the 6th March we finished two bridges of casks across the Goomtee. General Outram with his Division, consisting of the Bays (Harris's Regt.), Lancers, Highlanders, etc., crossed the river. They met with very little opposition. Brigadier Franks came in about this time with troops, Jung Bahadoor and 4,000 Goorkhas. This move of crossing the river was a splendid one and baffled the rebels completely, as their works are on this side the river. So when Outram got across he took their works in enfilade and rear with his heavy guns, as you will see by the plan. Several of our men went, Tennant (Augusta Dick's husband), etc. I remained on this side with the main body. On the 9th we assaulted and took the Martinière with very little loss. Lang, Forbes and myself were told off for the assault and two or three of the Royal Engineer officers. We each had a party of Sappers. Forbes slightly wounded. We drew up in rear of the Dilkoosha, my party went with the 42nd Highlanders. At the word, off we set at double quick time across the space between the Dilkoosha and the Martinière. The Highlanders presented such a solid appearance and made such a row, that I believe that alone frightened away the brutes. Anyhow, we took it without losing a man. We then pushed on into a village on the right close to their first line of works. To our astonishment we saw a man of the 1st Bengal Fusiliers* standing all alone on the bastion

* Lieut. (afterwards Lieut.-Colonel) T. A. Butler, who was awarded the V.C., had to swim the crocodile-infested river in order to reach the bastion, and signal that it was abandoned.

and waving his hand to us. What with being taken in flank by Outram's guns as you see in this sketch, and with our advance, they



had not only left the Martinière, but their first line of works, too, and we clambered up as well as we could by digging a few holes in the ramparts and getting up with our hands and feet like a ladder, and the first line up to Bank's house was taken with little loss. Running from the Martinière to the village was rather nasty work, as the bullets came rather thickly from the left of their works. We could see them running along the ramparts on the left in hundreds as we got in on the right. On the 11th we had battered and breached the Begum's house, with 68-pdrs. It was assaulted and carried, and about 500 of the enemy were killed inside.

It was in this assault that Capt. Hodson, the finest Irregular Cavalry officer in India, lost his life. He should not have been there, and was volunteering. The Chief was very angry, and has issued stringent orders that nobody is to go towards the city but on business.

I was not on duty in that assault, but had to go down in the evening and build a battery in the road, at the side of the Begum's house. Such a sight as it was. Imagine a splendid house and gardens with lamps all over it, with enormous rooms and mirrors and chandeliers and Highlanders lying about in all directions, and dead Sepoys everywhere. I never saw such a sight either as the engine house, bodies lying in and out the machinery. Half the room had caught fire. At night a great part of Lucknow seemed in a blaze, fires and mines exploding in all directions, while our shells continued

to pour into the city. I have seen three or four shells in the air at the same time. They had no shells (*i.e.*, shrapnel), at least only brass ones.

That was the last regular day of fighting. They hung about the native city for a few days. Our total loss has been about 25 officers killed and 50 wounded, 800 men killed and wounded. The duty was nothing like as arduous or dangerous as Delhi, and I would rather go through *four or five Lucknows* than another Delhi. We have the whole city now. The Kaiser Bagh is a most splendid place, an enormous garden surrounded by buildings with gilt domes, and full of tanks and statues. The plunder got by some of the regiments is enormous. Privates have got diamond bracelets and jewels worth hundreds of pounds, and which they have been selling sometimes for a few rupees. Shawls and swords of enormous value. The inhabitants had all left the city. The Kaiser Bagh lighted up at night must have been like Vauxhall.

Several mines exploded and we were occupied two or three days destroying powder and putting out fires. They say 9,000 troops are to stay here. We are knocking down houses and making large roads through the city. Numbers of the enemy are at Bareilly. The wretched brutes think that if they kill one Sahib they go to Paradise. It is a dreadful sight, I think, to see a dead Highlander, they are such fine-looking men, and their uniform so striking. The Sepoys meet death in the most sullen, indifferent manner. I never knew one ask for quarter, yet there is nothing fine about it.

We took several large houses and made batteries for the 68-pdrs. to reach the next large house, the "Eman Bagh." Fancy getting into a house in Park Lane, only twice the size, with gardens and courtyards, and knocking a hole in the next with 68-pdrs., then bringing up the guns and knocking a hole in the next, and rushing in, and so on. The rebels did not understand it, they had prepared the streets with batteries, loopholes, etc., while we went into the houses themselves and broke through from house to house.

(*Remainder missing.*)

The later stages of the capture of Lucknow were marked by no less than three lost opportunities, for which Sir Colin must share the responsibility. It is thought that he relied too much on the judgment of his Chief of the Staff, Sir William Mansfield. On the 14th, Outram, seeing thousands of the enemy in flight north of the river, asked the C.-in-C. for permission to attack them and cut off their retreat. Sir Colin's inexplicable reply was that he might do so if he would guarantee not to lose a single man. Three months before, during his relief of Lucknow, he had given identically the same answer to an eager

subordinate (Colonel Ewart). Sir Redvers Buller is reported to have said the same thing more tersely and forcibly as the Boers streamed away from Ladysmith—"Damn pursuit." Whatever their motives, pursuit in either case might have had an incalculable effect on the duration of the war. On the 16th, Sir Colin sent his cavalry in the wrong direction, and 20,000 fugitives slipped past under the noses of our piquets. Again, on the 18th, a large rebel force was allowed to escape for the third time, with the result that the seizure of Lucknow was robbed of its most decisive advantage. A hundred thousand escaped to swell the rebel armies elsewhere. This failure, together with Lord Canning's refusal to accept the advice of Outram and other Anglo-Indian statesmen, civil and military, and grant a general amnesty except to murderers and mutineers, allowed a desultory guerrilla warfare to drag on till near the close of 1859.

Sir Colin's next task was the conquest of Rohilkhand. Three columns, under Generals Walpole, Penny and Jones, were to invade the province from different directions, and supported by a fourth, under Seaton, who had been left in the Doab, to converge upon Bareilly, where the decisive battle was expected.

The Engineer Brigade was broken up, and Thackeray found himself with the Bengal Sappers and Miners, attached to Walpole's column. His concluding part in the Mutiny campaigns can be described in his own words, from his *Two Indian Campaigns*.

"The force under the command of Brigadier-General Walpole,* consisted of Her Majesty's 9th Lancers, 42nd, 79th and 93rd Highlanders, 4th Punjabees, 34th Company of Royal Engineers, Artillery and Sappers, the latter under the command of Major Maunsell, R.E. . . .

"The force arrived at the small fort of Rohiya on the morning of the 15th April. The dispositions for the attack of the fort were very indifferent, the skirmishers being ordered to advance without supports, no previous reconnaissance having been made. The fort was concealed in thick jungle, but one side was open. The enemy, who were commanded by a noted rebel named Nurput Singh, could not have numbered more than one-eighth of the British force, and among them were many excellent marksmen. Brigadier the Honourable Adrian Hope, who was in command of the Highland Brigade, one of the most gifted officers in the British army, after the check of the skirmishers in the ditch of the fort, went forward to endeavour to keep the men together, but he was immediately shot. Captain Cafe (afterwards Lieutenant-General, V.C.), 56th N.I., greatly distinguished himself by bearing away, under a heavy fire,

* Afterwards Lieut.-General Sir R. Walpole, K.C.B. Sir Colin's choice of this column commander was criticized at the time and proved to be unfortunate.

the body of Lieutenant Willoughby. Our guns then opened fire on the fort, but caused little, if any, loss to the enemy, and the troops were ordered to lie down under cover during the greater part of the day.

"About mid-day, while carrying out an order to report if there was any opening in the jungle on the west side of the fort, a bullet passed through my pony's neck, killing him on the spot. I at first thought that he had only stumbled, but on disengaging myself from the stirrups found that he was dead. After reporting on the condition of the jungle on the west side, I rejoined the Sappers. It was generally believed in the British force that Colonel Hagart, commanding the cavalry, sent a message to General Walpole to say that he could ride into the fort on one side, and I have never heard any contradiction to this statement. Our losses were 2 officers and 16 men killed, and 5 officers and 88 men wounded. The enemy evacuated the fort during the night. The Engineers under Major Lennox, R.E., were employed on the following day in blowing up the fort." [E.T.T.]

The unfortunate incident of Fort Rohiya is thus temperately dealt with by Colonel Thackeray. It was in fact a shocking blunder. The Taluqdar (chief) who defended it had made it clear that he was not anxious to fight, and would have contented himself with a mere show of resistance to save his honour. The fort was open on one side, as Colonel Hagart reported. But General Walpole neither reconnoitred himself nor trusted his cavalry, and ordered an infantry assault on the strongly defended front, a mistake of which the rebel chief naturally took advantage. The infantry, unprovided with ladders, attacked with the greatest valour across the open under a hail of bullets, but were repulsed. Over a hundred were killed —almost as many as in the whole siege of Lucknow. At last Walpole ordered a retreat. Every history of the Mutiny speaks of the angry resentment of the Highlanders against the General who had caused this unnecessary butchery, with the death of "the gallant and gentle Adrian Hope, their beloved leader; and when his burial took place, their emotions were so violently displayed that their officers, who in their hearts sympathized with them, feared that they would mutiny." [Rice Holmes.]

Thackeray passes lightly over the matter of his pony. An officer who was present gives a different version. He was under cover in a ditch with his infantry when he saw a man calmly approaching across the open with a bundle on his head. It turned out to be Lieut. Thackeray, carrying his saddle, who, in reply to astonished questions, said that he did not see why he should lose his saddle as well as his pony, so, having completed his reconnaissance, he had undone the girths and brought it back with him.

"On the 18th the force continued its march.

"The march of the Highland Brigade through Oude and Rohilcund was a grand and imposing sight. The regiments marched in line of battalions, wearing their bonnets and kilts, and with their bagpipes playing. Hares, pea fowls and antelope started from the grass, and ran the gauntlet of the line, occasionally being knocked over by the men. The large *topes* of mango trees, which are so scattered over this district, formed most excellent camping grounds at the end of the march.

"On the 23rd we found the enemy in position on the opposite side of the Senda Nuddee, where they were attacked and routed, with the loss of 4 guns, the cavalry and horse artillery pursuing for five miles to Aligunge. [*Lieut. Thackeray obtained leave to take part in this pursuit.*] Sir Colin Campbell overtook General Walpole on the 27th. On the 30th he learnt that General Penny* had been killed in a night skirmish. Shahjehanpore was found evacuated, and Sir Colin left a small force under Colonel Hales to hold it. On the 3rd May, he was joined by Penny's column, and next day he was within a single march of Bareilly.

"Khan Bahadoor Khan, reinforced by hosts of rebels flying before Brigadier-General Jones,† who had gained two brilliant victories on his march from Roorkee, was determined, though menaced in front and in rear by two powerful armies, to strike a blow for his cause. Between his capital and the position occupied by Sir Colin's army was a deep stream called the Nuttia Nuddee, spanned by a bridge. He crossed the bridge in the evening and planted his guns on some sandhills situated on either side of the road by which Sir Colin would have to advance. His first line of infantry, with cavalry on its flanks, was drawn up so as to cover the guns. The second line remained in the cantonment near the town.

"Early in the morning of May 5th Sir Colin put his troops in motion. At the sixth milestone he halted, and formed them up in two lines. The second line was to defend the baggage and the siege train. The whole force amounted to 7,637 men, with 19 field guns. About seven o'clock, as the first line was approaching the bridge, the enemy's guns opened fire. The British cavalry and horse artillery, unlimbering, replied to the challenge. The enemy's first line broke, and leaving several guns behind them, fled across the bridge into the cantonments. The British pressed on in pursuit. The left halted on the bank of the stream. The right crossed the bridge, and moved forward about three-quarters of a mile in the direction of the town. A regiment of Sikhs took possession of the irregular cavalry lines on the left of the road.

* A veteran of Bhurtpore and the Sikh Wars, aged sixty-eight years.

† Afterwards Lieut.-General Sir J. Jones. His successes as a column commander earned him the name of "Avenger Jones."

"The Sappers were with the left column, and a curious thing happened, which was witnessed by nearly the whole of the force. There was a large number of Ghazis (fanatics) among the rebels. One of these, wearing a green turban, walked alone out of a *tope* or grove of mango trees. When he came close to our troops he fired his matchlock, and then, choosing his tulwar, he rushed on the cavalry. He was, of course, cut down. During the battle a number of Ghazis with their green turbans, heads bent low under their shields, and flourishing their tulwars in the air, rushed down, shouting 'Deen, Deen,'* upon the astonished Sikhs in the irregular cavalry lines, driving them back upon the 42nd Highlanders, who had lined up to support them. Sir Colin was sitting on his horse close by, and had a narrow escape. As he was riding from one company to another, he saw a Ghazi, apparently dead, lying before his horse's legs. In a moment the man sprang to his feet, and was about to strike when a Sikh rushed up, and with one blow of his tulwar slashed off his head. The 42nd Highlanders repelled the charge of the Ghazis, killing a large number.†

"Meanwhile an exciting scene had been enacted in another part of the field. The baggage train had halted in the rear. Suddenly a vast wave of white-clad sowars was seen pouring down. Their tulwars flashed in the sun; their horses' hoofs thundered over the plain. Camp followers, with cloven skulls and bleeding wounds, rolled over on the ground. Men, women, children, horses, camels and elephants shrilly trumpeting, fled in one confused mass. But our cavalry now charged. Tombs' troop coming up at a gallop, fired round after round into the rebel cavalry, and the sowars were scattered in every direction. The battle lasted for six hours; a scorching wind was blowing, and several men died from sunstroke. Sir Colin, therefore, in mercy to his troops, who were faint and parched with thirst, allowed them to rest.

"We advanced next morning into the cantonments, and found that Khan Bahadoor Khan, with the greater part of his army, had fled. The sound of distant firing was heard. It proceeded from the guns of Jones' column, which was forcing its way into the city from the north.

"Next day the city of Bareilly was occupied after much fighting among the houses, and the two columns united. During the fighting in the town, Lieutenant Hovenden, of the Bengal Engineers, and myself, with some sappers, went into a house where there was a party of nine Ghazis. Hovenden put his hand upon the door, and had his fingers nearly slashed off by one of the Ghazis inside. We

* The Faith.

† Sir Richard Harrison describes the imperturbable steadiness of the 42nd under this onslaught. The line remained almost as unbroken as on parade, except where here and there a man fell, or a *ghazi* broke through, to be bayoneted by the rear rank.

had to bring up a gun and knock the place about, when the Ghazis jumped from the roof of the house, and rushed out with their flashing tulwars. An officer of the Highlanders was also there with some men. Two of the Highlanders were wounded, and the officer and myself had just time to step behind a small bank of earth when the Ghazis came at us like tigers. The bank of earth saved us, as 16 Ghazis were shot down by the Highlanders before they could reach us. I secured the tulwar of one of the Ghazis who had wounded one of the Highlanders.

"While we were in camp a few days after the capture of the city a tremendous storm of rain, accompanied by thunder and lightning, passed over the town. Many of the tents were blown down. Lieutenant Forbes, R.E., and myself shared a single-pole tent between us. The storm came on suddenly when we were both asleep. The pole of the tent came down or snapped, and we were left struggling under the canvas like rats in a trap. The rain fell in torrents, and when we succeeded in releasing ourselves, we were as wet as if we had just stepped out of the river. We obtained shelter in the tent of a friend, who had been more fortunate than ourselves, and who gave us some rum. . . .

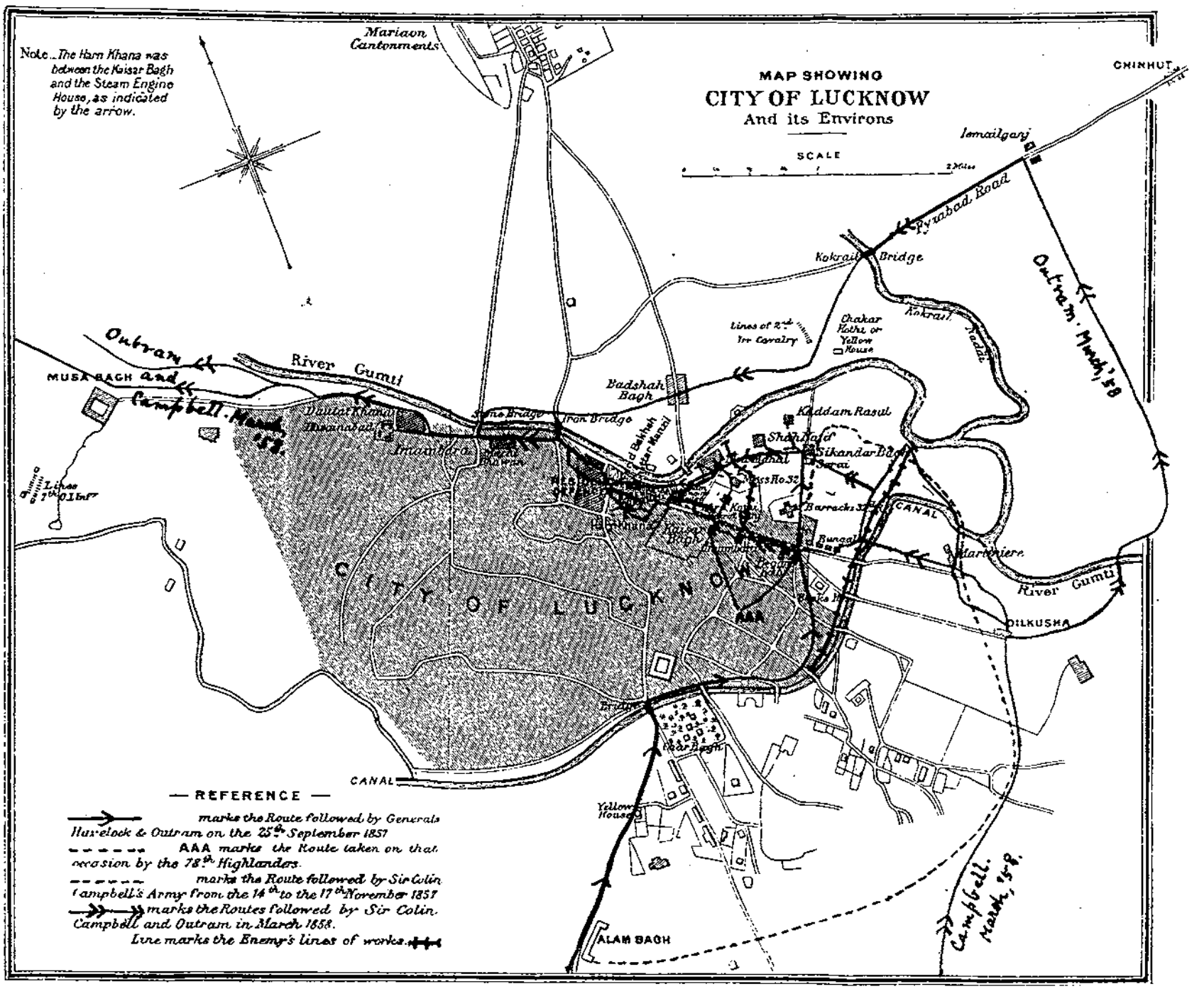
"We remained in camp at Bareilly until the 8th June, when the 23rd Company, R.E., and the Bengal Sappers and Miners were ordered to march to Roorkee, and arrived there on the 18th June, 1858, thirteen months from the time of starting in the boats on the canal." [E.T.T.]

This was the last of Edward Thackeray's experiences in the Indian Mutiny. His health had suffered greatly, and he was given sick leave, which he spent in the hills and with his cousins, the Ritchies in Calcutta, where Mr. William Ritchie was Legal Member of the Supreme Council. They said that he was much changed since he had stopped with them on his arrival in India eighteen months before, an eager, light-hearted boy. The stern lessons of war, the grim horrors of the Mutiny, left their mark upon him—as perhaps the Great War has done on many an impressionable youth in our own time.

The exploit for which he won the V.C. at Delhi had not yet been officially reported. It was four more years before he was again in England, to receive the decoration so long delayed, under circumstances which will be detailed in the next and concluding number of this series.

After June, 1858, desultory fighting went on here and there, and Tantia Topi carried on a guerrilla warfare in Central India until he was captured, tried and hanged in April, 1859. By the end of 1859 the last flickering embers of rebellion had died out, and India was restored to the normal tranquillity of the *Pax Britannica*.

(To be continued.)


MAP SHOWING
CITY OF LUCKNOW
And its Environs
SCALE
Note.—The Ham Khana was between the Kaisar Bagh and the Steam Engine House, as indicated by the arrow.
Mariaon Cantonments
CHINHUT
Ismailganj
Pyrabad Road
Kokrail Bridge
Outram's March, '58
Lines of 2nd Irr Cavalry
Chakar Kothi or Yellow House
Kokrail Nadi
Outram and Campbell's March '57
MUSA BAGH
River Gumti
Badshah Bagh
Stone Bridge
Iron Bridge
Kaddam Rasul
Shah Najaf
Sikandar Bagh
Imambara
Lines of 1st Div 1857
Barracks 32nd
CANAL
Martiniere
River Gumti
CITY OF LUCKNOW
AAA
DILKUSHA
Char Bagh
CANAL
Yellow House
ALAM BAGH
Campbell's March, '58.
— REFERENCE —
marks the Route followed by Generals Havelock & Outram on the 25th September 1857
AAA marks the Route taken on that occasion by the 78th Highlanders.
marks the Route followed by Sir Colin Campbell's Army from the 14th to the 17th November 1857
marks the Routes followed by Sir Colin Campbell and Outram in March 1858.
Line marks the Enemy's lines of works.

ENGINEERS OR PIONEERS?

By MAJOR A. W. HOLBROOK, M.C., *p.s.c.*, R.E.

1. The following article has been provoked by the article entitled "Sapper Officers in War," which appeared in the March number of *The R.E. Journal*. In his article Lieut.-Col. Everett enumerated the many activities undertaken in war by the R.E. and deduced from this varied list that an officer of the R.E. must be a competent all-round engineer as well as a good soldier.

He dismissed the suggestion that the Corps should be divided into two branches, one to specialize in field works and the other to specialize in technical engineering, on the grounds that there are many insuperable obstacles in the way of such a split.

He mentioned two of these obstacles. The first is that sooner or later the two branches must come together under one head, who would either be a skilled technical engineer, or else a typical field engineer, either of whom would be incapable of dealing efficiently with half of the duties he was called upon to perform.

This difficulty would undoubtedly occur if the split were made only in the lower ranks of the Corps, but, if the cleavage were complete, the two branches would never meet and the difficulty would not arise. It is proposed to examine later the advisability of such a complete split.

The second obstacle adduced is that a Field Company may occasionally be called upon to perform highly technical engineering work at the Base or on the L. of C. The case of the Field Companies in Mesopotamia in 1915 was quoted as an example.

The answer to this is that Field Companies are now expected to be able to tackle any engineering job because of the existing theory that all R.E. officers are good all-round engineers, capable of dealing with any problem in any branch of engineering. Were this erroneous theory to be abandoned, and were Field Companies not supposed to be able to tackle any engineering job, however technical, then they would not be asked to do so. If it were an accepted fact that Field Companies could not take on highly technical work, they would not be the only engineer units sent to a theatre of war, as were the Field Companies in the early days in Mesopotamia. An expeditionary force would be accompanied by other engineer units capable of all the technical work required at the Base and on the L. of C.,

and Field Companies would only be employed on their normal tasks, *i.e.*, field engineering.

2. The whole question of the functions of our Corps and the organization best suited to enable these functions to be carried out, became the subject of much lively discussion after the Great War. It was realized that our task had been made more difficult by the great complexity of modern warfare, and the enormous amount of engineer work and organization required behind the front to maintain the fighting troops.

Some people maintained that specialization among R.E. officers had become essential, and pointed to the high degree of specialization among civilian engineers. Others declared that there was no parallel between civilian engineers and the R.E., and that R.E. organization must be flexible, and all officers interchangeable.

Committees were convened by the War Office to consider the question, but whatever the result of their deliberations, little change has been effected in our organization or methods of training, which remain much the same as they were 30 years ago. Thirty years ago, the army in the field did not require any very technical engineer work, and R.E. officers were quite capable, with the training they had received, of dealing with the tasks with which they were confronted. However, in the last few decades, engineering science has made enormous strides, and at the same time the Army has increased its demands for engineer assistance to a corresponding extent.

The duties of the R.E. in war have been stated in some detail by Lieut.-Col. Everett in his article, so there is no need to repeat them here. It is clear that if an officer of the Corps has to be able to cope with any or all of these duties, he must not only be a soldier, with a knowledge of the ways of working and requirements of the other arms, but must also be a civil engineer, a mechanical engineer, an electrical engineer, a surveyor, and what one might term a transportation engineer. Now this is not merely a formidable task, it is an impossible task. The science of engineering is now so vast and complex that no man can be efficient in all branches of it. This is universally admitted, but it is apparently thought that a R.E. officer can obtain a sufficient general knowledge of all branches to enable him to deal with all engineering problems on sound lines. It is apparently assumed that the civilian expert will always be available in war for the more technical work, and that it is sufficient if the R.E. officer has enough knowledge of engineering to interpret, in more or less technical language, the military requirements, so that the civilian engineer expert can advise as to the best way of meeting them. R.E. officers, in other words, are to be in administrative charge of all technical engineering work while the work is actually carried out by civilian experts. This system has many disadvantages. In the first place there may not always be civilian experts immediately available.

In the Great War when the whole of the nation was conscripted, there was no lack of skilled engineers with the army. It was apparent from the very beginning of the Great War that its magnitude would be far beyond the power of the regular army to cope with alone, and an enormous expansion was immediately started. In a very short time there was a large number of temporary R.E. officers at the front, and any lack of technically skilled regular R.E. officers was not noticed. However, in a small campaign, where the regular army may have to carry on the war without much expansion, it is not to be expected that a host of civilian engineers will immediately be on the spot to help with all technical problems that arise in the theatre of war. A certain number may eventually be made available, but it is most likely that, in the opening stages of a war at any rate, the regular R.E. officers will have to carry on without expert assistance.

There is another point, even supposing that civilian engineers are available from the outbreak of war. With the wide range of subjects they are supposed to cover, and with the amount of technical experience at present received in peace-time, it is doubtful if the majority of R.E. officers have enough engineering knowledge even to control the expert and to understand his views on many highly technical subjects. Some specialists are so specialist as to be narrow-minded, and the "administrative" R.E. officer needs to be a really knowledgeable engineer, in order to know when the specialist is talking sense, and when he is losing sight of the essentials of a problem in the pursuit of some pet idea.

An amateur engineer is at a great disadvantage when dealing with a specialist, and it will probably not be denied that, during the war, the regular R.E. officers who were in charge of technical work at the Base and on the L. of C. were, in many cases, in the hands of their skilled subordinates as regards technical matters. The old joke about "Royal Engineers" and "real engineers" was very often heard in the mouths of temporary officers who were engineers in civil life. However damaging to our *amour propre* it must be admitted that the slight was not altogether unjustified. In fact, the reason why the gibe stung so was probably an unacknowledged suspicion of its truth.

3. There is no doubt that under the present system R.E. officers need to be highly trained supermen if they are to be able to cope with all that is expected of them in war, even if civilian assistance is available.

Let us now consider what training the R.E. officer obtains in peace to prepare him for his difficult task in war.

He starts as a cadet at Woolwich, where for 18 months he receives general education, combined with elementary military training and field works. Then, as a Y.O., he receives about three years' instruction at the S.M.E. and at Cambridge. During this time, he obtains

an excellent grounding in all branches of engineering (including field engineering), and in Survey, together with a certain amount of purely military training. At the end of the three years, full of hope and knowledge, he emerges from the chrysalis, a full-blown Sapper officer, feeling fully confident of his ability to embark on his engineering career. He is at this stage trained as well as, if not better than, the young civilian engineer of his own age, but from this time onward a difference begins.

The young civilian engineer finds himself in a field of ever-widening practical experience, and, if he is keen, he keeps himself abreast of modern developments, and, most probably, eventually specializes in some particular subject.

What, on the other hand, happens to the young officer, who, as we have seen, has need of a very comprehensive practical experience if he is to be fitted to fulfil his role in war?

He is posted to a unit for a year or two, a Field Company or a Fortress Company, either on the British establishment, or with the Sappers and Miners. Here he finds himself employed on regimental duties for a large part of the year, with a certain amount of field engineering during the collective training season. He learns something about the rest of the Army during his time with a unit, and, if with a Field Company, he joins in short periods of collective training with the other arms. If he is still keen on engineering, he may study its theory in his spare time. Later on, he is appointed Garrison Engineer on Works Services. Here, a very large part of his time is occupied with making himself familiar with regulations, in carrying out routine work, and in supervising the minor maintenance and repair of barracks. He is very lucky if he gets any large new construction work to supervise, and he will never have to design anything larger than a bath house. The design of new work of any importance is produced for him ready made. The actual organization for the execution of the work is done by the contractor, as very little W.D. building work is done by direct labour.

The young officer, therefore, receives but little real engineering experience out of Works, which will train him for technical engineer work in war. However, he obtains a certain amount of experience in elementary constructional engineering, and, in this way, the Works service does give him more technical experience than he will get in any unit in the Corps.

Now, although the Works service gives practically the only chance a R.E. officer has of getting any sort of engineering experience, most officers strive their utmost to avoid being posted to a Works job. In fact, there is quite a large number of officers who unashamedly affect to despise anything in the form of interest in technical work, as if it were something rather degrading, and not at all "good form." This

attitude in officers of one of the " scientific " arms is hard to understand, but it is not uncommon.

After some years as a G.E., the young officer is again posted to a unit, and resumes the routine of regimental duties described above. Possibly a promotion examination now looms ahead, and he is reminded that he has got to be as good a soldier as the infantry officer, and pass an identical test in infantry tactics in order to qualify for promotion. He has, therefore, to apply himself to the study of tactics, military history, and the rest of the promotion exam. syllabus, with the result that the study of engineering principles and practice has still less chance of being done than before. So, with similar variations, his service goes on.

For lack of opportunity to apply the engineering knowledge he learnt as a Y.O., it will be surprising if his keenness in technical work does not evaporate.

He probably devotes himself wholeheartedly to the games for which so much opportunity is given in the Army. If he is in a " horsey " place, he probably becomes a keen horseman, and equitation becomes his chief interest in life.

Now games and riding are both delightful forms of recreation, and, if indulged in with moderation, with a view to keeping fit, may be considered a necessary part of an officer's life. They are, however, hardly adequate preparation for the duties of a R.E. officer in war, and when they occupy too much of an officer's time and thought, that officer is not doing his job. If interest in horses supplants interest in engineering in a R.E. officer's mind, his place appears to be in the Cavalry.

The foregoing outline sketches the service of the large majority of young R.E. officers. There are, of course, a few officers who specialize in E. and M. or Survey, and a few others manage to obtain practical experience with the P.W.D. in India and elsewhere. However, on the whole the outline is typical, and it shows that for the greater part of his time, the R.E. officer is not receiving adequate training for war.

It is surely a waste of time and money to give officers an expensive technical training which is subsequently allowed to be forgotten for lack of opportunity to employ it. The average R.E. officer may pass the whole of his peace service without ever being called upon to solve an engineering problem of any sort, if we except the simple " f " project in field engineering, which he has to carry out before promotion to Captain. The high percentage of failures in this test is a sure indication that, on leaving the S.M.E., most officers soon lose all interest even in "field engineering," which really cannot be classified as engineering at all nowadays.

4. It seems clear that the present system of training R.E. officers after they leave the S.M.E. does not adequately prepare them for

war, and, with the present organization of the Corps, it is difficult to find a remedy.

The writer has a suggested solution to offer, which will, no doubt, call down upon his head contumely, abuse and possibly even personal assault from a lot of officers of the Corps. The suggestion is put forward with due humility, and is prompted only by a genuine feeling that the Corps is getting behind the times, and that something ought to be done. The solution appears to follow logically from an examination of the problem, but it involves a revolutionary change in organization, including a complete split in the Corps. The suggestion may be unnecessarily drastic, and if there is any way of coping with the situation without a break in the Corps, the writer will be glad to have his arguments demolished, as he has as much pride in our traditions as anyone.

There is an inherent conservatism in mankind that has always displayed itself throughout history. This conservatism is very often a serious bar to progress, although it has its value in preventing the rash jettisoning of a workable established order for visionary schemes of progress. As long as the established order of things works well, conservatism has a useful steadying influence, but, if the present order is obviously most unsatisfactory, conservatism should not be allowed to stand in the way of a change. The Army is specially conservative, and all proposals for radical change are always viewed with the gravest suspicion and generally met with hostility and great opposition. It is only necessary to quote the opposition to the Cardwell reforms. It was only in the teeth of great agitation and resistance that these reforms were pushed through, and yet there cannot be many to-day, who could contemplate with equanimity a return to the conditions obtaining before these reforms.

We live in rapidly changing times, and must keep abreast of the times. An organization that met the needs of the Army 30 years ago, will not necessarily do so to-day.

The secession of the Signals from the Corps was inevitable, when the system of intercommunication with the Army became so large and complex that it required specialization. So to-day, when the Army's requirements in engineering work have become so vast and varied as to demand specialization, another split in the Corps appears inevitable sooner or later. However repugnant these changes may be to our *esprit de corps*, and they undoubtedly are repugnant, personal feelings should not be allowed to overrule convictions that a change would be to the advantage of the Service. One cannot suppose that the substitution of armoured cars for their horses was a very welcome innovation for the Cavalry regiments thus affected, but it was necessitated by the relentless march of events, and this revolutionary change has been calmly accepted.

The Corps exists for the benefit of the Army, and not for the benefit of ourselves, and this fact should form the basis of all schemes of reorganization and progress.

5. In what way could our organization be altered, better to serve the Army's needs?

An examination of the list of functions of the Corps in war, summarized by Lieut.-Col. Everett, shows that they fall naturally into two main classes.

(1) Field engineering work, such as: Defences, demolitions, mining, hutting, repair of roads in forward areas, light railways, temporary bridging, etc.

(2) Engineer work in rear of the Army, *e.g.*: Dock construction and working, railway construction and operating, I.W.T., water supply, provision of electric light and power, repair and operation of machinery, permanent bridges, road construction, building construction in connection with installations, etc.

In addition, there are miscellaneous duties such as Survey, A.A. searchlights, fortress searchlights, provision of engineer stores, postal service and gas units.

Those duties in the first class are not really engineering at all in the modern sense of the term. Officers of units carrying out work of this nature do not need to be engineers, and the work is what is usually known as pioneering. These officers, however, need to be good soldiers, with an intimate knowledge of the way in which the other arms function. They will have to co-operate closely with the fighting troops, and, in fact, field engineer units are classed as fighting troops themselves.

The second main class of duties comprises engineering work, a lot of which is of a very technical nature, and units carrying out such work require to be officered by skilled engineers. These officers do not need to know anything about the tactical side of soldiering, as their work is purely non-combatant. They do need, however, to be quite familiar with the system of administration of an army in the field, and understand the special needs of the system as regards engineering work.

What is required, then, to carry out the duties of the Corps in war is two entirely different types of officer:

(1) The good soldier with a knowledge of the principles of constructional engineering, and a thorough training in all branches of field works.

(2) The skilled engineer with a good knowledge of Army administrative methods.

Can two such distinct types be produced within the same Corps? Obviously only if officers specialize in one branch or the other, and are given entirely different sorts of training. Then, if senior appointments in the Corps in war are going to be open to officers of both branches, one is up against the first obstacle pointed out by Lieut.-Col. Everett.

It might be laid down that only officers of the field engineering side should be eligible for the appointments of C.E.s and C.R.E.s of formations, and that these latter officers should only deal with field engineering work.(At present they may be made responsible for Works services in the forward areas.)

The technical work under the Director of Works and the Director-General of Transportation would then only be done by officers who had specialized in technical engineering.

This arrangement might work, but is there any object in combining pioneers and engineers in one Corps? A better solution appears to be to have two separate organizations to carry out two such very different classes of duties. It would then be logical to call the Corps which carried out the work in the field, a Corps of Pioneers, and the Corps which did the technical work behind the army, a Corps of Engineers. If this were done, however, it would mean that the Royal Engineers would be an entirely non-combatant arm, and would entail the break up of all the fine fighting traditions of our Corps. These traditions have been established by the field units of the Corps, while the more technical units have been non-combatant. Also a large number of the technical units now on the war establishment are comparatively new, some of them only having been formed during the Great War.

It appears necessary, therefore, in this case, not to be too logical, but to retain the name Royal Engineers for the field units for sentimental reasons.

It is suggested, then, that all the field engineering work should continue to be done by the Royal Engineers, and that the technical engineering work behind the army should be carried out by a separate body called the Army Engineering Service.

Under the proposed scheme the duties of the R.E. in war would be all those in the first main class mentioned above, and in addition they would take on A.A. and fortress searchlights. If gas units were formed, the specially trained personnel would belong to the R.E. The duties of the A.E.S. would be all those enumerated in the second main class. The A.E.S. would also be responsible for Survey, and for the holding and distribution of all engineer stores.

The postal service is not properly the work of the R.E., and is only tacked on to the Corps because no one knew quite where else to tack it. It is suggested that the R.A.S.C. might take over the postal service, and deal with the mails as a form of supplies.

Under the proposed new organization the R.E. would consist of Field Companies, Army Troops Companies, Fortress Companies, and A.A. Searchlight units, while all other units now found in the Corps in war would come under the A.E.S. C.E.s of Corps and higher formations would, of course, still be R.E. officers. The Director of Engineer Services and the Director-General of Transportation would be officers of the A.E.S.

6. The training which officers of the R.E. and A.E.S. should receive in peace will now briefly be considered.

Royal Engineers.

When gazetted on leaving Woolwich, officers of the R.E. would go to Chatham, where they would receive, say, a year's training in field engineering. Their course would include instruction in the principles of constructional engineering. They would receive no instruction in Survey (except simple chain surveying), mechanical engineering or electrical engineering (other than instruction in the use of any mechanical field plant with which R.E. units might be supplied, *e.g.*, small pumping plants, power tools, small E.L. plants for Div. H.Q.s, etc.). On completion of their training at the S.M.E. officers would be posted to field or fortress units at home or abroad. After three or four years in one type of unit, officers would be posted to a different unit, so that they would get experience in all branches of the work to be carried out in war by the R.E.

They would be eligible for the Staff College, and would spend their whole service in close contact with the rest of the Army, either as regimental soldiers or on the Staff.

Army Engineering Service.

Officers of the A.E.S. (with the exception of Survey officers), would be given much the same sort of preliminary training as R.E. officers now receive, spending two or three years at the S.M.E. and Cambridge. Their training at the S.M.E. would be quite separate from that of the R.E. officers. It would include no tactics, but would include thorough instruction in the work of the A.E.S. behind the front in war, and how this work fitted into the general system of administration of an army in the field. Rather more time than in the present course would be devoted to electrical and mechanical training, at the expense of the time now spent learning the details of barrack construction and maintenance.

The first half of the time at Cambridge would be given to the study of the groundwork of all branches of engineering, but, for the remainder of their time at the University, officers would be required to specialize, either in civil, mechanical, electrical or transportation engineering. This specialization would not be carried to the extent

of officers' studying one small side of the branch they had taken up, *e.g.*, an officer who specialized in mechanical engineering would not merely become an expert, say, in Diesel engines, but would have to cover the whole field of mechanical engineering.

Standing arrangements would be made by the W.O. with large engineering and contracting firms for A.E.S. officers to be apprenticed to them on completion of their theoretical training. Officers would thus be enabled to get a varied practical experience in the branch of engineering in which they had specialized, and also to keep abreast of modern developments in engineering practice.

This attachment of A.E.S. officers to civilian firms should not prove an expense, as with the good theoretical training they had received, the officers would soon prove valuable to the firms, and the financial arrangement might be that the firms would pay the War Office for officers' services after the first year or so.

It may sound difficult to make arrangements with civilian firms to take on A.E.S. officers, but if the firms were made to realize that they would not be the losers by the scheme, they would soon be willing to co-operate. It is of interest here to note that, in many cases, R.E. officers on E. and M. courses have been offered good jobs by civilian firms to which they have been attached. This shows that these firms are not slow to recognize good material.

For the greater part of their service A.E.S. officers would be keeping their hands in as skilled engineers, and, with their knowledge of Army needs, would be studying all new ideas and inventions, and investigating their potential value to the Army.

This latter point is of great importance, and some A.E.S. organization at the War Office would be established to consider and co-ordinate reports from officers, and also to collate and study information from other sources, on engineering matters that might have a bearing on the work of the A.E.S. in war. A Director of Engineer Services with a small technical and clerical staff is all that would be required.

Survey.

Officers of the A.E.S. who were selected to specialize in Survey would receive a long course in that subject at the S.M.E., together with some military training. They would not receive any instruction in engineering subjects. On leaving the S.M.E. they would be posted to the Ordnance Survey at Southampton, and would receive further practical experience, both in Survey, and in the process of map reproduction, etc. These officers would spend all their service on Survey duties at home and abroad.

All A.E.S. officers would occasionally return to the S.M.E. for refresher courses in the system of administration in war, in order that they might be kept informed of all changes. A.E.S. officers would

also be attached to the Q.M.G.'s staff in Commands and Divisions during manœuvres to keep in touch with Army life, and to remind the Staff of the engineering work that would be required in war to assist in the maintenance of the forces.

There would also be a certain number of technical jobs for A.E.S. officers within the Army in peace-time, *e.g.*, E. and M. officers in Commands, etc.

7. By means of the system of training indicated above, A.E.S. officers would spend their time in peace becoming expert in the work they would have to do in war. They would waste no time in receiving instruction in technical subjects they would never have to apply, *e.g.*, a mechanical engineer would not spend several months in being taught Survey, which he would forget for lack of practice within a few years. Officers would also waste no time in regimental duties, or in the Works service, which does not provide real practice in civil engineering. Similarly R.E. officers, who would not have to be trained engineers, would not receive an expensive technical education which would be wasted, having in view the fact that their work in war would consist of field engineering, or simple constructional work in Corps and Divisional areas.

This system is surely better and more economical than the present one, by which officers who, in war, are to be employed in field units, and officers who are to be employed in technical work, receive the same engineering education, this education then being allowed to become neglected in most cases.

R.E. officers at present are given more theoretical instruction than they need to become good field engineers (*i.e.*, pioneers), and not enough practical experience to become good technical engineers. The question of the actual numbers of officers who would be transferred from the peace establishment of the R.E. to the peace establishment of the A.E.S. cannot be gone into in detail here. It depends upon what policy the present peace establishment of the Corps is based. The existing establishment of officers would be divided between the R.E. and the A.E.S., in proportion to the number of officers required for field engineer units, and technical engineer units, on first mobilization.

It is not proposed that the change should be made with a stroke of the pen. It would have to be brought about gradually, over a period of years, so as not to cause hardship to serving officers.

8. The Works service in peace remains to be considered. Under the proposed scheme "Works" in peace obviously would not come under the R.E., nor, in the writer's opinion, should they come under the A.E.S. Having in view the technical training that A.E.S. officers would receive, and the sort of work they would have to do in

war, their employment on "Works" in peace would be most uneconomical. It would waste their special training, and would fail to prepare them for war.

The Works service requires Surveyors of Works rather than engineers, and it certainly does not need soldiers, as the duties are entirely civil.

It is suggested that "Works" should be run by a civilian staff, as in the R.A.F., where the Works and Buildings Department is purely civilian.

At first sight, it might seem that the replacement of all officers employed on "Works" by civilian personnel, would involve heavy extra expense, and that in these days when economy is the chief cry, it is hopeless to expect any change costing money to be approved. However, as mentioned before, civilian firms might be prepared to pay the War Office for the services of A.E.S. officers, after their apprenticeship period was past, and this would set off the cost of civilian staff for the Works service.

9. The question of "other ranks" will now be touched on very briefly.

No change is involved in the method of enlistment and training of other ranks for the R.E. A somewhat higher proportion of unskilled or semi-skilled men could be enlisted for this Corps, as the work does not require many highly skilled tradesmen.

The other ranks for the A.E.S. all need to be skilled tradesmen, and no man below Class II should be enlisted. As none of the A.E.S. units would exist in peace, and as the work is non-combatant, the other ranks might all be Supplementary Reservists, and given only a small amount of military training. By working at their trades in civil life these men would remain skilled, whereas as regular soldiers they would not get the same opportunity of keeping their hands in at their trades.

10. An argument that may be produced against the suggested reorganization is that the R.E. would become a very small Corps, with poor prospects of promotion and advancement, with the result that it would not attract the right type of officer. However, a small Corps may, of its nature, be a very select one. Also, there is no real reason to suppose that, with the loss of the appointments now available for senior officers in connection with "Works," promotion would become so slow, and prospects of going beyond Lieut.-Colonel so bad, that the Corps would fail to attract a good type. Promotion would still be better than it is in the infantry, where a Lieut.-Colonel's command in peace-time is about 30 officers, and the R.E. would still be free to compete with the rest of the Army for Staff appointments and Commands.

Someone may point out that, if the Works service is taken away

from the R.E., there would be no way of employing the full number of officers that it is necessary to maintain in peace to fill the field engineer units on mobilization, and to provide a reserve.

The answer to this appears to be to enlist a number of Supplementary Reserve R.E. officers as a reserve for war, and to limit the peace establishment of officers to the number that can be employed in field units in peace.

It should not be difficult to give S.R. officers sufficient training in field engineering to fit them to take their place in field units in war. As regards the A.E.S., it may be argued that if A.E.S. officers are going to spend most of their time with civil firms, there would be no difference between them and civilian engineers, and that officers for A.E.S. units in war might just as well be civilian engineers enrolled in the Supplementary Reserve. Actually, however, officers trained for the A.E.S. under an Army organization, would be very different from civilian engineers. They would be looking at engineering from the point of view of its application to military purposes, and not from the more narrow one of making a financial profit. Also, by going to different firms, they would get a wider experience than many civilian engineers, who nowadays specialize within very narrow limits.

11. The economics of the proposed split in the Corps have not been carefully examined, and of course these are a factor of very great importance. To obtain particulars of the increased cost, if any, of the proposed new organization, would need a large amount of detailed work by experts, and this is entirely outside the scope of this article. If the proposal would involve too much additional cost with the existing establishments there is no need to scrap the idea offhand on that account. The cost could be brought down by the reduction of establishments of officers and other ranks. It would be better to have a smaller number of officers and men, well trained for the jobs they would have to face in war, than a larger number imperfectly trained under the present system.

MARLBOROUGH'S CAMPAIGNS.

By CAPTAIN A. C. MITCHELL, R.E.

INTRODUCTORY.

THE object of the following notes has been to combine in one brief account sufficient outline of the campaigns, together with notes on their broader lessons and on the political and other factors of the period. The present writer has so far failed to find a short account which deals adequately with all these points and since the campaigns have been selected for the next two examinations for promotion, the notes are submitted in the hope that they may be of some slight use to officers. They make no attempt to take the place of recognized books and only form a skeleton or introduction to the campaigns, the result of considerable abbreviation of longer accounts. Of these Fortescue's *History of the British Army*, Vol. I, will be found useful.

CONTEMPORARY POLITICAL SITUATION.

The end of the seventeenth century saw France, under Louis XIV, predominant in almost every sphere. England was the one nation which would stand up to her, and the whole foreign policy of William III. centred on crushing French ascendency and in maintaining the balance of power in Europe. For this he had fought in Flanders, with but little success, till the Treaty of Ryswick, 1697, had brought a short breathing space.

In England the Catholic leanings of James II. had led to his downfall and to the accession of William and Mary, 1689. Churchill had been amongst the first to go over to William and had been made Earl of Marlborough, but his criticism of William's preference for Dutchmen and his negotiations with the exiled James led to his disgrace and imprisonment in 1692. The fact that the Duchess of Marlborough was lady-in-waiting to Anne, with whom Mary was on bad terms, further identified Marlborough with the party opposed to William. William, however, realized Marlborough's military qualities and in 1698, after Mary's death and William's reconciliation with Anne, Marlborough was fully reinstated.

The outstanding European question of the time was that of the Spanish Succession. Charles II. of Spain was childless and on his death a strong claimant for the throne would be Philip of Anjou, the Dauphin's eldest son. In 1698, however, Louis and William had

agreed that this claim would be prejudicial to the interests of European peace and had selected another candidate. But by 1700 this candidate had died and now Charles died, leaving his throne to Philip. Louis renounced the former agreement: a Franco-Spanish union, with France stronger than ever, seemed certain, and William again prepared for war.

England, Austria and Holland formed an alliance to put the Archduke Charles of Austria on the Spanish throne. Against them were France, Bavaria and parts of Spain. For England, however, the Spanish Succession merely proved a suitable "occasion" for the renewal of a war, the real object of which was to break the power of France. It was an early example of English intervention in Europe to preserve the balance of power. But the Spanish Succession was a poor "cause" with which to rouse the English nation, already tired of war. Fortunately, Louis' support of the exiled James and the fear of a Catholic restoration gave William, ready made, a far better cause to plead before Parliament.

War was declared in May, 1702, but shortly before this William had died and was succeeded by Anne. William's plans, however, went forward, and Marlborough was confirmed as Captain-General. So long as the Whigs held office and were committed to the prosecution of the war, and so long as the Queen was dominated by her lady-in-waiting, Marlborough's position was secure. In the later stages of the struggle, however, when the nation had grown tired of war, when the Tories came into office, pledged to peace, and when the Duchess was replaced in Anne's favour by Mrs. Masham, Marlborough's work was much more difficult, and one feels that his last two or three campaigns were conducted with one eye all the time on the "home front."

By 1711, the Archduke Charles had succeeded to the Austrian throne, and an Austro-Spanish union was as dangerous as a Franco-Spanish one. By that time, too, France was almost crippled. With their candidate no longer acceptable and with French power broken, the Allies had little incentive to continue the war. England had borne the chief burden and wanted peace. By the Treaty of Utrecht, 1713, Philip was confirmed as King of Spain, provided the French and Spanish crowns were never united. France received generous terms, but was no longer the dominant power of Europe. England's military reputation was enormously enhanced and her territorial possessions increased. In 1702 she had been merely one of the sea powers. In 1713, she was *the* sea power and with a strong foothold in the Mediterranean.

Military Factors and Contemporary Warfare.

With the Restoration, 1660, Parliament had gained complete control over the nation's policy and its armed forces. The army

was no longer the plaything of the King, but the instrument of the nation. On the Continent, however, the old practice continued. Armies formed the capital of kings and as such were not to be lightly squandered. This had a bearing on the warfare of the day, which thus had a tendency towards sieges and "situations," the threat and geometry of war, and the avoidance of pitched battles and decision by force. Mercenaries were freely employed: war was their trade and wars could not be indecently rushed to a hasty conclusion without throwing them out of work. Fortresses abounded, but with the weak artillery of the day their capture was naturally a protracted affair. Marlborough generally sought battle, whereas the French adhered to the old methods. The reason may lie in this difference in the constitution of the opposing armies.

England had seen considerable fighting in the latter half of the seventeenth century. Cromwell had laid the new foundations of the army and that army had been constantly practised by his successors. Its apprenticeship was now over: in Flanders it had already shown what it could do, but it remained for Marlborough to lead it to real success. Great as was his genius, therefore, Marlborough owed something to the work of his predecessors. In addition, he owed much to the qualities of his troops, particularly the British. Steenkirk and Landen had made their reputation: the Schellenberg, Blenheim and Malplaquet were to confirm it.

In 1702, however, England was not a military nation and, economically, her position was weak. Her population was some five millions and her revenue about £3,000,000. The recent wars had seriously drained her resources and the army had been considerably reduced after the Peace of Ryswick. Recruiting was difficult, pay generally in arrears and the administrative arrangements chaotic, but Parliament was hardly aware of the true state of affairs. Her own army being small and an ally being essential for operations on the Continent, England's policy had been to subsidize foreign states in maintaining contingents in the field. With her armies composed of British troops, mercenaries in British pay, and subsidized foreign contingents, each under its own commander, the difficulties of organization and command can be imagined. These were always amongst the greatest of Marlborough's problems, and it has been said that had his army comprised British troops alone, he could have smashed France in three campaigns.

William and Marlborough both appreciated the amphibious nature of England's power and sought to make full use of it by operations in Spain and elsewhere. Not always appreciated by Continental powers, this factor has proved decisive in many of our wars, allowing us to exert an influence out of all proportion to the actual military strength engaged.

France's position was very different. The strongest nation in

Europe, she had greater population and wealth, strong military traditions, an autocratic and centralized government, and a high record of success in war. Only at sea was she weak.

The economic state of Europe was backward. Agriculture was undeveloped. Roads were few and bad and in wet weather often impassable. Flanders was fertile and had an extensive system of navigable waterways, but was covered with fortified towns and was thus excellently suited to the defensive methods of the French. But it had been the scene of William's recent wars and supplies were scarce.

Campaign of 1702.

On the outbreak of war, French troops immediately occupied the Spanish Netherlands, with detachments on the general line Cleves, Venloo, Antwerp, Ostend. Their main army, 60,000, under Boufflers, lay east of Venloo, and behind this were their fortified Brabant lines from Namur through Diest to Antwerp. Only Maastricht remained in Allied hands and this was besieged by the French.

By July, Marlborough had 60,000 men, including 12,000 British, at Grave on the Lower Meuse. After great difficulty he had got the Dutch to accept his appointment in command of all Allied troops in Flanders on condition that two Dutch Deputies were attached to his headquarters. Advancing west of the Meuse, he forced Boufflers to retire hurriedly to the Demer to save his communications. He then set about the reduction of Venloo and other Meuse strongholds and by September had cleared the Meuse as far as Liège. He had seen the weakness of Boufflers' position east of the Meuse and had used surprise and mobility, rather than force, to clear the Meuse valley.

But Boufflers had not yet been brought to battle. Four times, by skilful baits, Marlborough had had the French within his grasp, but on each occasion the obstruction of the Deputies had prevented him attacking. The Dutch had been eager enough to clear their own frontier, but now showed little inclination to attack even under the most favourable circumstances. The campaign, therefore, closed with Boufflers secure in his Brabant lines and Marlborough in occupation of the Meuse as far as Liège.

Meanwhile, Bavaria had joined France and this gave the French access to the Danube. Villars had moved to the Black Forest and Tallard to the Moselle. The real rivals for the Spanish crown were France and Austria and the tendency was for the centre of the struggle to shift to the Upper Danube.

Campaign of 1703.

Villeroi and Boufflers were to clear the Meuse valley, whilst Tallard and Villars, in co-operation with Bavaria, were to smash Austria.

Marlborough's plan was to invade Brabant and Flanders, with a

view to bringing the French to battle and, if possible, securing Antwerp or Ostend as a new base. His first move, however, was to seize Bonn, thus weakening French influence on the Lower Rhine. His next step was against Antwerp. Cohorn was to create a diversion towards Ostend; Opdam was at Bergen; Marlborough was to join him and together they were to attack Antwerp. But Cohorn went off plundering into West Flanders, and Villeroi surprised Opdam before Marlborough came up, so that the whole combination failed. Quarrels amongst the Dutch generals prevented further major operations and the campaign closed with only Limburg and Huy as new acquisitions in Marlborough's hands. Petty jealousies and the desire for private gain amongst his subordinates had made co-operation impossible and had ruined Marlborough's plans completely.

Marlborough's object in capturing Antwerp had been to shorten his communications. With his base at the Hague and his troops about Liège, his communications, by road or water, had been long and difficult. In 1703, land movement was slow and difficult and short forward communications were all-important. Movements and maintenance were as much problems then as now.

Villars had crossed the Black Forest and had defeated the Emperor at Hochstadt, whilst Tallard had occupied Landau. The advance to Vienna could be undertaken in the following year. The Margrave of Baden, however, joined the Allies and by occupying the Stollhofen lines on the Upper Rhine hampered French movements through the Black Forest. Austria, defeated in the field and with a Hungarian revolt at home, was in a critical state. The Danube, not Flanders, was for the moment the decisive point.

CAMPAIGN OF 1704.

Realizing the danger of an Austrian collapse and despairing of success in Flanders, Marlborough decided to transfer his British troops and auxiliaries to the Danube, leaving the defence of Holland to the Dutch under Overkirk. Early in May his troops moved out from Ruremonde.

Marsin had joined the Elector of Bavaria on the Danube as advanced guard for the march to Vienna. Tallard with the French main body lay west of the Rhine, intending to follow Marsin. Villeroi was in Luxemburg, watching Marlborough, who was believed to be preparing an attack on Lorraine.

Marlborough did everything to strengthen this impression of a threat to Lorraine. He openly ordered supplies to Coblence and later sent bridging gear for a crossing at Philipsburg as if to invade Alsace. As he moved up the Rhine to Coblence, Villeroi moved south on his flank. Marlborough, however, kept south from Coblence

and Alsace appeared to be his objective. Tallard closed up to the Rhine. During this stage of his march, Marlborough's position might have been critical had Tallard and Villeroi closed on him and forced a general engagement. But they kept aloof, and at Mannheim Marlborough turned into the Neckar valley and was beyond their immediate reach. His intention was now plain, but it was too late to stop him: he had gained the initiative and a long start, and by 22nd June he was near Ulm, in touch with Eugene and the Margrave of Baden. Marlborough and Baden were to take command of their united forces on alternate days, whilst Eugene was to hold the Stolhofen lines and hamper Tallard's movements across the Rhine.

Marlborough had covered 250 miles in under six weeks, a creditable effort under the conditions of the time—heat, dust, bad roads and uncomfortable uniform. It was not a forced march: speed was important up to a point, but he had to have his troops fit for hard fighting at their destination. There have been many greater marches in history, but this to the Danube must always stand out as a splendid feat. "Audacious by any standards it was all the more so by the cautious strategy of the time" (Liddell Hart). Until the last moment Marlborough had completely mystified the French as to his objective. He had checked their advance and by creating an atmosphere of uncertainty had prevented their co-operation. From the time he reached Mannheim he was in front and with the advantage of interior lines. Liddell Hart goes on to say of the march: "Its security lay in the dislocating effect of its surprise." One can compare Marlborough's strategy here with Bonaparte's in March, 1796, when the latter appeared to threaten Genoa until he suddenly turned off to Montenotte. Power to threaten more than one point at a time must always be one of the best ways of effecting surprise. It is not essential to be on interior lines to effect this. Neither Marlborough, in 1704, nor Bonaparte, in 1796, were initially on interior lines.

Marsin and the Elector had retired down the right bank of the Danube to an entrenched camp at Augsburg, sending a detachment to the Schellenberg to cover the Donauworth crossing. Marlborough, keeping to the left bank, came up and attacked this detachment on 2nd July, his day in command, but paid dearly for his success. He then moved to Friedburg and, not daring to attack the Elector's strong position, sought to put pressure on him by laying waste the neighbouring countryside. This, however, failed to bring the Elector to battle.

Meanwhile, Tallard joined the Elector at Augsburg and Eugene fell back north of the Danube. Marlborough was now faced with a difficult problem. If he joined Eugene north of the Danube, Tallard would be free to march on Vienna. If Eugene joined him east of

Augsburg, this barred the road to Vienna but the French could cut off Allied supplies. The two forces could not remain separated without risk of being defeated in detail. Tallard, however, moved to the Danube and Marlborough fell back to join Eugene. By 12th August both armies were north of the river and within five miles of each other, but almost totally ignorant of each other's position. Tallard, having got astride Marlborough's communications, believed the latter had no alternative except retreat northwards. But he failed to push out his cavalry to reconnoitre and was actually going into camp when located by Marlborough. This is a good example of the French mentality of the period, showing the predominance of the "situation" theory of war. It never occurred to Tallard that Marlborough might seek to redress the situation by battle, to overcome strategical disadvantage by tactical success.

Tallard and the Elector were forming separate camps and, as was the custom of the day, each put his infantry in the centre and his cavalry on the wings. This meant that the French would have a weak cavalry centre if line of battle had to be formed hurriedly. The position, suitable as a camp, was too long for defence with the numbers available. Though it had the three villages of Blenheim, Oberglau and Lutzingen as defended localities the distance between the first two, two miles, was too great to be properly covered by cross-fire from these villages. This weak point happened to be near the centre, held by cavalry. The position was too far from the Nebel, flowing across the front, to allow the passage of that stream to be disputed, and the extensive front meant that Tallard had little reserve. Marlborough had seen the French going into camp. Though weak in numbers, 50,000 to the French 60,000, and with the marshy Nebel to negotiate, he determined to attack. He had come to the Danube to smash the French. Battle was essential to save Austria as well as to restore his communications. "I know the difficulties," he said, "but a battle is absolutely necessary and I rely on the discipline of my troops."

The morning of 13th August was foggy and the Allies had deployed east of the Nebel before Tallard was properly aware of their presence. He had to form up for battle at once, making the best of his dispositions for camp. Seeing the bulk of the British redcoats opposite his right and having learnt to connect these with the hardest fighting, he at once strengthened the garrison of Blenheim. On the left, the Elector's position was closer to the Nebel. Both flanks of the French position were secure as the Danube covered the right and dense woods the left.

Marlborough's plan was for Cutts to attack Blenheim and for Eugene to attack the Elector about Lutzingen. The capture of Blenheim would turn the French right, or, failing this, it was hoped that these attacks would draw off French reserves and weaken their

centre, against which Marlborough could then hurl his cavalry. Difficult ground delayed Eugene, who was not in position till noon. Cutts, on the left, was held up in front of Blenheim with heavy loss and Marlborough stopped further attacks here. In the centre, however, Tallard's failure to hold the Nebel allowed Marlborough to pass over the bulk of his cavalry almost unopposed. This then charged the French centre, broke it and drove it in confusion to the Danube. Blenheim, which had been contained meanwhile, was now surrounded and its garrison of 10,000 men surrendered. On the other flank, Eugene had made little progress until the Elector, finding himself separated from Tallard, set fire to Lutzingen and escaped under cover of darkness. Night prevented effective pursuit but the French were utterly broken. Their losses amounted to 40,000, including Tallard as a prisoner. The Allies lost 12,000.

The chief points to note are, on the Allied side, Marlborough's care for reconnaissance and his quick decision to attack at once in order to effect surprise. But he failed to realize the difficulties of the ground on his right over which Eugene had to advance. His plan fixed the French on both flanks and allowed him to drive home his decisive attack with superiority of force against their weak centre. With no flanks to turn he could not avoid a frontal attack, but Tallard's failure to dispute the Nebel crossing made this easier. The delay in attacking, due to Eugene's difficulties, was unfortunate. Had the attack begun at 9 a.m., instead of 1 p.m., not only would French resistance have been less, but several hours of daylight would have been available for pursuit.

Tallard's chief mistakes have already been noted. In addition, he put far too many men prematurely and unnecessarily in Blenheim, where they were wasted, and had little in hand to plug the hole made in his centre. To deploy the bulk of one's force prematurely, before ascertaining the real point of attack, is to lose all power of manœuvre. The Elector had held a line close up to the Nebel and had checked all Eugene's attempts to cross. Had Tallard also held a line closer to the stream the result might have been different.

Marlborough returned by easy stages to the Rhine, where he captured Landau. From there he moved to the Moselle and the campaign closed with the capture of Trarbach.

The campaign of 1704 must always stand out as one of the greatest in our history. Marlborough's first two campaigns had brought solid gains and had shown that the French were not invincible but they had been indecisive. 1704, however, had seen the French first completely outwitted and then decisively defeated and their morale not a little lowered. Austria had been saved and the prestige of the British Army and its commander was higher than ever before.

CAMPAIGN OF 1705.

Marlborough's plan was to invade Lorraine *via* the Moselle, thus turning the French right in Flanders. He moved against Villars, who occupied a strong camp at Sierck, near the junction of the Moselle and Saar. Villars refused to come out and fight but held Marlborough in front of Sierck long enough for Villeroi, in Flanders, to move against Liège and threaten Marlborough's communications. This is one of the few examples of real co-operation among the French commanders during this war. Villars was better employed doing nothing than in risking battle, and Villeroi's stroke had immediate effect in bringing Marlborough back to the Meuse. On his approach, Villeroi withdrew, but Lorraine had been saved. Compare Marlborough's threat to Boufflers' communications in 1702. This power to threaten communications must always be a valuable asset in war.

Villeroi had retired to the Brabant lines. Though these were strong he had not enough men to hold them in strength. The Wanghe sector was the strongest and Namur the weakest. But success at Wanghe would have greater effect than success at Namur. Wanghe, therefore, must be made the weak point. Marlborough first feinted towards Namur, and Villeroi hurriedly reinforced this point. Counter-marching by night, Marlborough appeared at Wanghe at dawn on 18th July, found the lines almost unoccupied and had passed them before Villeroi could get back. Thus, on almost the identical ground, was avenged William's defeat at Landen, twelve years earlier. The French retired to Louvain, but the Allies were too exhausted for effective pursuit. Marlborough had again mystified and misled his enemy, effecting his object by surprise and mobility and with great economy of force. The forcing of the Brabant lines can be compared with the similar operation at Arleux, in 1711, or with Allenby's final offensive in Palestine, in September, 1918.

Marlborough closed up to the Dyle and worked round the French right by the Yssch. The Dutch, however, refused to attack. He next moved wider round this flank and, unknown to the enemy, got into position for attack near Soignies, but again the Dutch refused. The season being over, Marlborough had to withdraw to winter quarters on the Gheete. The Deputies had ruined his plans for 1705, as they had ruined those for 1702 and 1703, and feeling in the army ran high. "Jealousy, timidity, ignorance, treachery and flat imbecility seem to have been the motives that inspired these men. . . . It was they who were responsible for the prolongation of the war, for the burden it laid on England and for the untold misery it wrought in France." (Fortescue, Vol. I, p. 457.)

Campaign of 1706.

Marlborough wanted to join Eugene in Italy and attack Toulon, but the Dutch refused to fight so far afield. He turned to attack Namur instead and this brought Villeroi out of his position behind the Dyle. The two armies met at Ramillies on 23rd May.

Villeroi's position lay along some crescent-shaped rising ground, his left covered by the marshy Gheete, his right resting on the Mehaigne. The village of Ramillies was in the right centre of his line. But the position was too extensive for the numbers available: no cavalry had been pushed out in front: the bulk of the French were prematurely deployed and there was little reserve.

Marlborough sent the British against the French left and Villeroi, seeing the redcoats, at once reinforced this flank from his centre. Marlborough then sent his Dutch and Danish cavalry to work round the French right between the Mehaigne and Ramillies. This movement was checked by fire from Ramillies till Marlborough launched his main attack against the weakened French centre. Pressed in front and flank, the French broke and fled. A vigorous pursuit was begun and the French only rallied at Lille, 80 miles west. By September all Brabant and most of Flanders had been cleared and Ostend opened as a new base. In a single campaign, as the outcome of a single battle and an energetic pursuit, the Allies had advanced from the Meuse to the sea. Marlborough had dealt another heavy blow at the methods of passive warfare so long favoured by the French.

There are several points of similarity between Ramillies and Blenheim. In both, the French position had strong flanks but was too extensive. In both, the French deployed prematurely before locating the direction of the Allied attack. In both, Marlborough first pinned the French flanks, forced them to weaken their centre, and then drove home his decisive attack against this point. But it is difficult to understand how Villeroi was deceived by the movement against his left. No attack was likely to succeed over the marshy Gheete.

The pursuit after Ramillies is a good example of the results of fully exploiting tactical success on the battlefield and is the only great pursuit in the whole of Marlborough's campaigns. Unpursued, Villeroi might have rallied on the Dyle, leaving the situation almost in *statu quo ante*. Vigorously pursued, he could only rally west of the Scheldt, his losses considerable and the morale of his army broken. Tactical success on the battlefield had allowed Marlborough to get the French on the run, but it was the exploitation of that success which gave the Allies Brabant and Flanders at a single stroke:—"*Vaincre n'est rien; il faut profiter du succès.*"

CAMPAIGN OF 1707.

1707 is of little interest. Rain hampered operations in Flanders: Eugene failed before Toulon: Galway was defeated at Almanza, and this lost us Valencia.

The winter of 1707–08 was a difficult one for Marlborough. England liked short wars and this one had now gone on for six years without any sign of final success. Recruiting had become very difficult. Parliament, hitherto united in support of the war, began to be split by factions, and Louis sought to widen these breaches by renewed threats of invasion and of a Catholic restoration. The Emperor, intent on acquiring Naples, had left Eugene before Toulon and had been negotiating secretly with Louis. Dutch obstruction continued. This disunity of purpose amongst the Allies, these disruptive influences in England, made 1707 a completely wasted year, made Marlborough's task immensely more difficult, and gave France time to rally for a further effort.

CAMPAIGN OF 1708.

The spring found the main French Army in Flanders, 100,000 strong, under Vendome and Burgundy. Eugene had come up to the Moselle and was ready to join Marlborough in Flanders if necessary.

During the preceding winter the French had opened negotiations with the authorities of Ghent and Bruges, and when Vendome moved north these opened their gates to him. This cut Marlborough's communications with Ostend and lost him the use of the Scheldt and Lys waterways. Without Eugene he had been too weak to stop Vendome's advance, but he now moved west to cover Brussels. Having garrisoned Ghent, Vendome turned to invest Oudenarde, intending to cover the siege by holding the line of the Dender about Grammont. But finding that Marlborough had, by forced marches, forestalled him at the Dender crossings he abandoned the project and turned back to cross the Scheldt at Gavre so as to have that river between himself and the Allies and to bar their approach to Bruges. Marlborough had already marched his troops far and hard, but he immediately sent off Cadogan with a detachment to seize a bridgehead at Oudenarde. Marlborough was now close to the French and the latter were away from their protecting fortresses. If he could cross quickly at Oudenarde he could interpose between the French and their frontier and force them to fight.

As Cadogan seized the bridgehead at Oudenarde the French cavalry appeared from Gavre, at first unaware of the presence of Allied troops. Vendome, realizing that Marlborough's main body was still east of the Scheldt, wanted to occupy a position close to the river to hem in Cadogan. Burgundy, however, ordered a line two

miles back, defending the Norken. Burgundy and Vendome were not on good terms and the result was confusion. By 4 p.m., as the Allies had not attacked, Burgundy ordered his right and centre to advance. But Marlborough's main body had by then come up and was thrown in to extend the line on Cadogan's left. The ground was very enclosed and the battle resolved itself into a series of individual encounters between regiments. Little headway had been made on either side and daylight was fast disappearing when Marlborough saw that the French right was in the air, that they had failed to occupy the Boser Couter, a spur on this flank at right angles to their line. He immediately sent Overkirk with twenty Dutch battalions along the reverse slope of this to attack the French rear about Oycke. The move was completely successful. The French right was now surrounded and their troops melted away in the darkness.

Vendome withdrew the remnants of his army to Ghent. There was no pursuit as the Allies were too exhausted. In the preceding sixty hours they had marched fifty miles, passed two rivers, crossed the Scheldt in the face of the enemy, and won a general action. Compare the passage of the Brabant lines in 1705, when their previous exertions prevented immediate pursuit.

Oudenarde was an encounter battle, a general action without any set order of battle. Units of the main body, as they arrived, came into action in support of the advanced guard. It was probably Marlborough's most hazardous action, fought after forced marches without preliminary reconnaissance, with his army not concentrated, and with a river at his back. There was danger of his force being defeated in detail. But he saw that this was his one chance of bringing the French to battle in the open and he took the risks. French morale was low and their commanders at variance: he had got across their communications and they were forced to fight. The poor co-operation between Vendome and Burgundy was fatal to the French. The late hour at which the battle began robbed Marlborough of the full fruits of victory. Another hour of daylight, he declared, would have ended the war. Compare Blenheim.

Oudenarde is a good example of complete understanding between an advanced guard commander and his chief. Cadogan was weak and at first his position was critical, but he knew that Marlborough wanted battle and that the main body was getting nearer every minute. By seizing the bridgehead he pinned the French and forced them to accept battle. It is an excellent instance of an advanced guard acting in the interests of the main body.

Marlborough's eye for ground and for an enemy's mistakes is well shown. Boser Couter was the key to the French position and their failure to hold it primarily responsible for their defeat.

Vendome's seizure of Ghent and Bruges had been sound strategy, but its effect had been largely nullified by his tactical defeat at

Oudenarde. That battle had not restored Marlborough's communications but it had cut Vendome's.

With Vendome at Ghent the road into France lay open. Berwick hurried up from the Moselle to cover the frontier, but by 14th July, three days after Oudenarde, the Allies were camped about Menin, actually within French territory. Marlborough now proposed to leave the French frontier fortresses untouched and, co-operating with a fleet in the Channel, to invade Northern France. It was perhaps his most ambitious project, but he saw the limitations of fortresses unsupported by a field army and how they commanded nothing beyond the range of their guns. Working with a fleet he would be free from set communications and if beaten could always retire to his ships. Moore, in 1809, and Wellington, in 1813, turned sea power to account in this way. The plan, however, was too daring for Eugene, who, bred in the Continental school of war, failed to appreciate the advantages of sea power and placed an exaggerated value on the importance of fortresses. He would not agree to Marlborough's scheme till Lille was taken.

The siege of Lille was, therefore, undertaken. Eugene's army had come up to Brussels and now escorted the siege train over to Lille, Vendome at Ghent and Berwick at Mons failing to co-operate and intercept it. Vendome later joined Berwick, but they made little effort to relieve Lille, and, early in December, after a long and gallant defence, Boufflers was allowed to march out of the city with the honours of war. During the siege the Elector of Bavaria had come up from the Rhine and threatened Brussels, but he withdrew hurriedly when Marlborough appeared with a small escort. Marlborough's name alone had saved Brussels.

After the fall of Lille it was too late to invade France that year, but Marlborough was able to reoccupy Ghent and Bruges and re-open the navigation of the Scheldt and Lys. Note his constant thought for his communications by water in those days of bad roads.

Had Marlborough carried out his original scheme of invading France in July, in all probability he would have succeeded and brought the war to an end. France was very weak and her people tired of the war, but so far their territory had been untouched. They could hardly have resisted Marlborough's advance and the loss of territory and its resources would have brought Louis to terms. As it was, in the winter that followed, Louis sought peace, but the Allied governments foolishly refused his generous terms.

CAMPAIGN OF 1709.

Villars, now the French commander in Flanders, was occupying the La Bassee lines from Douai to the Lys and was unwilling to risk battle. The Allies lay south of Lille and made obvious preparations

to attack the lines. Villars called in part of the Tournai garrison and Marlborough at once invested that town, which surrendered on 23rd July. Villars had not dared to leave his lines in case Marlborough might turn from Tournai and pass them in his absence. 1705 had not been forgotten. From Tournai Marlborough moved to invest Mons and Villars' dilemma became serious. If he tried to relieve Mons, Marlborough might turn and pass his lines. Yet that town was lightly garrisoned and in Marlborough's hands would open the Sambre route into France and turn the La Bassee lines. He decided to move to Mons.

Approach to Mons from the west was barred by forest except at two gaps, Jemappes and Malplaquet. Villars moved his main body to Malplaquet, sending a detachment to Jemappes. Leaving a small investing force at Mons and sending Orkney to hold Jemappes, Marlborough moved the rest of his army towards Malplaquet, where he found that Villars had entrenched a strong position across the gap, his flanks well protected by woods. Marlborough was persuaded to delay attack for two days till Orkney's detachment and the remaining troops from Tournai could rejoin the army, 11th September. This delay allowed Villars to improve his position considerably.

Marlborough's plan was for converging attacks against the salient of wood which ran forward on the French left, and for the Dutch, under the Prince of Orange, to develop a holding attack against Boufflers on the French right. If Villars could be made to reinforce his left from his centre, that centre might then be broken by the Allied cavalry. The fighting on the French left was extremely stubborn and little progress was made. On the other flank, the Prince of Orange, impatient at delay, turned his holding attack into a real one and was badly mauled by Boufflers. But Withers now came round beyond the woods on the French left and, taking this flank in enfilade, forced the French to give way. The centre was then carried but on the right Boufflers retired in good order.

The French losses were 12,000, including Villars wounded. The Allies lost 20,000, chiefly through the folly of the Prince of Orange. Villars wrote to Louis: "If God gives us another defeat like this, Your Majesty's enemies will be destroyed." No action of Marlborough's was fought less in accordance with his plans. He had not wanted the two days' delay: he had ordered a holding attack on his left: his army was too exhausted to pursue. Some claim that he was wrong to attack at all. But his object all along had been the defeat of the French field army and he had had few chances. Tournai and Mons had only been means to that end, pin-pricks to bring Villars to do battle away from his lines. A battle meant more to Marlborough than the capture of many fortresses.

It has been said that Malplaquet cost the Allies decisive victory

as in 1710 they could effect nothing and stalemate arose. Be that as it may, Malplaquet must rank as a great action. The French position was a "veritable citadel." Their strength equalled Marlborough's and they fought under trusted commanders. Yet they had been driven from the field and, despite Villars' remark to Louis, the future did not look promising.

CAMPAIGN OF 1710.

The La Bassee lines were still intact and Villars had begun the construction of his great Ne Plus Ultra lines. He was weak in numbers and refused to risk battle in the open. Marlborough had, therefore, to content himself with the capture of Douai, Bethune, St. Venant and Aire, thus clearing the Upper Lys and Scarpe and biting deeply into the belt of French frontier fortresses.

The end of the year saw the fall of the Whigs at home and the breach between Anne and the Duchess of Marlborough. Harley and the Tories came into power and quickly began secret negotiations with Louis. Marlborough's position at Court and in Parliament was waning.

CAMPAIGN OF 1711.

Louis, fully aware of the changed situation in England, was making every effort to prolong the struggle until his negotiations with Harley were completed, and to this end Villars was ordered to adopt a strictly defensive attitude. The death of the Emperor Joseph brought the Archduke Charles to the Austrian throne and the Allies had now little incentive to continue the struggle. But Marlborough realized that to make peace now would be to undo all his work of the past ten years. France was near breaking point, but had yet to acknowledge the fact. Eugene, however, had returned to the Rhine and, single-handed, Marlborough was too weak to force Villars' lines and bring him to one last decisive battle.

Villars' great lines ran from the coast at Etaples, through Arras and Arleux to Valenciennes, thence to Maubeuge and along the Sambre to Namur. Only in parts were there actual defences: in many places rivers or inundations formed an effective barrier.

Marlborough lay near Lille. To the south the Sensee valley was flooded, but there was a causeway at Arleux. Marlborough captured Arleux, left a small garrison, and then moved his army back to Lens. Villars immediately recaptured Arleux. Marlborough, pretending to be very angry at this, now made obvious preparations to attack the lines west of Arras, and Villars, short of men, drew in his outlying garrisons, including that at Arleux. But on 3rd August, Marlborough sent off his artillery and some infantry

eastwards, evidently in pursuit of the raiding detachment which Villars had recently sent into Brabant. In any case, Villars suspected nothing and was, in fact, pleased at thus easily weakening Marlborough's main army in front of Arras. The force moved to Douai, where it joined another body of infantry and, under Hompesch and Cadogan, the whole marched out the next night for Arleux. On the 4th, Marlborough issued orders for battle for the remainder of his army on the 5th, his officers thinking he had gone mad to risk attack with his artillery and a considerable portion of his infantry absent. That same evening the cavalry moved out of camp westwards in full view of Villars' lines but, having thus misled the French, they turned back after dark. The remaining infantry struck camp and the whole army marched eastwards during the night. Cadogan and Hompesch reached Arleux at 3 a.m. on the 5th and crossed unopposed. By 5 p.m. the main body was across, many units having marched forty miles in eighteen hours, but hundreds of infantry had fallen out *en route*. Several hours elapsed before Villars realized Marlborough's plan. With a small escort he hurried to Arleux, only to run into the Allied outposts south of the Sensee and be nearly captured. Villars then offered battle at Cambrai, but Marlborough refused and, crossing the Scheldt, besieged and took Bouchain, Villars making no attempt to relieve it. "So vanished the Ne Plus Ultra of Villars, a warning to all generals who put their sole trust in fortified lines" (Fortescue, Vol. I, p. 547).

Marlborough had been too wise to run his head straight into such a brick wall as Villars' lines and had relied on surprise and mobility to effect his object. His plan was a repetition of that for the passage of the Brabant lines in 1705. He knew Villars could not hold the entire lines in strength, and his feint west of Arras made Villars weaken the selected decisive point at Arleux. So much for surprise, but it was mobility, real hard marching, which allowed him to reap the full fruits of that surprise and effect his object with economy of force. Note also his use of night marches to effect surprise, both at Wanghe and in the present instance.

1705 and 1711 saw continuous trench lines just as 1914–1918 did. But there were two great differences in the last war—increased numbers and the greater stopping power of weapons. Against Marlborough the French had never enough troops to man their long lines in strength at all points. In the last war greater population, besides improved transportation and supply, allowed longer lines to be held continuously in strength. In the last war, too, the machine-gun, with its enormous stopping power, allowed long lines to be held with great economy of force. Marlborough broke through by getting the French reserves in the wrong place. Foch broke the German line and Allenby the Turkish line in exactly the same way, by threatening one or more points so as to draw strength towards them,

then pushing in in strength against the now lightly held decisive point.

"So, with the capture of Bouchain, the last and not the least remarkable of Marlborough's campaigns came, always victoriously, to an end" (Fortescue, Vol. I, p. 548.) But all that he had done in the field during the last ten years had not prevented his position at home from being undermined. In December he was recalled in disgrace, accused of embezzlement, and dismissed all public employment. Ormonde became Commander-in-Chief, and in July, 1712, the British were withdrawn from Flanders. Harley's infamous negotiations terminated in the Treaty of Utrecht, signed in 1713.

Marlborough had already left England, disgraced, but on the accession of George I., in 1714, he was reinstated, though now too old for public affairs. A victim of paralysis, he died in 1722, at the age of 72.

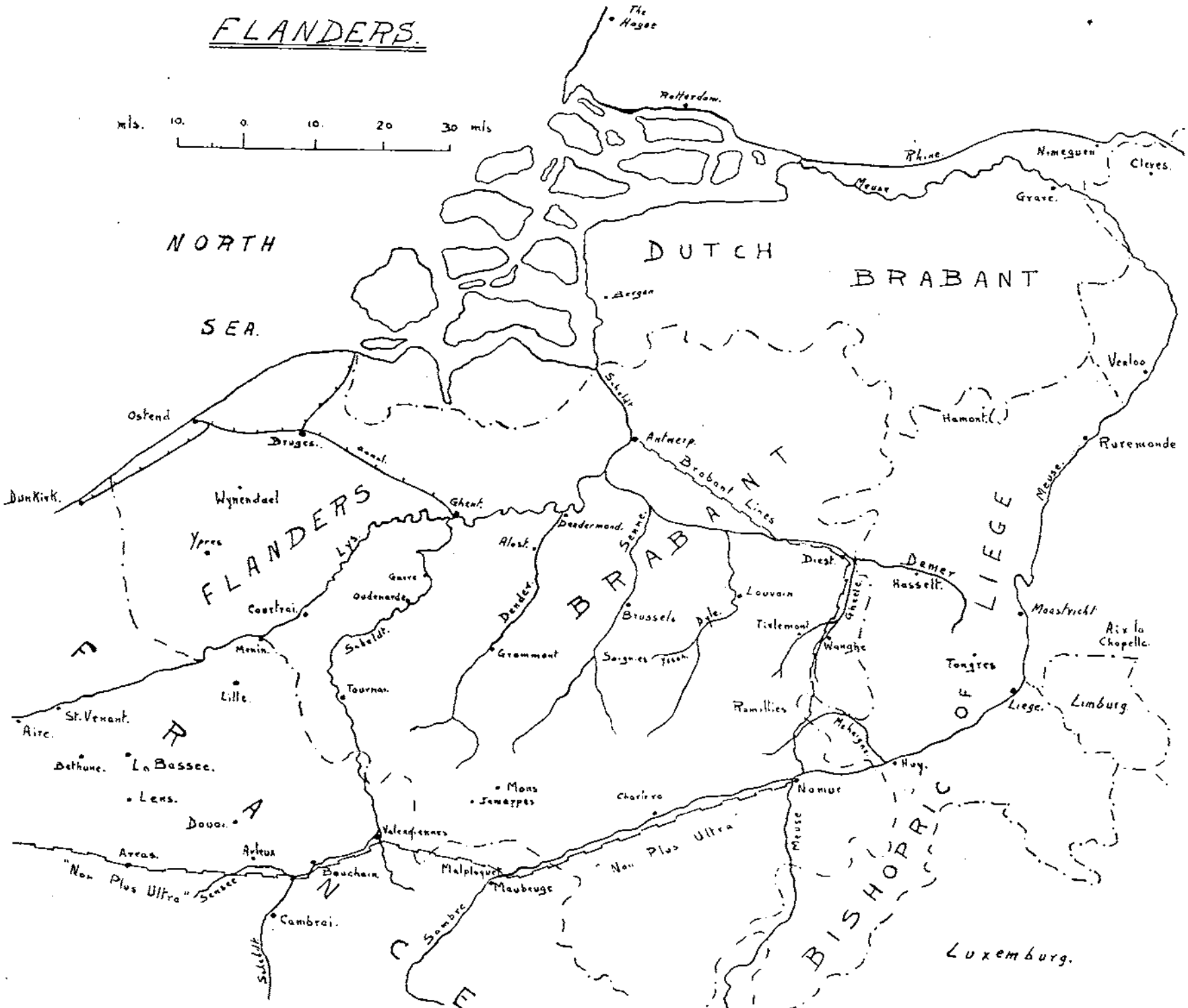
MARLBOROUGH THE SOLDIER.

Marlborough will always rank amongst the great captains of history, the greatest military genius our nation has produced. That he is to-day almost unknown to the man in the street may be due to the British public's curious characteristic of admiring its army most in defence. Wellington, most of whose battles were defensive, is better known than Marlborough, who always attacked.

But Marlborough's greatness is unquestioned. Despite enormous difficulties, political and military, both at home and abroad, he broke the long run of French ascendancy and raised the prestige of the British Army to be the highest in Europe. He was more than a mere commander of men. He could always take the great line and see the war as a whole, and in the midst of his work in Flanders could find time to advise on operations in the Peninsula and Mediterranean. He guided not only England, but Europe, safely through the War of the Spanish Succession.

His victories were the result of skill and finesse rather than of mere bludgeon work, though his plans were always simple in conception. He generally sought battle, knowing that tactical results were the only things that mattered in war. But he could use surprise and hard marching, as much as force, to gain his ends; and he restored to their proper importance in war the principles of offensive action, surprise, mobility and economy of force. Unlike most Continental soldiers, he appreciated the value of sea power to an army and he saw France's weakness in the Mediterranean.

He had all the qualities of the great statesman—tact, breadth of vision, infinite patience and a great capacity for taking pains. Without such qualities he could never have achieved what he did or held together the various Allies and their forces in the field. That there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Ruremonde
Antwerp
Brabant Lines
Ostend
Bruges.
Canal
Dunkirk.
Wynendael
Ghent.
Ypres
FLANDERS
Lys
Alost.
Dendermond.
Scheldt
Diest.
Demer
Hasselt.
Louvain
Brussels
Dyle.
Tirlemont
Ghete
Maestricht
Aix la Chapelle.
Courtrai.
Oudenarde
Menin.
Scheldt
Dender
Grammont
Sargnies
Wanghe
Tongres
Tournay.
Lille.
Ramillies
Liege.
Limburg
St. Venant.
Aire.
Bethune.
La Bassee.
Lens.
Douay.
Mons
Jemappes
Charleroi
Namur
Huy.
Meheyen
Valenciennes
Arras.
Arleux
Bouchain
Malplaquet
Maubeuge
Cambrai.
"Non Plus Ultra" Senset
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Scheldt
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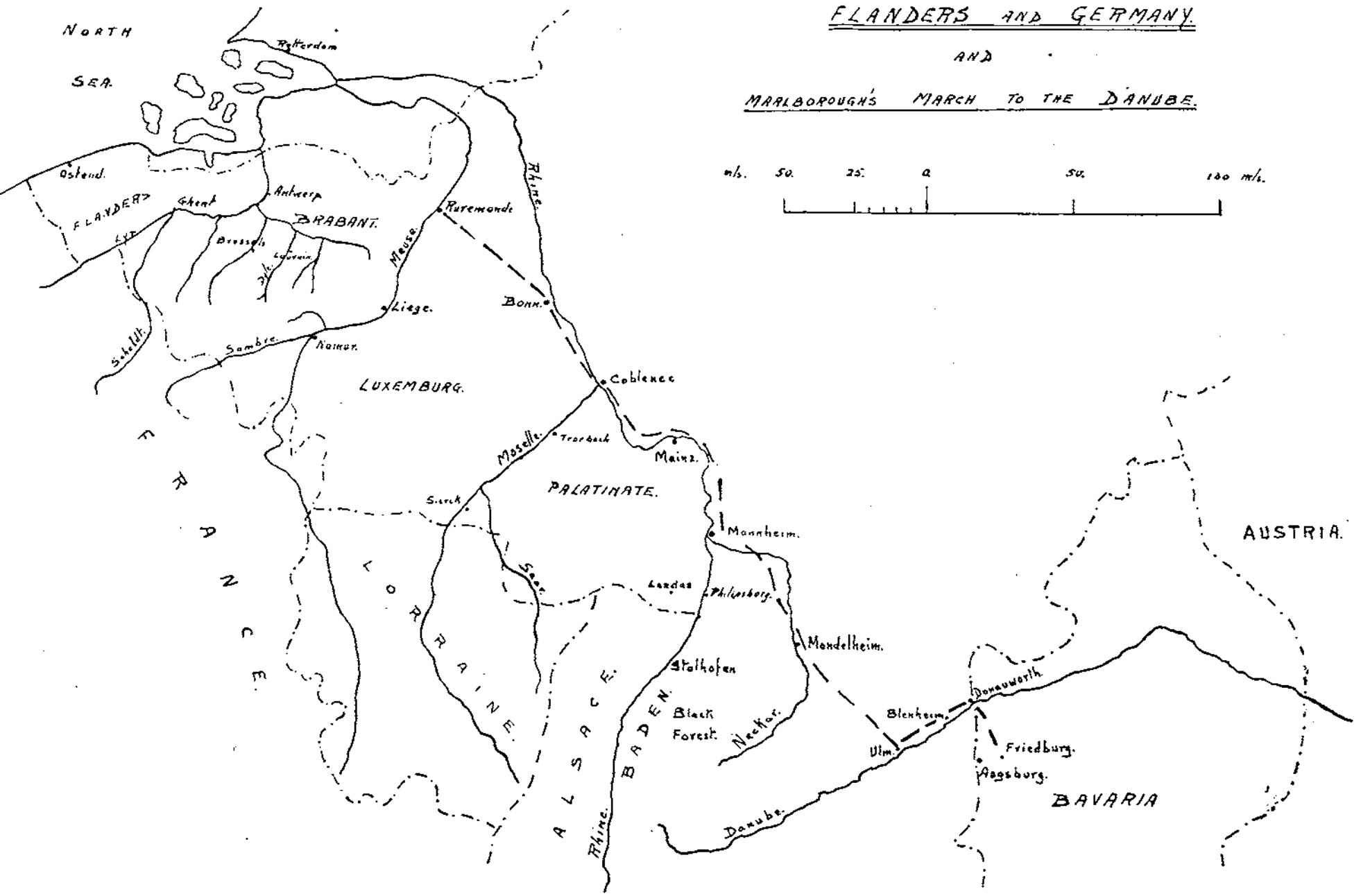
BISHOPRIC OF LIEGE
Luxemburg.


FLANDERS AND GERMANY
AND
MARLBOROUGH'S MARCH TO THE DANUBE
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Rotterdam
Ostend.
FLANDERS
Ghent
Antwerp
BRABANT.
Bruxelles
Louvain
Meuse
Ruremonde
Rhine
Liege.
Bonn.
Scheldt
Sambre
Namur
LUXEMBURG.
Coblence
Moselle
Trarbach
Mainz.
PALATINATE.
S. Arck
Saar
Landau
Philipsburg
Mannheim.
FRANCE.
LORRAINE
ALSACE
BADEN
Stolhofen
Black Forest
Neckar
Mendelheim.
Donauwerth
Blenheim.
Ulm.
Friedburg.
Augsburg.
BAVARIA
Danube.
Rhine.
AUSTRIA.

were stains on his character is nowhere denied. His negotiations with the exiled James and his notification to Louis of the contemplated Brest expedition in 1694, during his period in disgrace, were little short of black treachery. But allowance must be made for the circumstances of his time and for the fact that he lived in a period of corruption, revolution and undisguised immorality. Judged by the standards of that time, Marlborough stands far above most of his contemporaries.

Perhaps more than any other man he thoroughly understood the British soldier, feeding him well, working him hard, and insisting on strict discipline. Yet there was a strong bond between him and his men, on the one side of sympathy and consideration, on the other of trust and devotion which found expression in his nickname. " Great as Wellington was, the Iron Duke's army could never have nicknamed him the Old Corporal " (Fortescue, Vol. I, p. 589). His men were largely the scum of the nation, yet they were proud to follow Marlborough, and under him performed wonders. There could be no greater tribute to his personality and leadership.

His ten campaigns saw few pitched battles because it required two to make a battle and the French persisted in defensive strategy within the shelter of their fortresses and lines. " It must never be forgotten that we possess only the wreck of many of Marlborough's finest combinations, shattered, just as they entered port, against the rocks of Dutch stupidity and German conceit " (Fortescue, Vol. I, p. 588). But his tactics at Blenheim and Ramillies, at Wanghe and Arleux, his boldness in marching to the Danube and in pinning Vendome at Oudenarde must always stand out as excellent examples of their kind. His quick decision, his eye for ground, his power of seizing on an enemy's mistakes, his insistence on reconnaissance, his patience, and his personal courage mark him out as something greater than his fellows. In his practice of the art of war, he forestalled by some 150 years Stonewall Jackson's precept to " mystify, mislead and surprise your enemy."

NOTES ON THE PONTOON BRIDGE PARK, R.A.S.C.

By MAJOR W. A. F. KERRICH, D.S.O., M.C., R.E.

I.—On active service, where the time factor is of paramount importance, bridges are best built with standardized equipment. The issue, on January 15th, 1930, of an Army Council instruction, giving the War Establishment of a Pontoon Bridge Park, must be classed as an event of primary importance to the Corps at large. On mobilization, a unit is fitted out on the scale laid down in *War Establishments*, no more and no less: and though the equipment of a pontoon bridge park has been foreshadowed now for several years in *Engineer Training*, the figures given therein could only be regarded as a pious hope for the future, until they were certified as correct by the issue of this Army Council instruction.

The seal has now been set on the labours of those officers and others who, ever since the last months of the War, have been at work on the problem of providing the army with an up-to-date pontoon equipment; and we must heartily congratulate them on the outcome of their efforts.

II.—Now that we have got our pontoon park, it is very necessary that we who will have to use it in war should make a present study of its attributes. Unfortunately, in peace-time it will probably never be seen on any road in all its full mile-long majesty; and there is, therefore, perhaps, rather a tendency on manœuvres or when doing tactical schemes to say "the pontoon park (or necessary portion thereof) will report at the point X at a fixed hour," assume that it does so, and then pass on to other matters, without paying any further attention to the park as such.

The object of this article is to show, by means of a few examples chosen at random, how varied in point of fact are the problems connected with this unit.

III.—Consider firstly this quotation from *Engineer Training*, Vol. II, 1926, Chapter VIII, Sec. 61, 4, p. 118:—

> "It is the duty of the corps staff to send forward to the points decided upon for crossings as much of the pontoon bridge park as may be necessary, to ensure its timely arrival, and. . . ."

It is a fundamental maxim of supply in war that the rear should keep the front supplied with what it needs ; and that no one in touch with the enemy should have to go back to fetch what he requires. This principle naturally applies to pontoons as much as to any other requirement, and the paragraph quoted above makes this quite clear. Read quite literally, however, the words might be taken to mean that at a given hour, fixed in advance, the corps staff will deliver the whole of the required equipment right on the actual site of the bridge. Such a procedure is, of course, not practicable, and is not intended. The man who is going to build a bridge in the face of the enemy must have full control of his bridging equipment some time before the work actually starts ; in order that he may look it over somewhere secure from enemy interference, see what he has actually got to do his work with, make sure that the pontoon park personnel understand fully what is required of them, and be in a position to order up each vehicle to the site of the bridge at what he considers to be the psychological moment. It is essential that there be no question of divided control, and that, some time before the operation begins, the R.E. officer who is to build the bridge should assume full responsibility for the equipment he is going to use. How, then, is this to be assured ?

It is suggested that the actual procedure should be for the C.R.E. of the division which is to make the crossing to select a suitable rendezvous in the divisional area, some way back from the river, and for the corps staff to be responsible for its timely arrival at this point. From then on the C.R.E. (or officer appointed by him) is to have full control over the equipment ; and in particular, the R.A.S.C. officer of the park must take his orders from him. Divided responsibility for the safety of the equipment between the corps staff, the R.A.S.C. officer of the park and the divisional engineers must be avoided at all costs if the operation is to be a success.

The question of what constitutes " timely arrival " is one of the first that the R.E. officer is called on to answer in work of this sort. The considerations affecting it are too numerous to be discussed here. The normal case, however, is that in which bridging is to be undertaken at dawn, and it is suggested that, as a rule, the pontoons should report at the divisional rendezvous the night before, so soon as they can be got up under cover of darkness from their back position in the corps area.

IV.—" . . . as much of the pontoon bridge park as may be necessary. . . ."

Who decides how much is necessary ? It is not unusual to assume that the divisional engineers reconnoitre the river which is to be crossed, and then indent on the chief engineer of the corps for what

they require. This is the normal procedure in the case of R.E. stores.

In the case of bridging equipment, however, the amount available may quite likely be the vital factor that decides what course operations are to take. The staff cannot write their orders until they know whether they have enough pontoons with which to effect their purposes; and the engineers cannot say how much they want until they know what they have got to do. The ideal solution is a thorough general reconnaissance by both the staff and the engineers, a round table conference of corps and divisional staffs with their engineer advisers, a preliminary plan; and then a detailed reconnaissance by the engineers of the sites selected for bridging in this plan. This last report will show whether there is enough equipment available for the plan to be put into effect.

In practice, this procedure will often have to be considerably curtailed; but the underlying principle that the engineers cannot take independent action will always stand good. Seeing that the park is an R.A.S.C. unit, it is doubtful even whether the chief engineer will exercise any direct control over it at all.

Even in an urgent crisis, such as the destruction of part of the equipment supplied to him, the C.R.E. who wants more had better go straight to division headquarters, and leave the responsibility for getting what he needs in their hands.

While the need for the closest liaison and the exchange of ideas and information between the chief engineer and his C.R.E.s will remain, in order that they may not tender conflicting advice to their respective staffs in regard to the bridging situation, it would appear that the actual demand and supply of the equipment required should be entirely a staff matter.

V.—*Engineer Training*, Vol. II, Chapter VIII, Sec. 61, 4, p. 118, says:—

> "In order to keep bridges in action, 50 per cent. of spare material . . . will normally be required."

This is a hard saying, and if it is to be adhered to, requires to be brought much more prominently to the notice of staff and sapper officers. In the S.M.E. *Notes on Engineer Organization*, published in September, 1929, where the alternative spans that a pontoon park can provide are set forth, no mention is made of this 50 per cent. Surely this omission conveys a false impression. The pontoon park cannot, for example, provide 6 heavy bridges of 105 feet each and 50 per cent. of spare material as well. It is very necessary that this point should be stressed in all tactical schemes, so that it may become universally recognized.

VI.—The study of the art of camouflage is one of the duties of the R.E. officer, and an excellent subject for study is the pontoon bridge park.

When it is required to move the 121 four- and six-wheeled vehicles under consideration, they can only be concealed by moving them at night. The question is how to conceal them in the day-time. The stock solution is to " hide them in the woods " ; but woods are not always available, and a loaded pontoon wagon cannot be driven into every kind of wood. The first precaution to take will obviously be to split the park up into as small packets as the necessity for control will allow. It may be said that when this has been done the park must take its chance with the rest of the corps transport. Consider, however, the situation when the enemy have decided to defend a river line. Their mechanized field companies will have had no difficulty with their great mobility (if adequately provided with explosives) in destroying all the bridges over the river. Only one move will be open to us ; we must force the crossing. Momentarily our bridging equipment will be our most treasured possession. Therefore, the enemy will try by all means in his power to destroy it. The great bulk of the wagons will make them easily distinguishable, and some form of camouflage for them is clearly essential. It should not be left to the ingenuity of the park commander to improvise this ; he ought to be provided with a standard form of camouflage equipment specially devised to meet his peculiar needs.

VII.—Some method requires to be devised for supplying the pontoon park on mobilization with personnel who have had experience in the work of mending damaged pontoons.

The work is done in peace-time by ordnance artificers, whereas in war it will presumably be done by the R.E. personnel attached to the park. Few R.E. officers or men have any experience of this work, and though it does not involve a very high degree of technical skill, it should not be entrusted to those who have no previous experience of the processes involved. Arrangements, too, must be made for the park to carry the special materials required for this purpose.

VIII.—The equipment of the pontoon park having now been decided upon, it might be worth while considering the question of our divisional bridging equipment again. The writer cannot lay his hands on the reference ; but he is sure that the two trestles carried by the field park company were intended for bridging dry gaps only. Officers outside the Corps are quite unaware of this restriction. They naturally have little conception of the difficulties involved in launching the service trestle in deep water without the aid of pontoons, and imagine that there are 63 feet of medium or 42 feet of heavy bridge immediately available for any kind of gap that may be encountered

by a division. While it is possible to slide out the trestles on two wire ropes, stretched from bank to bank, the method is slow and the wire rope is not part of the standard equipment.

It is suggested that the present situation is too misleading, and that four pontoons should be carried in addition to the existing equipment. The divisional staff will then know that they have 63 feet of medium or 42 feet of heavy bridge immediately available for any kind of gap; and we shall be relieved of any suspicion of making unnecessary difficulties.

IX.—Any R.E. officer, when asked how long it will take to build a bridge on a site selected from the map, will reply at once that it depends on the approaches. Now that we have got our standard bridging equipment, is it beyond the bounds of possibility to devise a form of portable standard approach road? Even if it proved to be too bulky to be carried as part of the pontoon park equipment, which is the ideal to be aimed at, there are many occasions when it would be used if it could be drawn like other R.E. stores from the Corps dump. It is understood that some progress has been made on these lines by using a mat made of chestnut paling. With the complete disappearance of horsed transport, the problem will be immensely simplified, since all that will then be required will be a pair of parallel tracks, laid on the ground axle length apart.

X.—It is hoped that these notes have demonstrated how well deserving of study are the manifold problems connected with the R.A.S.C. Pontoon Bridge Park.

If there be any very out-of-date matter in what has been written above, the writer pleads in mitigation of criticism that Hong Kong is a long way off from such centres of advanced thought as Aldershot and Chatham.

STANDARD TESTS OF FIELDWORKS TRAINING.

By LIEUT.-COLONEL L. V. BOND, R.E.

THE writer was fortunate enough, some years ago, to hold the appointment of Superintendent of Instruction to the K.G.O. Bengal Sappers and Miners. As such, he had, among other duties, the charge of the fieldworks training of the recruits.

The recruits' course was a good course, and covered a wide range of subjects. It was organized on the basis of "periods"; so many days for one subject, so many days for another; so many days for examinations. The Superintendent of Instruction and his fieldworks staff watched the recruits at work and periodically examined them. The recruits worked hard: the Superintendent of Instruction and his staff spent many tedious hours in examining them. The majority of the recruits obtained the 50%, or whatever the pass marks were; a few only were put back.

It seemed as though the recruits, as a body, were well trained, but the Field Companies thought otherwise: there were rumours that some of the recruits did not know the rudiments. What was the remedy? To increase supervision? To increase examinations? The S. of I., a congenitally idle officer with a very full job, shrank from these solutions. What was the alternative?

Turning the matter over in the mind, the question arose: Surely there must be many subjects in which a recruit, to be worthy to be called a "trained sapper," must have a 100% knowledge? What is the use of a 50% man at wiring; what is the use of a man who only knows 50% of knots and lashings?

Then another question arose. Does a recruit who gains 50% or even 66% of marks know 50% of what he ought to know in each of the necessary subjects? Is it not possible that he knows 100% of some and nothing per cent. of others? What guarantee have we that he knows or has ever learnt any particular essential?

The answer to every question was unsatisfactory. The questions which were then forced on one were: What, after all, are the essentials of a sapper's knowledge? What are the "Things which every young sapper should know?"

These questions gave a line on which to work, and from them was evolved a series of "Standard Tests" for recruit training. Some of these are given in the Appendix of this article. Some will be seen

to be progressive, *e.g.*, Nos. B (4) and B (5); these were applied at different stages of the recruit training. The majority were absolute.

A record was to be kept of the tests, and a recruit before passing out had to pass in every test, and a pass meant 100%.

Notice in tests Nos. B (20) and B (25), the words "Without hesitation." One who hesitates is imperfect in his knowledge and will forget quickly. "Without hesitation" means, or should mean, ingrained knowledge and manual aptitude.

The tests were found to have a further advantage. They gave a perfectly definite objective to the instructors and to the recruits. A clear objective which could be recognized when it was reached, an important point in objectives whether tactical or otherwise. The tests added a snap to the training and marked out a perfectly clear line of stepping stones to perfection.

Moreover, they greatly reduced the labour of the examining staff. A definite and constant routine, which allowed of the rapid testing of a batch of recruits in a group of tests, soon framed itself. There was the danger that the thing might become mechanical; but the danger was greater that weariness on the part of the examiner and nervousness on the part of the recruit might make the old examination superficial.

One, anyhow, had the feeling that one knew what the recruits had learnt, and to what extent they had learnt it. There could be no evasion through absence or other causes. That, at any rate, was a step in the right direction.

It is permissible to draw attention to the catholic nature of the tests. When one came to work out "What every young sapper should know," one was forced to the conclusion that no sapper could be worthy of the name who could not handle simple carpenter's tools, make mud bricks, build a rough wall and make or unmake a pipe joint.

The recruit course did not end with these standard tests. In addition to knowing the elements of individual sappery, the recruits must learn to apply them collectively. They must learn to watch the instructor; to watch the weight; to handle heavy lifts; to heave together; to work at the double; to work at a height; to be horny handed, alert and nimble; to be resourceful and experienced. That is to say that we must introduce into the course, in addition to things to be learnt (standard tests for individuals), things to be done (standard tasks for recruit squads).

Among the innumerable tasks which we might set, which shall we choose, since time is short? Trestle, suspension, cantilever bridges? Macadam or slab roads? The answer is that it does not greatly matter so long as the task is calculated to teach the qualities which we desire. A trained sapper can apply himself readily to any job

provided that his officers and N.C.O.s know and can explain what is wanted.

But we are wandering from our subject of standard tests. Let us admit, as we surely may, that they are good for recruits. Are they of use to trained sappers during the individual training period? We believe that they are. Not, however, as tests after instruction, but as a test before instruction. Try out the section or half-company; discover who the weaklings are; give them extra instruction; don't bore those who know with teaching them what they know already. Expose the "dud" who so often escapes notice.

Ensure at the same time that our N.C.O.s know these elementary matters. Can we swear that they do? We doubt it. Are there any standard tests for them? Can we fix a standard? Are the qualifications for a L.-Cpl. on the general roster capable of definition? We believe that they might be, and have even made the attempt to define them, but not for inclusion in this paper.

One last word on the recruits' standard tests. The Territorial recruit and trained sapper is perforce an intermittent soldier. He may turn up at the Drill Hall for half an hour at any time. He may turn up with a dozen others each at a different stage of instruction. What is the harassed instructor to teach him? What does he know? Surely a "Sapper's Record Book," showing what standard tests he has passed and what he has yet to pass, would answer these questions? Its empty spaces would convict the sapper of ignorance; and not realizing how much one doesn't know is one of the things which handicap the Territorial sapper.

(Extract from draft of *Indian Manual of Military Engineering.*)

SOME STANDARD TESTS SUITABLE FOR USE IN RECRUIT TRAINING.

(Sappers and Miners and Pioneers.)

A. Field Geometry.

(1). To measure the distance between two points (not less than 10 ft. apart) with a 4′ rod, correct within an inch.

(2). To lay out a given distance (not less than 10 ft.) with a 4′ rod correct within an inch.

(3). To measure accurately the distance between two points with a measuring tape.

(4). To lay out a given distance with a measuring tape.

(5). To measure distances of 3″, 6″ and 9″ with the hand, and distances of 1′, 2′, 3′, 3′ 6″, 4′ 6″ and 6′ 6″, using hand, foot and pick handle.

(6). To drive in a peg level with a given peg, using a field level.
(7). To lay out a right angle from a given line with a field level.
(8). To hold a picket at a slope of 4/1 and 6/1 using a field level.
(9). To lay out a right angle with a measuring tape by the 3, 4, 5 method.
(10). To lay out a right angle at the end of a given line by eye with an error of not more than 5 degrees.

B. FIELD DEFENCES AND USE OF TOOLS.

(1). To drill and march correctly and silently with pick and shovel.
(2). To carry out digging drill correctly and to know the reason for each movement.
(3). To understand what is meant by a clean "face" and "base" and explain their value by demonstration.
(4). To excavate correctly and methodically, keeping a clean "face" and "base" in a standard trench with sloped sides, in average soil 80 cubic feet in 4 hours by day, 60 cubic feet in 4 hours by night, the rest pauses being signalled by the instructor.
(5). As in (4), but to excavate 100 cubic feet in 4 hours by day, 80 cubic feet in 4 hours by night, judging their own rest pauses.
(6). In average soil to excavate a trench 5′ x 3½′ x 1½′ in one hour, throwing all earth over a line 10 feet from the front edge of the trench.
(7). As in (6), but to throw the earth over a screen, 6′ high, placed 5 feet from the front edge of the trench.
(8). In average soil, working alone, to excavate a trench 3′ x 3′ x 2½′ in 40 minutes.
(9). Working in a party of three with one pair of tools and changing round every two minutes by the whistle, to excavate in average soil 40 cubic feet of trench in 18 minutes.
(10). To use a crowbar and fulcrum to shift a weight by the 1st and 2nd methods (see *I.M. of F.W.*, sec. 132).
(11). To saw through a 10″ x 5″ sleeper deodar or chir sleeper to a line with a hand saw in two minutes.
(12). To saw down 2′ in 1″ deodar or chir plank to a line in one minute.
(13). To point a 3″ sal picket correctly with a hand axe in 1½ minutes.
(14). As in (13), but to use a basulah (a small adze).
(15). To drive three 4″ wire nails *in succession* straight into a deodar sleeper.
(16). To make a 1″ auger hole through 9″ of deodar straight.
(17). To drive an anchorage picket at a correct slope in good style, 3′ in average soil in 2 minutes.
(18). To fit a 15″ bolt with two washers through a 12″ timber and nut up tight, using an adjustable spanner, in 45 seconds.
(19). In a pair, changing round, to bore holes not less than 2′ 6″ deep, with jumper or boring bar in . . . minutes, according to nature of rock or concrete.
(20). To prepare holes for and to drive and draw screws with a screw-driver, without hesitation and without damaging screwhead.

(21). To extend for work on task 1 of a standard fire trench, marked by a single tape, by the first and second methods (see *I.M. of F.W.*, sec. 46) by day, to lay out arms and equipment correctly and to mark out his task.
(22). To extend for work by either method on a standard 6′ communication trench, to lay out arms and equipment correctly and to mark out his task, allowing for the slope of the sides.
(23). Given the direction from which the party is working, to screw in long and short screw pickets correctly.
(24). Given the direction of the enemy, to drive in long and short angle iron pickets correctly.
(25). To make all the knots required in wiring *without hesitation.*
(26). In a standard party, to erect 50 yd. of Double Apron Fence with screw pickets in 35 minutes by day, in 40 minutes by night.
(27). As in (26) but using angle iron or wooden pickets.
(28). In a standard party, to carry out the stores for 50 yd. of D.A. Fence 40 yd. and to erect the fence with screw, angle iron or wooden pickets, in 40 minutes by night *silently.*
(29). In connection with the above, to know how to act when a Véry light is fired.
(30). In a party of three, to make up and prepare for carrying a concertina in 30 minutes.
(31). In a standard party, to erect 50 yd. of a double belt of concertinas by day in 30 minutes.
(32). As one of a pair, changing round after 5 minutes, to fill correctly 12 sandbags in 10 minutes.
(33). As a party of two, to build in a revetment correctly 45 sandbags in 30 minutes.
(34). In a party of 4, changing round correctly, to carry forward a 6′ 6″ sap, in average soil, 3 feet in 40 minutes, the earth being thrown out.

C. Bridging and Use of Spars.

(1). To make the knots shown in Plates 109 and 110 of the *Indian Manual of Field Works* and to know their uses.
(2). To make the remainder of the knots given in the *Indian Manual of Field Works* and to know their uses.
(3). To whip the end of a rope with twine.
(4). To make an eye splice.
(5). Being given the direction of the strain, to lash a leading block to a spar.
(6). To " mouse " the hook of a block.
(7). To reeve a 3/3 tackle and to attach an anti-twister.
(8). To make a square lashing.
(9). To make a diagonal lashing.
(10). To fit a thimble to a 1½″ wire rope with screw clips.
(11). Heaving alone on a 3″ fall through two leading blocks to raise a weight of 75 lb. 10 feet and to lower it slowly.

(12). To climb without boots up a 6" vertical post to a height of 15 feet in 3 minutes.
(13). As one of a party of three, to assemble 3 bays and 2 piers of standard assault bridge in 1 minute by day, 3 minutes by night.
(14). To know the names and purpose of all parts of a normal pontoon bridge.
(15). To know the names and purpose of all parts of a trestle.
(16). To row in good style, pulling his weight.
(17). To make fast a rack lashing.
(18). To make fast cable and buoy line to anchor and buoy.
(19). To heave a 48' breastline to within 1 yard of a picket at a distance of 40 feet.

D. ACCOMMODATION.

(1). To mould mud (*kacha*) bricks at the rate of one a minute.
(2). To build a pillar of sun-dried bricks in mud, 4 bricks long, 1½ bricks thick and ten courses high, in correct bond with square corners, vertical faces and straight joints.
(3). To know the names of water supply stores and their uses.
(4). To fit a Lift and Force pump with 1 length of delivery hose, 1 length of suction hose with foot valve in 3 minutes.
(5). To know the maximum lift of the pump and how to start it to work.
(6). To fold and lace the corners of service tanks and troughs.
(7). To use the pipe wrenches carried by his unit.

E. COMMUNICATIONS.

(1). On a hill road or sloping ground, being given his two end points, to know how to get to work.
(2). To know the names and uses of the various tools and Light Railway stores used in constructing curves and straights.

F. EXPLOSIVES AND DEMOLITIONS.

(1). To know the names and uses of stores used in the firing of gunpowder, guncotton and dynamite by fuze or electricity.
(2). To know the precautions necessary with each of the above explosives and stores.
(3). To cut and light a length of safety fuze and to know the right time and manner of burning.
(4). To make an insulated joint in two insulated cables.

Note.—" By night " means a clear but moonless night.

SAPPER OFFICERS IN WAR—A REPLY.

By MAJOR E. E. NOTT-BOWER, M.C., R.E.

I.—There seem to be certain points in connection with Major Everett's article, " Sapper Officers in War," in *The R.E. Journal* for March, on which, if an unbiased view of the situation is to be obtained, more requires to be said.

II.—His second paragraph contains the following :—" It has been suggested that our Corps might, with advantage, be split into two branches, one of which, the ' Royal Horse Engineers,' would specialize in field works and tactics, and would provide the divisional engineer units, while the other, the ' Royal Skilled Engineers,' would man all the technical units, but there are many insuperable objections to this.

" Firstly, what would happen in the senior ranks ? The two branches must come together under one head at some stage. Let us assume that they meet at the Chief Engineer of the Corps ; and suppose that the Chief Engineer had spent all his days in peace studying electricity : how much use would he be to his General in war ? Or suppose that he had never in peace dealt with anything more abstruse than the building of a box-girder bridge : how could he advise on an electric light scheme for Corps dumps ? "

The two latter questions may be answered as follows :—(1) The Chief Engineer would not have spent all his time in peace in " studying electricity." He might (as is indeed the case under the existing system) have spent a large proportion of his time in engineering work involving a detailed knowledge of electricity, and he would be none the worse Chief Engineer for that. Practical electrical engineering work in peace-time necessitates not only an ascendancy over the intricacies of electrical theory, but also a sound knowledge of general engineering, and the exercise of precisely those capabilities of foresight and careful organization which are required of a Chief Engineer in war. His military knowledge would have been acquired primarily at the " Shop " and Chatham, and subsequently by attachments, at suitable intervals, to the " Royal Horse Engineers."

(2) The Chief Engineer who had never dealt with anything more intricate than a box-girder bridge would not exist. The highest technical appointment open to a " R.H.E." officer might well be C.R.E. of a division. The general engineering knowledge required of him would be derived, after the " Shop " and Chatham training, from attachments to the " R.S.E." In respect of his attainment of higher rank he would be on the same footing as a cavalry or infantry officer. Similarly the " R.S.E." officer would be restricted, in the higher ranks, to technical appointments.

III.—Major Everett's article continues as follows :—" Secondly, it is wrong to suppose that the Field Company will never have to do any technical work at the Base or on the L.-of-C. For example, in Mesopotamia, in 1915 and 1916, there were, to begin with, no R.E. units except Field Companies, the officers of which had to deal with all the technical work involved in getting Basra into shape as a Base, and also had to do all the survey work : the officers of at least one of the field companies in the Lahore Division were very largely employed on survey in 1916."

It is admitted that, in the initial stages of a war, field companies would be called upon to carry out all sorts of jobs—railway work, survey, water transport, road construction, etc.

Is it contended that, under the present system, the average Sapper officer acquires a working experience of all these things? With the possible exception of road construction, he probably sees none of them after he leaves Chatham.

IV.—Is it not possible, then, that the objections to some such division of the Corps as that referred to and dismissed by Major Everett are not, after all, " insuperable " ?

Generally speaking, every officer on leaving Chatham would thereafter specialize either as a " R.H.E." or in one of the sub-divisions of the " R.S.E."—Military works, E. and M., railway and survey—his general engineering and military knowledge respectively being maintained by " attachments."

V.—Admittedly no economy in the *training* of officers would be effected. E. and M., survey and railways are already in a great measure specialized, but military works are not, and it is here that Government would reap a rich reward in getting its work done by officers who really knew the job.

The present system of filling all those military works posts, both senior and junior, for which, in their civil counterparts, men would be required who had directed their whole training and energy to no other end, by a succession of Sapper officers, some who take an interest and some who don't, some who do it once and some twice or more, cannot fail to represent a very serious loss to Government.

VI.—But specialization has more to be said for it than this. Morale is pre-eminently a war quality, and may be defined as the self-confidence born of efficiency ; but it is a quality which must be built up in the individual in peace. An officer who is appointed to a succession of jobs of which (though he may have a nodding acquaintance) he has not a real bedrock grasp, is liable to have his morale undermined, and to develop a habit of bluff to his superiors and dependence on his inferiors. One who, on the other hand, by a thorough and complete grasp of his permanent peace-time job, has acquired a very justifiable self-confidence, is better fitted in war, by the character thus built up, to assume heavy responsibilities.

THEORETICAL MILITARY TRAINING.

By Bt. Lieut.-Colonel R. H. Allen, m.c., R.A., *p.s.c.*

It has fallen to my lot for the past four years to be concerned in the setting and correction of trial tactical papers for practice by intending candidates for the Staff College. These few notes have accordingly been compiled in the hope that they may assist future candidates to avoid what appear to have been the weakest points in their predecessors' efforts.

Four years ago the most marked weakness lay in an absence of "technique." When confronted with a request to write an operation order, many showed an almost complete ignorance of the correct form. Errors in the abbreviations, details such as writing "E of DEAL" in lieu of "E in DEAL" abounded, while those who really could differentiate between Object and Objective could be counted on the fingers of one hand.

This particular error is really not to be wondered at, as even a prominent soldier crammer publicly confused the two in the course of a lecture delivered at the School of Military Engineering. Latterly, however, the hesitation between these two has disappeared, partly, I hope, on account of a certain illustration of the difference—which illustration it is not convenient here to relate.

But from year to year the technique has improved, and this year mistakes of this sort are very few and far between. This is almost certainly because anyone can lay his finger on a tangible mistake such as an incorrect abbreviation and say definitely, "This is wrong, *vide* Regulation XYZ."

My own belief is that because failings of this description are failings on a point of fact, while tactical failings are failings on a point of opinion, officers have been definitely strafed for the one, but rather hesitatingly corrected for the other. So far have we advanced from the days when tactics were defined as the opinion of the senior officer present on the spot.

Consequently, in the natural effort to protect themselves where they are most hurt, officers have concentrated on technique to the marked absence of application to "tactique."

This failing is enhanced by our official method of theoretical teaching of the art of war. Tactical instruction is given to the young of the R.A. or the R.E. at the Schools at Larkhill and Chatham, but

only a minute dose; after a brief period of illumination they are thrown to the slender resources of a commanding officer.

The young of the infantry are never permitted at all to imbibe from a tactical milk-bottle. Their tactical instruction commences in a unit and is entirely dependent upon the capacity of the individual commanding officer.

Now a commanding officer may be a most admirable commander —without any capacity whatsoever for imparting knowledge. Qualities may be inherent in himself which he may find the utmost difficulty in explaining; further, the recipients of his instruction are all on different rungs of the military ladder. The scheme which may be most suitable for the senior subaltern on the third rung is far above the head of the second-lieutenant who is groping for his first foothold.

It may be urged that a reasonable familiarity with the tactical doctrine of the army may be acquired by an intelligent perusal of *F.S.R.* But useful though these are to the expert, yet the penetration of their meaning is for the novice an appalling difficulty. Even the expert suffers from a certain embarrassment, witness the necessity for the interpretation of paragraphs disseminated in *Training Memoranda*, or issued by the G.S. of commands as the translation of that particular C.-in-C.

In fact a very pretty "Case Law" has sprung up. In the pages of the *R.A. Journal* it has been thought seemly to publish a review of the latest *F.S.R.*, presumably because the differences between it and its predecessor required elucidation.

Now a manual of this description is clearly a necessity, and the best brains in our army have been compelled to its compilation, yet, as I have shown above, the interpretation of its doctrine is fraught with difficulty even to the expert, as it is quite impossible to confine tactical doctrine within clearly-defined and rigid laws.

You cannot say, "In this particular operation the correct function of the reserve battalion is to act thus, *vide F.S.R.*, para. 3,000," in the same way as you can definitely say, "The correct designation of this unit of the Royal Artillery is 100 Fd. Bty. R.A., *vide Notes on Abbreviations, etc.*, para. 50."

It may or may not be on this account, but anyway the papers that I have corrected during the past two years have largely failed in tactical application. The concentration applied to the technique has been so marked that the less consideration of tactique stands out in contrast.

In the case of the few who show signs of having concentrated upon tactique, the method of their concentration appears to have been misdirected.

They approach their problem exactly as do the directing staff at a military exercise. That is to say, you can almost hear the creaking

of the mental wheel as it slowly revolves and endeavours to turn out a solution that will exactly conform with a para. of *F.S.R.*, rather than the one which will produce the most profitable result in war.

I suggest that the way to approach a tactical problem is that of Verdy du Vernois. Cast aside all your academic knowledge, do not hastily pull out your well-thumbed *F.S.R.* and see whether the position you hold is ground vital to the defence as defined in para. (A) or ground vital to the conduct of the battle as defined in para. (B). All this you have read and pondered over in the past and it should now be assimilated by your digestive juices so that you possess a well-nourished mental perception prepared to deal with each case on its merits.

Say to yourself, as did Verdy du Vernois, "*De quoi s'agit il?*" Next, "Where can I hurt the enemy most and where can he hurt me most?" Once you have the answers to these three questions finally fixed in your mind, you can then decide on your course of operation. Incidentally, if you care to equate your mental process in academic terms, you will be surprised to find that you have appreciated the situation by fixing in succession Object, Factors, Plan.

Now statements made in general terms, such as I have made above, to the effect that the application to "tactique" is wanting are very much simplified by an illustration. I always feel that the greatest stumbling block to the understanding of *F.S.R.* is the complete absence of concrete example; it is almost as marked as the absence of humour in the Holy Writ. The reason for its absence is, of course, obvious, that it is most dangerous to illustrate principles intended for general application by a particular instance. For the uninitiated will continue to apply that particular example to totally dissimilar situations. Still to support my own general statement, I can give a particular example. The last paper which I set had to deal with rearguards and retirements. An unfortunate general was, at 6 o'clock on an autumn evening, suddenly required to withdraw his division a matter of 14 miles as expeditiously as possible. Ninety per cent. of the candidates concentrated upon the technique of the withdrawal, the precise occupation of rear positions as laid down in certain sections of *F.S.R.* They accurately worked out the time and space problem as to where the head of the withdrawing columns would be at daybreak. But 90 per cent. completely missed the crux of the problem. For at daybreak the head of these columns would exactly be entering a defile which was further complicated by a river in the middle with a single bridge. Whether it was advisable in the interests of urgency to continue to cross the defile by day in face of certain violent air attack or whether it was preferable to lie up in some conveniently situated woods and wait till nightfall for the passage was a consideration that appealed to few. As for the air

defence problem, whether you can defend against air attack better by day or by night, this attracted no attention at all except from certain bigoted experts from Biggin Hill, who delighted in pointing out that the correct proportion of searchlights to guns according to our rules had not been observed by the propounders of the problem.

Another minor point that showed the desire to keep strictly between the rules as laid down by precedent, was the exception taken by many R.A. officers to the allotment of the C.R.A. of the Division to look after the artillery of the rearguard. Apparently their reasoning was that this must be unsound, as it was not anywhere pre-ordained in either *F.S.R.* or *A.T.*, Vol. III. As the Babu always puts it against your legitimate claim for financial compensation, "The matter is unforeseen and therefore the claim cannot be allowed."*

Some candidates, not satisfied with confining their own action within the rules of our manuals, were most insistent that the enemy should do the same. For when it was suggested that the enemy might make use of fighting aircraft to attack his foes, they pointed out that if the enemy should do so he would directly contravene one of the rulings in our "Case Law," namely, "The normal use of fighting aircraft is to fight for superiority in the air and single-seater fighters will seldom be available for attacks of this nature."

And yet the surly Siberian plods across his frozen tundras all unwitting of the recent demise of a Principle of War, while the peripatetic Pathan prances down the Bara Valley still muttering in his ignorance, "Infantry is the arm that in the end wins battles."

I am sure that it will pay future candidates for the Staff College to give more attention to this vital point—tactique. Naturally a great deal may depend upon the mentality of the individual selected to set the papers.

You may strike a pedant who ascribes a particular value to the technique which he dignifies by the title of "Staff Duties," but from what I know of the generation of officers from whom the puzzle-producer is likely to be drawn, I venture a guess that a solution likely to meet military realities rather than to square exactly with some paragraph of the Regulations is the one that will bring most grist to your mill. This is the purely commercial aspect; from the point of view of the improvement of your capacity for war, well, your military soul is your own to save.

* I must admit that it is with a certain unholy joy that I can now quote a precedent to these objectors, as "Case Law" has come to my rescue since the setting of this problem. Those who are sufficiently interested can turn to para. 23 of *War Office Exercise No.* 3 of 1930, and will there find a precedent for this distribution of the C.R.A.

TEMPORARY PIERS IN OPPOSED LANDINGS.

By CAPTAIN W. G. R. NUTT, M.C., R.E.

AN opposed landing is accepted as being one of the most difficult operations to organize in war; let anyone who doubts this study the *Official History of the Gallipoli Campaign.* Let him note, among other points, that the 29th Division and the Royal Naval Division from England had to be diverted to Alexandria, put ashore, re-sorted and re-packed; let him note that the allied fleets and transports were too numerous to be accommodated in Mudros Harbour, which is comparable in size to Plymouth Sound; let him note that only 28 guns were landed in the first three days at Helles to support a force of over 1½ divisions. In future wars, owing to the menace from the air and from submarines and to the need for co-operation with the R.A.F. as well as the Royal Navy, such operations will be even more difficult to organize.

The problem of constructing temporary landing piers is fraught with no great technical difficulty except in waters with a large range of tide, but the organization required deserves more careful study.

CLASSIFICATION OF TEMPORARY PIERS.

The purpose of a temporary pier will vary somewhat with the operations. *M.M.E.*, Vol. III, classifies temporary piers as:—

"(i) A pier which can be constructed rapidly on the beach to enable fighting troops and their transport to land from small lighters and similar craft.

"(ii) A pier which can be constructed within 48 hours at which lorries, medium artillery and aeroplanes in cases can be landed from lighters of a gross weight of 100 tons."

This appears open to criticism for two reasons:—

(*a*) A pier to accommodate lighters of 100 tons can usually be built in one or two hours.

(*b*) Light lorries are part of the normal transport of the fighting troops.

The question as to whether the first pier built should take a full medium load, including three-ton lorries and 60-pdr. guns, is considered further below, but it will be shown that the first pier can

usually be arranged to accommodate 100-ton lighters and to take a 3½-ton axle load. This axle load includes light lorries and horse-drawn 6-in. howitzers.

If an aircraft carrier is available, it should be possible to uncrate and assemble machines on board the carrier and to fly them off to the aerodrome without interfering appreciably with her capacity for fleet air arm flights or their efficiency. The problem of landing heavy cases at the temporary pier will not then arise.

TACTICAL CONSIDERATIONS.

That it is impossible to construct a pier under direct machine-gun fire is proved by the failure of the landing from the *River Clyde*, on April 25th, 1915, at Helles. The *River Clyde* was a collier specially prepared to be run aground. She mounted a battery of machine-guns forward with sandbag protection. Large openings were cut in both sides of the ship to give access by wide gangplanks to a platform rigged under the bows; the gap from this platform to the shore was to be bridged by three lighters connected by gangplanks. Within 13 minutes of grounding the lighters were held in position by a few officers and men in the water and disembarkation commenced, but machine-gun fire was opened from both flanks and with casualties to the men in the water the lighters drifted apart. Connection by single plank from lighter to lighter was not established for another 2½ hours, although such heroic work was done that no less than five V.C.s were awarded. Troops disembarking experienced such terrible casualties that disembarkation was eventually postponed to nightfall. R.E.s were not employed, the work being carried out by the navy.

In the writer's opinion, it would also be impossible to construct a pier under observed indirect machine-gun fire or the observed fire of well-trained artillery without incurring prohibitive casualties. On the other hand, the landing at Anzac Cove on the same day, where an excellent landing stage was constructed, despite continuous but unobserved shrapnel fire, goes to show that pier construction can be started as soon as the enemy can be denied direct observation.

Where the covering force is landing under the protection of darkness, there is a strong case for constructing a pier before dawn. As the transports will have to keep well away from land on the previous day in order to secure surprise, only a minimum of time will be available before dawn, but under normal conditions and with good organization it should be possible to complete the pier within an hour of materials reaching the shore. This could not be done in war unless the covering force had driven the enemy from his positions in observation of the beach; casualties from observed artillery fire would be too heavy. The correct procedure would appear to be to

withdraw from the pier at dawn and to leave it unattended except for a small maintenance party under cover; no attempt would be made to work the pier till the infantry had secured the observation posts. It is probable that the enemy artillery would not attempt to destroy the pier unless it was being used; many far better targets, such as the landing of the main body, would present themselves. In any case a large concentration of artillery would be required to effect damage that could not be quickly repaired.

It is hardly necessary to stress the fact that the troops cannot develop their full efficiency until their artillery and transport have been landed, and that every effort must be made to have a pier ready as soon as it could be used. To build a pier before dawn is to steal a march on the enemy and to gain invaluable time.

Technical Considerations.

(*a*) *Bottom.*—Except in a flat calm, troops can only be landed in ships' boats on sandy or shingly beaches. Such beaches will, therefore, usually be available for temporary piers, so that in normal cases pontoons and barrel piers can be grounded. The locality selected must obviously be protected from the weather in some degree and under such conditions marked changes of slope in a sandy beach are unusual.

(*b*) *Tide.*—Tide is not quite such a formidable obstacle as at first appears. We are a little apt to forget that tidal variations round the British Isles are considerably above the normal. A study of the Admiralty tide tables will reveal the rather startling fact that, although the tide range round Britain averages about 15 feet, half the world has an average range of under 5 feet.

Tides in excess of five feet are a difficult proposition unless floating piers can be grounded. The question of tidal ramps is dealt with in *M.M.E.*, Vol. III, and will not be further considered in this article. It is obvious that the more complicated cases of tidal ramps would take so long to construct that they would be out of the question for getting ashore the transport and guns of the fighting troops, and that a simple pier for use at high water only would usually be the first requirement. This could subsequently be extended at high water level till there was enough water at low tide for lighters to come alongside. Vehicles and stores would then be lifted on to the pier by a crane on the pier head or on a special lighter. It may be noticed that alteration in bridge length, which is one of the difficulties in tidal ramps, does not appear in grounding floating supports in pier work.

Where tides do not exceed five feet and floating piers are not available, the variation can be taken up in a single bay between trestles and a pier head lighter; the details of the attachment of the road

bearers of this connecting bay to both pier and pier head lighter would have to be carefully worked out and previously tested. Another method where a trestle pier is used and there is a medium range of tide, is to extend the pier by a few bays as the tide falls, dismantling these bays again as the tide rises.

(*c*) *Slope of Bottom.*—Information on this point is very valuable, as it affects the length of pier required. 4 ft. 6 in. of water at the pier head is enough for naval pattern 100-ton lighters laden with horses and vehicles, though it might be barely enough for a lighter carrying a full load of ammunition; steam piquet boats draw 5 ft. of water. Information from charts will often be of value but a reconnaissance from some small craft should be feasible on a dark night; the final stages might have to be performed by swimming.

(*d*) *Sea.*—It will obviously be impossible to use a pier in anything of a sea even if the pier itself withstands it, so a sheltered spot must be selected. The pier head, however, should be made strong enough to withstand the bumping action of a lighter in waves about one foot high. The covering force and main body will usually land in cutters; this can only be done in practically calm weather, so no difficulty should be experienced during the actual construction of the pier, which will take place on the same day.

(*e*) *Current.*—The chief difficulty about current is that, if the proper allowance is not made for it by the navy, the pier may be landed at the wrong spot. For instance, the covering force at the Anzac landing, on May 25th, 1915, was carried a full mile to the north by an unexpectedly strong current. There are two precautions which can be taken to remedy this. The first is to measure the current during the reconnaissance referred to above, remembering that the current may vary with the tide, and the second, which should always be taken, is to land with the covering force an advanced party which will select the pier site and mark it by a screened light shining seawards.

TYPES OF PIER.

(*a*) *Pontoon.*—The writer has unfortunately never even seen a consuta pontoon, but it seems clear that the present pontoon equipment is ideal for the work. It is suitable for medium loads, and it can be used in tidal waters, provided that the slope of the bottom does not exceed the ruling gradient for traffic and that the bottom is suitable for grounding pontoons. A sandy beach will usually fulfill both these requirements.

Steel trestles may be required in conjunction with a pontoon pier, but they should not be used unless absolutely necessary, as they are clearly a much slower form of construction.

(*b*) *Barrel Piers.*—These are superior to pontoons as regards grounding, but inferior as regards load-carrying. It is doubtful if a

pier to carry even a 3½-ton axle load is a practical proposition. Each support for such a load would have to consist of at least nine 108-gallon casks; it would be 25 ft. long, require 8 in. x 8 in. gunwales and submerge an additional 2 ft. 3 in. under full load. A barrel pier might be a useful auxiliary for landing horse transport and for the evacuation of wounded.

(*c*) *Trestle Piers.*—Trestle piers with fixed transoms are only suitable when the range of tide is less than five feet, though as has been stated above, this is quite a frequent phenomenon. It has also been pointed out above that if a landing is to be attempted at all, sandy or shingly beaches must be available, and that in the sheltered water required to work a pier, marked changes of slope, hollows, etc., are not usually found, though occasional boulders may be encountered. The height of the last trestle will be about 7 ft., depending on the freeboard of the lighters to be used, and will be placed in 4 ft. 6 in. or 5 ft. of water. It follows, then, that if trestles are made up beforehand, with heights more or less in arithmetical progression up to 7 ft., a workable pier should result. Ample insurance against the unexpected can be made by providing a few spare trestles of different heights and by providing packing pieces to put under the ledger, or on top of the transom. A high trestle is, of course, dealt with by packing up those on either side, or in a serious case by changing over two trestles. The tremendous advantage gained is that time need not be wasted in taking sections, cutting and fitting trestle legs, and making up trestles. The only reconnaissance required is for one of the advanced party to wade up the line of the pier with a tape and a 6-ft. rod and report the length of pier required to reach 4 ft. 6 in. of water.

The above may seem a little revolutionary to the officer experienced in bridging as opposed to pier construction, but the writer is convinced from experience that it is perfectly sound. The underlying principle which permits the use of pre-constructed trestles in pier work but not in bridge work, is that the beach, being formed to a slope by the regular action of the waves, is not subject to the deep drops formed by scour in a river. Sufficient trestles have therefore to be taken to form a long pier and, if the slope proves steeper than expected, the pier can be shortened and many trestles of varying heights will be available from which a selection can be made. Trestles of 6 in. x 6 in. squared timber are very satisfactory and strong enough to take medium loads.

Longitudinal bracing of trestles always requires careful consideration. The writer believes that, with the low trestles required for a pier of this nature, the bays need only be braced in one direction, provided that the last bay is well braced in both directions; this would speed up construction considerably. It cannot be too strongly urged that longitudinal bracing should be relieved of the

stresses induced by lighters bumping against the pier head. If this is done bracing can be of 6 in. x 3 in., bolted to a leg at the bottom and nailed to a leg at the top, the nails being replaced by bolts as early as possible.

There is no need for vehicles to hurry off a pier to avoid congestion; the bottleneck will occur at the ramp from lighters to pier head. Drivers will have plenty of time to negotiate a roadway 7 ft. 6 in. wide between ribands of 6 in. x 6 in. If this is done there will be little room for loads to wander and the number of road bearers can be reduced. For road bearers there is a choice between timber and rolled steel joists. If timber is used it will be found that four 12 in. x 4 in. baulks will carry a 3·5-ton axle load over a span of 12 feet. For medium loads, any arrangement of timber road bearers up to 12 in. deep results in very high bending and shear stresses. It appears, then, that timber road bearers are unsuitable for medium loads unless Group I timber is available, which is a pity, as it is often an advantage to use only material that will float. Whichever kind is used, they should be cleated at the ends, the cleats being 1¼ in. farther apart than the width of the transom. Transoms, too, should have cleats to prevent the road bearers falling over. No other fastenings are required.

Decking will usually be 3 in. thick, though 2 in. might suffice for a 3·5-ton axle load. It has been found an advantage to nail two packing pieces 6 in. x 3 in. x ½ in. thick to each edge of the decking; they must be a fixed distance apart and should come roughly over the road bearers. A space of 1 in. is thus left between each piece of decking, which affords economy, foothold and drainage. In addition, the packing piece is of great assistance to the chess takers, enabling them to maintain the dressing of the decking at night. It is sufficient, in the first instance, if every fourth piece of decking is nailed down. (See Sketch 1 and Photos 1, 2, 3 and 6.)

Piers of this nature are sufficiently simple to permit of rapid construction at night and can be built at a rate of about 100 ft. per hour in semi-darkness.

(*d*) *Tubular Scaffolding.*—Tubular scaffolding is too slow to be of much use for temporary pier work, though it is ideal for a semi-permanent pier. With special training a pier 100 ft. long might be constructed in three or four hours.

(*e*) *Pile Piers.*—Piling is a slow business and if possible should be avoided. Fortunately, it will very rarely be necessary to resort to piling for a first temporary pier.

PIER HEAD.

It is an advantage if a pier head is almost as long as the lighters using it. Stores at the ends of the lighters can then be unloaded

at the same time as vehicles in the middle. 40 ft. to 60 ft. x 12 ft. to 18 ft. is a useful size.

In a pontoon pier the pier head can be made with pontoon equipment (*M.M.E.*, Vol. III, Plate 17), but a lighter pier head is less liable to damage from other lighters coming alongside. Moreover, a pontoon pier head is expensive in equipment. Using a lighter would effect a saving of sufficient material for another pier 63 feet long.

A trestle pier head is difficult to make quickly, for it must be strong enough to stand up against a good bump from a 100-ton lighter. Heavy and carefully fixed bracing will be required, both laterally and longitudinally. A trestle pier head should be relieved of mooring stresses by putting down anchors and cables, the ends of the cables being coiled down on the pier head, and then passed to each lighter as it comes alongside.

Piles are ideal for a pier head, but time is against their use. They might well be added later to strengthen up a trestle pier head.

Lighter pier heads may be sunk or floating. The floating type is obviously preferable for use with a floating pier. With a trestle pier the lighter is probably better sunk if there is no tide. When, however, the pier is to be worked over a small range of tide, a floating lighter is preferable.

The anchoring of floating pier heads is very important, as they must hold and also check the way of vessels coming alongside; anchors of about 10 cwt. with 3-in. steel wire cables are required; they are best laid out by the navy, who are more used to handling wire rope and anchors of this size.

Off-shore cables should make an angle of about 20° with the length of the pier head; a smaller angle gives little resistance to bumps, and with a larger one there is a risk of fouling vessels coming alongside. Inshore cables can be 4 in. hemp, run out to piquet holdfasts on shore. Floating lighter pierheads are shown in Sketch 2 and Photos 2, 3 and 6.

Transport of Stores from Ship to Shore.

There are four possible methods of getting pier construction materials ashore.

(*a*) By pontoon raft.
(*b*) By small craft.
(*c*) By lighter.
(*d*) By towing floating packages.

Let us first consider what the general situation will be at this time. Firstly, it may or may not be dark. Then, by reason of

shallow water or risk of discovery, ships will have to anchor at least a mile from the shore and possibly three miles. The main body will be landing either at the same time, or immediately afterwards, so there is certain to be a shortage of small craft and of towing craft.

Unless this stage is carried out under cover of darkness, the transporting craft will probably come under artillery fire and perhaps under long-range machine-gun fire.

Discussing the four alternatives :—

(*a*) *Pontoon Raft.*—In a recent article in this journal* it was stated that working on two rafts at a time, six medium rafts could be made and loaded in eight to ten daylight working hours, or, say, three hours for each raft. Possibly this could be reduced by special training to two hours by night, but forming raft from a ship appears to be a slow business.

Another alternative would be to form rafts the day before the operations and tow them through the night. But as has been pointed out above, ships must keep well away from land on the previous day to reduce the risk of discovery, and it will be more or less of a race against time from dusk to dawn. Pontoon rafts would hardly tow at more than six knots ; less if there was any sea. This alternative, therefore, must usually be ruled out.

A third alternative is to make up rafts on board ship prior to anchoring and to hoist them out complete. Generous deck space and a powerful derrick are, of course, required. The arrangement of the load and its slings is rather a nice problem, which the writer does not propose to tackle as he is unfamiliar with the consuta equipment, but he feels sure that it could be solved. If so, this is possibly the most satisfactory answer to the question of preparing rafts for towing ashore.

A steam piquet boat could tow two, or perhaps three rafts.

(*b*) *Small Craft.*—The use of these will be confined to the transport of tools and small stores. They are unsuitable for the carriage of pier materials and would be badly required for the transport of the troops of the main body.

(*c*) *Lighter.*—The advantages are as follows :—

1. It is available for use as a pier head. (Photo 2.)
2. It is economical of towing power ; provision of sufficient towing craft is always a problem in a landing operation.
3. Men and pier are carried together. There is no risk of parties of men or loads of materials going astray and being landed at the wrong beach.

* "Off-loading Pontoon Equipment and Forming Rafts from a Ship," by Lieut. L. T. Grove, *R.E. Journal*, September, 1928.

Photo 1.—Pier and beach roadway. The lighter has finished off-loading.

Photo 2.—Pier with lighter loaded with horses in horse boxes alongside. Pier built from pierhead lighter to shore.

Photo 3.—Pier and pierhead lighter.

Photo 4.—During construction; note distance-piece men. Trestle about to be raised, chess-laying proceeding.

Temporary piers in opposed landings 1-4.

Photo 5.—During construction. "Baulks."

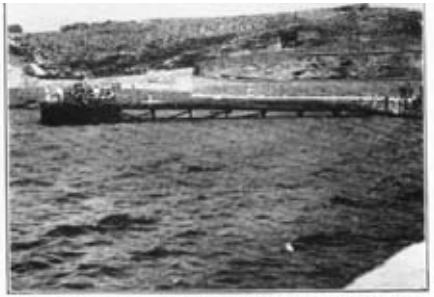


Photo 6.—Pier built from pierhead lighter to shore.

Photo 7.—Floating packages of decking.

Photo 8.—Loading pierhead lighter from a warship. Note deck marked to show where packages are to rest and bearers under each package.

Temporary piers in opposed landings 5-8

The great disadvantage is that all the eggs are in one basket; one small shell on the side of the lighter will sink it. Although the men might be rescued and most of the floating portion of the pier collected, it is obvious that construction would be delayed for several hours.

It seems, then, that to send the pier ashore in a lighter is very risky, unless it is landed either in the dark after any enemy searchlights have been extinguished, or else by day after artillery observation of the water to be covered has been wrested from the enemy. (This is much more difficult than denying observation of the pier site, referred to under "Tactical Considerations"; the beach itself may well be naturally defiladed to a great extent.)

Loading the lighter from a ship and organization of the construction of the pier are referred to below.

When a pontoon pier is to be constructed and when rafts cannot be made, the best method would be to tow in a string of pontoons, which might well be used to assist in the conveyance of troops, and to send in the superstructure on a lighter which would probably be used as a pier head. This also applies to barrel piers.

(*d*) *Towing Floating Packages.*—In the writer's opinion, this is the best method where transit from ship to shore is to be carried out by daylight and when observed artillery fire is to be expected on the journey. It has the advantage of dispersion; moreover, the packages themselves are invulnerable and if one of the towing craft should be disabled or sunk, the packages can be taken in tow by another. On grounds other than tactical, methods (*a*) *Pontoon Rafts* and (*c*) *Lighter* are clearly superior to this method.

Although floating packages are expensive in towing power and the method slow, it is not so slow as would at first appear. Construction can start as soon as the first two or three packages arrive, and after that it is only necessary to ensure a steady stream of packages in the right order.

A suitable size of package is ten to fifteen hundredweight, that is, one 12-ft. bay of decking or two bays of road bearers or two to four trestles (Photo 7).

A steam piquet boat can tow four such packages. Naval motor-launches and motor-boats are not very suitable for this work as their thrust blocks are weak. If used they must be given easy tows—two small packages or one big one. One or two whaleboats should be detailed to work at the pier site, taking over packages from the towing craft.

Spare packages must be taken to replace any that go astray. Probably it would be best to duplicate the whole pier; surplus material can then be collected later on and built into a second pier. About 40 packages would be required for a duplicated pier 100 feet long.

LOADING ON BOARD SHIP AND HOISTING OUT.

It is most desirable that materials should be taken on board ship in the same way as they are to be landed; the experience thus gained in co-operation with the navy or mercantile marine will be most valuable, even if the operation has been previously rehearsed. The difficulties of co-operation with another service are not always appreciated. The language difficulty, particularly if accompanied by a certain diffidence, presents a really serious stumbling-block; it is the exception rather than the rule for a technical term to carry the same meaning in both services. Fortunately, the navy is hospitable and many misunderstandings can be quickly cleared up over a glass in the wardroom. As an example, the writer was once discussing methods of hoisting out packages with a naval officer for about half an hour. He spoke of "slings," whereas the naval officer advocated "strops," and little progress was made. They then repaired to the wardroom, where under the soothing influence of eggy cocktails it quickly became clear that each was referring to the same thing. A "sling" in the navy is an arrangement of wire rope or chain used for lifting one particular article, such as a motor-car tray.

Whatever method of transport from ship to shore is adopted, pier material will have to be made up into crane loads; these will be referred to in this article as "packages." These packages should be made up on shore and remain unbroken from the time they are lifted by the wharfside crane until construction starts, though this may not be possible where a pontoon raft forms one package. Each package must be lettered or numbered and the contents of each tabulated on lists circulated to all concerned. As far as possible each package should contain only one class of material, such as chesses.

Where transport from ship to shore is by lighter, packages can weigh up to two tons; heavier packages are a little dangerous to handle into position on the lighter in a swell; smaller packages mean more loads and waste of time in loading the lighter. A two-ton load of timber can only be satisfactorily made up by piling the timber on two bearers whose ends project beyond the package; slings are then made fast to these ends and remain in position from start to finish (Photo 8). If this is not done the package simply collapses when landed and has to be re-stacked. The deck of the lighter must be clearly marked with white paint to show the position of each package, each space being lettered with the package letter. The lay-out of the loads on the lighter must give sufficient room for working, but loads must not be stacked so high as to topple over when the lighter rolls (Sketch 2).

When transport from ship to shore is by towing packages, the

packages should be smaller; a large package does not tow so well as three or four small ones; ten to fifteen hundredweight is a satisfactory size (Photo 7). The fastenings round packages to be floated ashore must be carefully thought out; they are sure to work loose in loading, so it must be possible to tighten them on board; it must also be possible to cast off the fastenings quickly in the dark by cutting or otherwise, when the packages arrive at the pier site; hoop iron is therefore ruled out. Probably the best fastening is about four turns of spun yarn with a Spanish windlass for tightening; four or more such fastenings would be used for each package. The system of tightening fastenings with wedges is most unsatisfactory, for when the strain comes on the sling the package bunches up, fastenings slacken and wedges fall out. The centre of each package should be clearly marked to assist fixing slings. To fix slings or tow ropes in the water, a single turn of spun yarn is taken round the package before it is placed in the water and tied with long ends. The long ends are then tied round the sling, the spun yarn is cut and the sling hauled under the package by the spun yarn.

Organization of Work of Construction.

(*a*) *Pontoon and Barrel Piers.*—These should be constructed at high water if possible. The alternative methods appear to be forming pier from rafts, which should present no particular difficulty, and (where the superstructure is carried on a lighter) forming up or booming out from the lighter. In the second case, work will obviously have to be from the lighter shorewards. The same considerations apply to barrel piers and organization of work should follow the pontoon drill fairly closely.

(*b*) *Trestle Piers.*—The organization of work on a pier with ready-made trestles will be considered. Except for the last bay, such a pier only requires longitudinal bracing in one direction. (Sketch 1.)

The best method is to base the organization on the pontoon drill for forming up; the party should, therefore, be divided into a bridge detachment which builds the bridge, a trestle detachment which supplies trestles at the bridge head instead of pontoons, a baulk detachment, a chess detachment and a spare detachment to fix ribands and nail decking; chess and baulk detachments can be diluted with unskilled labour. As the water will only be 5 ft. deep, men can work in the water and unless the temperature is very low this should always be done, even if several reliefs for the wading numbers have to be provided. Working in the water speeds up enormously the placing of trestles in position and permits the laying of the superstructure simultaneously; work on baulks and chesses does not have to be stopped while trestles are launched.

The following detail of duties has been found to work well :—

Trestle detachment working ashore, bolts braces to the foot of each trestle, ties them to the head of the trestle with spun yarn and floats the trestle to the bridge head with the transom towards the bridge and braces on top.

Five trestlemen of the bridge detachment get the trestle roughly into position, raise it by standing on the ledger and pulling it up and lean it outwards from the bridge head till the braces from the foot of the trestle in bridge can be passed under the transom. The trestle is then accurately positioned for line by sighting over the centre on two leading marks fixed on shore, and for squaring and distance by two light-cleated distance pieces fitted over each end of the transom of this trestle and of the last trestle in bridge. Two bracemen, wading, then nail on braces; four baulkmen, wading, receive the ends of baulks from the baulk detachment, carry them forward to the new trestle and drop them in position; two distance-piece men cut the spun yarn securing the brace to the transom of the last trestle in bridge, operate distance pieces and relieve two chess takers (Photos 4 and 5).

By this method trestles can just keep pace with superstructure; baulks should be cleated as described previously and they then have only to be dropped into place between cleats on the transoms.

Even when all material is carried on a lighter it is usually best to build from the shore and not from the lighter. Actually one does not build "from the lighter"; one has to build from the two outer trestles braced in both directions (Photo 5), and until these trestles are braced to one another construction must be delayed. Starting at the shore end, one has at once the firm base of the shore transom to build from, and the first few trestles being light and small, the trestlemen have a chance to get ahead. The delay at the end, owing to heavier trestles and double bracing on the last bay, is no disadvantage as the spare detachment has to catch up with its work of bolting down ribands and nailing chesses. Moreover, by working from the shore, congestion on the lighter is avoided and more room is available on the lighter for stacking loads, since no space has to be left clear for working. Material has, of course, to be floated ashore, but this does not matter much on an open beach; it merely means that baulk and chess detachments must be strengthened a little. If, however, the shore transom rests on top of a quay wall, as in Photos 2, 3 and 4, it will be difficult to get baulks, chesses and ribands on to the quay and construction will have to proceed from the lighter shorewards.

A small advanced party will be required to select a site, marked with an agreed light or sign, place leading marks (which may be lights shining through slits), and prepare moorings for the pier-head lighter.

(*c*) *Piled Piers.*—As has been mentioned earlier in this article, these are hardly suitable for rapid construction ; they are referred to in some detail in *M.M.E.*, Vol. III.

Working of a Pier.

To work a pier efficiently requires the closest co-operation with the navy. The first point to settle is whether lighters are to be off-loaded over the sides or over the bows. Off-loading over the bows is infinitely preferable for lighters carrying motor vehicles, as the vehicles can be driven straight off without moving the lighter or the ramp ; vehicles in this case must be placed on the lighter pointing towards the bows (Sketch 3). For off-loading over the side, motor vehicles, ambulances, etc., must point towards the sides, and both the lighter and the ramp must be moved for each vehicle ; guns and limbered wagons can, of course, be turned on the lighter and can be unloaded over the side without moving the lighter or the ramp.

An additional reason in favour of unloading over the bows is that the standard naval 100-ton and 60-ton lighters have a gunwale 1 ft. 7 in. to 1 ft. 9 in. high ; this, however, does not reach right up to the bows and there is plenty of room between the end of this gunwale and the stem post to off-load vehicles ; to do this the lighter would have to be moored bows on and at an angle of 45°. The writer believes that by using a special " distance frame " (see Sketch 3), it should be quite an easy matter to moor a lighter in this position.

Whatever system of off-loading is decided on, the responsible R.E. officer should request the Staff to arrange that clear orders are issued to all naval or mercantile marine vessels loading vehicles on to lighters as to which way vehicles, other than guns and limbers, are to face, and whether lighters are to come into the pier broadside on or otherwise. It must also be clearly laid down who is responsible for providing ramps for unloading. The writer strongly recommends that the R.E. should be responsible for the provision of all ramps, including that from the deck of a lighter up to the gunwale.

It must also be published in orders that the pier head will fly a certain flag by day and show a certain lamp by night when it is ready for use.

The fastenings of a ramp from lighter to pier head or from pier-head lighter to pier will require the most careful design and must be carefully tested at all possible slopes before the operation.

Where a heavy ramp has to be lifted, it may be worth while to provide a pair of small derricks just outside the track of the vehicles.

EXITS FROM THE BEACH.

The actual site of the pier may be decided to a great extent by the proximity of a road of some kind, the ideal, of course, being to build the pier on to a quay wall, or an embanked road or causeway. Where this is not possible, provision must be made for constructing a road across the beach. A plank road (Photo 1) or plank wheel tracks will usually afford the best solution; traffic will usually be too heavy for a wire netting road and the salt moisture in the sand would produce very rapid corrosion. Roadwork must proceed simultaneously with pier construction if both are to be ready together.

SUMMARY OF CONCLUSIONS.

A pier to off-load divisional transport and supporting artillery should be ready as soon as the tactical situation permits of it being used. A temporary pier should, therefore, carry axle loads up to $3\frac{1}{2}$ tons and accommodate 100-ton lighters. Such a pier cannot be built under fire controlled by direct observation, but can frequently be built before dawn.

A gently sloping sandy or shingly bottom can be expected at any place where a landing is to take place. Pontoons and barrel piers can, therefore, usually be grounded and trestle piers can be built rapidly with ready-made trestles. Piling is too slow to be of much use. Barrel piers are too weak to take $3\frac{1}{2}$-ton axle loads.

Service pontoon equipment is preferable, especially in tidal waters, and the service trestle is a useful adjunct to a pontoon pier. Tubular scaffolding is too slow for temporary pier work, though ideal for a semi-permanent pier.

Piers of ready-made wooden trestles can be built very rapidly, and are suitable when the range of tide is small, which occurs quite frequently.

It is an advantage if all pier material will float. It can then be towed ashore in packages under a fire which would certainly sink a lighter carrying the material.

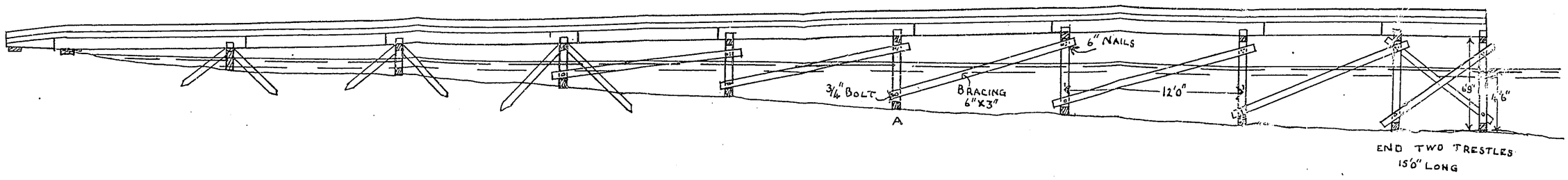
A pier head is best formed by mooring or sinking a lighter, which can also be used to carry the material if the approaches to the pier site are not swept by observed fire. Mooring or sinking of a pier-head lighter should be carried out by the navy.

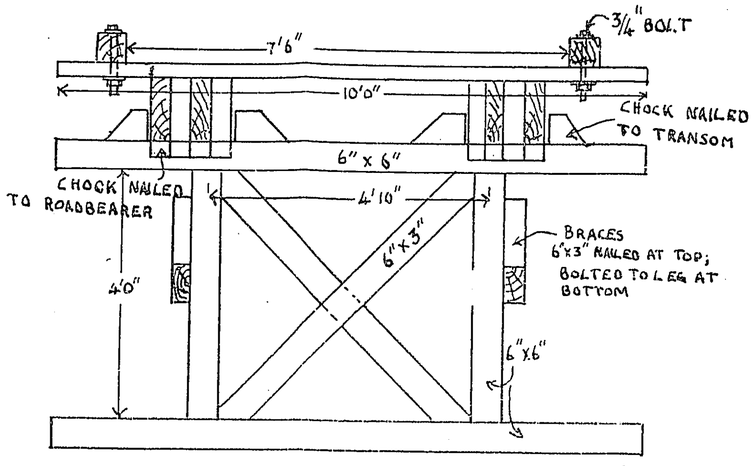
Vehicles can be unloaded from a lighter more rapidly over the bows than over the sides. The R.E. should be responsible for the provision of all ramps and should be consulted as to the loading of the lighters.

The whole operation should be rehearsed if possible.

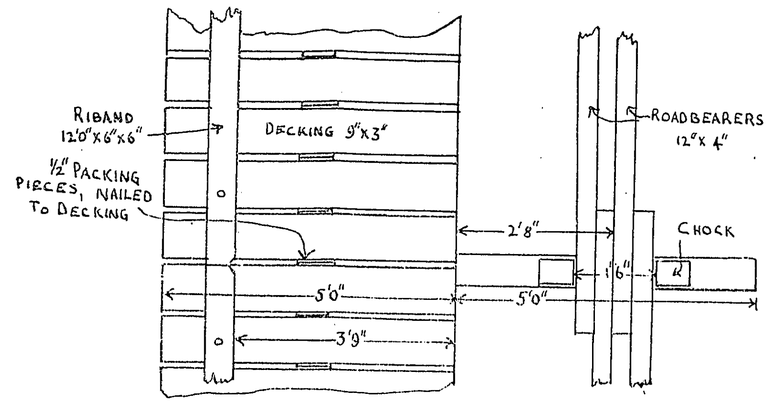
SKETCH 1

SIDE ELEVATION OF PIER





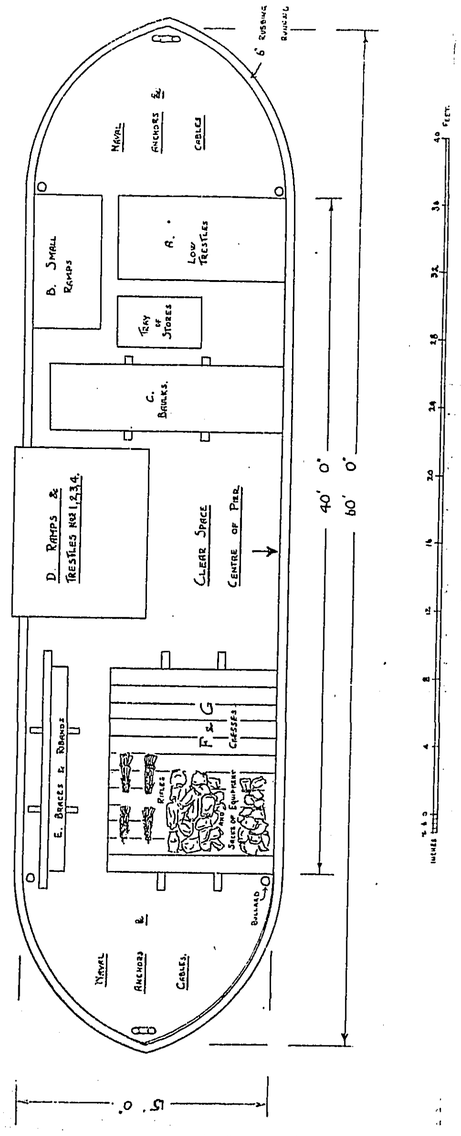
ELEVATION OF TRESTLE "A"



HALF PLAN

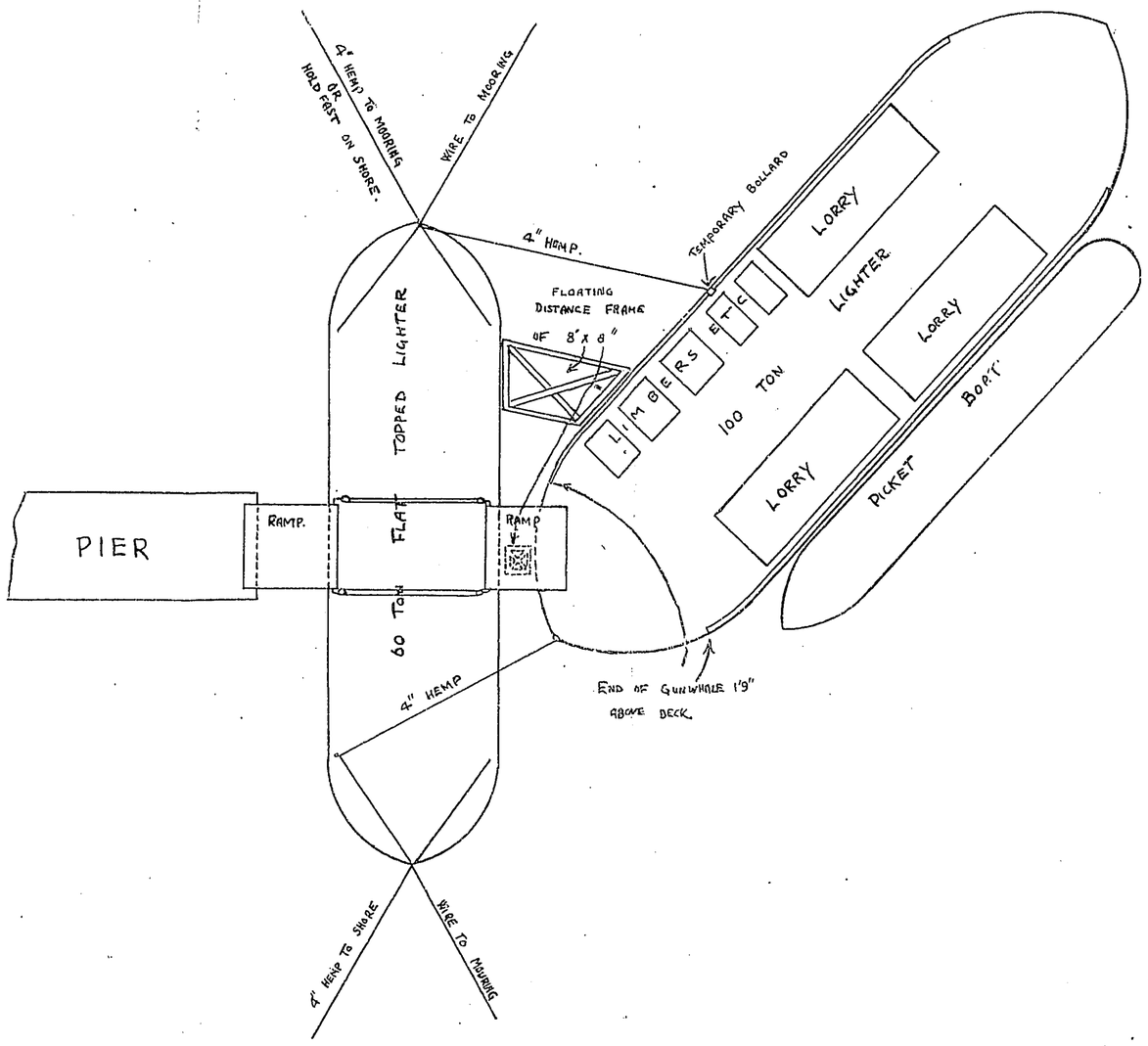
SKETCH 2

LOADING OF PIERHEAD LIGHTER



SKETCH 3

SUGGESTED METHOD OF UNLOADING A LIGHTER OVER THE BOWS



THE EVOLUTION OF THE ATTACK.

By MAJOR S. W. KIRBY, O.B.E., M.C., *p.s.c.*, R.E., AND CAPTAIN J. R. KENNEDY, M.C., *p.s.c.*, R.A.

IN all modern armies there has been an increase in the establishment of machine-guns in divisions, a fact which has added enormously to their defensive power. No corresponding weapon of attack has, however, been added, neither has the artillery been increased. The problem of driving home the attack under these conditions has become so difficult that, should the next first-class war break out before this problem has been satisfactorily solved, a return of trench warfare within a very short period of time is inevitable. Such a war will become one of attrition in which the whole resources of the combatants have to be mobilized, and can only end in the destruction of civilization as it is known to-day. The solution of this problem is, therefore, of great importance, and the writers have attempted to state the case and offer some ideas towards its final solution.

A study of the war of 1914–18 shows how the fire of automatics paralysed the attack from the very first days. Attacks on both the Western and Eastern fronts by any of the combatants were brought to a complete standstill unless a turning movement in those cases where open flanks existed came to the rescue. The immense size of the armies engaged led to a front which had no vulnerable flanks and from the moment that this occurred the problem that faced all general staffs was how to regain the power of the attack in face of the machine-gun.

Many methods were tried, but all failed or defeated themselves till the last year of the war, when the advent of the tank, supported by vast masses of artillery, used so as to ensure the observation of the principle of surprise, provided the answer.

These facts are common knowledge to all who have studied the war, but the conditions under which they happened have gone, it is hoped, never to reappear.

The situation to-day, thirteen years after, is very different. The armies of most powers are modelled on similar lines to those of 1914, with the addition only of large numbers of machine-guns, a few tanks, and mechanical in place of horse transport.

At the commencement of any European war, therefore, the large number of tanks and masses of artillery by which the machine-gun was overcome in the late war will not be available, nor are they ever likely to be available, owing to financial considerations, until some time after the outbreak of a war.

The problem, therefore, is how to overcome the defence as represented by the machine-gun and the anti-tank gun with the weapons that can be expected to be available on the outbreak of a European war.

It is first necessary to examine the problem and see in detail exactly what has to be faced.

The first reason for the predominance of the defence is the power of the machine-gun. This weapon on any ground is so small and inconspicuous and its power, *vis à vis* the unarmoured human being, is so great that movement has become impossible in the zone of its fire. It can, however, be rendered innocuous in several ways, viz. :—

(1) *By knocking out each individual machine-gun.* The machine-gun offers a very small target, it is very easily concealed, and if properly sited cannot be located except at very close range. Modern surveying methods make it possible to produce rapidly maps of great accuracy on a scale of $\frac{1}{10000}$ or thereabouts. It has been claimed that these maps, used in conjunction with stereoscopic air photographs, produce a solution for the reason that any average officer can accurately pin-point these vital spots in the defence organization. The fact that no two men, set such a task as a test, would produce two answers bearing even a similarity to each other is sufficient to disprove this theory. But should even 50% of the machine-gun positions be located, no artillery officer would guarantee that they were knocked out without an immense expenditure of ammunition and time. Moreover, the very fact that these spots were bombarded for destructive effect would dissipate the chances of using *surprise*, which was one of the factors found to be essential in the late war if the attack was to succeed.

The various methods now used for increasing the accuracy of artillery fire do not yet produce such results that the situation is altered, nor promise that it will alter in the near future, and so it is assumed that artillery fire cannot be counted on to annihilate the machine-gun.

(2) *By neutralizing the machine-guns in the area attacked.* This was the method adopted in the war, and proved fairly successful provided that there was sufficient artillery available to produce a barrage to "brown" the area effectively, and provided that the attackers were prepared to accept the risk of moving close to the barrage so that

there was little lapse of time between the cessation of the artillery fire and the arrival of the bayonet.

In open warfare, that is to say, when the defence has not had more than 24–48 hours to prepare their position, it is usually considered that 25–30 yards per gun at 4 rounds per gun per minute is a sufficient density of barrage to effectively neutralize any enemy weapon that is located within the zone of that barrage.

It must be remembered, however, that the machine-gun has an effective range up to 2000 yards, especially when sited in enfilade, and thus an area on either flank of an attack must be neutralized as well as the ground over which the attack is to pass.

The division in most modern armies has artillery, some 50–55 field guns suitable for barrage work, and it can be presumed that when attacking it may be reinforced by not more than an additional 18 field guns.

The artillery within a division can thus cover with their neutralizing or barrage fire a front of from 1800–2160 yards, which is obviously insufficient to allow any attack to be launched if the ground is favourable for the siting of machine-guns on its flanks.

It may thus be said that only by the skilful use of ground, so that the flanks of an attack are protected, can a division hope to be in a position to launch an attack with prospect of success, and then only on a maximum front of some $1\frac{1}{2}$ miles, and at a heavy cost in ammunition.

Is an attack which is limited to $1\frac{1}{2}$ miles or even three miles (if a Corps attacks with two divisions) likely to overcome the enemy's defence unless the salient created in the enemy's position can be immediately widened?

To effect the widening the same process has to be gone through again, necessitating time for preparation and time for dumping the necessary ammunition. Time allows the enemy to continue his defensive preparations and so produce more and more the conditions of static warfare.

It can thus be seen that the neutralization of the defending machine-gun, though a satisfactory method under certain conditions, is not really a solution for the armies of to-day unless under very favourable combinations of ground and morale.

(3) *By blinding the machine-guns and stalking them when they are thus blinded.* A study of the German attack against the Fifth Army on March 21st, 1918, shows, among other things, how infantry aided by fog can, when resolutely led, penetrate into the gaps between machine-guns and defended localities, isolate them and either destroy them by killing the crew with the bayonet, or by close-range fire.

The same effect can be seen in the attack of 46th Division over the Nord Canal at Belle Eglise in October, 1918, when the attackers in a fog, so thick that it was impossible to recognize objects more than a couple of yards away, penetrated deep into the German positions, bayoneting or bombing the crews of all the machine-guns still in action and gaining their objective up to time with inconsiderable casualties. And this over ground which under normal conditions would have been wellnigh impregnable, even under the thickest barrage fire. It would appear, therefore, correct to state that fog assists the attacker and hinders the defence, for it enables the unarmoured infantry soldier to come within close range of his objective, the machine-gun, without being subject to its aimed fire, thus placing him on equal terms with his opponent, while from the point of view of the defence, which must rely on fire, fog has a paralysing effect and can cause the fall of the most carefully prepared position.

(4) *By means of tanks.* The tank, by reason of its armour, is not vulnerable to small-arm fire and thus can move across ground swept by machine-gun fire and either destroy the machine-guns by closing with them or by fire, provided that they can be located.

The tank, then, is an antidote to the machine-gun, but it, in turn, may be faced when the next war breaks out with the A/T gun, which may turn out to be to the tank in a minor degree what the machine-gun is to the infantry. No nation, however, has yet produced a satisfactory A/T gun.

Nevertheless, if they are to perform the role of machine-gun destroyers, they must be given protection against the A/T gun.

The problem of destroying the A/T gun is more difficult than that of the machine-gun as, owing to their small number and the nature of their role and probable siting in ambush, they will be even more difficult to locate and destroy, and quite impossible to neutralize by fire. Infantry provided with special observers and machine-guns can then scarcely be hoped to provide the solution. The only methods of dealing with them appear to be, to use tanks to find and destroy them, or blind them by some means or other. Fog is even more effective in the case of the A/T gun than in the case of the machine-gun as the gun has to aim each individual shell.

To sum up : It will be seen that under existing conditions there are only two likely methods of effectively dealing with the machine-gun defence :

(i) To blind it with artificial fog.

(ii) To destroy it by tanks, which themselves are protected by belts of artificial fog, in selected spots.

The second reason for the superiority of the defence is the use of wire, which, so long as it remains intact, either prevents all movement or forces it into certain channels covered by defensive fire.

Wire was, as is well known, a very important factor in the late war once the static phase had begun. Training since the war has, however, been on the basis of a war of movement; the importance of wire has been minimized if not entirely forgotten. It is seldom that the tactical scheme of to-day brings in wire in any form, yet a single apron of concealed wire uncut will bring the best-planned attack to a temporary if not permanent standstill. This is even more so when it is realized that wire can be erected in a remarkably short time provided that it is available. It can be taken that any enemy worth his salt will, if he be given even 24 hours to prepare a defensive position, produce a sufficient quantity of wire to give the attacker an added problem to solve.

There are three possible or more or less effective ways of dealing with wire.

(1) *By cutting it with wirecutters by hand.*

Infantry battalions carry wirecutters, and can under certain circumstances cut gaps in wire. Such a proceeding is hazardous and only possible if it can be carried out unknown to the enemy.

Neutralization of the enemy's fire is not a practical solution since the intensity of the fire required could not be kept up for the time taken to cut the wire.

(2) *By artillery fire.*

Wire can be destroyed by artillery fire provided observation is possible and that the time and ammunition are of no particular importance. Even where no ground observation is possible, provided that the wire is visible from the air and medium artillery can be used, wire can be cut. The cutting of wire by artillery has, however, some very big disadvantages, viz. :—

(*a*) It precludes all possibility of surprise.

(*b*) It is of no value when wire is concealed from ground and air observation.

(*c*) The gaps once made must be kept open at night by artillery fire necessitating the expenditure of ammunition, or the attack must follow directly the gaps are cut and incidentally when the enemy is ready to receive it.

(*d*) The expenditure of ammunition is heavy, and if the enemy has a good counter battery system in operation it may be expensive in guns.

The method, therefore, has not much in its favour under the conditions of open warfare, conditions that we hope to maintain.

(3) *By tanks.*

The tank is the ideal weapon for the destruction of wire ; it can crush, wire wherever, met whether previously located or not ; it needs no preparation beforehand and therefore surprise can be obtained. The wire likely to be met with in open warfare will probably be of a nature which can be overcome by both the light and medium tanks.

To sum up ; it will be seen that under existing conditions and for the type of warfare we hope to maintain, a war of movement, the tank is the only satisfactory form of wirecutter.

The third reason for the superiority of the defence is the time factor. Time for reconnaissance and preparation is vital for the defence, and every moment that the defence gets above a certain minimum time adds to the strength of the defensive position. Yet the immense delaying power of even weak cavalry units as now organized is such, thanks to the machine-gun, that no general who adopts the defensive should lack time for his preparations. How much more important, therefore, is it for the attacker to be in a position to launch his attack with the minimum of delay and feel assured that when launched it has every chance of rapid success !

The preparation of every plan needs time for consideration and reconnaissance, but that time should be cut to the minimum, in fact " waste of time " should be considered as a cardinal sin in war.

The preparation of barrages, the cutting of wire, the location of machine-guns, etc., all require considerable time and often prevent surprise.

The methods adopted should, therefore, be such that they can be put into effect with rapidity.

It is submitted that a tank attack, supported by artificial fog produced by artillery, can be launched more rapidly than any other form of attack.

Whatever may have been said above does not detract from the value of artillery to the defence, but it should be realized that the artillery of the defence does not and cannot expect to defeat an attack by itself except under extremely favourable circumstances.

The attacker must, however, reckon with it, and his best means of dealing with this danger is by the organization of an effective counter battery plan.

As has already been stated, modern methods of mapping from aerial photographs used intelligently in anticipation are such that large-scale maps of any battlefield should exist as soon as the opposing armies are in close contact. These maps coupled with aerial observation should enable a counter battery system to be organized efficiently and rapidly.

But the attacker must be given the means to produce this counter battery fire, and should, therefore, find a place for medium artillery in his organization.

Conclusion.

It cannot be denied that "time" is of vital importance to the attacker whether the attack be in the form of an outflanking movement or a frontal attack with a view to penetration. Nor can it be denied that the commander who has it in his power to follow up his strategic moves with an extremely rapid and overwhelming attack, before the enemy has had time to counter his strategy, is in an extremely favourable position. Our problem is then how to cross the last 600 yards, how to do it without pause for the collection of masses of material and how to ensure success when it has been crossed.

The infantry attack under a barrage can, it is admitted, cross the last 600 yards, but owing to the narrow front on which it can be launched under present and probable future conditions and the time taken to prepare it, it is considered an out-of-date method.

It is submitted that the previous pages prove that a force provided with sufficient armoured vehicles and smoke-producing weapons can overcome most of the difficulties that now face the attacker. Such a force cannot be produced out of a hat, as its weapons organization and training must of necessity differ from those we know and understand to-day, yet the nation which learns and studies the value of smoke, and the tactics of tanks in conjunction with smoke, is well on the road to success in the next war.

TRAINING IN THE FIELD COMPANY.

By MAJOR C. DE L. GAUSSEN, M.C., R.E.

INTRODUCTION.

THE position of the field company within the Corps in peace differs widely from its position in war. The majority of regular officers in a war of any magnitude should be prepared to be employed in field companies, whereas in peace a comparatively small proportion serve in field units. This is a very different situation from that in other branches of the Service, such as the infantry and artillery, where the officers are daily considering similar problems to those which would face them in war. They are, therefore, in a position to concentrate on training for those problems. This possibly may be the reason why there is not so general an interest in the Corps to look upon the training of field companies in the same light.

Many officers serving with field companies are asking themselves if the present methods are "producing the goods." Some of the factors are considered below, but it is also suggested that the post-war conditions in civil and military life largely affect the question.

Before the war, the Corps enlisted from civil life a large proportion of trained tradesmen. As is well known, for various reasons this is no longer the case, nor do the Boys' Training Centres make up for the deficiency. Similarly, formerly it was possible to draw men from civil life who had some knowledge of horses, and the average officer, too, was more often accustomed to horses, even if he was not a "hunting man."

At the same time, within the army there has been the swing to mechanization and making use of modern inventions, with consequent complications of tactics and movements problems.

The organization, equipment and training of the field company remains much the same as before the war. Of the organization and equipment, it is intended to say nothing; they are interdependent and are under careful consideration. But pending any changes, it may be possible to modify the method of training in order to meet modern conditions.

CLASSIFICATION OF THE ROLE AND THE TASKS OF FIELD COMPANIES.

The principal tasks of field companies in war are fully set out in the training manuals, and they may be roughly classified as under :—

(*a*) *Standard Tasks.*—This heading covers work for which there is

a definite design, such as pontoon and trestle bridging, wiring drill, demolition charges, elementary work with spars and lashings. To some extent the design, though not the fitting on the ground, of field defences comes under this heading. These are largely "drill" subjects, in which every Sapper should be so conversant as to be able to carry them out automatically.

(*b*) *Improvisation.*—There will always be so many works to be undertaken under unusual conditions, such as repairs of a bridge with local materials, repairs of pumping plant, lifting awkward weights, that it is obviously impossible to practise them all. Such tasks are likely to increase, and demand from officers a thorough technical knowledge in order to tackle them in the right way, and a thorough knowledge by N.C.O.s and Sappers of the elements of field engineering. It further demands adaptability and capacity to get down to a job at once.

(*c*) *Tradeswork, either as Part of Larger Works, or as Workshops Job.*—The field company tradesman must be prepared to produce a serviceable article from unpromising tools and materials.

(*d*) Co-operation with other arms, demanding military knowledge, in order to anticipate military needs, besides training in field service conditions.

Difficulties.

It is as well to consider some of the difficulties under which field companies labour, including those in administration.

(*a*) *Administration.*—Compared with other arms, the officers have a very heavy load of administration, one officer being responsible for many activities, and frequently with absolutely no previous experience and little training. It is essential, therefore, that the machine be smooth-running, in order to relieve the officers as much as possible for training work. It is worth while training more than the minimum clerical staff, both in company office and for the C.Q.M.S., even though this slightly swells the "company employ." It is a good thing to ask oneself if any individual is indispensable. If he is, the organization is wrong.

If short of clerks, it is suggested that it is worth picking out an intelligent pioneer and training him as a clerk during the individual training season.

The problem of "employ" is always with us and can only be kept within reasonable bounds by the closest personal attention of the O.C. It is suggested that it is more satisfactory to strike men off for employ for a complete season and train them thoroughly the next year, rather than train many partially each year.

(*b*) *Change of Personnel, especially Officers and Senior N.C.O.s.*—There is no necessity to dwell upon this point, which is recognized as a great difficulty.

In some officers there is, perhaps, a tendency to pay more attention to the materialistic side of their profession rather than to the human side and routine of military training. This, coupled with frequent changes, must of necessity reflect on the standard of efficiency of the unit. It is rarely possible in practice to work to the half-company organization and chain of command. This means that the section serjeants may have to be directly responsible to the O.C. for their sub-units, and the realization of this is the best form of training a senior N.C.O. It must be remembered, too, that a N.C.O., coming from another type of unit, has a very difficult task, and he should be given an opportunity to establish his personality at a very early date by taking sole charge of some piece of work. Until he has done this, he has very little chance and is consequently of little use.

It is not intended to discuss the individual training of officers and N.C.O.s. This is an essential part of the unit's training and particularly for young N.C.O.s. It is not fair to expect them to carry out their duties by merely placing a stripe on their arms and giving them no instruction. With a little organization, time for N.C.O.s' courses can usually be found while the Sappers are employed on straightforward trades training.

(*c*) *Lack of Opportunity.*—One of the most important elements in the training of the R.E. is the absolute completion of a task—the assurance that it will stand up to its work. This is very different from practising with standardized equipment on a permanent training ground, where every inch of ground is known. Unfortunately, the opportunities for practical field works, to be put to practical purpose, are very few and can only be procured if special efforts are made, involving, as they do, considerable expenditure.

It is difficult, also, to provide very much work in co-operation with other arms. This often results in the Sappers suffering from a certain isolation.

(*d*) *Interferences.*—Finally, there are always the extraneous calls on the services of field companies to do "odd jobs," which take up much of the available time in the training season. Although they may interfere with training programmes designed to cover a certain amount of matter contained in the various volumes of military engineering and the *Manual of Field Works*, it must be remembered that, taken in the right spirit, these "odd jobs" have their value. Besides often affording training in handiness, adaptability and improvisations (if the tasks are carefully selected), they bring the field companies into contact with the staff and other arms. Above all, such work should impress on all ranks that the R.E. exist to work where, when and how the situation demands and not necessarily as they themselves would choose.

Classification of Training.

Bearing in mind the previous remarks as to the results required and the obstacles to be overcome, the training may be classified as below :—

Military : individual and collective.
Trades.
Field engineering :
(*a*) Standard subjects.
(*b*) Miscellaneous.
Co-operation with other arms and application of engineering training.

Military Training.

The aims are laid down in *Engineer Training*, Vol. II, and the time devoted to attain those aims depends largely on the standard of smartness maintained throughout the trades training period. There is no doubt that even one hour's drill a week throughout the year makes a difference to the turn-out of the unit. The factor which to a large extent should decide the attention paid to military training is the developing of N.C.O.s in command. For this, whether in the daily life or in taking charge of works, there is no better training than taking squads in good drill, P.T. or in field movements.

Map reading and instruction in field service conditions are important branches of training which may well be carried out in the "spring drill period" and apply as much to the mounted section as to Sappers.

The time to be devoted to preliminary musketry must be carefully scaled to the individual. It is the writer's experience that the Sapper of normal intelligence is ready to go on the range after a few muscle exercises and regaining the feel of his rifle, bolt and trigger. An annual reiteration of the theories and elements of musketry often has the effect of either boring or worrying a man. Allowances must, of course, be made for coaching the really bad shot. But musketry is entirely a question of intelligence and confidence.

Trades.

Even were there no question of trades establishments and ratings, trades training would remain the best mental training for the Sapper in the individual training season. Intellectually, it is claimed that it provides as good educational training as any amount of "schooling," and at the same time develops self-respect, handiness and the will to see a job well done. From this aspect alone, the more time devoted to real trades training the better. But to remedy the lack of skilled tradesmen, the winter period, with furlough in the middle,

is hardly sufficient and the time allotted for trades training may very well be increased.

The first essential, obviously, is efficient instructors. The field company which has these in even the most important trades, carpenters, blacksmiths and bricklayers, is fortunate. It is suggested that the trades standard of the Corps as a whole will be improved by a full N.C.O. trade instructors' course at the S.M.E. Something more than trade skill in itself is required.

A " works " task, such as constructing a quarter, is often allotted to field companies during the winter season. The great value of such work is that it affords an opportunity for tradesmen to combine their different spheres of skill. Although at times some men will not be employed at their own trades, eventually nearly all will have practice, and the unit has the great moral satisfaction of having produced a permanent useful work of some magnitude.

The lines on which the organization of the work should be based are given in *Engineer Training*, Vol. II, and every opportunity must be taken of practising officers and N.C.O.s at design, organizing supply of materials at the right time and place and accounting for stores. They also have to pay strict attention to the absolute correctness of every part of the work. This minute correction of detail, so essential in engineering, is sometimes allowed to be slurred over in field works.

The objections sometimes raised to this class of work, that it entails a great deal of unskilled labouring by men who should be employed at their trades, can and should, whenever possible, be overcome by supplementing the companies with unskilled civil labour, or skilled labour if it will enable the unit to undertake a larger, and so more valuable, job.

FIELD ENGINEERING.

(*a*) *General.*—Certain classes of work are sometimes referred to as " not Sapper jobs." It is essential to realize that circumstances may render digging, wiring or other so-called unskilled work the most useful employment for R.E. Besides this, they should be prepared to instruct other arms either directly or by precept and example. Although the infantry are responsible for the construction of their own defences, by circumstances and tradition the R.E. are considered the experts in all branches of fortification, and they will remain so. Every Sapper must therefore be practised regularly in the art of digging and care of his tools.

(*b*) *Standard Subjects.*—As explained above, this covers those subjects which are so standardized as to become almost drill. These are essential and must be practised every year, in the minimum time according to local facilities. For some companies, camp construction and pipe-line work has become such a regular task that it, too, has

become standardized and the necessity of preparing the camp is the limiting factor in the time devoted to it. It is doubtful, however, if the annual repetition of the work affords training commensurate with the time devoted to it.

(*c*) *Miscellaneous.*—Other subjects are covered under this heading for lack of a better. Their extent is so vast that it is impossible to cover all, even in a period of years. Certain subjects such as pile-driving, corduroy roadmaking, suspension and heavy trestle bridging are so fully described in manuals that they have become standardized, and although it is necessary that every officer and N.C.O. should have a thorough knowledge of them, it is doubtful if the Sapper need be practised in them even triennially.

For the Sapper, the execution of a good job well done, involving handiness, rapidity and work as organized skilled labour is the best form of training in field engineering. The field company has often to lay the foundations by improvisation for a more permanent structure and it is suggested that one such job in all its stages, to the completed work, carried out each year will afford very much better training than an attempt to touch on a great many subjects mentioned, say, in the *Manual of Field Works.* The ability to make a preliminary improvisation which is to be of use later and not a hindrance demands sound technical knowledge and experience of field engineering in all ranks.

The ideal is to construct a work which is to be of definite use either for military or civil purposes. It is recognized that such work is not readily come upon in England, as it is in India for Sappers and Miners. It is suggested, however, that if the principle of this employment and more latitude in the type of work were accepted, it would be possible to obtain valuable jobs for field companies. Employment of this nature appears to be adopted to a great extent for the French Engineers (*vide R.E. Journal*, September, 1929, review of *Revue du Génie*), and the writer has seen an example of the type of work carried out by the Belgian Engineers, in the form of a temporary pile and trestle bridge over the River Meuse at Liège.

The danger to be guarded against, however, is that these jobs may necessitate an excess of labouring. If so and if no labour can be provided from other sources they lose their value. The time of execution, too, must be carefully watched. If this interferes too much with other training, or completely precludes it, the value must be carefully balanced against what is being missed.

Co-operation with Other Arms.

There are two objects to be attained :—

(*a*) To accustom commanders, staff and other arms to the employment of R.E. Unless this is done in peace, we cannot expect the treatment we should like in war.

(*b*) To accustom R.E. to applying their technical training to the conditions and time available on service.

Lieut.-Colonel Martel, in the June, 1930, number of *The R.E. Journal*, made some valuable suggestions on this subject and there is little to add to them. As pointed out by him, there must be a definite task for the R.E., as the time on brigade and divisional exercises is so very limited. It is better, therefore, to concentrate on one or two constructive or destructive jobs in the season's training.

It takes two to co-operate and the R.E. commander, if he wishes to get useful training out of these exercises, must produce a cut-and-dried scheme with suggestions as to how it might be worked into them. Usually he will find the staff only too glad to receive suggestions, as lending more reality to the exercise.

In any case, there is no need for a field company to confine itself to "marching along the road." There are innumerable schemes and problems that the company commander can set his officers and N.C.O.s on situations as they arise.

CONCLUSION.

Of necessity, only the fringe of the matter has been touched upon here. One of the greatest problems is the balancing of time to be devoted to the various headings. This depends largely on local circumstances, training facilities and equally on the individual Sapper. It is suggested that a sliding scale might be adopted in some subjects, such as musketry and the "drill" field works. If a Sapper passes certain tests early in the course, he might be allowed to go into workshops, which is always popular. This would be an inducement to make him proficient in other subjects.

No Sapper is of use unless he is accustomed to hard work and long hours. To train an efficient unit, therefore, equally demands long hours from officers, and the more time spent with the men and the less in offices the better will be the results.

Nothing has been written of the mounted section, although it probably causes as much worry to the O.C. as the rest of the company. For the reasons stated in the Introduction, the training of drivers presents more difficulties than it did before the War and the closest attention of the officers appears to be the only solution to the problem. As long as this is given, all will be well, but things slide very, very quickly if it is relaxed. We can always learn a lot from wholly mounted units and should not let our pride prevent us from trying to do so, particularly in the care of transport in the field.

THE DEMOLITION OF A BRICK WORKS.

By LIEUT.-COLONEL G. G. MCLEAN, R.E. (T.).

PRIOR to the Annual Training of the 52nd (Lowland) Division, R.E., information was received that a firm of contractors had purchased the buildings and kilns of the Perceton Brick Works, which they proposed to demolish in order to make use of the materials in other structures.

As it was considered that a great deal of useful training and experience could be obtained in the carrying out of the demolition work by explosives, negotiations were entered into with the contractors and permission obtained to carry out the destruction of the various erections by high explosives. The 241st Field Company were detailed for the work, which consisted of :—

A. The felling of a 75-ft. chimney stalk.
B. The demolition of a triple fire brick kiln.
C. The felling of a 66-ft. chimney stalk, built through the roof of a standing building.
D. The demolition of a single kiln.
E. The felling of a 30-ft. chimney stalk.
F. The cutting of cast-iron stanchions supporting roof beams, etc.

These various tasks had to be efficiently carried out so that experimental blows, entailing unnecessary destruction, were not permissible. In addition, certain local conditions governed the felling of the chimney stalks. These will appear in the course of the narrative.

A. This stalk was of square section and built of 22½" brick. It stood 75 feet high and measured 7' 6" x 7' 6" at the base. In addition, as will be seen in Photo 1, a flue ran up the back of the stalk to a height of about 35 feet. This flue was built of 9" brick, and was bonded to the chimney and to the gable of adjoining building, being, in addition, strapped to the stalk by 2" x ½" straps and tied with ½" steel rods.

Owing to the local conditions it was imperative that the stalk be felled in one direction only. The reasons for this were as follows :—

1. On the east side of the stalk, a railway siding ran north and south at a distance of 6 feet from the foot of the stalk. This siding was in use for conveying material out of the works.

2. On the west side at approximately the same distance from the stalk was a triple kiln which it was advisable to preserve intact for future experiments.

3. On the south side or rear of the stalk was a partly dismantled building which was being used as a store by the contractors.

It was, therefore, essential to fell the stalk in a northerly direction, parallel to the siding and kilns, at the same time avoiding both of these. As will be seen from Photo 2, large holes were cut in three walls of the stalk, W., N. and E., leaving the stalk supported along the back and on two forward corners, the flue on the south side forming the third pier. In order to drop the stalk in the required direction the two north piers were blown away from the base.

By the formula, p. 58, *Military Engineering*, Vol. IV, the charge required for each pier is just over 4 lb. As the effect of the flue in rear was doubtful, this was increased to 6 lb., a total of 12 lb. of guncotton being employed.

The charges were placed against the back of the two piers as shown in Photo 3. The charge was fired electrically, detonators being wired in series. Photo 4 shows demolition complete and stalk felled clear of kilns and siding. The total length covered by the debris was 80 feet and the breadth 18 feet.

B. The triple kiln was 40 ft. x 50 ft., and was very heavily buttressed, having 8 brick buttresses on each side and 4 back and front. The four corners were double buttressed. The buttresses were 2′ 3″ in breadth, had a base length of 8′ 6″, and tapered into the top of the kiln 10′ 6″ above ground level. In addition the kiln was reinforced with steel bulb rail section running through the buttresses and flush with the wall, for the entire length of both sides of the kiln.

It was decided to insert charges at the four corners, in the first place, and holes were cut at the junction of the double buttresses. Photo 5 shows these holes ready to receive the charges. They were fired one at a time, using safety fuze. Here again the charge employed (10 lb. guncotton) was made high to counteract the effect of the rails. It was considered that the formula on p. 60 of *M.E.*, Vol. IV, could be employed, regarding the charge as a mine with a L.L.R. in brickwork of 4 feet.

The results shown in Photo 6 give an impression of the manner in which these heavy buttresses were shattered and torn away from the side of the kiln.

It may be mentioned, although unfortunately no photographic records are available, that experiments were tried using small charges of guncotton braced between two buttresses and held against the kiln wall. These charges were fired with safety fuze and "Cordeau Detonant." The brickwork of the kiln was shattered locally and loosened over a fair area, and could quite easily be picked out by hand. Holes were blown completely through the two 2′ 3″ buttresses, without, however, detaching the buttresses from the main kiln.

After the corners had been demolished, mine charges of 10 lb.

Photo 1.

Photo 2.

Photo 3.

The demolition of a brick works 1-3

Photo 4.

Photo 5.

Photo 6.

The demolition of a brick works 4-6

Photo 7.—The chimney and building before work was commenced.

Photograph by "The Daily Express."

Photo 8.—Immediately after firing charge; note difference in height of chimney

Photograph by "The Daily Express."

The demolition of a brick works 7-8

Photo 9.—Smoke rising after chimney has fallen through the roof.

Photograph by "The Daily Express."

Photo 10.—Showing building still intact after demolition completed.

Photograph by "The Daily Express."

The demolition of a brick works 9-10.

guncotton and 30 lb. gunpowder were placed in the floors of the kilns, and in this manner the walls and roof were demolished.

C. This chimney was built through the roof of a building, and it was decided, as an experiment, though rather a difficult problem, to drop the stalk within the building without damage to the surrounding structure. We were influenced in this decision by the fact that the contractors were desirous of saving as much of the timber and roof trusses as possible. Further, it was only on these conditions being fulfilled that they allowed us to carry out this demolition.

The stalk stood 66 feet high, was of 14″ brickwork, and 6 feet square. Thirty-eight feet of the chimney projected above the roof. It was butted in two floors about 18 feet above the base and at one corner was bonded into an 18-inch stone wall. Timber beams carrying the roof and floors were bolted round the four sides, and it was necessary to saw these through preparatory to the felling. The demolition was carried out in a somewhat similar manner to case A as regards preparation, with the exception that holes were cut in all four walls, and charges placed against the four piers thus formed, the object being to drop the stalk on its own base.

Although of 14″ brickwork, the thickness to be cut remained as in case A, so the calculations for that case were used and a charge of 4 lb. of guncotton (16 lb. in all) was placed against each pier. These were simultaneously fired by electricity and the stalk was felled within the building without damage to the structure. (See Photos 7 to 10.)

D. This single kiln was of very stout construction, being heavily buttressed. The stone buttresses were of the same dimensions as in the triple kiln, although there were only four buttresses on each side and two back and front. This kiln was demolished with a mine charge sunk in the centre of the floor and fired with safety fuze.

As, of course, complete destruction was not permissible, the formula on page 61, *Military Engineering*, Vol. IV, did not apply, and a charge was made up consisting of 15 lb. of guncotton, primers and detonating fuze. Only the roof and part of the walls were demolished, although the buttresses were cracked and substantially loosened.

E. This chimney was also of square section and stood 30 feet high, having a base of 3′ 6″ x 3′ 6″. It was decided in this case to fell the stalk without any preparations to the walls. 7 lb. of guncotton slabs were laid along the base of the stalk on one side and securely lashed up against the outside of the brickwork. The charge was fired electrically, the base at one side of the chimney being completely blown away, causing the chimney to fall over in that direction.

F. The stanchions in this case were of cast-iron, being $\frac{5}{8}$″ thick and having a diameter of $6\frac{1}{2}$″. A necklace of primers was tried in the first place, but did not cut the stanchion right round. Another stanchion was cut right through with a slab of guncotton, and the others were similarly treated.

SOME NOTES ON THE ART OF LECTURING.

By CAPTAIN A. C. SHORTT, R.E.

LECTURES may be divided into two classes.

Perhaps the clearest way of differentiating between them is to consider the attitude of mind of the lecturer *vis-à-vis* his audience.

In the first class, which may be referred to as "Large Scale Lectures," the lecturer is in a position analogous to that of an actor. His audience is an impersonal entity: its units are unknown to him and probably, for the most part, invisible: he endeavours to impress them by his oratory, but, apart from "atmosphere," he has no personal contact with them. His lecture will be the same whether three, thirty, or three hundred are listening to it. His object is to express in words his own knowledge of a particular subject in order that those who are interested may hear and learn.

In other words, in the personal sense, he is entirely detached from his audience.

In the second class, which may be called "Intimate Lectures," his audience is, to the lecturer, a collection of individuals, limited in number; known to him personally; observed and studied by him —as individuals. Here his object is not merely to display his knowledge for the benefit of those who care to listen and are mentally capable of following his argument: it must be to express what he wishes to teach in such a form and with such simplicity that each individual member of his audience may understand and learn what he has to tell them.

In other words he must study the individual characteristics of his audience.

From the point of view of the lecturer, the two types of lecture have much in common. Most of the rules to be observed apply equally to both. There are, however, many points in which the methods of the lecturer must differ materially in accordance with the type of lecture he is giving.

The following is the text of a lecture given to Young Officers: it is, therefore, confined exclusively to the discussion of the second type —the "Intimate Lecture." Many well-worn platitudes are, of necessity, included, but if the reader will suffer them, he may perhaps discover one or two original ideas, the outcome of the writer's experience in lecturing to Gentlemen Cadets.

I propose to divide my lecture into two parts :—

I. *The Preparation of a Lecture.*

II. *The Delivery of a Lecture.*

I. *The Preparation of a Lecture.*

(i) *Know your subject.* This seems almost too simple and obvious an idea to justify inclusion at all. Actually it is the first and most important rule of lecturing, non-observance of which is the commonest cause of failure.

The point is that there are degrees of " knowing your subject." A common method of preparing a lecture is somewhat as follows :— You satisfy yourself in your own mind that experience of the subject has taught you all you need to know about it. You turn your proposed lecture over in your mind, decide vaguely on the line you are going to take and, for the rest, rely on your natural ability to express yourself to give you inspiration and carry you through. This is not " knowing your subject " from the point of view of a lecture. There are few people who are competent to give a good lecture on such casual preparation.

" Knowing your subject " means (i) deciding upon the exact scope of your lecture, (ii) examining yourself on it and testing your power of explaining clearly each successive point—in other words your ability to write it down—and finally, (iii) having passed yourself out, revising your knowledge of kindred matters, outside the actual scope of your lecture but possible sources of enquiry by your audience. Always be question-proof on more of the subject than you actually include in your lecture.

(ii) *Never lecture without notes.* By which I do not mean " Never lecture without *referring* to your notes." To do so, on the contrary, should be the ideal at which to aim ; but do not scorn invariably to write out beforehand full and comprehensive notes to form the basis of your lecture, or, better still, write out the whole thing verbatim. This is no confession of incompetence. There is a story of a well-known political orator who, on one occasion, by delivering a masterly " impromptu " speech at the appropriate moment, was enabled to win an important victory for his cause. Every word of that speech, it afterwards transpired, had been written out by him, not once but three times ! Men with the gift of impromptu speaking—by which I mean speaking without written preparation—are extremely rare, and in ninety-nine cases out of a hundred the perfect speaker has only attained perfection by hard work. In this, oratory differs in no wise from the other arts : the easier it looks, the more labour its perfection has probably entailed.

Therefore, write full and thorough notes—if possible, write out your

lecture in full. The latter process has the additional virtue of ensuring that you know your subject.

(iii) *Arrange your lecture in a logical order.* There is little to be said about this except on one important point. Remember the limitations of your audience and do not assume that they know more than they actually do. If you are beginning a subject *ab initio* you will find yourself, unless you take pains to avoid it, omitting or slurring over points which, because you yourself are so familiar with them that they are almost second nature to you, you either forget or consider unworthy of mention. Everything seems simple when you know all about it. Your audience do not know all about it, and these small points may not seem as simple to them.

(iv) *Use of the blackboard.* Decide beforehand what sketches you are going to draw on the board; include them in your notes and, if any of them are elaborate, draw them on the board before starting your lecture. Long pauses for drawing on the board break the thread of your argument, and the attention of the audience is apt to wander. Devote a certain amount of trouble to these sketches and, above all, draw them correctly. A bad or inaccurate sketch may give an entirely wrong impression or obscure an otherwise well-developed argument. Good sketches, on the other hand, may save hours of talk.

(v) *Convince yourself.* Read through your lecture or your notes and convince yourself that it is "the goods." If you cannot do this you will never convince, impress or even interest your audience. Get up with the idea in your mind that you are going to tell them something worth listening to, and they will listen and be infected with your own enthusiasm. If, on the other hand, there is doubt in your mind as to the importance or value of the lecture you are trying to give, you will merely be wasting your own time and that of your audience.

Therefore, (i) avoid padding, and (ii) make quite certain that you yourself clearly understand every point or fact with which you propose to deal. It is surprisingly easy to miss the point when reading up subject matter for your lecture. A sentence which may appear obvious when read over casually often presents unforeseen difficulties when you attempt to elucidate it.

II. *The Delivery of a Lecture.*

(i) *Don't be in a hurry.* Speak slowly; complete each sentence; deal with each point in turn and finish with it before going on to the next. So far as you are able, speak good, grammatical English. Split infinitives, and the like, may not matter materially, but a proportion of your audience will be irritated by them and their attention distracted from the subject.

The thing to remember is this: in lecturing, as in acting, both speech and movement appear very much slower to the performer than they do to the audience. The average man speaking in his normal voice and at his normal speed would, even if he were perfectly audible, be perfectly intelligible only to the more nimble brains in his audience. The ruck would be left far behind. It may seem to you that you are progressing at a funereal pace: it will seem otherwise to your audience.

(ii) *Speak as if you yourself were interested.* A great many lecturers—not only beginners but those with considerable experience of lecturing—either through self-consciousness, nervousness, or lack of interest when dealing with an elementary subject, speak in a bored, dead manner which may be guaranteed to send any audience to sleep with unfailing regularity. Above all, avoid speaking in a scornful and superior way as if to imply that the subject is so ridiculously simple that it is hardly worth talking about. This method merely gives your audience a feeling of inferiority; they ask no questions, and they learn nothing. Remember that it is all new to them; they are, presumably, interested, and they will expect you to be the same.

Therefore, no matter how elementary your subject, or how many times you have given the lecture before, do your best to work up some sort of enthusiasm about it.

(iii) *Look at your audience.* Look at them individually and make them feel you are talking to *them* and not to the four walls, your notes, or the blackboard. Watch them: you will sense it directly their attention begins to wander, and this is the moment to wake them up again with a joke, a startling statement of some kind or an argument.

The writer is reminded of a course of lectures which, in his younger days, he was compelled to attend. The subject was of academic rather than human interest, and the lecturer, the top of whose head was just visible above a tall desk, read from copious notes in an unvarying monotone. The sole benefit which the writer derived from this course of lectures was that he learned to play chess.

(iv) *Keep as still as possible.* Mannerisms and movement of any kind, in addition to being irritating, distract attention from the main issue. If you must refer to your notes, keep calm about it: don't get flustered and lose your head. Similarly, when asked a question, don't be afraid to stop and think a moment before answering if the answer does not come readily. If you do not know the answer there are several courses open to you: (i) admit your ignorance and promise to find out (ii) invite suggestions from your audience and initiate a discussion (iii) say that you are proposing to deal with the

point in full in a later lecture, and seize the first opportunity of looking it up, etc., etc., according to your individual preference. Provided that you keep your head and don't get flustered you will get away with it.

(v) *A few miscellaneous Do's and Don'ts.*

About jokes. Jokes are excellent tonics, provided that they come naturally to you. If they don't, avoid them: they are by no means indispensable.

Avoid monotony: either of tone of voice, or of facial expression. Put some light and shade into your lecture.

Be natural in your manner and behaviour. Treat your audience as intelligent human beings, expect them to be interested, and avoid affectation of voice or manner, particularly sarcasm.

Avoid "Er" like the plague.

Don't apologize for your ignorance of your subject. Your audience will probably take you at your own valuation and resent being compelled to listen to you.

You need to be a good lecturer to hold the attention of an audience for more than three-quarters of an hour at a stretch.

Speak "up" both literally and metaphorically. Hold your head up and don't drop your voice at the end of a sentence.

Don't mumble. If a thing is worth saying, it is worth saying sufficiently loud for everyone to hear. If it isn't, don't say it. Mumbling merely aggravates your audience.

If you start off *expecting* to get ragged or laughed at, you assuredly will be.

III. *Conclusion.* The essence of good lecturing is self-confidence. Self-confidence springs from two things: (i) Personality; (ii) Knowledge. A really first-class lecturer must have both. Anyone with normal faculties can acquire proficiency in lecturing, provided that he is able to make up for a lack of one by an abundance of the other.

SURVEY SIDELIGHTS.

III.

By CAPTAIN J. C. T. WILLIS, R.E.

A TRUE TALE OF A TREK.

AFTER a long and weary day,
My work still incomplete,
I sat me down outside my tent
To manicure my feet.

For I had wandered long and far
Through *paya* all the day
And like to many an idol, both
My feet seemed made of clay.

Then drifted up my head-man,
His *kris* was in his hand.
He mumbled out a flood of words
I did not understand.

The only word I recognized
Was *makan* (means " to eat ")
I wasn't listening much, but paid
Attention to my feet.

Hearing this word *makan* I thought
He, eating much, was ill,
So then and there I sought him out
A Mark I special PILL.

This he consumed, and mumbled on
Altho' I bade him go.
My interest was still affixed
To blisters on my toe.

I bent again unto my task.
The head-man lingered still.
I guessed he must want something, so
Produced another pill.

This too he ate, and later one
I gave him for his wife
But as he stayed and stayed and stayed
I laid aside my knife.

Now when I paid attention I
Discovered that the price
That he had lately had to pay
For half a sack of rice

Was the main burden of his chat
And hence the word "to eat,"
But my attention had been glued
To scissors and my feet.

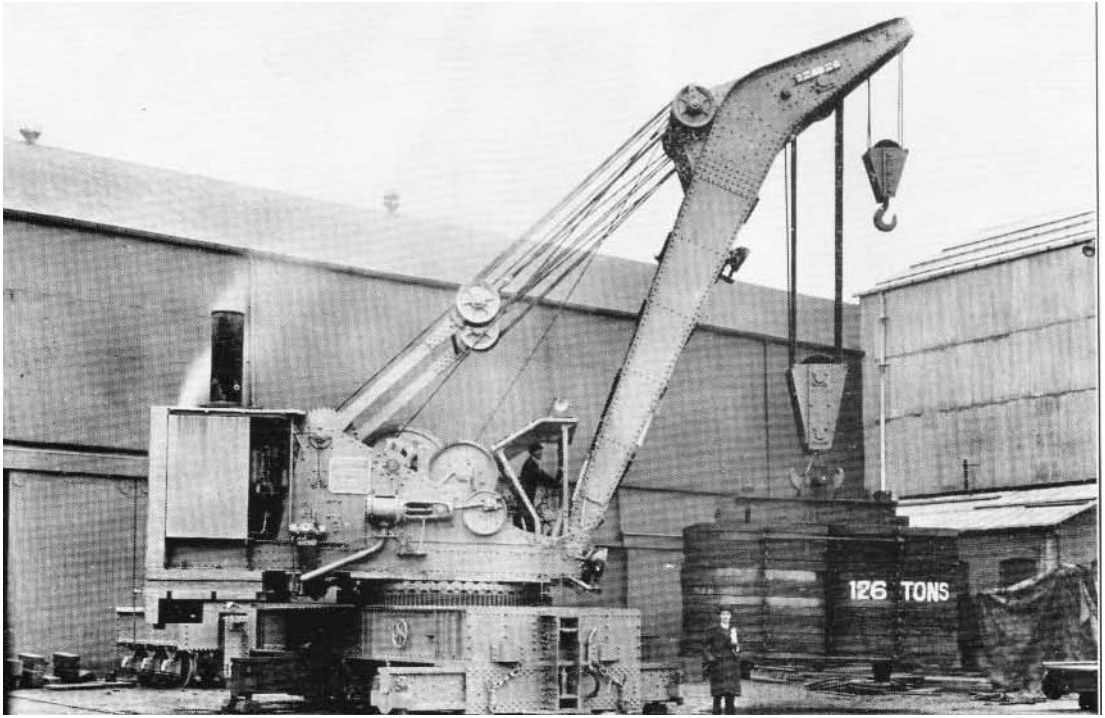
I settled then the question of
The price that he should pay,
And now I'm waiting patiently
For him to come and say:

"Oh, master, since I saw you last
I *have* been feeling ill,"
And with a graven face I shall
Produce another pill.

THE HEADQUARTER BUNGALOW.

The O.C. wants to call the place
"The Survey G.H.Q."
I think "Mon Repos" would mean
More to me and you!

But think of all the instruments
With which it is replete!
Well then, "The Goat and Compasses"
Seems really rather neat.



105 ton railway crane

PROFESSIONAL NOTES.

105-TON RAILWAY CRANE.

THE following brief description of a 105-ton railway crane which has recently been delivered to the War Office by the makers may be of interest. Although not as large as some railway cranes built in America, this crane is the heaviest duty breakdown crane built in Great Britain.

The crane was built to a specification prepared by Q.M.G.9 Branch at the War Office by Messrs. Ransomes & Rapier, Limited, of Ipswich. In order that the design should be limited as little as possible by considerations of space, an unusually large loading gauge, especially as regards height, was permitted, as it was not expected that the crane would have to pass under any bridges. The crane will not comply with the British loading gauge. The maximum axle load, however, was limited to 17 tons with the crane in the travelling position.

A feature of the crane is the "Stokes bogie," one of which is attached at each end of the crane when travelling. The object of these is to relieve the four main axles by the addition of two three-axled bogies on to which a portion of the weight of the crane is transferred by a patent worm wheel and screw gear. The removal of the bogies when the crane is "in action" greatly increases the clearance available when the jib is working over the head stocks.

The duties for which the crane was designed are as follows, each motion being tested with loads 20% above the working loads given.

LIFT AND SLEW A COMPLETE REVOLUTION WITH PROPPING GIRDERS.

Main Hoist.

105 tons at 20-ft. radius with full ballast.
65 ,, ,, 25 ,, ,, ,, ,,
45 ,, ,, 30 ,, ,, ,, ,,
90 ,, ,, 20 ,, ,, with part of full ballast.
60 ,, ,, 25 ,, ,, ,, ,, ,, ,,
40 ,, ,, 30 ,, ,, ,, ,, ,, ,,

Auxiliary Hoist.

25 tons at 35-ft. radius.

TO OPERATE ON ALL MOTIONS ON A LEVEL TRACK OR GRADE OF 1 IN 50 WITHOUT PROPPING GIRDERS.

Main Hoist. 20 tons at 20-ft. radius.
Auxiliary Hoist. 15 tons at 25-ft. radius; 12 tons at 30-ft. radius; 8 tons at 35-ft. radius.
Propping Base. 17 feet.
Hoisting speed with 105 tons—10ft. per minute.
Hoisting range at 20-ft. radius. From 16 ft. below rail level to 24 ft. above rail level.

The crane is fitted with a Cockran-Hopwood multitubular boiler working at 150 lb. per sq. inch and a turbine-driven electric lighting set giving 500 watts AC at high frequency, by Stone & Co., Ltd., of Deptford. To facilitate extremely slow lowering of heavy loads, a special oil-resistance pump is fitted, by means of which the 105-ton load can be lowered at a creeping speed of ¾ inch per minute. The photograph shows the crane, with propping girders in use, carrying the test load of 126 tons. One of the Stokes relieving bogies can be seen in the background.

P.R.A.

FOUNDATIONS ON FERRO-CONCRETE PILES WITH THE BASE ENLARGED BY EXPLOSION OR UPSETTING.

Translated from "La Revue du Génie Militaire."

THE modern industrial movement tends to the construction of factories situated for the most part along rivers and roads, in valleys and alluvial plains where the resistance of the soil is weak.

Many methods of providing foundations in such circumstances have been devised and a number of patents have been taken out. One of the most recent is the method "*Wilhelmi et Pieux Explosés.*"

The piles usually called "exploded piles" (*pieux explosés*) or "upset piles" (*pieux refoulés*) can be constructed in all soils, water-bearing or otherwise; their special feature is that they spread the load over a wide footing and improve the resistant properties of the soil by the powerful compression caused by the manner of their construction.

"EXPLODED PILES."

They are made in the following manner:

1. A steel tube is driven into the soil by means of a pile-driver. Inside the tube is a false-pile of wood the point of which, furnished with a shoe, projects at the bottom. The whole arrangement, tube and false-pile, capped with a turks-head, can be driven as easily as

an ordinary pile until it reaches a resistant soil (Fig. 1a), the presence of which is revealed by the extent of the refusal.

2. At the desired depth the false-pile is withdrawn and an explosive charge with an electric fuze and lead is lowered to the bottom of the tube. (Fig. 1b.)

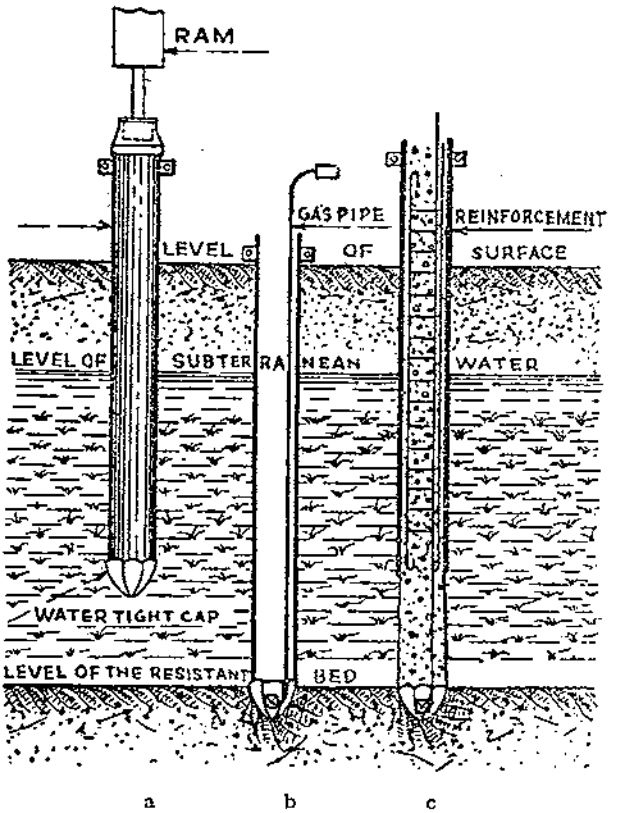


FIG. 1.—Driving an exploded pile in water-bearing soil.

3. Over the charge, which must be suitably protected, a quantity of plastic cement is poured, corresponding in volume to the estimated base of the pile.

4. If the pile is to be reinforced for its whole height, the reinforcement is lowered into the tube, which is then filled with concrete.

5. The tube is then withdrawn about one metre (Fig. 1c) in order to disengage it from the base of the pile where is the charge, and the latter is fired.

6. The chamber formed by the explosion is immediately filled by the concrete, which is denser and more fluid than the soil which has been pressed back. As the concrete in the tube falls through a height of two to three metres, it follows that to the static pressure

of the liquid concrete there is added a considerable dynamic pressure due to this fall. The concrete drags the reinforcement with it, which enters the enlarged base of the pile.

To complete the pile it only remains to fill up the tube to the desired level (care must be taken to prepare sufficient concrete to fill up the space occupied in the soil by the tube and the lateral enlargements).

7. Before withdrawing the tube the false-pile is placed over the concrete with a plug in between; short blows are given with the ram in time with the withdrawal of the tube, to compress the concrete and to make it flow into the voids and soft strata. (Fig. 2a and b.)

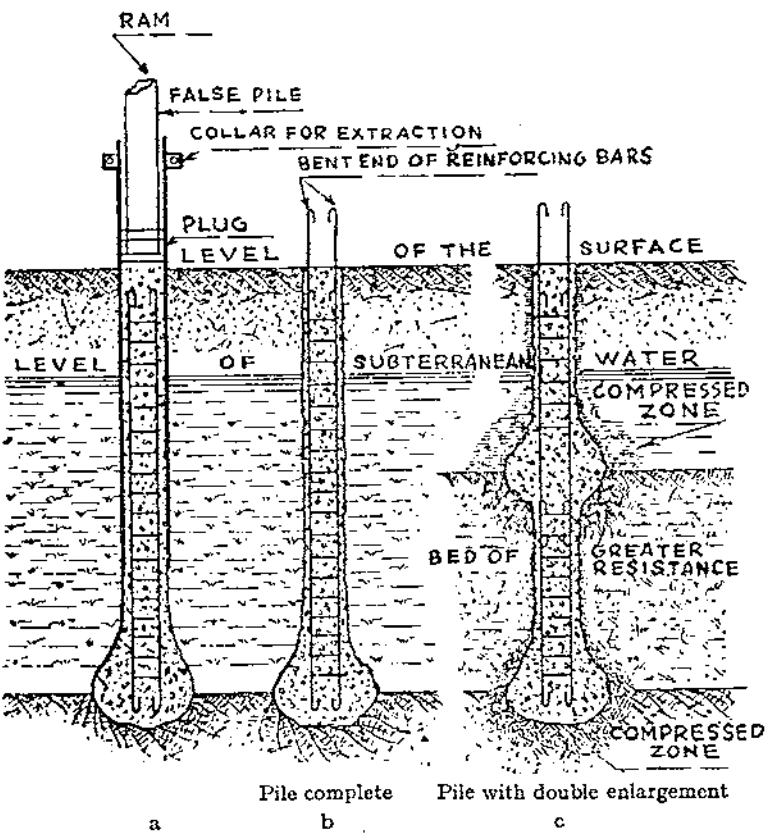


FIG. 2.—Driving an exploded pile in water-bearing soil.

By this method it is impossible that contractions should occur in the column, the static pressure of the concrete against the surrounding soil being greater than the pressure of the earth, however fluid it may be.

"Exploded Piles" with Several Enlargements.

In very compressible soils, where a good stratum cannot be reached, piles with a succession of enlargements called "floating piles" (*pieux flottants*) can be employed with success. The method is the same as for piles with enlarged bases.

The enlargement at the base having been obtained as already indicated, another charge is lowered to the desired depth and the tube filled with concrete after the introduction of the reinforcement. This has to be sufficiently long to reach below the new enlargement and connect with the reinforcement below. The tube is raised to about one metre above the charge which is then fired. An enlargement is produced like that at the base resting on soil which has been strongly compressed. (Fig. 2c.)

Shape at the Base.

If the gases released by the explosion met with equal resistance in all directions, the shape of the chamber formed would be a sphere. But during the construction of an exploded pile these conditions are not realized, and the shape of the base resembles an ellipsoid with the short axis vertical. The reason of this flattening, proved by many experiments, is that sedimentary soils offer stronger resistance in a direction perpendicular to the line of stratification than in a direction parallel to it.

Moreover, the explosion takes place between two points of higher resistance, the upper one consisting of the practically incompressible column of fluid concrete and the one below being the resistant earth on which the pile was stopped.

If the charge is enclosed between two horizontal sheets of steel, the lateral force of the explosion is increased.

The diameter of the base, usually obtained with charges of 400 (14 oz.) to 800 grams of Favier powder No. 2 is 1 metre to 1·3 metres.

The concussion caused by the explosion is, as a rule, not harmful to structures near the scene of operations, as it is not more violent than that due to the fall of the ram. However, in the case of piles driven in the immediate proximity of foundations, the stability of which is doubtful, it is preferable to have recourse to the method of enlargement by "upsetting" (*refoulement*).

Piles with the Base Enlarged by Setting Up.

By a very simple method, but one a little less rapid and effective than that of explosion, the base of a pile can be enlarged by

"upsetting." The same apparatus is used, the procedure being as follows (Fig. 3a) :—

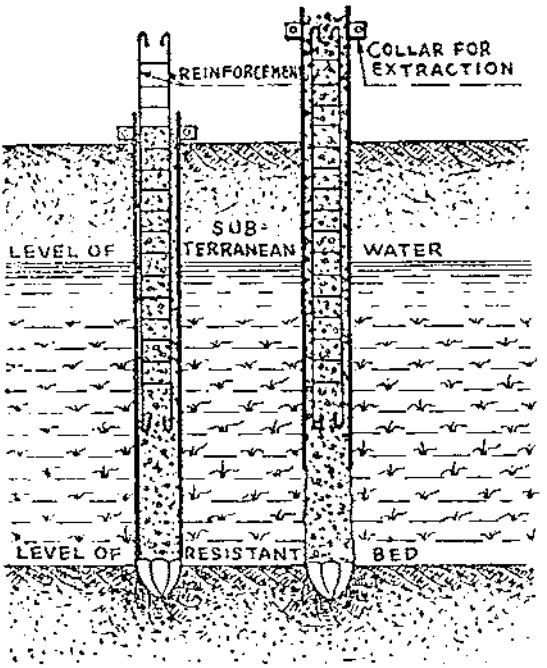


FIG. 3.—Driving a pile with base enlarged by upsetting.

The tube having been driven as previously described, is filled with fluid concrete which has been carefully mixed. The tube is then raised about 1·2 metres and is filled up to the lip (Fig. 3b). The full tube, carefully stopped with the turks-head, is again driven up to the base of the pile, which becomes enlarged by the pressure. This operation is repeated till the base is sufficiently enlarged. This enlargement has a cylindrical form, each new driving of the concrete enlarging the base over an area equal to the section of the tube.

If the pile encounters a strongly resistant soil at its base, the widening can be produced by driving the concrete column with a plug on the top of it. (Fig. 4a and b.)

The concrete which is made to flow from the bottom of the tube will spread over the surface of the resistant bed, forcing the soil away laterally.

As in the case of exploded piles, the reinforcement can be let down in the concrete to an extent which will ensure its having entered the enlarged base when the operation is complete.

The lateral enlargements for the so-called floating piles are

obtained in the same manner, the column being driven in time with the withdrawal of the tube. (Fig. 4c.)

As in the case of exploded piles, the internal pressure of the piles being always greater than that of the earth, any contractions are impossible; this is one of the essential characteristics of this mode of driving piles which are cast in the soil.

Pile-drivers used in these operations are specially arranged to allow of the rapid withdrawal of the tube by means of a powerful steam winch and tackle.

The extreme simplicity of the procedure and the ease with which each step of the operation can be verified ensure rapidity of execution, uniformity of construction and a bearing power on the pile which can be accurately foreseen.

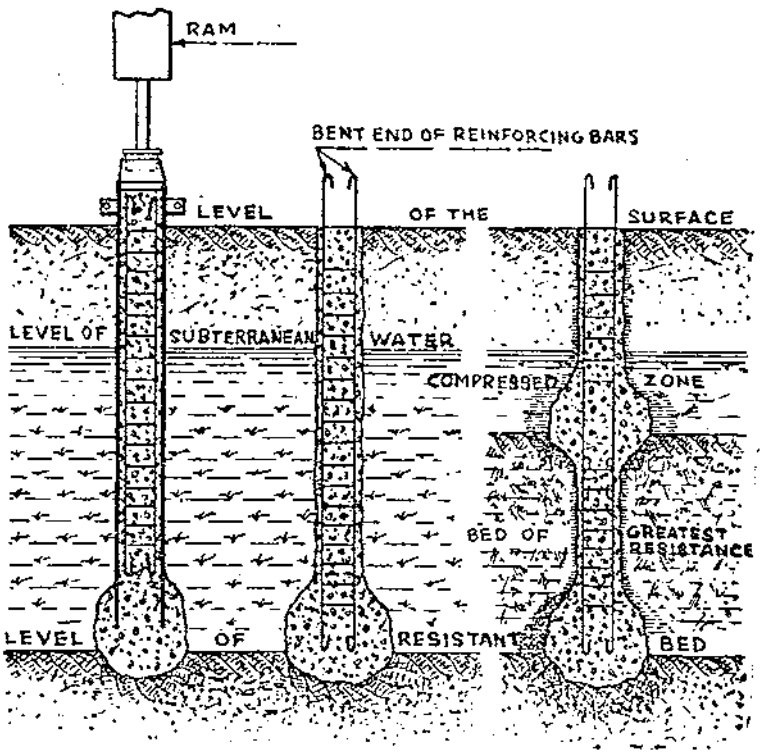


FIG. 4—Driving a pile with base enlarged by upsetting.

PROTECTION AGAINST THE ENTRANCE OF WATER INTO THE TUBE BEFORE THE CONCRETE IS RUN.

By a very simple and cheap device, the entrance of water into the tube can be prevented in permeable water-bearing strata after the

withdrawal of the false-pile and before the concrete is run. This device consists of a circular iron sheet, the middle of which has been made concave to fit over the end of the false-pile, and with radial cuts forming sectors. (Fig. 1a.)

When the pile is being put into position, this cap is placed over the point and the flaps are bent back so as to overlap. During the driving the pressure on the point squeezes the flaps over one another and against the lower rim of the tube, thus forming a watertight box. When the false-pile is withdrawn, the cap remains at the bottom of the hole, kept against the end of the tube by external pressure. It offers no resistance to internal pressure, and the explosion or the upsetting easily opens out the flaps.

CALCULATIONS.

Owing to the principle on which the piles are driven, the determination of their bearing power can be very simply and accurately arrived at, as it is done by direct measurement without reference to approximate values for the resistance of the soil at the base and ambiguous coefficients of friction for the lateral surface. In fact, thanks to the two distinct elements presented by the tube and the false-pile during the process of driving, it is possible to measure directly and separately the resistance of the soil at the base and the lateral friction caused by the earth against the body of the pile.

To arrive at the effective bearing power of the soil at the depth reached, it suffices to strike the false-pile alone and measure the refusal. As the false-pile is free inside the tube, which does not move, there is no resistance due to lateral pressure.

If R is the unit of resistance of the soil, S the section of the false-pile, P the weight of the ram, h the height of the fall, p the weight of the false-pile, e the distance driven to refusal, according to the principle of work the following holds good:

$$RSe - \frac{P^2 h}{P + p} = 0$$

whence

$$R = \frac{P^2 h}{Se\,(P + p)}$$

To the resistance R so obtained must be applied a suitable coefficient for safety of $\frac{1}{6}$ to $\frac{1}{10}$ according as one wishes to take into account or not the increased resistance due to the compression of the soil when the enlargement takes place. The refusal obtained by driving the tube and false-pile together, allows of a value being

obtained for the total resistance offered by the soil to the driving of the pile. If e_1 is this refusal, the total reaction will be :

$$F = \frac{Ph}{e_1 (1 + \frac{p}{P})}$$

The difference F − RS gives the value of the friction of the earth on the tube. The value of the coefficients of friction for earth on steel and earth on concrete being known, it is easy to determine what will be the resistance of the pile.

The two elements of resistance of the pile being known, the surface of the footing required for a given load can be determined.

The composition of the soil, a knowledge of which is very important, can be ascertained in the case of each pile, as the false-pile will bring with it samples attached to the point when it is withdrawn.

In practice, the resistance at the base and the lateral friction need not be ascertained for each pile. From calculations made for a few piles, the coefficient to be used for a determination of the total refusal can be calculated from the formula :

$$e = \tfrac{1}{3} \times \frac{Ph}{F (1 - \frac{p}{P})}$$

The coefficient of $\frac{1}{3}$ is the factor of safety, and takes into account the widening at the base and the lateral friction.

The pile, which can be reinforced as already explained, is regarded as an ordinary column for purposes of calculation, whilst the composition of the concrete is that usual in reinforced work. The piles are most conveniently made with tubes of 30, 40 and 50-cm. diameter allowing for loads of between 30 and 80 tons per pile, according to the resistance of the soil and the position of the load.

The piles can be made at different slopes, a fact which makes them particularly suitable for supporting oblique and horizontal loads. They have often been used for anchorages, their resistance to extraction being considerable.

Their great resistance to tension and compression render these piles particularly suitable for certain kinds of foundations, especially where vibration and shock occur, notably beds for machinery.

For so-called floating piles, that is to say, piles the bases of which are designed with one or more lateral enlargements, it is easy by the method of driving explained above, to determine very accurately whilst the tube and false-pile are being driven, what is the resistance of each layer of soil encountered and therefrom the admissible bearing power of the pile.

The depth of the more resistant beds can be ascertained by observing the varying refusal of the false-pile. In these beds it will be

possible to make successive footings, either by explosion or upsetting, whereby the bearing power of the pile will be considerably increased.

Inversely, the resistance of the soil having been found as indicated above, it is possible, knowing the size of the footing by the amount of concrete which has filled it, to determine very accurately the increase of bearing power afforded by each enlargement.

REMARKS ON THE NATURE OF "REFUSALS."

When the piles have reached a strongly resistant bed such as sand or non-clayey gravel or rock, measurement of the "refusals" only serves in general to show whether the pile has arrived at the required depth. In such soils, piles with enlarged bases act chiefly like simple columns of reinforced concrete, resting on the resistant bed with their base much enlarged, and causing the soil to exert its full resistive power. The resistance due to lateral friction and the supplementary resistance of the soil due to the explosion or upsetting can be neglected.

On the other hand, in the case of piles driven in compressible ground such as loam, clayey gravel or sand, etc., it is necessary to complete the record of refusals by observations on several piles in a static state, that is to say, piles in similar conditions and bearing the same load as those in the structure contemplated.

Actually, during driving, refusals cannot correspond to the real resistance of the soil, for either the adherence of soil to the surface of the tube becomes weaker under the pressure of repeated blows (a smooth surface almost always being formed, especially in water-bearing soils), or on the contrary the compression of the soil, momentarily stronger in the immediate neighbourhood of the pile, causes a resistance to the driving which is liable to diminish when the earth is released from compression.

It is a very simple matter to verify the significance of the refusals by the method described below.

The tube and the false-pile are driven near the end of the day's work on Saturday; the refusals are measured on the tube and on the false-pile to get the resistance at the base and that due to lateral friction, and nothing is touched till the following Monday morning; during the interval, the soil and the pile have taken up a position of equilibrium, and it suffices to measure again the refusals to find the actual resistance of the pile under the action of static loads.

If the piles have to support dynamic loads or withstand abruptly changing forces of tension and compression, the most unfavourable values of the refusal are always taken to determine the admissible load on a pile.

This method of procedure admits of the extra resistance imparted to the soil by the explosion or setting up being taken into account; for it immediately shows whether the compression of the soil under the false pile is permanent or transitory. A.H.B.

Colonel John Edward Broadbent. CB

MEMOIR.

COLONEL J. E. BROADBENT, C.B.

COLONEL JOHN EDWARD BROADBENT, who died on the 7th January, 1931, was born in 1845, being the son of Mr. John Broadbent, of Longwood Edge, near Huddersfield, and the younger brother of Sir William Broadbent, Bt., the celebrated physician.

Passing out first from Woolwich in 1866 and winning the Pollock Medal, he sailed for India in 1868, after completing the usual Chatham course, and practically the whole of his future service was in that country.

After serving in the Submarine Mining Services on the Hoogli, he joined the Military Works Department in 1874, and from 1879 to 1882, was on the staff of the Inspector-General of Military Works, Simla. From 1882 to 1892, he served in the Military Department, Government of India, first as Assistant Secretary and later as Deputy Secretary. From 1892 to 1894, he was Deputy Director-General of Military Works, in which latter year he assumed the duties of Chief Engineer, Bombay Military Works.

On the creation of four Military Commands in India in 1895, he was appointed Chief Engineer, Punjab Command, a post he filled until his retirement in 1902.

It was during his tenure of this appointment that the scope of the duties of R.E. officers in the Punjab Command was increased so largely by the creation of the N.W. Frontier Province, in which all Public Works, civil and military (other than Canal Works) were the responsibility of the R.E.

In 1897, the year which saw a general blaze-up along the whole of the North-Western Frontier, he was appointed C.R.E., Malakand Field Force, and later on Chief Engineer, Tirah Expeditionary Force, with the rank of Brigadier-General. For these services, he was created C.B.

He was twice married, his first wife being Dora, daughter of Mr. Thomas Nicholson (she died in 1897); and in 1900, he married the Hon. Alexandra Twisleton-Wykeham-Fiennes, daughter of the 17th Baron Saye and Sele.

After his retirement, he settled at Reading and immediately interested himself in the social and religious life of the neighbourhood. He was a Magistrate for Berkshire, Hon. Treasurer of the Royal

Berkshire Hospital, President of the Berkshire Branch of the Church Missionary Society and a Member of the Committee of the parent body.

During his long service in India, he made many friends, and to all such his house was always open. To all who served under his command, he proved a true friend, wise in counsel and helpful in difficulty. Many now living must look back with gratitude for his ever-ready help and guidance and treasure the memory of his high character and never-failing sympathy and kindness.

By his first wife, he had one daughter and three sons. His eldest son is Major-General E. N. Broadbent, Director of Movements and Quarterings at the War Office.

H.B.

BOOKS.

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

BRITMIS.

A Great Adventure of the War. Being an Account of Allied Intervention in Siberia and of an Escape across the Gobi to Peking.

By MAJOR PHELPS HODGES.

(Jonathan Cape, London, 1931. Price 12s. 6d.)

The author joined the Royal Field Artillery from Woolwich in 1914 shortly before the outbreak of war, served in France till severely wounded in March, 1918, and on return to duty in England volunteered for service in South Russia on the strength of a slight—very slight—knowledge of the Russian language picked up while convalescing in hospital. After the Armistice, in December, he found himself ordered—much to his surprise—to Vladivostok, and in January, 1919, with thirty other officers, he embarked to join the British Mission under General Knox attached to the White Russian forces under Admiral Kolchak in Siberia. After an adventurous time with the Russians, first as an instructor in gunnery and later as a liaison officer, he eventually made his way back with another English officer and a French officer to Peking in May, 1920. Returning to England, he resigned his commission in 1921, and subsequently returned to China.

The greater part of the volume is devoted to an account of the author's adventures while nominally attached as a member of an Allied Mission to the remnants of the Southern Army, the Cossack Ataman Dutov, during its retreat from the Orenburg district right across the Gobi Desert to the Chinese frontier, whence he and his companions made their way to Peking.

Written ten years after the events he describes, Major Hodges' book has not the same value that it would have had if it had been written earlier, but the author claims that in delaying putting pen to paper he is in a better position to weigh the real significance of the events he records, and can discuss them with maturer judgment and in better perspective.

The author, however, has a stronger claim to the reader's appreciation than the mere recital of a thrilling narrative, in which he describes the hardships and dangers

he met with while traversing what was practically enemy country in the depth of a Siberian winter. In his introductory chapter he reminds us of the part played by the Allies in Russia during and after the Revolution, and the reason why British officers were sent to Russia even after the Armistice with Germany. In view of the little that has been written in English of this phase of the aftermath of the World War, and the little that is generally known about it, in this country, it is worth while to refresh one's memory by quoting the author :—

"The intervention of the Allies at the end of the War has been, and still is, severely "criticized by both extremes of political opinion. From the conservative, militarist "or royalist point of view, far too few troops were sent to help the anti-Bolshevik "forces, and no concerted action was taken to drive the Soviet leaders from power. "On the other hand, liberal and socialist opinion condemns the whole episode as an "unjustifiable adventure, which did nothing but inflict added hardships on the "population of Russia, and had no object but to replace a hated oligarchy in author-"ity. But in view of the military situation at the end of 1917, and beginning of "1918, it is obvious that Allied intervention of some sort was inevitable. A study of "subsequent events fully justified the landing of small detachments of Allied troops "at various points in Russia, and the support given to the local anti-Red forces, "while at the same time it is quite evident that it would have been a very grave "mistake to have intervened in Russia's internal affairs to any further extent, as, "for example, by the despatch of an Allied Army to drive the Bolsheviks from "Moscow. Whether we stayed too long in Russia after the end of the War is a "question of opinion, but to have withdrawn our forces immediately after the Armis-"tice would have been unwise from a military point of view, and a flagrant betrayal "of the Czechs and our White Russian comrades."

Major Hodges proceeds to give us in a few pages a very clear account of the series of events which led to the dispatch of British officers and men to Murmansk, Siberia, and South Russia, and explains what they were sent to do. In conclusion he writes :

"If the Allies had decided on the downfall of Lenin and Trotsky, they could easily "have chased them out of Moscow with Allied troops ; but they had to keep up a "pretence of neutrality, and therefore armed the White Russians to do the work for "them. The Allies were in an awkward position, for, having assisted the Whites "to resist, and having succeeded in preventing the Bolsheviks from handing over great "quantities of stores to the Germans before the War ended, they could not very well "drop their Russian friends without giving them some further assistance, while at "the same time they wished to see the speedy downfall of the Communist Govern-"ment, whose propaganda was having such a disturbing effect all over the world, "without openly engaging in hostilities. Not only would the advance of an Allied "Army on Moscow have caused serious disturbances in other countries, but this "crude attempt of foreigners to settle domestic disputes would undoubtedly have "greatly strengthened the Bolsheviks, and made Lenin's return to power sooner or "later a certainty."

No reader of Major Hodges' book can lay it down without realizing the hopelessness of the task of the British Mission, and the futility of the Allied effort to try and get the Anti-Bolshevik Russians to help themselves. By the beginning of 1919 the White Russians were utterly demoralized, and apparently unable to make even a show of resistance when they came up against the Bolshevik forces. But before condemning the survivors out of hand, it is as well to recall the frightful circumstances under which the loyal remnants of the Imperial Army had attempted to carry on the war against Germany and Austria, after the Revolution had destroyed all trace of discipline in its ranks and caused the death of hundreds of its officers.

The volume has a fairly good index, but the two small-scale sketch maps provided are inadequate.

H.B-W.

THE GIBRALTAR SOCIETY: ANNUAL JOURNAL, VOL. I, 1930.

(Garrison Library Printing Establishment, Gibraltar, 4s. 6d.)

123 pp., with 3 maps, 1 diagram, 1 photograph.

This is the first number of what promises to be a very interesting and valuable publication. It not only records the proceedings of a Society which has been established for the advancement of knowledge of, and interest in, Gibraltar, but it also includes really interesting papers which cannot fail to promote these objects. The first paper is by the Editor, Rev. I. L. Brown-Smith, well known for many years past to all who have been stationed on the Rock, who gives an excellent summary—prehistorical and historical—of its general setting. This is followed by a reproduction in Spanish and English of an oft-quoted, but not previously published, account by the Rev. Juan Romero of the British capture of Gibraltar in 1704. This gallant priest was then in charge of the Church of Santa Maria la Coronada, and elected to remain on the Rock to protect his beloved Church and its property, rather than to migrate with most of his flock to San Roque, where his original MS. still exists, a copy being preserved in the Gibraltar Library. Captain Gonzalez contributes an excellent history of the Dockyard, with three plans showing its growth from the building by Philip IV. of the "New Mole" in 1624 to the present time. A valuable report by the Architect in charge of the Alhambra on the Moorish Baths—the oldest Arab structure on the Rock except the contemporaneous "Tower of Homage" in the Castle—gives full details and also makes recommendations for such works as are feasible in order to remove modern excrescences and to restore the baths as far as possible to their original condition. "Ordnance House," which has been built over them, has now been appropriately converted into a Museum where collections and specimens illustrating the history, flora and fauna of the Rock will be housed. There are excellent papers on the flowers and birds of Gibraltar and a most useful "Gardener's Calendar" for the twelve months. Descriptions of the Moorish Castle, the Galleries, the Caves and the Geology are given, which not only include full records of some of the explorations carried out in former years, but also bring them up-to-date by references to those of the Abbé Breuil and Miss Garrod between 1917 and 1927, which culminated in Miss Garrod's remarkable discovery of the skull of a Mousterian or Neanderthal child near the Devil's Tower, an exceedingly interesting companion to the woman's skull discovered in 1848 in the not far distant Forbes' Quarry.

It is to be hoped that this admirable publication will lead many former residents to join the "Gibraltar Society" (entrance subscription 5s., annual 5s., life member £2 2s.), and thus help to provide funds for the proper equipment and maintenance of the Museum, the opening of which by the Governor, Sir Alexander Godley, forms the subject of another article in this journal. Under his auspices it may be hoped that the Museum will have a better chance of survival and extension than its ill-starred predecessors of 1844 and 1897, which languished and expired from lack of interest. The journal gives full details of the organization and rules of the Society and Museum.

E.R.K.

THE INDIAN MUTINY IN PERSPECTIVE.

By LIEUT.-GENERAL SIR GEORGE MACMUNN, K.C.B., K.C.S.I., D.S.O.

(G. Bell & Sons, 15s. net.)

Voluminous as the literature on the subject of the Indian Mutiny is, few will disagree with Sir George MacMunn's reason for adding to it, namely, that "the last "history of merit appeared over 30 years ago, and that it is the habit of the age to "read eagerly stories of the past, if written from a modern angle."

Few can be better qualified to give us a perspective view of the events of 1857 than the author, who has served with the Indian sepoy in peace and war, has visited many

of the scenes of the fighting, and by dint of long and useful service at A.H.Q., India, appreciates the point of view of the "powers that were" in the Mutiny. Added to a careful sifting of facts and theories presented by the many historians, he gives us little bits of local colour gathered from survivors, British and Indian, of the great storm, even from ex-mutineers. Indeed, it is, no doubt, owing to his assiduity in collecting information from those who fought against us, that he gives us a better picture of what was happening on the other side, than we remember seeing in any history.

In 1857 there were three separate armies in India, the Bengal, Madras and Bombay, each consisting of British and Indian units. In addition there were a good many contingents, Indian regiments, generally at the capitals of Indian states. There were also cavalry regiments and infantry battalions of the Queen's Army. British troops in all amounted to 40,000 men, being less than establishment by two cavalry and two infantry corps, which had been sent to the Crimea and not replaced. Indian troops in all amounted to about 300,000, with 5,400 British officers.

It is to be remembered that it was only in the Bengal army, and in some of the contingents, that mutiny occurred; the other two presidency armies remained almost, if not quite, staunch. The greatest number of trained troops we had against us at any one time was probably about 120,000, to which must be added disaffected rajahs' troops and stray dacoits. The area covered by military operations measured about 1,100 miles by 700, the area of France and Germany combined. The climate was against us, and yet the Mutiny was suppressed in less than two years by an addition of only about 10,000 men to our normal British garrison. These facts serve to put the Mutiny in its right perspective.

Only in Oudh and the adjacent parts of what are now the United Provinces was there anything like a national rising. By far the greater part of India was with us. To defeat the enemy we used the Madras and Bombay armies, regiments hastily raised from the newly-conquered Punjab, our Gurkha allies and the loyal remnants of the Bengal Army, who were in many cases fighting their own kith and kin. In this connection the author mentions the excellent work of the faithful sepoys of the Bengal Sappers and Miners, who at Delhi and Lucknow fought against their own late comrades.

In addition to the British troops already in the country, we were most providentially provided with a first reinforcement in the shape of an expedition on its way to China, for a war which could be postponed. Ceylon, Burma and Mauritius provided a few more, while four infantry battalions and three R.E. field companies, sent *via* the Cape, arrived in time to take part in the major operations at the beginning of 1858.

That there has been only one serious mutiny in the Indian Army during the 180 years of its existence is an extraordinary tribute to the British officer and to the martial races of India. And it is pleasing to note that Sir George is optimistic as regards the future, if only its organization remains in our hands.

The main reason for the outbreak, Sir George considers, lay in the recent annexation of Oudh. Misrule there by the ruling dynasty had reached such a pitch that Government were compelled, after half a century of warnings, to take over the country. Before the benefits of British rule had time to make themselves felt, our land settlement policy caused discontent, to a great extent justifiable, in that it dispossessed many of the land-owning class. Moreover, the pre-Mutiny sepoy who was largely recruited from the high-caste Brahmins and Rajputs of Oudh, now found himself without honour in his own country; where previously he had enjoyed great prestige under the ægis of the British Resident, now he was on a level, in the eyes of the civil administration, with the meanest outcaste. Added to this, and some lesser causes of discontent, came the panic fear, which persuasion and demonstration could not allay, that the greasy cartridges were designed to destroy the souls of Hindu and Musalman alike.

It is an interesting question to ask whether the pre-Mutiny British officers were

as assiduous as those of the present day as regards the welfare of their men, and it is to be regretted that Gen. MacMunn, in common with most historians, leaves this question unanswered. Many civilian writers have laboured the point that the British officer was an utter stranger to his men, but naturally they have little actual knowledge of the state of affairs.

Although there was ample warning, the outbreak at Meerut found both civil and military authorities unprepared for such an emergency. British troops were concentrated, almost entirely, in the north. Delhi, with its large magazine, was garrisoned by an all-Indian brigade, and A.H.Q. had gone to summer in the Simla hills. There were no internal security schemes, and no plan of campaign to come into operation in the event of a rising. Further, all organized transport had recently been abolished, and the collection of hired transport in such an emergency was most difficult.

The author exonerates A.H.Q. from the charge of supineness usually made against it, as regards its conduct in the crisis. Within six days of the reception of the news of the outbreak, transport had been collected, and the first batch of troops began its march from Ambala towards Delhi. But was A.H.Q. right in attaching itself to this force, at the outset not more than two weak brigades? In doing so, it naturally relaxed its hold over operations in other parts of the country, and after the death, from cholera, of the C.-in-C., it seems to have merged its identity in the staff of the Delhi Field Force. Again, no less an authority than Fortescue has questioned the wisdom of maintaining a force before Delhi for months before it was strong enough to take the city, and we would have welcomed the author's views on the subject.

The Governor-General—the term Viceroy was not introduced till after the Mutiny—was at Calcutta when the crisis arose. His actions come in for some criticism from Sir George, who, however, notes his difficulties in the absence of his chief military adviser, separated from him by hundreds of miles of revolted and disturbed country. It was necessary to organize an army in Bengal, which was almost destitute of British troops, before it was possible to move up country. This was done by Sir Pat Grant, C.-in-C. of the Madras Army, whose work was continued and carried through to ultimate success by Sir Colin Campbell.

The operations are described in a somewhat condensed but very vivid way. One can almost see the British troops, grim and weary, marching through intolerable heat and dust, their comrades stricken down daily with bullet and shell, sun and cholera, yet animated with a burning zeal to get to grips with the mutineers, and avenge the murders of their countrymen and countrywomen. Nor does he forget the praise due to the regiments of Sikhs, Punjabi Musalmans and Pathans, from the newly conquered Punjab; nor the staunchness of the loyal remnant of the Bengal army, which remained faithful and served to carry on the continuity of their units to this day.

He has a good deal to say on the subject of reprisals, for the Mutiny was not put down without severity, which at times, especially in the beginning of the operations, fell often upon the innocent or less guilty. But he effectually disposes of the contention that atrocities committed by the British were in any way the cause of the present unrest—a favourite theme of Congress-walas, and, to their shame be it said, of a few British writers. Severity there undoubtedly was, but such as is not to be compared with the cruelty of the Nana Sahib, nor of the sons of the King of Delhi, nor with the sufferings which the peasantry underwent at the hands of mutineer and dacoit while British rule was in abeyance.

The author, though he well might, comments little on our strategy and tactics, for his purpose has not been to make a text-book for military students; yet it should be read by all officers who are likely to serve in India.

There are unfortunately numerous slips, which closer scrutiny might have revealed. Kaye wrote three volumes of his Sepoy War, not two (p. x). The "Persian couplet" quoted on p. 28 is Urdu, not Persian. The author takes credit to himself for being

the first to point out that a large powder magazine existed outside Delhi in 1857, though Fanshawe, in *Delhi Past and Present*, written in 1902, mentions it. The railway from Calcutta to Raniganj is stated on p. 21 to have been over 140 miles long, on p. 92 to be 120 miles long, while scaled off on the map at the end of the book (a very inadequate one) it seems to have been at least 250 miles in length. Though the style is usually light and easy, for clumsiness it is hard to beat the following sentence (p. 124):

"Christian it will be noticed having placed all his faith in the Irregulars, the stream at his back prevented practically any escape from them, and a trap his position was soon to prove."

The Muhammadan festival of the 'Id at the end of May, 1857 (p. 102) did not commemorate the death of Husain, son of 'Ali, which is celebrated on the 10th Muharram, which in 1857 occurred in August.

To close, the author is generous in his tribute to the Bengal Engineers, to whom a very large share of the credit for the capture of Delhi must be given. The work of the loyal men of the Bengal Sappers and Miners has already been mentioned; the Madras Sappers and Miners took part, among other operations, in the second relief and final capture of Lucknow, the campaign in Central India and the capture of Jhansi, the Bombay Sappers and Miners also taking part in the last two operations. Four field companies R.E. helped in the campaign, the fourth, eleventh, twenty-first and twenty-third, the last named being deflected at Singapore with the rest of the China expedition. A survivor of the Mutiny campaign, who served as a subaltern with the 23rd Field Company, is still with us—our senior Colonel Commandant, General Sir Richard Harrison.

F.C.M.

COUNT ZEPPELIN—A BIOGRAPHY.

By MARGARET GOLDSMITH.

(Jonothan Cape, 7s. 6d.)

This is the story of Count Zeppelin as a man, not a technical account of his development of the airship, although the progress of his invention is briefly noted. It is of interest to the Corps, as it shows that Zeppelin served some time in the Engineers, and was not originally a cavalryman, as generally believed. He was first commissioned in 1857 in the 8th Württemberg Infantry Regiment, but in less than a year, finding the life dull, obtained permission to attend the University of Tübingen as a student of engineering. In 1859, at his own request, he was transferred to the Engineer Corps. A few months afterwards he was attached as a probationer to the General Staff. In 1863 he went to America and joined the Northern forces. In the war of 1866 he served on the Württemberg headquarters Staff. He took part in the celebrated raid at the beginning of the Franco-German War, as a General Staff officer. It was after that war that he was transferred to the cavalry.

J.E.E.

MY EXPERIENCES IN THE WORLD WAR.

By JOHN J. PERSHING, Commander-in-Chief of the American Expeditionary Force. (Hodder & Stoughton, 31s. 6d. net.)

(Reprinted by permission from *The Times Literary Supplement*.)

The title of General Pershing's book is well chosen: he does not give us a complete and formal history of his command in the War, but an account in plain language of his experiences and troubles in raising and employing the American Expeditionary Force. Under his direction it increased from one division of about 14,500 men (the first contingent which landed at St. Nazaire at the end of June, 1917) to two armies of

about 1,200,000, which were engaged in the Meuse-Argonne fighting in November, 1918. Simultaneously he had to improvise all the elaborate rearward services required in a foreign country 3,000 miles from home, equip and supply his army largely by purchase and borrowing, resist the strenuous attempts of the French and British to use the American troops as reinforcements for their depleted units, fight to have his men trained on lines which he judged best rather than on those recommended by his foreign advisers, and explain his actions to his far-away Government. The book is founded on a brief diary, extracts from which serve as section headings, expanded with the help of his official reports, letters and notes of conversation kept by his Staff.

M. Clemenceau, in a letter to Maréchal Foch quoted in the latter's memoirs, spoke of General Pershing's "invincible obstinacy which enabled him to win out against you as well as against your immediate subordinates"; and such an estimate of the character of the American Commander-in-Chief is not uncommon. His book will do much to remove such an impression of him and to raise his reputation. He shows himself as a man of sound judgment, who knew his own mind and what he wanted, who was not to be diverted from his purpose but at the same time was reasonable and helpful. Though not perhaps very sympathetic, he undoubtedly understood the nature and sentiments of his country and of his countrymen whom he was called on to command. His primary purpose in writing his story, which was to render further service to his country, is certainly achieved. "In that adventure," he says, "there "were many lessons useful to the American people, should they ever again be called "to arms, and I felt it a duty to record them as I saw them." But in what he writes he has understanding of the nature of the War and consideration for the nations whom his troops went to assist, closing his foreword with the words: "there is credit for "all of us in the final triumph of our united arms. The struggle of the Allies was "much longer, their sacrifices much greater than ours."

The first that General Pershing knew of his possible employment in Europe was the receipt of a telegram from his father-in-law, the late Senator F. E. Warren, four weeks after declaration of war: "Wire me to-day whether and how much you speak, read and write French." He sent a "rather optimistic" reply, and a week after was informed that he had been selected to command a division to be sent to France. He was at the time the junior Major-General of the United States army, having a few months earlier been promoted from the command of a brigade to that of the Southern Department on the Mexican border. To his astonishment and chagrin he found that nothing had been done in the way of preparation, although it had been apparent to everybody for months that America would be forced into the War. "The War Department seemed to be suffering from a kind of inertia." The General Staff, a very small body, "not yet properly organized . . . too much the inarticulate instru-"ment of the Chief-of-Staff, who often erroneously assumed the role of Commanding "General of the army," had done little more than consider the immediate question of sending abroad one division and 50,000 special troops. The situation as to munitions was "deplorable." General Pershing was particularly mortified at the state of aviation; there were only thirty-five officers who could fly, and only fifty-five aeroplanes, "fifty-one of them obsolete and four obsolescent."

America's Allies immediately began to ask for men: as individuals to recruit their ranks; if that was judged open to objection, then minor units, such as battalions and regiments, were to be incorporated in their divisions. This had the immediate result that in the instructions handed to General Pershing he was told he must always keep in view that "the Forces of the United States are a separate and distinct component of the combined forces, the identity of which must be preserved." From first to last the Allies, especially after March, 1918, tried to get this idea altered. But although many, including Mr. Lloyd George and M. Clemenceau, tried their powers of persuasion on General Pershing, they all failed—even Foch in his final attempt to separate the two American armies by putting a French one between them. In time of crisis Pershing lent all he had, but he insisted on getting his men back again, and he formed and

fought his two American armies; he did, however, leave two divisions with the British to the end.

Looking back, one must admit he was right. We ourselves objected furiously to the "amalgam" and other devices proposed for mixing the French and British armies. For the Americans there was not only the language difficulty, but we have learnt since, from their regimental histories, that although American and British officers hit it off admirably, the rank and file of the two armies did not view each other with the eyes of friendship. General Pershing does not say this, only telling one story about an American regiment objecting to wearing coats with British regimental buttons on them.

He had endless trouble with French officialdom—if a subordinate officer made a decision, the next senior always upset it—in building up his bases and lines of communication. One of his officers said: "We have come 3,000 miles to help them, "and we are treated like mendicants on the street corner." He found in particular both railways and telephones "inefficient and unreliable, as Government-owned utilities usually are." But his chief troubles seem to have been with home. The Washington "bureaux," having little of what the Army wanted, dispatched things which were useless, so that he was moved to cable:—

"Recommend no further shipment be made of the following articles . . . bath "bricks, bookcases, bath tubs, cabinets for blanks, chairs except folding chairs, "cuspidors, office desks, floor wax, hose except fire hose, step-ladders, lawn mowers, "refrigerators, safes except field iron safes, sickles, stools, window shades. Further "stop orders will soon follow."

In regard to senior officers he had to request that only those of "strong mental and physical vigour be sent." On the training of new units he was constantly forced to write; the methods employed were "discouraging to their officers, disastrous to morale," threw on the A.E.F. an extra burden of training and delayed the appearance of divisions in the field. It is interesting to find the commander-in-chief of a democracy whole-heartedly approving of conscription, and insisting on men saluting their officers as a means to discipline, loyalty, readiness and alertness: "The slovenly, "unmilitary, careless habits that have grown up in times of peace in our Army are "seriously detrimental to the aggressive attitude that must prevail." For the slowness of the American advance in the Argonne General Pershing gives good reasons; the district was indeed "ideal for defensive fighting," and he might have added that the defences had been elaborated by one of the best of the German generals, von Mudra, an Engineer officer.

The book kills one legend; General Pershing did not say in the Picpus Cemetery "Lafayette, we are here," but often wished this striking utterance could have been his. He thinks that a Colonel Stanton made it.

There are not a great number of expressions of opinion on the leading men with whom he was associated. With General Pétain he always got on admirably, and found co-operation easy on account of his "breadth of vision, his common sense and his sound judgment." Of Sir Douglas Haig he naturally saw little, his headquarters being at Chaumont, and he merely mentions their relations did not lack cordiality. General Franchet d'Esperey he speaks of as "one of the most picturesque and delightful personalities in the French Army." The Frenchman had been in America: "To have heard him describe how he suffered (from prohibition) while in Iowa one would have thought he was talking of a trip across the Sahara Desert." Foch did not impress him; he "never seemed interested when I talked to him of our problems. . . . He was essentially a student and teacher of history and strategy." He found him dull compared with Clemenceau, who was full of witty stories told to the point and of wonderful vitality. Late in the book there is a significant sentence:—

"In their mental processes Foch and Weygand were somewhat alike. It had been frequently noticed that when Weygand expressed himself on any question under discussion Foch was quite certain to be of the same opinion."

General Pershing goes out of his way to praise the alertness and confidence of the Canadians when he visited them.

It is of interest to us to know that the French were greatly surprised and chagrined at their defeat at Kemmel, after they had relieved the British there, and that after the Chemin des Dames defeat he dined with Foch and his staff, and it "would be difficult to imagine a more depressed group of officers. They sat through the meal scarcely speaking a word as they contemplated what was probably the most serious situation of the War."

It has generally been represented that there was a difference of opinion—"a tug of war" in which the Scotsman won—between General Pershing and Sir Douglas Haig with regard to the direction in which the American forces should be finally employed, the American taking the view that an offensive north-eastwards into Lorraine, east of Metz, would be the more effective one, and better than the northward one towards Sedan, which was adopted. Foch in his memoirs does not mention that Haig was at the conference; and now General Pershing definitely states, without mentioning Haig, that it was Foch and Weygand who opposed his view, giving their reasons, and that at a later date when the operation was again mooted Foch objected.

There are black-and-white sketch maps sufficient for the comprehension of the narrative, and one portrait.

INTERMEDIATE MECHANICS.

(STATICS AND HYDROSTATICS.)

By D. HUMPHREY.

(424 pp., 324 diagrams. Longman's, 10s. 6d.)

This is a companion volume to the author's *Dynamics*, published a short time ago. As may be supposed, one can hardly find anything new in the well-established principles dealt with, but the method of presentation is fresh, and much clearer than in many of the older text-books.

The most valuable feature of the book is the large number of examples. 36% of the space is devoted to *worked* examples, and 27% to upwards of 900 questions (with answers), which have been taken from the papers of various examining bodies, including Cambridge and London Universities.

The standard is up to that required for intermediate arts and science of London University and for Cambridge and London University Scholarships.

The printing and diagrams are excellent and numerical errors, if they exist, are not easy to find. W.M.

ELASTIC ENERGY THEORY.

By J. A. VAN DEN BROEK, PH.D.

(Chapman & Hall, Ltd., 22s. 6d.)

In advising only those members of the Corps who have taken Structures B in the Tripos to study this book, it is not intended to be in any way unkind. The author himself issues a warning that it is not to be regarded as a handbook, and that "browsing therein is likely to lead to disappointment."

Nevertheless, to a determined student anxious to analyse any indeterminate structure (from watch-springs to submarines, from airships to arches), this work will be of real value.

The author is convinced that for the analysis of such structures there are only two basic theories, the Theory of the Elastic Curve and the Theory of Elastic Energy.

"All other so-called theories are the personal methods of their proponents, all of "which may be developed from the Theory of Elastic Energy, some of them from "the Theory of the Elastic Curve."

He certainly makes out an excellent case in support of his belief, and although one sighs for the simple directness of Macaulay's Equation in Chapter VI (Redundant Beams), yet it must be admitted that even the latter is of less general applicability than the author's more laborious methods.

The estimate in Chapter XIII of the limitations of the Elastic Energy theory is arresting, in that it is so unusually fair, and the author, although showing no hesitation in displaying his bias against other methods, is scrupulously careful not to overstate the case with regard to his own.

The printers are to be congratulated on the scarcity of misprints, although these do occur in places, notably on pages 17 and 29.

In general, it must be acknowledged that from the point of view of structural bibliography this book clearly needed writing.

Whether, from the point of view of the average Sapper officer, it needs reading is, however, another matter. A.D.C.

POWER AND THE INTERNAL COMBUSTION ENGINE.

By Professor W. E. Dalby, F.R.S.

(Edward Arnold & Co. Price 18s.)

The author is convinced of the great importance of the internal combustion engine as a prime mover in modern life, and gives as instances the revolution of land transport in recent years, the complete dependence of the aeroplane on, and the growing demand in ships for, this type of engine.

He does not say very much about the Diesel engine, and then practically nothing about the solid injection types, but gives his opinion that the petrol engine of the future is the single sleeve valve type highly supercharged though he makes no mention of the I.C. turbine, which, I think, is bound to come. Indeed, one apparently successful working model has already been produced in France.

Professor Dalby begins his book with a short, well written chapter on Thermodynamics, and continues with a chapter on Mixtures and Fuels, and then comes to the various types of engines.

He assumes that his reader has an elementary knowledge of the subject, and does not deal with dynamical problems and only very briefly with component parts of engines and problems of design.

One excellent feature of the book is that he realizes the impossibility of dealing completely in one volume with such a large subject, and he gives plenty of references to papers published in various scientific journals in amplification of the points he makes.

Another good and very unusual feature in a book of this sort is that he deals with the petrol engine in the motor-car, giving much valuable information on torques and torque reactions on the chassis, and he touches on the vexed question of "pinking," advancing the "peroxide" theory as the probable explanation.

Altogether a most useful and interesting book, clearly written and containing information on subjects not readily found elsewhere. I recommend it to anyone interested in mechanization. E.W.L.W.

APPLIED MECHANICS FOR ENGINEERS, VOL. III.

Differential Equations with Applications.

By T. Hodgson, B.A., B.Sc., Mathematical Lecturer at the City and Guilds (Eng.) College, Imperial College of Science and Technology.

(Chapman & Hall, 13s. 6d.)

This is the third and final volume of a series of which the two previous volumes were reviewed in the December, 1930, issue of the *R.E. Journal*.

It will be recalled that Volume I was devoted to Graphical Statics, Volume II to Dynamics and the Elements of Differential and Integral Calculus, with the application thereof to dynamic problems.

Volume III rounds off the subject by dealing with the standard methods of solving Differential Equations, particular attention being paid to those which may be encountered in Structural, Electrical or Mechanical (Heat Engine) problems.

The arrangement of the book is excellent, the general sequence being the statement of a theory, exercises in its use and finally examples of its practical application.

In short, the various mathematical tools are produced in turn, and the student is taught both how and where to use them.

It was a pleasant surprise to find Macaulay's method expounded in the chapter dealing with "Deflection of Beams," and although the tabular form employed is more cumbersome for the initiated, it is, for the neophyte, probably simpler than the "curly bracket" notation.

The publishers are again to be congratulated on the attractive presentation of the volume, which is in every way a worthy partner in the trilogy.

A.D.C.

PLANE TABLING FROM THE AIR.

By O. M. MILLER.

(American Geographical Society, New York.)

In this pamphlet the author, one of the staff of the A.G.S. School of Surveying, claims to have evolved methods for using the detail in an oblique air photograph for the purpose of producing a reconnaissance map.

He claims that the methods can be rapidly applied in cases when no careful flying organization has been previously arranged for, and when photos may have been taken in the course of a reconnaissance flight over a proposed air route or along an unknown coast line.

"The method developed depends on the assumption that it is possible to determine "the horizontal on the photograph by trial and error, provided the silhouette of the "landscape against the sky is visible.

"Once two or more air positions have been determined from the initial ground "control the extending of the latter, so that other air stations can be determined "and other ground points plotted, is undertaken in much the same way as a plane "table surveyor makes his map in the field—hence the title of the paper."

The writer is evidently informed to a certain degree as to the progress already made by the British Air Survey Committee, and suggests his method as being less laborious and costly than the methods we have evolved ourselves.

In view of the recent progress made by the British Air Survey Committee, however, in the direction of reducing cost and labour in plotting from vertical photographs, it is doubtful if the American method has anything but a very limited application.

In using oblique photographs it would appear that considerable drawing ability is necessary, together with extensive experience in the particular "dodges" the method requires, and at the best the final result is only an approximation to a correct map.

Apparently also the author suggests that, for higher accuracy in the final plotting, the whole area to be mapped should be covered by oblique photographs to give intersections and stereoscope overlap, and ground control should be as liberal as possible. But if these are his requirements, then it would undoubtedly be much more economical to use the aeroplane for taking vertical photos and to employ the ground control staff to give the comparatively little ground control now necessary for plotting by the British methods.

A.P.

ORGANIZED PLANE TABLING.

ORDNANCE SURVEY TRAINING SERIES No. 1.

(Ordnance Survey Office. Price 2s. 6d.)

This excellent pamphlet, written by Brigadier Winterbotham, the present Director-General of the Ordnance Survey, with an Introduction by Sir Charles Close, who filled that appointment for so many years, is well worth the closest study by all officers engaged or interested in topographical surveying. As one would expect from Brigadier Winterbotham the whole pamphlet is essentially practical, and tips and hints to would-be plane tablers abound in every page. "Each scale is a special trade" is one remark made in the pamphlet, and officers with plane tabling experience will heartily endorse that. Actually the work deals with plane tabling method for topographical scales such as ½-inch and 1-inch to one mile, rather than with the somewhat different work of 2-inch and 3-inch to one mile plane tabling where tacheometry begins to be a useful adjunct. It would have been interesting to have had more of the author's views on such largish scales and his advice as to the use of range-finders and tacheometers. The example plane table sheet at a scale of 1/125,000, which is included in a pocket at the back of the pamphlet, is a perfect model of this class of work, and well merits the use of the author's own words on page 15, "a pleasure to do, and a joy to look at."

The pamphlet is rendered additionally attractive by a series of excellent thumbnail sketches of a plane tabler's life, but the artist's name is not revealed. The little picture entitled "Swung," which appears on page 12, might well have the sub-title "Hari Kari."

Altogether a most useful, practical and helpful pamphlet, and one whose appearance has long been needed.

P.K.B.

NATURAL TRIGONOMETRIC FUNCTIONS.

By HOWARD CHAPIN IVES, C.E.

(Chapman & Hall, Ltd. Price 45s.)

Although English practice is to arrange that engineering calculations of any complication, such as the solution of Survey formulæ, shall be in logarithmic form, there still remain occasions when a knowledge of the *natural* trigonometrical function to a high degree of precision may be of great usefulness. Up till now there have been no tables of such functions taking them to more than four or five places of decimals. Messrs. John Wiley & Sons Inc. (London agents Chapman & Hall, Ltd.) have just published a book of such natural functions carried to seven decimal places. The compiler of these tables is Mr. Howard Ives. The work is comparable to Major-General Shortrede's well-known book of seven-figure logarithms, except that Ives takes his functions only to 10 seconds of arc, whereas Shortrede laboriously gives us logarithms for every second. If computations involve the use of natural functions and not their logarithms, the computer may be interested to know of the existence of Ives' work.

P.K.B.

SWIMMING FOR ALL.

By R. C. VENNER.

(G. Bell & Sons, London. Price 3/6.)

In choosing the title "Swimming for all," Mr. R. C. Venner includes two classes of swimmer, those who are, and those who wish to become expert, and for whom this

book is not recommended. In order that there shall be no misunderstanding of this somewhat abrupt criticism, the qualification of the expert referred to is, broadly speaking, one who can swim 60 yards in 40 seconds or 440 yards in 7 minutes.

An enquiry, admittedly extremely cursory, as to Mr. Venner's position in the swimming world, and as to the results obtained from the methods outlined, drew a blank. No information on these points is to be found in the book itself, although the text suggests that the methods are proved. On a controversial subject of this nature any criticism on style or method of teaching must be based, largely, on results; in the absence of information on this point, the critic can only compare the treatise with his own knowledge and experience, both of which, in this case, are very limited. The various remarks which follow, should, therefore, be read with this proviso in mind.

In the Preface the author sets out seven principles; these are correct except that Nos. 2 and 7 require slight modification :—

No. 2 is only correct in so far that the *sequence* of the various positions of the limbs, relative to the body, can be more easily learnt on land than in water. No. 7 is incorrect in that the natural method of swimming is the "dog-paddle"—the stroke used by all animals and that which a human being, with no knowledge of swimming strokes, would use were he thrown into deep water. The crawl stroke, which comprises the most economical and effective series of movements in swimming, is a direct development of the dog paddle. That the movements of any stroke require to be practised in detail is correct and cannot be over-emphasized.

The ideas and exercises described in Chapters I and II are very good, particularly those in Chapter II for giving confidence in the water to the non-swimmer. Chapter III on "Modern Swimming" brings out the essentials which are easy, regular breathing and watermanship. The importance of this latter point is not fully realized, just as a good rowing crew balances the boat and lets it travel between the strokes, so the good swimmer balances his body and lets it glide between his strokes.

Chapters IV to VIII inclusive give the details of various strokes. The author goes in for extensive land drill, and rather suggests that the student can learn to swim on land, and that when that has been accomplished, all that is required is water to swim in. This method is not generally agreed with, nor is the statement, on page 5, that contrivances for supporting the body are harmful. The normal method involves sufficient land drill only to acquire a knowledge of the positions and their sequence; the movements of the muscles and balance of the body are so different in water from on land that they cannot be learnt by land drill. It is during the initial stages in the water that some external support is a necessity to the student.

The details of the strokes are correct, with the exception of Chapter V, which deals with the crawl; the accepted style, adopted and taught by, amongst others, the present British Olympic Coach, embraces the following divergencies from those described by the author :—In the leg action the knees must be stiff, the ankles allowed to flex and the legs worked entirely from the hips. In the body position the back should be slightly arched and the head approximately in the "P.T." position of head backward bend, but with the muscles relaxed. With regard to the method of teaching the crawl or the back crawl (Chapter VIII), the leg action should be acquired first. Anyone who proposes to learn the crawl strokes with the aid of Mr. Venner's book is strongly advised to follow the above suggestions and not those given in the book.

Chapter IX on turning is, perhaps, the only one in the book suitable for experts. Chapter X on diving is admirable for beginners.

In conclusion the author is to be congratulated on his attempt to present a correspondence course on swimming for the benefit of people whose access to the sea or to swimming baths is limited. It is felt that this is the underlying reason for the prolonged land drill, and it is a matter for regret that information as to the results obtained is not available.

I.L.H.M.

FOXHUNTING.

The Publishers of *Foxhunting*, which was reviewed in *The R.E. Journal* of June, 1931, have written as follows :—

" Your reviewer states that there are no chapters on ' Stable and Kennel Management ' nor on ' Hunting Dress.' Now chapter 8 is entitled ' Kennel Management ' and feeding and sanitation and the duties of the kennel staff are dealt with in the greatest detail. Stable management is not dealt with in this volume of the Lonsdale Library because a very large proportion of the Horsemanship volume is devoted to this subject. Chapter 12 from page 146 to the end is devoted to dress in the hunting field, and deals with everything individually from hat to spurs.

" The diagram showing the points of the horse mentioned in another paragraph also appears in the Horsemanship volume. I think your reviewer has forgotten that this volume is an integral part of the Lonsdale Library and dovetails in with the Horsemanship volume."

To this our reviewer replies :—

" The criticisms made may be divided into two parts, one of which is that certain parts, not included in the Lonsdale Book on Foxhunting, are in the volume on Horsemanship. My answer to that is that the review was written from the point of view of the soldier who cannot afford to buy, or to carry round the world, the whole or perhaps even more than one volume of the library. Stable procedure in a hunting stable and in the stables of a pack of hounds are subjects which do pertain more peculiarly to the foxhunting volume. Also, one must buy a horse for the country in which it is to be hunted, and one must have general and particular knowledge of the points of a horse.

" As regards the chapters on Kennel Management and Dress, it was not intended to convey that these subjects were not touched on at all, but that there are certain omissions.

" The pages on kennel management form exceedingly useful notes for improving the practice carried out, but they do not in any way outline the procedure in kennels, and are not sufficient to enable a kennel routine to be started. I write feelingly, as I run a pack of hounds, and I read this part several times, but remain unconvinced that there was enough constructive information.

" As regards dress, no one, lady or gentleman, could from the information given in the three pages order herself or himself the clothing and appurtenances in which to hunt. From the young soldier's point of view all he would discover is that he must dress in a pink coat with leather breeches with his hat worn a little lower (than what ?), the tails, his whip and his spurs a little shorter ! "

BOOKS RECOMMENDED.

By Brig.-General Sir J. E. Edmonds :—

FOURSQUARE (Macmillan). By John Rathbone Oliver.

Reminiscences of an American physician, 12 years chief medical officer to the Supreme Branch of Baltimore City, who has tried to understand his fellow-men.

PRINCE CONSORT (Philip Allan). By Frank B. Chancellor.

A life of Prince Albert, which appears to include all the essential factors.

THE ENGLISH. ARE THEY HUMAN ? (Williams & Norgate). By G. J. Renier.

A curious appreciation of the Englishman by a Dutchman 17 years resident among us.

MARSHAL LYAUTEY (Bodley Head). By André Maurois.

MAGAZINES.

REVUE MILITAIRE SUISSE.

(1931. NOS. 1 TO 6 INCLUSIVE.)

La mobilisation d'une place forte. This article appears in No. 1 as an anonymous contribution ; a vivid picture is given therein of the events which took place in Belfort on the declaration of war in 1914, and in the succeeding period (July 31st to Aug. 17th). The facts recorded are taken from the diary of an officer who was serving in the garrison during the period in question ; the lessons to be drawn from this record are summarized in the original article. The mobilization had the effect immediately to upset the mental balance of a large number of people and to create serious depression ; many suicides took place. In order that peace conditions may quickly and smoothly give place to a martial law régime, it is essential, it is pointed out, that, in the case of a fortress, its commander should be an officer who is ready to accept responsibility and to act with energy and firmness.

As in Belgium, so also in France, the experience of the Great War shows that it is a grievous mistake to assume that the defence of a fortress can be safely entrusted to troops of inferior training and morale. In view of the range of modern arms, it is imperative that the troops employed to defend a fortified region should be active and possess considerable mobility.

L'armée et le " carburant national." This article is contributed to No. 1 by Premier Lieut. E. Naef ; he points out that geologists have predicted that the output of the oil wells will in 20 years be so reduced that it will no longer be possible to rely on them as the chief source of supply of motor spirits. Therefore, in view of the rapid increase of self-propelled machines and vehicles, particularly in the fighting forces of the world, the problem of discovering suitable fuels of home manufacture to replace benzine is one requiring urgent attention. The subject is being investigated at the present day in France, Germany, Italy, Belgium and Switzerland ; the last country is looking for a solution of the problem in the products of her forests and peat deposits.

As long ago as 1923, the French Army was carrying out experiments with gas-driven engines. Much progress has been made in this direction since then ; new types of portable gas-producers are now available and are in experimental use in the French Army. Similar experiments have also been carried out in Switzerland, and extracts are given in the original article from the reports of two officers who have been associated with the experiments carried out with a vehicle equipped with a gas-engine by a Swiss heavy artillery regiment in Oct., 1927, at Grimsel. The particulars which are given indicate that gas, as a fuel for military vehicles, is more economical than petrol.

Dans le domaine de l'artillerie. A translation of the second edition of *Die Artillerie beim Angriff in Stellungskrieg* by Colonel Bruchmuller, a well-known authority on artillery matters, has been published in the *Revue d'Artillerie* (in numbers from Feb., 1930, onwards) ; Capt. Gonard calls attention in No. 2 of the *Revue* to the more important points dealt with in the translation of the aforesaid treatise.

Le baptême du feu. This article is contributed to No. 3 by General Rouquerol ; he bases his remarks on the article entitled " Temoins " which appeared in the numbers of the *Revue* for Nov. and Dec., 1930, and dealt generally with the subject of fear on the part of soldiers when under enemy fire. General Rouquerol discusses the

same subject more particularly in relation to the duties of those in positions of command; in order to illustrate how readily the personal conduct of a superior officer can produce a reassuring effect on his subordinates, he refers to an incident which occurred at Michelbach (S.W. of Mulhouse) in Sept., 1914. A Brigade Commander, on going forward personally to ascertain the state of affairs in the firing line after the German artillery had opened fire on his troops, found some infantry, under a young subaltern, retiring hastily; he quietly ordered the subaltern to take his men back to his place in the firing line; the order was instantly obeyed by every man.

Nos équipages de ponts. Leur adaptation aux exigences de la guerre moderne. This article appears in Nos. 3 and 4, and is contributed by Major J. J. Vischer. An outline is given in No. 3 of the general requirements relating to military bridges. The bridging equipment designed by the Austrian General Birago was introduced into Switzerland in 1844, and, after many years of trial, was definitely adopted in the Swiss Army in 1862; it has undergone many modifications since the latter date.

The Swiss "heavy bridge," although it will carry motor lorries weighing up to 9·5 tons when loaded, is not safe for the 5-ton lorry when *fully loaded*; consequently, the question of adapting the bridging equipment of the Swiss Army in order that all the requirements of a modern war may be completely met, is now under examination.

It has been felt that, in addition to pontoons, the Swiss Army also requires boats in which troops can be ferried across rivers. A boat suitable for this purpose has for some time now been under trial in Switzerland, and is known as the "grande nacelle"; 16 soldiers, with their equipment, can be carried in this boat, which can be propelled by four oarsmen. A description is given, with illustrations, in No. 3 of the several purposes for which the "grande nacelle" can be utilized.

The subject of heavy bridges is discussed in No. 4 of the *Revue*; the Swiss Engineers aim at possessing bridging equipment suitable for lorries weighing up to 15 tons when *fully loaded*.

Deux nouveaux avions militaires étrangers. This article gives brief descriptions of two new types of aeroplanes.

Du haut Commandement. This article is an anonymous contribution to No. 5 of the *Revue*, and deals with a proposal for the re-organization of the Swiss War Office. It is suggested that the Council of National Defence should consist of the Chief of the Military Department, as President, the Chief of the General Staff, as Vice-President, and three or four of the Corps Commanders, who, it is intended, should hold active commands in war-time. The much discussed problem relating to the boundary which should exist between the "civil power" and the "military power" in the domain of army administration is examined in the original article, the author of which accepts the view that in peace-time the "civil power" must dominate the situation. He points out, however, that, admitting that this domination is inevitable, nevertheless in practice there must at all times be some distinct sub-division of real responsibility in a headquarters organization. He suggests that a proper sub-division of responsibility would be attained if the control of general administration was vested in the Chief of the Military Department, whilst at the same time the real control of military training and matters affecting the military commands was definitely vested in a Chief of the General Staff.

La fortification du champ de bataille dans notre armée. This article is contributed to No. 6 by Col. H. Lecomte, who gives an account, based on his personal experiences, of the developments which have taken place in relation to field fortifications since 1895 in the Swiss Army. He points out that instruction in field fortifications plays but a very small part to-day in the training of the Swiss infantry, and, further, that the Swiss General Staff is paying but slight attention to the use which can be made of field fortifications in war. Col. Lecomte examines with care the arguments which have been advanced in support of the view that the advent of bombing air squadrons, heavy artillery and tanks has completely destroyed the value of fortifications, and that, in consequence, military operations of the future will consist almost entirely of

a war of movement. The requirements of a military situation cannot, he says, be satisfied by a resort invariably to one form of operations alone, whether it be trench warfare or a war of movement. It is significant, he points out, that in the French *Règlement de l'infanterie*, which has been compiled by officers who have had a wide experience of modern war, it is definitely and clearly laid down that recruits shall receive ample instruction in the use of tools and also in the preparation of defensive positions.

La début de la guerre de 1914 en Autriche-Hongrie. The first part of an article on this subject by Col. Feyler is published in No. 6; it consists of a review of the political and military situation during the period immediately preceding the dispatch of the Austrian ultimatum to Serbia in July, 1914.

W.A.J.O'M.

REVUE DU GÉNIE MILITAIRE.

(*February*, 1931.)—There is a continuation of the long article about the work of the Engineers in Algeria, which includes the siege of Zaatcha from October 4th to November 27th, 1849, and the insurrection of 1871.

In "The Defence of the Land Frontiers of France," Commandant L. Montigny points out that the problem is very different now from what it was in 1914. In a future war the troops of the assailant will be far more mobile, will be more powerfully armed and will be able to travel across country in caterpillar tractors. The whole of the interior will, in war-time, be open to the attacks of aerial fleets which will scatter explosive bombs, poisonous gases, and toxic germs, and the aggressor will perhaps be in a position to land armed detachments in rear of the frontier.

The author outlines the defensive systems of France from 1875 onwards, and refers to the ungrounded mistrust placed in the latest examples of permanent fortification, which in 1916 and 1917 underwent bombardments of a duration and intensity hitherto unknown. They resisted magnificently though designed against attacks of much less severity.

He then gives a sketch of the defensive measures required under modern conditions, when the aerial resources of the aggressor necessitate the defence not only of frontiers but of the whole territory.

The preparation of the frontier defences is dependent on the peace strength of the army. To-day there is only one class present with the colours and numbers are insufficient to provide an adequate mobile covering force for the whole extent of the frontier for the two or three weeks during which the concentration of the armies is taking place. This insufficiency must be compensated for by the organization of the country, the framework of which must be prepared in advance as the six weeks or so of continuous work required cannot be postponed till the time of action arrives.

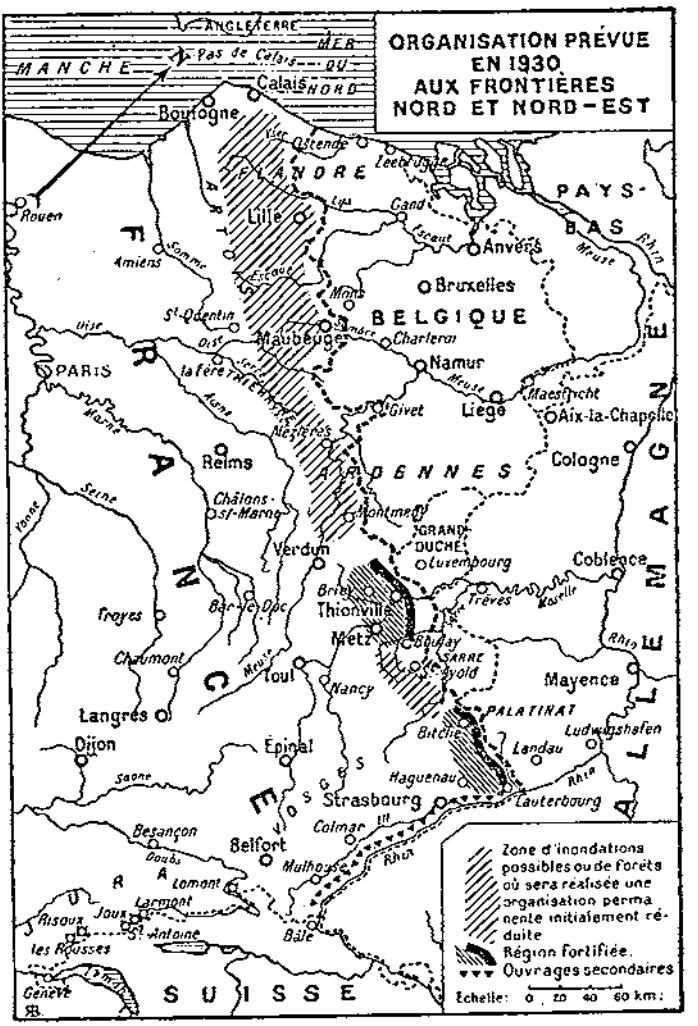
This framework is on the way to realization. A position as near as possible to the frontier has been chosen to prevent the loss of any of the wealth of France in the shape of mines, industries, power centres, agricultural lands, forests and communications, and to avoid the ruin and desolation, the moral and material misery which in 1914 overwhelmed the rich departments of the north. This skeleton position will not take the same form throughout its length.

From Calais to Montmédy, the land is intersected with waterways, rivers and canals suitable for the formation of rapid inundations, and with extensive forests which can easily be rendered impassable. At carefully chosen points difficult to find in the endless industrial areas a certain number of essential concrete works will be constructed to demarcate the position, which will be completed at the moment of need by the covering troops using tools and materials stored in depots nearby, known as "mobile fortification parks."

From Montmédy to Boulay, the frontier traverses a region bristling with factories and industrial establishments squeezed one against the other up to the frontier itself,

and affording no natural obstacle to the advance of an adversary. Here the covering army must find a powerful position ready prepared. Numerous petty permanent works combined with less powerful works or with collections of works must be created in order to offer a continuous barrage by means of cross-fire.

The importance and stability of these collections of works which will be limited in number (six), will justify their armament with powerful automatic weapons and with



a new type of rapid-firing artillery. They will be connected by underground communications, and will be gas-proof and secure against the most powerful projectiles. They will be provided with improved mechanical appliances served by special troops.

These collections will not constitute a fortress designed to withstand a siege or investment, they will merely be supporting points in constant communication with the rear, from which they will be reinforced and supplied. The other works of position will be concrete redoubts, infantry casements, turrets and observatories.

From Boulay to the west of Bitche, the defence will rest on the ponds and forests which are dotted about this region, and will include several permanent works.

From Bitche to the Rhine will be a fortified region similar to that between Montmédy and Boulay.

From Lauterbourg to Bâle the Rhine forms an obstacle difficult of passage by an army in face of a vigilant adversary. There will be a number of secondary works which will cover the whole stretch of the river with their fire. Behind the Alsatian plain the *Vosges* form an obstacle offering few openings to an operating army.

The Jura is an obstacle still more difficult to cross, and no permanent organization is contemplated. The railways and roads across the Alps will be commanded, where they debouch, by the old works made proof against modern artillery fire.

The coastal region of Nice, which screens an area of great wealth and importance, will be fortified like the regions of Briey and Bitche in a manner suited to the special features of the ground.

The framework so constructed on the whole frontier will be completed when the hour arrives by the covering force by means of the mobile fortification parks located at the most suitable points. The defensive position which is in parts rich in roads and railways will be protected by demolitions prepared in advance. The equipment of back areas will include the construction and improvement of roads, railways and electric power and transmission lines.

The covering force occupying the frontier position will only be able to oppose the land forces of the aggressor. The modern speed of aircraft is so great that no part of France can be considered secure from aerial attack by a neighbouring power. It is certain that the aggressor will use his aerial resources in the largest possible measure at the outbreak of hostilities. He will attack troops already assembled, troop trains, nodal points on railways, important stations, essential industrial establishments, and depots; he will hinder concentrations, stop manufactures, destroy supplies, bomb villages, and sow panic amongst the people by spreading disease, asphyxiation and death.

In the future an enemy may be able to land armed detachments over the country, which will destroy by explosives works commanding main lines of communication, vital centres of electric power and light, and of telegraphs and telephones.

It will be impossible for financial reasons to render the whole of France immune from such attacks. The expenditure will be spread over several years, and men unfit to bear arms will be called upon to take part.

The organization of a defensive system on these lines is an entirely new problem which was but partially presented in 1914–18. It has now been studied, and its solution is on the way to being realized in neighbouring countries, especially in Italy.

The measures to be employed will include primarily the aerial bombardment of the enemy's aerial installations on land, hangars, depots of petrol and bombs, and landing-grounds; then aerial combat with the enemy's air fleets, and aerial pursuit by patrols of scattered aircraft and dirigibles.

The flight of hostile aircraft will be hindered by smoke screens, extinction of lights, creation of false objectives, luminous halos and screens of captive balloons. Numerous anti-aircraft guns and machine-guns will be installed at sensitive points, and also on a line parallel to the frontier to form a barrier which will be difficult to cross.

Finally, for the personnel indispensable to the life of the country and its inhabitants and for the civil population itself, shelters proof against bombs, gas and fire will be constructed, masks and protective clothing will be distributed.

All these measures will cost millions of francs to complete, and for their efficient fulfilment certain new services of great importance will be required; a Service of Information to announce the approach of aircraft, by day and night, with its accompaniment of listening posts to pick up the waves from the magnetos of aerial motors and the infra-red rays from their exhausts, radio-goniometric posts, visual observation posts, fixed and mobile projectors, special telegraph and telephone lines;

a Service of Alarm with its own transmission lines, which will order the extinction

of lights, the emission of smoke, the working of sirens, the carrying of masks, the occupation of shelters;

a Service of All-Clear to inform all people in shelters that normal life may be resumed;

a Service of Aid to deal with fires and the effect of gas and bombs, removal of ruins, the identification of gases by analysis, the distribution of neutralizing substances, the transport and treatment of the sick;

a Service of Defence to cope with armed detachments landed from hostile aircraft.

* * * * * * *

The most difficult problem to solve by reason of the expense will be the protection of populations. It will be necessary to manufacture, maintain and replace when out of date, masks and protective clothing; to construct bomb and gas-proof shelters for millions of people, with roofs several metres thick provided with air filters and air webs.

The expense will be in the nature of an insurance premium, heavy it is true, but calculated to save numerous human lives and considerable wealth.

What are the 70 millions which the forts of Verdun cost in comparison with the lives saved and areas preserved from ruin? Would it not be preferable to devote a like sum to the defence of the north than to have ten departments laid waste? The past with its lesson becomes remote; it must not be forgotten.

An article called "Use of boats for the passage of rivers by infantry" describes experiments carried out by the Génie of Besançon in connection with the passage of the Doubs.

The regulation pontoon cannot, as a rule, be transported without great difficulty to a point suitable for navigation, and the Hebert bag can only be used when current and wind are favourable. The officers of the Génie of Besançon decided, therefore, to evolve a type of boat suitable in all circumstances for the passage of infantry either by navigation or in the form of footbridges.

The conditions were:—

(1) The infantry must be carried in groups or in half-groups.
(2) The boats must be such as can be quickly formed into a handy and not easily damaged footbridge.
(3) It must be possible for the sappers available in advance formations to construct the boats in large quantities, using ordinary material of commerce.

The boat evolved resembles the fishing boats used on the Doubs. It weighs 200 to 250 kilos (440–550 lb.) and carries five fully-equipped men. It can easily be carried by its crew—a half-group (six) with two sappers to row. Two boats can be coupled together to take a group. Singly or in pairs they can be rowed by two men in a two-metre current. Four can be carried on a pontoon wagon. One boat can be made in 44 man-hours, 38 carpenter and 6 blacksmith.

A footbridge can be made with boats at 5-metre centres to take infantry in file without vehicles.

There is a detailed list of material required for making a boat, and the article is illustrated by several photographs.

(*March*, 1931.)—There is a report of a lecture given by General Ferrié on December 12th, 1930, to the Society of Civil Engineers on the "upper atmosphere and the evolution of radio-electricity." The long account of the "Work of the Engineers in Algeria" is continued. Lieut.-Colonel Lobligeois begins an article called "Ideas on Permanent Fortification," in which, after pointing out the necessity for permanent fortification, he discusses the influence of arms of various kinds and the traces of obstacles.

(*April*, 1931.)—The article on Algeria contains short biographies of the officers who played a prominent part in its history. It is interesting to note that Colonel Boutin, who was sent by Napoleon I. to report on Algiers, was the officer responsible

for the defence of Constantinople in 1807, when Admiral Duckworth forced the Dardanelles but failed to capture that city. In a continuation of the article on permanent fortification there is a discussion of the different kinds of traces of the work itself and the flanking of ditches.

An article by Chef de Bataillon Ollivier describes a number of mechanical apparatus for clearing roads of snow.

(*May*, 1931.)—The article on Algeria concludes with a copy of Boutin's report on the town, forts and batteries of Algiers. A continuation of "Ideas on Permanent Fortification" discusses the use of water as an obstacle, also abatis and fougasses.

General Sergent contributes an article, called "Practical Advice to Directors of Engineers," which is interesting and instructive. Galliéni's "Il ne faut jamais invoquer le règlement contre le bon sens" should appeal to many. Another excellent maxim is: "Pour diriger, considérez l'ensemble et non les détails; pour contrôler examinez les détails et non un ensemble."

Other articles are on electric installations and calculations for resistance of ferro-concrete piles.

A.H.B.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1931. TOME I.—NOS. 4 TO 6 INCLUSIVE.)

(1). *Les Préparatifs de Défense d'une Position à l'Échelon Régiment d'Infanterie—Cas Concret.* (2). *Les Préparatifs de Défense dans un secteur de Régiment et de Bataillon d'Infanterie.* (3). *Les Préparatifs de Défense dans un sous-secteur de Règlement et de Bataillon d'Infanterie.* Three articles with the foregoing titles appear respectively in numbers 4, 5 and 6 of the *Bulletin*; they are contributed jointly by Lt.-Col. I. Lesaffre and Capt. Fraeys, of the Belgian General Staff. In each case, the authors set out in an introductory section the doctrine inculcated in relation to each particular aspect of the subject dealt with by them in the Belgian Manuals entitled *Instruction sur l'organisation de terrain; Emploi tactique des grandes unités; and Règlement de l'Infanterie au combat.* In the subsequent parts of each of these articles, the authors show in detail the manner in which the principles enunciated in the service regulations should be applied; they do this by setting special schemes and providing solutions to them.

In No. 4, the subject of reconnaissance is first dealt with; the duties of a divisional commander and the subordinate commanders under him in relation thereto are examined. The example set for solution assumes that a Northern Army is retiring to a retrenched camp lying to the north of the river line Nethe-Ruppel-Scheldt, its rear guards being in contact with the light troops of a Southern Army advancing from Brussels. The orders assumed to have been issued by the divisional commander for the occupation of a position to meet the situation are set out; the various measures which the subordinate commanders should take are discussed, and the typical orders which might appropriately be issued by them are given.

The subject of fire-tactics is dealt with in No. 5, and an example of the manner in which a position should be prepared for defence is worked out on a map.

The principles laid down in the Service Regulations in relation to outposts are discussed in No. 6 of the *Bulletin*.

Influence des lois de milice et linguistique sur l'organisation de l'armée. A series of four lectures were given recently on this subject at the École de Guerre; they are published by Col. Michem, of the Belgian General Staff, in a summarized form in the *Bulletin*—the first part appeared in No. 3, the two remaining parts appear in Nos. 4 and 5.

The Belgian Law relating to service in the militia which is now in force received the Royal Assent in 1923; it has been modified by three subsequent Laws, the latest

of them being dated Nov. 7th, 1928. Every Belgian citizen, unless physically unfit, is liable for military service without any right to claim exemption.

The language question has long been a burning one in Belgium; the matter is dealt with in the Law of 1923, and under its provisions a regional grouping is provided for recruits, who are given certain rights both as regards the language in which they shall receive their military instructions, and the units to which they shall be posted —the accessibility of their homes is made an essential factor. These branches of the subject are discussed in No. 5 of the *Bulletin*, which also contains information relating particularly to officers and N.C.O.s.

Procédes de combat de l'armée allemande. The concluding part of the article on this subject by Capt. Verweyen appears in No. 4; it deals with the defensive in a war of movement. Capt. Verweyen points out that the schemes which are set in Germany to-day relate to operations in which a so-called "modern army," and not the "Reichsheer," of 100,000 men allowed under the terms of the Treaty of Versailles, is assumed to take part. The term "modern army" is used by Germans to denote the type of organization which would, in the light of the experience of the Great War, have been adopted in Germany had the Great General Staff been free to make a choice: the Order of Battle of a division of the "modern" type is set out in the original article —it contains approximately 20,000 men.

An example of a typical scheme is given; the Divisional Orders are set out and the part which the various units would be expected to play are described. In conclusion, a brief reference is made to the *Hinhaltendes Gefecht*—commonly translated by the expression "combat traînant" or "combat d'attente" in Belgium. The *Hinhaltendes Gefecht* is in defensive operations what a "geint" is in offensive operations; it is a type of defence in which a commander lays his plans in such a manner as to deceive an enemy, his intention being to hold a considerable part of the enemy's force on his own front, in order thus to prevent its utilization on a decisive part of the battle line.

Écoute et camouflage des communications. This article is contributed to No. 4 by Capt. Flahaut; he mentions some of the occasions during the Great War on which the plans of some of the belligerents were forestalled owing to their telegraphic and telephonic messages having been tapped by their opponents. The tapping of an enemy's communications is a matter, the importance of which is fully recognized by the Signal Corps of the Armies which took part in the Great War. The General Staffs are alive to the fact that much profit will result by "overhearing" an enemy's messages in a future war; the subject is adequately dealt with in the Service Manuals issued to the Belgian, French and German Armies, since the conclusion of the Great War. A summary of the regulations on the subject will be found in the original article.

Much attention has also been given in recent years to the question of maintaining the absolute secrecy of one's own telegraphic and telephonic messages. The subject is dealt with under the heading "le camouflage des communications"; Capt. Flahaut describes some of the technical devices employed to secure this end; he also discusses the factors which are of essential importance in designing cipher codes.

Notes sur l'artillerie belge de 1850 à nos jours. Parts 4 and 5 of this article by Capt. Comdt. Lambinon appear in Nos. 4 and 6 of the *Bulletin*. The details of the reorganization of the Belgian Artillery effected under the provisions of the Royal Decrees issued in Dec., 1902, and June, 1910, are set out in Part 4 of the article. The "Agadir Incident" caused considerable attention to be given to the problem of National Defence by the Belgian Parliament; in consequence, the establishment of the Belgian Army was increased by a Law passed in Aug., 1913. Thereupon, a *war organization* was laid down for the Belgian Army by a Royal Decree dated March 1st, 1914; details of this organization are set out in Part 4.

Particulars relating to the War Period are dealt with in Part 5; at the date of the outbreak of hostilities the Belgian Army possessed 6 horse and 81 field 4-gun batteries,

armed with " 75's " (348 field guns in all). The losses, etc., in the early days of the War, had reduced the number of field guns to 200 by the end of Oct., 1914; at this date, the Belgian Field Army had not heavy artillery.

Details are given in Part 5 relating to the measures taken to provide ammunition, field pieces and siege guns for the Belgian Army during the progress of the War, and in connection with the establishment of ordnance repair shops. Part 5 concludes with a statement giving particulars of the artillery in possession of the Belgian Field Army on July 1st, 1918.

Troupes Légères et Motorisation. This article is contributed to No. 5 of the *Bulletin* by Major Bastin; he points out that the several schemes under discussion at the present time for the " motorization " of mounted troops are variants of one or the other of four distinct types of organization, viz.: (1) the mounted division proposed by General Camon, which consists of three completely mechanized brigades—a light, medium and heavy brigade, on the analogy of the cavalry organization of the Napoleonic Period; (2) the mounted division proposed by General Fuller, which consists of units carried on cross-country armoured cars capable of travelling at high speeds; and (3) the two kinds of mounted division proposed by General Allehaut, viz., (*a*) troops mounted on horses reinforced by units carried on armoured cars, infantry and artillery, and (*b*) a completely mechanized mounted division.

A brief reference is made to the measures which have been adopted in relation to the mechanization of mounted troops in this country, France, Germany, Russia and Belgium.

Major Bastin summarizes the duties which " light troops " are normally called upon to undertake, and then discusses the relative merits of the various " motorization " schemes which have been proposed—the military factors involved alone come under review, the financial and technical factors are purposely left out of consideration. He is of opinion that the first of General Allehaut's schemes mentioned above (*i.e.*, 3 (*a*)) most nearly meets the present-day requirements; the reasons for this preference are set out.

Le Problème de la Réduction des Armements devant la S.D.N. This article is contributed to No. 5 of the *Bulletin* by Major Diepenryck, who deals with the Draft Convention which was accepted at the Disarmament Conference in December, 1930.

Char A de F pour Mitrailleuses et Munitions. This article gives a description of a four-wheeled hand-drawn truck designed as a mounting for heavy machine-guns—the truck is under trial in the Belgian Army.

Instructions des recrues en vues des opérations de nuit. The original article is an anonymous contribution to No. 6. In a modern war, night operations play a most important part in almost every phase of attack and defence; obviously then, it is essential that troops should become accustomed during their peace-time training to carry out their duties under conditions which are, as far as possible, similar to those with which they will be faced in war-time. In the numbers of the *Militär Wochenblatt* for Oct. 4th and 11th, 1930, a scheme for the training of infantry in night operations is outlined in the form of twelve exercises.

Méthode raisonnée de la direction d'un exercice de groupe de combat en ce qui concerne la combinaison de la technique du mouvement et celle du feu. This article is contributed to No. 6 by Capt. J. Collin; he points out that the theoretical aspects of the subject are dealt with in a Belgian pamphlet entitled " Instruction du groupe de combat." He considers it to be the duty of those responsible for the training of troops to apply the principles formulated in the aforesaid pamphlet in as simple a manner as possible, in order that the lessons may be easily and quickly understood by the dullest of the recruits; a proper understanding of these lessons must result, he thinks, in the forming of habits in the trained soldier which will be of a permanent character.

The *technique du mouvement* and the *technique du feu* are separately discussed by Capt. Collin; he examines the effectiveness of various types of rifle-fire on opposing troops, and suggests a practical method by which the accuracy and intensity of the

fire of an opposing force can be readily and easily indicated during training in attack and defence.

Le transport des compagnies de mitrailleurs des Régiments Cyclistes. This article by Lieut. Ivan Goes discusses the various methods which have been proposed for increasing the mobility of cyclist units, and also refers to the experiments which have been carried out in England, Germany, and France in recent years in order to attain this end.

W.A.J.O'M.

HEERESTECHNIK.

(*September*, 1930.)—*Telephony by Directed Beams.* The third instalment of what was done on this subject during the War deals with the selenium cell, and Dr. Thirring describes a pattern which he devised in 1915 for firing land-mines by means of the searchlight. The land-mines were to be laid by an army in retreat, and then fired at the appropriate moment by the light being directed on to a "light-fuze." The latter consisted of a cylindrical camera containing an ordinary plano-convex lens, 12 cm. diameter and 50 cm. focal length, which directed the searchlight's rays on to a selenium cell in circuit with a very sensitive relay. To eliminate the influence of daylight the light-sensitive surface of the selenium cell was made hardly larger than the rays at the focus; viz., 1 mm. in diameter. In order to keep the resistance as low as possible, Dr. Thirring abandoned the spiral and other modern forms of selenium cell, and reverted to the condenser shape, originally used by Graham Bell in his photophone fifty years ago. Instead, however, of filling the condenser interstices with melted selenium he melts a selenium disc on the side of the condenser connecting all the plates. He calls them focus-cells, and their resistance is 50 to 100 megohms in darkness, and 5 to 10 megohms under 100 candle-power illumination. The military technical committee in Vienna, charged with the task of bringing Bell's photophone into a shape suitable for the army in the field, adopted Thirring's form of selenium cell. For transmission of speech the searchlight is used, or the service pattern signalling-lamp. The latter is also used for reception, with a Thirring's cell substituted for the glow-lamp.

The whole proceeding would hardly rise above the results obtained by Graham Bell, Ruhmer and Simon, viz., that a 90-cm. searchlight can produce scarcely audible speech at one mile's distance, but for the advent of valve amplification. The weak current through the high-resistance cell can now be increased by L.F. amplifiers so that both range and signal-strength become a working proposition; the very resistance of the cell makes it suitable for resistance-capacity coupling of a valve. The author compares the selenium cell with the inertia-less alkali cell, and says that the greater sensitiveness of selenium makes up for this, while the distortion, due to inertia expressed in a preference for the lower frequencies, can be perfectly compensated for by suitable amplification arrangements. The compensation is best distributed at sender and receiver, a slight distortion in favour of the higher frequencies being arranged for at the former and fully corrected at the latter.

A further application of the Thirring cell is to tone-films; France and England taking them in increasing quantities, so that the Selenophon Company in Vienna is turning them out at the rate of 15,000 a year.—(*To be continued.*)

Use of Machines for Earthwork in the Russian Army during the Great War. The machines in question fall into two categories, for trenches and for roads. As far as is known German experience was confined to the former, and that only late in the War. Results were distinctly modest, owing to there being too few machines, the machines being too little suited to the work, too many interruptions, and long delays for repairs.

In the West it is known that, possibly due to American influences, road-making in the last years of the War was mechanized in every possible way (*vide R.E. Journal*, December, 1930, pp. 742–3); but nothing authoritative on the subject has yet

appeared in West European or German military literature. Consequently the report compiled from documents at the Russian Military Technical Directorate and published in *War and Technics* is the more welcome.

In January, 1915, in the Russian army machines were demanded for road-making, and the demand extended to include trench-diggers. It was considered at Headquarters that two machines per Corps would be the minimum allotment, and that they should be on charge to the Sapper battalions. The latter decision caused them to be ordered by the Fortifications Branch instead of by the Motor Transport Branch, who had asked for them. Tenders were called for, for 90 mechanical diggers for taking out trenches from 1·8 to 2·2 metres deep, for 100 ploughs for trenches from ·6 to ·9 metre deep, and for 360 tractors of agricultural or road-making type. Most of the tenders came from America, and the machine chosen was the Parsons, Type K, weight 17 tons; performance, a ditch 1 m. broad and about ·6 m. deep, at 1 running metre a minute, or 58 cubic metres an hour; road-speed, 2 2-3rd km. per hour; engine petrol, 60 h.p.; revs., 500; works also on uneven ground up to a gradient of 20°; easy to run and maintain.

The article goes into experiences in some detail, which may be summed up as follows:—In spite of remarkable keenness on the part of the authorities, a proper use of the machines, which were eventually available, was not arrived at even in three years, because there had been no peace preparation as regards personnel, material or organization. The failure of the machines for earthwork is no proof against their utility. And if the objection is made that the need of such machines arose from the character of the last War, and will hardly be repeated, the answer is that nobody can tell with certainty what the next war is going to be like, and that if indeed through tanks, etc., position-warfare becomes an impossibility, the nature of the machines required for earthwork would alone be affected, since motorized troops and columns will make enormous demands on roads.

Special or Universal Weapons for the Infantry? The War brought many surprises about infantry-weapons, and also revealed some new needs. In attempting to satisfy these needs there has come to light a great diversity of opinion, the result of which has been to put the solution further off than before. Col. Fischer makes this contribution towards a solution on the grounds of many years' peace experience. He considers the chief cause of the diversity is that the mass of infantry officers has received insufficient weapon-training to be able to arrive at an independent judgment, let alone at anything creative. Musketry training before the War was mechanical and based upon wrong ideas, such as firing single rounds at a bull's eye which was smaller than the average dispersion of the bullet, whereas the beaten zone is the decisive element. To keep down the extent of the beaten zone we must spare the soldier whatever makes him shoot badly. The physical, mental and moral strain of performing in action the motions of unloading, loading, aiming and firing must be diminished or simplified. Col. Fischer naturally concludes that the automatic rifle, as soon as its complete serviceability for war has been proved, is not only the most suitable weapon for general equipment in the infantry, but is also to the highest degree necessary.

The Grave of the Unknown—Bunnia! An extract from a book, *Generals, Merchants, and Soldiers*, by the brothers Ziese, which goes to show, by means of separate figures for each commodity, the export year by year, 1913 to 1917, from England to Denmark, Sweden and Norway, respectively, of vegetable oils, earth oils, lubricating oils, and cotton. From the rise in figures between 1913 and 1914, and between 1914 and 1915, it appears quite clear that merchants in England—whether they knew it or not—were supplying these neutral countries with war-necessaries far in excess of what they could have required for their own use. The figures have been compiled to show up the "English" dealers who for money would sell to the enemy the means of fighting their own country.

Perhaps the title chosen by the brothers Ziese means that they would like to have

a hand in providing a grave for the unknown *bunnia*. If this is so, there are, no doubt, many in England who would be happy to join them in aspiration, or in deed.

(*October*, 1930.)—*Telephony by Directed Beams*. The fourth instalment is by Dr. Kröner of Hanau a/M, and deals with signalling by means of ultra-violet rays. In 1916 it was decided to try out signalling by invisible rays. Two fundamental questions appeared to offer no difficulty. It was well known that the alteration of refrangibility which produces the phenomenon of fluorescence occurs to a great extent in the ultra-violet rays. Reception would therefore be provided by a fluorescent layer of barium platinocyanide. And further, Johansen had shown that both the carbon arc-lamp and the mercury vapour lamp, although their energy radiation curves bear otherwise no resemblance, have a surprising maximum between ·35 μ and ·4 μ, *i.e.*, just outside the lower limit of visibility. The strong radiation of the mercury lamp in the neighbourhood of ·366 μ had long since been studied by Wood, who by means of para-nitro-dimethyl-aniline in gelatine managed to make a filter which removed nearly all other rays.

The first difficulty was with voltage, since the known types of lamps worked exclusively from mains, while for use in the field it was necessary to find a form requiring much less energy. A kind of Geissler's tube with induction-coil was first considered, but rejected for poor radiation. The next arrangement tried was on the lines of Simon's Interrupter, which has two leaden electrodes in dilute sulphuric acid, one of which is in a porcelain tube with very fine openings. This electrode is only connected with the other electrode by the liquid when no current is passing. As soon as current passes, the liquid in the capillaries vaporizes, contact is broken by the vapour-bubble formed, which condenses again immediately and the liquid again closes the circuit. In this case mercury was used instead of sulphuric acid. Radiation was satisfactory, from ten to twenty flashes per second being obtained; but from continuous use the capillaries became over-heated, mean current fell to one-quarter, duration of current fell, and light-intensity fell considerably.

In 1917 the difficulty was solved by means of the mercury-point lamp, having instead of two mercury electrodes separated by a long tube, a fixed arc 1 mm. long between a mercury cathode and a Wolfram wire anode. The arc is struck by slightly tipping the Hg tube towards the wire and then back into its upright position. At 18 volts and with 1 mm. arc-length a perfectly steady arc is obtained for 1,000 hours. Radiation intensity is double that of the ordinary mercury vapour lamp. Both kinds of lamp radiate twice as much at ·366 μ as within the visible limits.

Special or Universal Weapons for the Infantry (*continued*). The whole of the remainder of this number is taken up by the continuation of Col. Fischer's article. It consists of notes on the following subjects: A 15-cartridge clip for the automatic rifle, hand grenades, tracer ammunition, A.A. defence, rifle grenades for village and trench fighting and for cleaning up nests, infantry guns, anti-tank guns, light minenwerfer, and accompanying artillery.—(*To be concluded.*)

(*November*, 1930.)—*Telephony by Directed Beams*. This month there are two contributions to the series of articles bearing this title. Under the heading "Ultra-violet or ultra-red?" Dr. Löwenstein carries on the story subsequent to the production of the mercury-point lamp. The firm of Zeiss, "the mother of lamp-signalling in the German army," and well-known in England by reason of their field-glasses, very quickly adapted this radiator of dark rays to fit the Service pattern signalling lamp, and made it possible to send Morse by lamp invisibly. Professor Weigert, of Leipsic University, produced the appropriate receiver. He made an attachment to the ordinary signalling telescope, containing a barium platinocyanide crystal, which fluoresces under the ultra-violet rays. In normal weather visible signals were thus made in trials at a distance of 6 km. In mist or rain, however, there was a great loss of range.

At the same time telephony was also being tried out on ultra-violet rays. The receiver in this case was the alkali cell, the inventors of which, Elster and Geitel,

conducted the trials. The experiments were successful up to a point, but were then broken off for the best of reasons. It was discovered that the rays outside the spectrum at the other end, *i.e.*, the ultra-red rays and the shortest Hertzian waves were less susceptible to weather conditions.

Zeiss was experimenting at the time with reflectors, having thermo-elements at the focus, as receivers of heat rays. With such receivers it was possible, for example, to direction-find on ships at night by the heat radiation from their smoke stacks. Heat-ray telegraphy, although the apparatus for reception by thermo-elements was still somewhat complicated, could thus have easily been successfully accomplished at 12 km. distance, but Dr. Löwenstein decided not to be deterred from his original idea of getting telephony by invisible light rays by methods similar to those used with visible light telephony. He entrusted the task to Professor Krüger, of Greifswald University, stipulating only for the ultra-red rays. Professor Krüger suggested a detector made of tellurium compounds, which has since been made and used successfully for telephony by ultra-red rays, but he appears almost immediately to have turned his attention to the shortest Hertzian waves. These experiments were conducted in collaboration with the great Telefunken Company. Although broken off abruptly at the end of the War, they were subsequently revived and have led to success in the end. Their result has thus been that telephony by the invisible light ray having been transferred from one end of the spectrum to the other, and having proved fairly successful on both wave-lengths, has passed over the intervening octaves and become wireless beam telephony on the shortest Hertzian waves. But, meanwhile, Dr. Michelssen in this month's second contribution continues the story of "Telegraphy and Telephony with directed infra-red waves."

Originally the Telefunken Coy. started experimenting in order to find fresh aids to navigation, especially in heavy mist. Certain of their results have also an application to the army, since they fulfil the military requirement of secret communication. This they do by using a beam, instead of radiating equally all round, and by using invisible rays, viz., those of dark heat. All technical sources of light radiate heat; and the carbon-flame can be used at the sender, or the electric arc, or the incandescent lamp. A Wratten No. 87 Infra-red Filter removes the light rays. This filter, according to its characteristic diagram, is entirely impervious to rays of wave-lengths from $\cdot 4\,\mu$ to $\cdot 75\,\mu$ (*i.e.*, within the octave of light-waves), and 88% pervious to rays of wave-lengths from $\cdot 75\,\mu$ to $1 \cdot 4\,\mu$, or roughly the next octave beyond red light. As regards the use of concave mirrors and lenses, the same geometric-optical laws as for light govern the behaviour of the infra-red rays. As regards the bundling of the rays, dispersion, which is unavoidable with all light-sources that cannot be concentrated at a point, can be kept below 3°, and with the largest searchlights down to the neighbourhood of 1 degree.

An important point is to avoid interference at the reception end through extraneous sources of heat. This is done by modulation of the sender, which causes no particular difficulty. For telegraphy, modulation is effected by rotating perforated discs, for any desired frequency in front of the crater, and for telephony by using the pattern of Kerr cell, as improved for picture telegraphy and for talking films by Karolus (*vide R.E. Journal*, September, 1929, p. 527).

A new, and quite easily modulated, sender of infra-red rays is the helium lamp of Dr. Schröter, which originated in the fact that helium re-radiates in the form of a powerful infra-red spectral line of $1 \cdot 1\,\mu$ wave-length a large proportion of the electrical energy necessary for maintaining the glow-light.

For the reception of Morse signals thermopiles or bolometers are suitable. They utilize the smallest heat effect to work electrical measures; but on account of heat-inertia a reproduction of speech-frequencies thereby is not possible. Detectors sufficiently free from inertia are obtained by the photo-electric effect, *e.g.*, in Elster and Geitel's alkali-cell.

Selenium cells, which are normally sensitive to red waves, fall off in sensitivity very

much with infra-red. The same Dr. Schröter has counteracted this by an admixture of tellurium. These selenium-tellurium cells must be housed in evacuated, or inert, gas-filled tubes to avoid being spoilt by moisture or by oxygen.

Another detector of infra-red rays is furnished by thallium sulphide. It is the basis of the thallofide cell invented by T.W. Case in America, and also of a very sensitive cell made by the Telefunken Coy. The inertia of these detectors is sufficiently small for them to reproduce well both speech and music.

As regards results, with a D.C. arc-lamp, converting energy at the rate of ·6 kw., and a beam dispersed 6° for searching purposes, speech was obtained at 28 km. without any difficulty. This is a fair weather result, and more could hardly be required, since the light would have to be raised 185 feet to do it in any case. Ordinary mist is penetrated well by infra-red rays, and noticeably better so than by light: but very thick mist with heavy drops of moisture stops telephony on the shortest infra-red waves. Better penetrability is found on the longer wave-lengths. This greater penetrating power of the longer rays serves, however, only telegraphy, since the inertia of their only known detectors, bolometers and thermopiles, rules telephony out.

Except with this one limitation of very thick wet mist, the creation of secret telephony of military utility by a beam of infra-red rays is possible, and its technical completion may be early expected.

Optical Apparatus for Guiding the Manufacture of all kinds of Barrels and Tubes, and for Proving Completed Rifles. To be taken in conjunction with the article describing Dr. Marcuse's patent in the June number. Instead of a photograph it furnishes a drawing with parts lettered and named.

Special or Universal Weapons for the Infantry? Col. Fischer recapitulates the whole nine weapons, constituting the arsenal which the infantryman has to drag about with him. He does not deny that new needs in battle demand new weapons, and therefore specialization cannot be avoided. He adds the same warning as others have done, viz., that ruthless specialization for its own sake, in order to obtain maximum performances, is the troops' greatest enemy. It loses sight of the fact that the weapon is for the troops, and not the other way about. Col. Fischer suggests, modestly enough, that the future infantry equipment might be reduced to: (1) Automatic rifle, to be usable as light and as heavy machine-gun; (2) A grenade, for use as both rifle grenade and hand grenade; (3) A super-heavy machine-gun for A.A. defence and anti-tank defence; (4) Accompanying artillery with a universal gun.

F.A.I.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*September-October*, 1930.)—*The Baptism of Fire of the Iron Corps—the first day of the battle of Zloczow, 26th August*, 1914, by General von Fabini. While recognizing the necessary limitations of official histories as regards details, the author holds that an even approximately true picture can only arise from the reports of fighting, illuminated and amplified by the commentary of the senior officers who took part. His qualification for the present task is that when the Russians invaded Galicia in August, 1914, he was commanding a brigade in the IIIrd (or Iron) Corps of the Austro-Hungarian army: and he considers that his personal experience and personal knowledge of the troops and of the ground, will enable readers to come to a better understanding of the lessons to be learnt, than an account by an outsider. The outstanding lesson appears to be that Zloczow was an encounter-battle, where the two sides, equally imbued with the generally laudable idea of getting on, simply bumped into each other, and that the Austrians, who were actually in the process of being outflanked, should have been not fighting, but entrenching. Other lessons which Gen. Fabini wishes us to learn, are: To be prepared in the first battles for many a manifestation, ugly yet quite typical, about which war-histories are generally silent, such as the different

forms taken by individual demoralization, the disturbance to powers of thought and of decision among leaders of every grade; and the effect of these factors upon the fighting troops. These things must be seriously reckoned with in future wars, and guarded against accordingly. The best preventive is to get started early on the road to success: for which reason a good start is very important.

Machine-guns in wooded country, by Major-General Korzer. This is not an article on general lines, but an instructive example from real warfare. It lays down no general principles, but by showing what well-sited, well-protected and well-served machine-guns can do, how they are not defeated, and how they are, it enables lessons to be drawn.

In May, 1915, in Galicia, after Mackensen's break-through between Gorlice and Tarnow towards Przemysl and Lemberg, the object of which was to set free Austrian troops for the Italian front, in case (as appeared likely) Italy should declare war, Russian troops were occupying wooded heights in a rearguard action near Rymanow. At 6 p.m. on the 8th May two Austrian battalions supported by a mountain-battery were put in to capture a wooded hill covering a mile of front. What seemed to the attackers an hour's job, dragged itself out into over two days' expensive fighting, and in the end the decision fell outside the wood to a fresh battalion.

The Russian defence was found to consist mainly of one m.g. company with four machine-guns, located in two m.g. nests, built of earth and sods, covered with branches both within the wood and 1,000 yards apart.

Two good examples of the unavoidable confusion in wood-fighting are those of the probationer-officer who led his section by mistake in the wrong direction, and captured a number of rifle-posts with great gallantry; and of the O.C. battalion in reserve who, seeking the brigadier in the dusk of the third day, found himself alone with the Russians, summoned them to surrender, and thus took single-handed over 250 prisoners, who were subsequently joined by four Russian officers.

The Problems of a modern Air Power, by Capt. Ritter, late of the German General Staff. A comprehensive picture is aimed at, of how the important air-powers, Great Britain, France, Italy and the United States, regard the questions connected with the conduct of war by air-forces. First, the fundamental question of the role of air-power in the war policy of a country. Second, the principal features of present-day ideas on strategy and tactics of an air force. Third, a review of the ideas on organization and equipment among the great air-powers, which are of decisive significance.

As regards the first of these questions, upon the answer to which the answers to the others must be based, Capt. Ritter holds that England was the first to appreciate the correct ideas. To this appreciation it was helped by its centuries-old tradition as a sea and colonial power, thus gaining an advantage over European powers which thought or think only in terms of the Continent.

He quotes Sir Samuel Hoare in the House of Commons, Wing-Commander Garrod in the *R.A.F. Quarterly*, and other English writers, as evidence of the ideas obtaining in Great Britain, that our air forces must be regarded not as supplementary to other forms of defence, but to substitute them. It is essential both for imperial needs, and for the fullest application of Great Britain's power to war, that the Air Force exists separately and independently from the Army and the Navy. The creation of the Independent Air Force at Nancy gives a respectable antiquity to these views. They do not affect the other question of how essential it is that army and navy should contain as integral portions air forces, contributing to their efficiency in land and sea-fighting respectively.

These opinions, which Capt. Ritter claims as those of "England," he ascribes also to Italy, quoting from the late General Douhet in the *Revista aeronautica*.

When he turns to France the author gives us another picture, and he quotes General Armengaud, who from his experiences in fighting the Riffs even went so far as to demand *une aviation de ligne*, to assist the infantry by ground-fighting (*vide R.E. Journal*, Sept., 1930, p. 557). Such a proposal, Capt. Ritter says, would, if carried

into effect, be a death-sentence to the conduct of war by an independent air force, which alone is in a position to obtain the utmost value from the special peculiarities of the air weapon. The army's concern is land warfare, and it should not meddle with the conduct of war in general.

Capt. Ritter explains the French ideas on the subject by suggesting that France has always regarded war as a land affair, and that even Napoleon furnished no exception to the French rule of failing to understand the importance of the sea. Nor did the Great War change French official ideas, since a true recognition of the effect of sea-power in that War would deprive the land forces of some of their credit, thus withdrawing importance from the very sphere in which France almost exclusively applied its strength.

It is true that General Rouquerol, in *France militaire*, and other writers, have expressed themselves to the same purpose and just as clearly as the English and Italian writers quoted, but the French Air Ministry has nevertheless continued to refrain from committing itself to any theory on the role of air forces in war, while the *Revue des forces aériennes* approves this attitude on the plea that any such formulation must lead to rigidity!

As regards the United States, the determining factor is geographical position. Since wide oceans give the United States nothing to fear from enemy aircraft, until such time as the latter shall have obtained convenient bases through the defeat of the United States navy, the question of an independent air force arises neither in peace nor in the early stages of war. The chief role of the air forces in the U.S.A. is thus as auxiliary to the navy, the first line, and next as auxiliary to the army, which is charged with coast defence.

The remaining sub-heads are, as far as space allows, adequately dealt with, introducing appropriate quotations from Wing-Commander Garrod, from General Douhet's book *Riepilogando*, from Commander Prentice (*R.U.S.I. Journal*), and from two writers in *Les Ailes*, Lt.-Col. Vauthier, and the well-known air expert and pilot, Chavannes.

The Wandering Fight- and Situation-Reporter, by Lieut. Schmied. The microphone which is no longer confined to the broadcasting studio has been with us some years. Its earlier manifestations from a particular theatre, or concert hall, public dinner or football match, soon developed into the "wandering" microphone. This wandering is done in one of three ways. At first, reports were delivered to the broadcasting studio from points already existing on the public telephone network. Then, where the public telephone network proved inadequate, prearranged systems of temporary leads had to be provided in extension thereof, with the necessary microphones. A further development occurred when the reporter being unable to use wires at all was forced on to wireless. These cases, *e.g.*, describing a journey or following a race, are catered for by carrying in car or aeroplane a small short-wave wireless sender, self-contained as regards energy for some hours. The reporter's utterances have thus already undergone one wireless journey before being again put on the ether by the broadcasting main sender.

The present article proposes to apply the "wandering" microphone to war. For this it demands as reporter, in the simplest case, a General Staff officer, who is *au fait* with the situation and with his commander's wishes, who is fully experienced and alert. This list of requirements might easily be extended, while anything less might well fail to satisfy. For larger operations the article recommends a Reporting Staff consisting of four officers, one of higher rank, a practised observer and of the first class as regards his duties, and three to assist, one from each branch, infantry, artillery and signals. This staff is to have at its disposal the existing telephone network, extended where necessary with new lines and instruments, also wireless telephony and optical telephony. Multiple telephony will also be necessary in order that all four officers can report at the same time.

From the foregoing it appears certain that the author has stationary warfare in his mind and that he intends intrepid observers to wander from one observation post

to another, or outside the area of the communication network from one point of advantage to another. Something on these lines can and will certainly be done. The Second Army Intelligence Report Centre at Reninghelst in 1917, drawing information from many sources, including its own Intelligence O.P.s, which were distinct from the Artillery O.P.s, was a forerunner of such ideas.

But the chief applications of the "wandering" microphone are not touched upon in this article, viz., that in mobile warfare reconnoitring troops will include officers moving in cars provided with wireless telephony for the purpose of making situation-reports, while staff officers in aeroplanes similarly equipped, with the assistance of flares and ground-sheets, will be invaluable for reporting the course of operations. Here also the thing has already been done. In fact war produced the "wandering" microphone, and peace-time broadcasting has re-invented it.

The new Combat-Regulations (continued), by Lt.-Col. Rendulic. The instalment in this number deals with the attack, the pursuit, defence in mobile warfare (including communications, reliefs, and supplies), the breaking-off of the fight, and retirement. The following are not, or have not yet been, dealt with: Mountain fighting, wood fighting, and the opposed crossing of rivers. For attacks before or at dawn a caution is introduced as to the necessity for ascertaining beforehand if the enemy's position is still fully occupied. The neglect of this precaution before the great German attack on the evacuated position of General Gouraud's army in the summer of 1918 is reported as having had "catastrophal" results.

The Intelligence Branch of the Austro-Hungarian General Staff. This is a commentary written by Field Marshal Urbanski upon Major-General Ronge's recently-published work, "Secret Service, Military and Industrial," Amalthea, Leipsic. The writer says that the narrow limits necessarily imposed upon the *Official History of the War* permitted no allusion to the share the Intelligence Branch had in the performances of the army, so that he welcomes Gen. Ronge's work as appropriately filling a gap. At the same time he adds the caution not to be misled by the contents of the book into thinking that spying plays a very great part in the activities of the Intelligence Branch. The greater part of their information about the enemy, troops, industries, resources, etc., has been acquired and constantly brought up to date in peace-time: while in war it is deduced from observations made by the troops themselves, from patrols, observers, identifications, listening-sets, wireless intercepts, sound-ranging, air reconnaissance, deserters, prisoners, inhabitants, foreign newspapers, captured documents, etc., etc.

Altogether the public is far too ready to believe in spies. An exhortation to the police in Stuttgart to keep their heads because the population has gone spy-mad, is believing the most unlikely things and behaving in a most ridiculous manner, makes instructive reading as long as one bears in mind *de te fabula narratur*. How many worthy people in England drew places at night for spies signalling with lamps, where there was no reason why a spy should signal at all, since he could deliver his message by word of mouth! Or, to be fair to the civilians, how many soldiers went through spy-fever, like measles, on arrival at the front, and, owing to the *onde de choc* of an "over" from the trenches sounding like the report of a rifle close at hand, swore that spies were sniping behind our lines!

The article gives a case of mass-psychosis, which is interesting as furnishing a counterpart to the belief, both wide and firm, in England in the autumn of 1914, that Russian troops in their tens of thousands were passing through England on their way to France. Similarly in Germany and in Austria it was believed that Belgian officers in cars were passing through with bullion on their way to Russia. This belief, which spread everywhere, made it dangerous for anyone to travel in a car, since, especially at night, cars travelling fast were invariably fired at.

The Commander in spite of himself. Major-General Schäfer reviews *Der Feldherr wider Willen*, the latest book by the Minister for War, in Germany, Lt.-General Groener. This book was preceded by *Count Schlieffen's Legacy*, and both works are

a hymn of praise of Count Schlieffen, and an anathema of his successor, the younger Moltke. The first book dealt with plans for the campaign and with the initial operations, and it was intended to lead the reader to the conclusion, "Moltke, hadst thou carried out exactly the plan bequeathed to thee by Count Schlieffen, thou couldst not but have conquered!"

In this second book General Groener deals with the time from the frontier fighting to the battle of the Marne, and the subsequent retreat, inclusive; and he tries to show that in spite of the departure from Schlieffen's plan of the advance, it was still possible for Germany to have won. He also extends his attacks on the Chief of the Staff to include all the Army Commanders. Note, he served at G.H.Q. himself.

The title of the work arises from the author's idea that the younger Moltke took over Chief of the Great General Staff against his will. He does not prove this, and it would perhaps be more correct to say that Moltke was not a commander, but a legatee, against his will. There is evidence that he did not like Schlieffen's plan.

The Austrian reviewer now carries the war into the enemy's camp by showing that Schlieffen's plan was no longer as good as it had been in 1905, and in any case the number of corps in 1914 was less (one 1st line and eight 2nd line) than Schlieffen had laid down. He thinks that the crying down of the younger Moltke in Germany has led to a regular Schlieffen cult, which is hardly justifiable, and has caused people to forget one, greater than Schlieffen "of the ready pen," the never-defeated elder Moltke.

(*November–December*, 1930.)—*The German Offensive from East Prussia across the Narew on Siedlec*, by Lieut.-Col. von Schäfer. It was high time that the question of this promised, or not promised, offensive should be handled by a German writer of authority, not only to show that a question may have two sides, but also as an answer to very grave charges.

When after the war Nowak's *The Road to the Catastrophe* appeared, Dr. Wiesner supported its contentions by saying that "The Germans have betrayed us, not simply left us in the lurch—betrayed us with the clear intention of winning alone," was an ever-recurring thesis of discussion at Austro-Hungarian headquarters.

Lt.-Col. Schäfer, although he says that the Germans were horrified at such an accusation, is able to treat this painful subject and to marshal his facts, in a quiet and dignified manner, which in itself bears testimony, if we believe the proverb that it is only the truth that wounds. He begins with January, 1909, when an interesting correspondence started between the Chiefs of the Staff in Austria and Germany about plans in event of a war against Russia and France; shows how the idea of a German offensive from East Prussia in a southerly direction across the Narew behind Warsaw, in order to relieve the pressure on the Austrians, arose; how such an offensive was entirely conditional, and how the conditions under which it was promised never eventuated.

The trouble lies in diverse governing ideas. Austria, with all her attention concentrated upon Russia, found it too difficult to fall in with Moltke's dictum in February, 1913, to Conrad, viz., that Austria's fate would be decided not on the Bug, but on the Seine.

From diverse points of view between allies there are bound to arise friction, misunderstanding, and, after defeat, recrimination. A preliminary condition of frictionless working together is complete mutual confidence. This can never be great enough between two independent nations for each of them to show all its cards. There will always be sore points to avoid, and wishes which one cannot express. The author says that on the whole the staffs of the two nations worked well together, and if Germany had won in the west all would have gone well.

Problems of Organization in the first year of war, by Major Franck. It is true that on the outbreak of war in mobilization and in the assembly-march the organizer gains a triumph, clear even to outsiders, but operations then claim people's attention, and after that the organizer's work no longer appears in the foreground. It continues,

nevertheless, and is of varied kind, as this article shows. Although the latter is written of Austria in 1914–15, several points in it are of general application. Among the organizer's chief tasks are the replacement of casualties, the fullest utilization of the military resources of the country as regards personnel, and the same as regards material. All three of these fields of activity are intimately connected, increase each other's urgency, and at the same time hinder each other, so that they must be brought into a working relationship. Much of the work of organization bears the character of expedients and improvisation, and still has to be capable of inclusion in a unified plan. In many cases the very foundations of the work have to be made, *e.g.*, factories have to be built: and all three tasks are liable to be disturbed by enemy action.

A Calculation of the Losses in the Carpathian Winter, 1915, by Gen. Ratzenhofer. The time actually referred to is the first four months of 1915—what we would call the winter, 1914–15. The troops concerned are the Austro-Hungarian Northern Group of Armies, First to Fourth, which were on the 31st December, 1914, just over 300,000 strong. The operations included the Russian advance, stabilization, the Austrian attempt to relieve Przemysl, the surrender of Przemysl, the Russian advance with the addition of the forces thus released, and their attempt on the Carpathians being brought to a standstill by the arrival of three German divisions.

The author calculates that on an average each man served between four and six weeks before he was either killed, taken prisoner, or sent back as a casualty. During the four months' fighting the four armies lost 600,000 men, or twice their original fighting strength. At this moment after such losses they might well have had no fight left in them; but the moral effect of being reinforced by the Eleventh Army, including four German Corps under Mackensen, was such that two days later they started a victorious advance. In the next six weeks they drove five Russian armies back 120 kilometres.

Tactical Experiences from the Great War (continued). This translation from the Hungarian by Major Nemeth, omitted in the last number, carries on the story of the first Isonzo battle from the 30th June to the end, taken as eight days later. It compares the fighting value of the troops, and makes many criticisms. For instance, that no real defence scheme existed, and no one knew what to do in one sub-sector in the event of the line being carried in the next. It is stated that the Italians had at the commencement of the fight as many divisions in the line as there were battalions opposing them. From this, considering how little ground they conquered in the fifteen days' fighting, the main lesson is drawn of the uselessness of trying to overwhelm by numbers. This lesson worked also in the defence, where eight to ten fresh battalions in a sub-sector, which they did not know, defended it less effectively than a single battalion, used to the place, knowing the ground and the enemy's method of attacking.

The Employment and Leading of Motorized Troops. Lt.-Col. Rendulic after distinguishing between motorized troops and mechanized forces, and having discussed the tasks of the former, takes examples from last autumn's Austrian manœuvres. To increase the scope of motorized troops and gain experience of their possibilities, a rapid brigade was formed of the following composition:—

Brigade H.Q. with Brigade Signals, with cable, lamp and wireless;
3 motorized battalions, one of which had its machine-gun company on motor-cycles with sidecars;
2 cyclist battalions;
2 mechanized batteries (1 gun, 1 howitzer), on own carriages but without tracks;
1 mountain battery, carried on lorries, but possessing also a caterpillar-tractor.

There were besides a repair-unit with mobile workshops, a petrol van, and two motor-ambulances; but no armoured cars and no tanks.

Schemes, situations and orders are given for each of the four days that manœuvres lasted, the exercises being attack, day-march with air precautions and debussing, attack, and raid respectively.

The lessons learnt were the great accession of strength to the side which has a "rapid" brigade in place of an ordinary one, the helplessness of the opponent who has no such rapid troops, and hence the necessity of motorizing troops wherever motorized troops are likely to be met.

Italy's Ultra-mobile Troops, by Col. Paschek. If England's professional army is able to adopt a quicker tempo in mechanization, it is easy to understand how the conscript armies of France and Italy must move more slowly in the matter, while Austria and Germany, being forbidden the possession of armoured cars and tanks, might be expected to move more slowly still. Austria, in any case, naturally studies her neighbour, Italy.

These notes are compiled apparently from articles by the Spanish military attaché in Rome, and from a personal visit to an exercise in the Etruscan Appenines.

They claim that the title "ultra-mobile" belongs, in addition to mechanized forces and to motorized troops, to all cavalry with modern equipment and to cyclists. An intermediate step is thus taken in the process of mechanization, and the Italians have produced mixed formations, such as, a "light" division, which is principally mounted, and "rapid" troops, capable of covering in a day's march 28 to 56 miles, compared with the 45–90 miles daily performance of motorized troops.

The forerunner of the Austrian autumn exercises, 1930, of a "rapid" brigade, referred to in the preceding article, was a nine days' exercise by the Italians in August, 1929, which embraced not less than seven "rapid" groups. The composition of one of these groups is given as :—

2 cavalry regiments ;
2 cyclist battalions of Bersaglieri ;
1 heavy m.g. company ;
2 field batteries ;
tanks occasionally allotted.

A comparison of the composition of the formations exercised discloses no backwardness on the part of the Austrians.

F.A.I.

CORRESPONDENCE.

REINFORCED CONCRETE ROAD DESIGN.

Shoeburyness,
11th August, 1931.

The Editor, *R.E. Journal.*

DEAR SIR,

Before replying to the points raised by General Wace in his letter published in this June's issue of *The R.E. Journal*, I would like to thank him for the complimentary manner of his opening, and to make quite clear the motives which prompted the articles upon which he comments.

My idea was to examine past and present use of concrete and steel in road making with the object of finding how these materials could be better employed in the future. I was not concerned with other materials.

My first article was confined to fault finding, and I thought I had mentioned most defects of R.C. roads. I find, after reading General

Wace's letter, that my catalogue of the defects in past R.C. road practice was even more nearly complete than I thought at the time.

General Wace (if only because of his claim to be "a vigorous opponent of reinforced concrete" for road making) has presumably a stronger motive for destructive criticism of R.C. roads than have I; at any rate, he seems to have used a very fine-toothed comb in his search for things which he might exhibit to their disadvantage. Yet he has not been able to add anything worth mentioning to my original indictment.

Of the list of eight disadvantages which he proposes to add to mine, two were dealt with in my first article and three in my second; the remaining three do not exist.

Taking them in the order I indicate, the two with which I dealt in my first article were (1) the difficulty of inspection of piped services under concrete roads, and (2) the higher degree of skill required in R.C. road construction as compared with, say, macadam.

I discussed the first at some length, and implied the second throughout the article; but no reasonable person would suggest that either reflects against R.C. as road making material.

To say that R.C. is something which is not easily messed about, is at the same time a compliment to the material, and a warning to the constructor to use forethought.

As regards those of General Wace's list which I consider to have been dealt with in my second article, two of them can be dismissed at once. I mean (1) glare and (2) cracking of surfaces.

The third, which refers to repairs in towns, is worth more trouble. My articles were confined to complete new road construction, and I did not contemplate repairs of existing roads. Still, I can see no reason why the top layer in my suggested R.C. road of the future should not make a more lasting, and in every way more preferable, repair, than a similar thickness of any other material.

A foundation which is good enough for a bituminous or wood-block carpet is good enough for a concrete carpet in which steel is incorporated, not for reinforcing, but for localizing shrinkage.

Now as regards General Wace's three "disadvantages."

He says that the construction of R.C. roads causes a greater obstruction, etc. This might have been true some years ago. It is not true now. The boot is on the other leg.

Next, "The destruction of laitance and subsequent surface wear causes a concrete road to be dusty." The statement has a little foundation in fact, but is untrue in its full implication. To make it quite true I suggest the addition of the words "for a very short time."

Lastly: That a concrete surface is unsuitable for horse traffic, is true; but not more so than other modern road surfaces. When General Wace goes on to say that a concrete surface "is objected to by all road users" one is left speechless. I can do no more than leave such a remark to the contemplation of the reader, knowing of no better way of refuting it, than by repeating it.

There are still a few things in General Wace's letter which require reply.

As regards economic advantage:—

Whilst I agree that R.C. roads cannot show an advantage in first cost

in every situation (and have expressed the opinion that a great deal of bad design in the past can be attributed to mistaken attempts to compete under unfavourable conditions with other construction), I am of the opinion that new construction in most cases can be done as cheaply (sometimes cheaper) in R.C. as any other method remotely comparable in quality. And there are few cases where cost over ten years or more —always assuming intelligent design—will not show an enormous saving in favour of R.C.

I am at a loss to understand why General Wace quotes Mr. Van Horn. I have read the passage several times without seeing more in it than a tacit agreement that R.C. roads have a certain named quality claimed for them (" slab or beam strength ") ; and there is no suggestion that any other type of construction has even that.

Unless General Wace has taken too short a passage out of its context to do justice to his own cause, there seems to be little force behind Mr. Van Horn's speech beyond a laudable desire not to displease anybody ; in the manner of talking without saying anything which is so common at conferences and in after-dinner speeches.

As regards my remarks on the bastard construction wherein a plastic carpet is employed on a R.C. base, I am still unrepentant.

A carpet which, as General Wace claims, is soft enough to " cushion " traffic shocks, is obviously soft enough to roll out under wheels, like dough under a rolling pin, if it is laid on such a foundation as R.C. ; unless it has the tenacity of rubber.

The fact that the Ministry of Transport are trying out test lengths of this nature does not affect me in the least. It is the duty of that long-suffering Authority to " try everything once." General Wace is somewhat premature in assuming its " blessing."

And now for his postscript :

I think I have shown that there *was* something in my second article to make him alter his remarks if he had paid me the compliment of reading more carefully.

General Wace wonders " how invisible " the intentional cracks in my proposed top layer will be. I can tell him from experience. They are completely invisible to the naked eye. Not that it matters two hoots ; the main thing is that they shall be there.

My remark about the resilience of R.C. must surely have been better understood by General Wace than he makes out. He must have seen that I was writing about the lower or foundation layer, and referring to the ability of R.C. to resume its original shape after deflection by such stresses as are imposed by expansion ; and not to any supposed ability to " cushion " traffic shocks. That " dope," as he so well says, is better left to the *asphalt* engineer.

Finally, General Wace's criticisms are based on R.C. road practice of many years ago, ignoring recent developments. They give one the impression of being things learnt years ago and confirmed by rote into articles of faith.

I am, Sir,

Yours faithfully,

A. MINNIS.

HEALY'S MORTAR, GIBRALTAR.

The Editor, *R.E. Journal.*

DEAR SIR,

The following account of Healy's mortar, Gibraltar, appears as Appendix No. XX in Vol. II of a curious old book entitled *Military Antiquities respecting a history of The English Army from the Conquest to the Present Time*, by Francis Grose, Esq., F.A.S., London. Printed for S. Hooper, No. 212, High Holborn. MDCCLXXXVIII.

Yours faithfully,
T. E. KELSALL, *Lt.-Col.*

COPY OF A LETTER FROM CAPTAIN PHIPPS, ENGINEER, AT GIBRALTAR, TO LIEUTENANT-COLONEL RAMSAY, OF THE 30TH REGIMENT, DATED MAY 17TH, 1771.

"Dear Sir,

"Agreeable to promise, I set down to write a few lines, relating to Healy's mortar; the 14th instant was at length fixed for trying that new invented pierrier; eight in the morning was the time ordered by the governor; South Port Gate was shut, and the three guards between that and the South Barracks retired out of harm's way; the general had referred the charge of the mortar &c. to Colonel Philips; Healy stood out for 50 pounds of powder, but the Colonel insisted that the first experiment should be with 27 pounds; proper paving stones were collected, and a detachment of artillery attended to assist in loading; after the powder was placed in the piece, a tompion, or bottom of wood was carefully put to cover the charge, a copper tube conveyed the quick-match from the tompion to the centre; the stones were carefully put into the mortar, 1,470 in number; the least a pound weight, and few exceeded 1½lb., a hollow cane well directed, conveyed the quick-match thro' the stones to the copper tube, and upon the extremity was fastened a port fire, to burn five minutes before the fire should reach the quick-match, when the port-fire was first lighted, and everyone retired to a great distance with various conjectures about the success of the machine; five minutes passed, ten minutes passed, no explosion! poor Healy, very impatient; at length, people approached nearer and nearer to inquire into the mortar's silence, when upon examination it was found that the portfire had but half burned; by some accident it was choaked in the making; another was immediately applied, which had the desired effect; great was the explosion, near a quarter part of the stones went into the sea, above 100 yards; to the right they extended as far as Ragged Staff, and to the left, as far as the Watering Pier, but no damage was done, the cavity of the piece was searched, but no fracture could be seen, and what was surprising, the rock above that appeared so bad did not give way; it was fired a second time with the same charge, the success much the same as the first.

"The 3d time it was loaded with 13½lb. (viz. half the former charge)

and 1220 stones, when I suppose about 200 passed over the line wall; with these three discharges, the eight gun battery was covered over with stones; she spit her venom most there; after three experiments, Healy received the congratulations of Colonel Boyd and all the officers upon the road; the general took his observation from the terras walk; the mortar has not received the least damage; its complection is a little changed by the powder.

"COLONEL BOYD who goes home in the *Lizard*, which sails the first Levantor, hopes to see you in London, to give you a particular account of the success of your friend Healy, who wished several times you were present, such a number of people assembled together, and gaping upon one spot, put me in mind of the mountain in labour: Dr. Monington was man-midwife, and many others had a finger in the pye; the delivery was not a mouse, (according to the fable), but 1500 paving stones, and by way of secundine, a large tompion, which made no small figure in the air. It may not be improper to remind you that the figure of the mortar is a parabolic conoid, length of the axis 4 feet, and the diameter of the bore at the muzzle 36 inches, and the solid content 14 cubical feet.

I am sir, with great esteem,
Your most obedient,
and very humble servant,
J. PHIPPS."

As this letter is not perhaps explicit enough to gentlemen who have neither been at Gibraltar, nor have heard of the construction and utility of this mortar, I shall endeavour to explain it a little further.

This mortar is cut out of a rock, which Mr. Healy pitched upon, about 200 yards higher than the level of the sea, and 400 yards horizontal distance from the line wall.

He began by forming a plain surface of 45 degrees elevation, then bored a centre hole or axis, four feet deep, and perpendicular to the said surface, from that centre described a circle three feet diameter; the rock being so hard that he could not excavate it by chipping, was therefore obliged to bore holes all round the circle, each inclining to the centre, so that all those holes run into one another, and into the centre hole near its bottom.

Then, cutting away the partitions betwixt the holes, a core of a conical figure became loose and was extracted, which core, Captain Benttinck brought home in the *Centaur;* Healy's next care was to chip off that conoid, so as to form it into a true parabola, and then to polish it.

As the nature of a parabola is such, that either light or sound sent from its focus proceeds in parallel lines, so he concluded, that the impetus given to any charge by the explosion of gunpowder, would be also parallel, doubtless it would be so, but as his mortar was loaded brimful of stones, those which lay close to the tompion, being first impelled, must of course strike those before them variously, by which means, like billiard balls, the foremost must pursue the direction in which they were struck, whence their spreading to the right and left a good distance is obvious, and rather an advantage than otherwise, where a great body of

men are supposed to be marching, or a great number of boats are attempting to land troops.

This mortar has no other chamber but the bottom of the parabola, nor touch hole, but the hollow reed and copper tube which convey the fire from the muzzle to the focus, down through the very centre of the stones and tompion; by this contrivance the copper tube terminating in the focus and centre of the powder, the whole being instantly kindled, acts more forcibly than when lighted on one side, as in cannon, mortars, etc.

The utility of this mortar in defence of any pass is very evident, especially where it may be formed on a high ground not easily comeatable by an enemy, and the weight that each stone will fall with, renders this a very terrible machine to invaders, and a very serviceable one to defenders; for by the same rule, that one of three feet diameter can throw about 1,500 weight of stones, what would one of six feet diameter do, and be easier made than the former, because labourers could go into the inside to chip and polish it.

One objection to such is, that it cannot be turned or traversed as may be requisite; in answer thereto, it is only calculated for a pass, and if taken by an enemy cannot be turned against its friends, which is too often the case of mortars and cannon.

When there are rocks of any kind at the entrance of harbours, etc., such a mortar might be constructed at a cheap rate for the defence of our ships, etc., and where there are no rocks, I have invented an artificial battery of such mortars, that with great safety to the defenders, and peril to the offenders, might be put in practice at every accessible place on our coast, and the mortars traversable as need required; but as we are at present more attentive to domestic than foreign enemies, this is not the season for guarding against the latter, therefore needless to propose it.

If the above description of Healy's mortar be not sufficient to convey an idea of it to those who are not acquainted with parabolic curves, the inside of a common wine-glass is nearly the figure of it; 'tis likely the book you mention may have given Healy the hint of this, which you will allow is a great improvement; on the same principle he has invented mines, which with a tenth of the powder, will do ten times more damage by blowing tuns of stones and rubbish horizontally.

J. RAMSAY.

COOMBE HOUSE, CROYDON.

R.E. OFFICERS are reminded that they and their dependents may be received at Coombe House as guests when they are in need of a rest or change. It offers a haven for a time to officers when retiring or going on half pay, or while looking for a permanent home on returning from abroad.

Coombe House is situated at the foot of the Addington Hills, about two miles out from East Croydon, whence trains run to Victoria every twenty minutes.

The house and grounds are delightful. Those who have been there have greatly appreciated them, and all the arrangements made for their comfort by the retired officer and his wife whose hospitality has prompted the scheme.

The accommodation limits the number of guests to four at one time. With this limit it is necessary at times to arrange for selection among applicants, and adjustment of the dates for visits. The responsibility for these arrangements rests with the R.E. Corps Committee. Applications should therefore be made to the Secretary of that Committee in person, by telephone, or by letter. The address is Room 231, War Office, and the telephone number Victoria 9400, Extension 467. No particulars are normally asked of applicants, other than the dates which would be most convenient to them for their visits. Applications are, of course, treated as confidential.