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CONTENTS.

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Index to Authors.

(Memoirs and Reviews Omitted.)

CONTENTS.

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

INFANTRY FOOTBRIDGE

INFANTRY FOOTBRIDGE.

By Bt. Major R. L. McClintock, R.E.

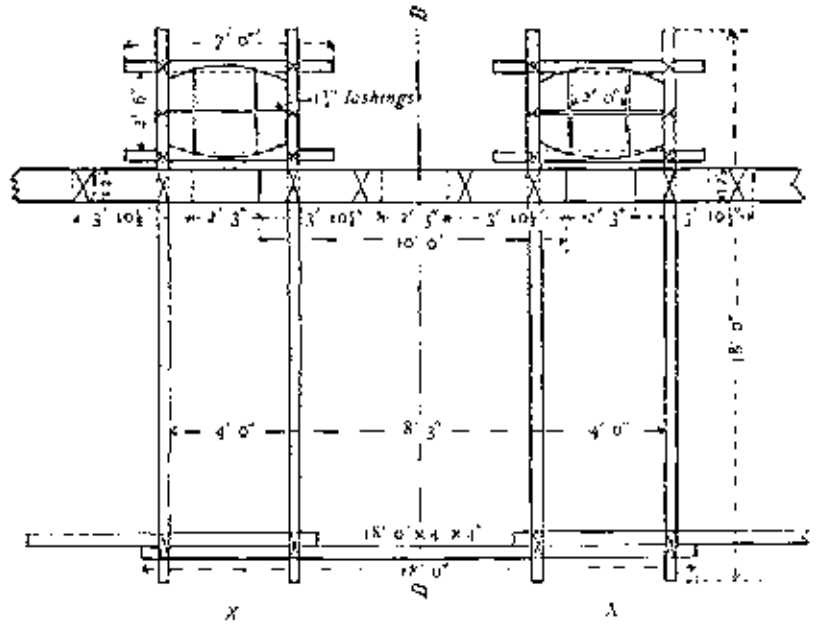
In the July, 1907, number of the *R.E. Journal* an article was published entitled "Some Ideas on Field Engineering." In this (*vide* para. 8 and *Plate* II., *Fig.* 4) details were given of a floating footbridge—to carry infantry in single file at 4′ distance—composed of 108-gallon casks, light 18′ spars and 10′ planks.

(In case present readers have not the volume in question immediately at hand, the drawing is reproduced in *Fig.* 1).

From the first, the idea appealed strongly to this unit. A light and easily constructed cask footbridge might be very useful on service, and the *Manual*, Part III., contains no information on the subject. Further, such a bridge makes a little material go a very long way, and detached companies of Sappers & Miners are not overburdened with fieldworks stores. Gaps over real water, convenient to cantonments and of width small enough to be spanned with the exiguous material at the disposal of a detached company in the form of the ordinary heavy floating bridge, are rare in India. When water at all is available it is usually of considerable width, and when it is a case of possibly a 160′ wet gap, it is far more interesting to the officer and aquatically instructive to the man to cross it in reality with a footbridge, than to use the equivalent in material in making some 20′ of heavy bridge leading nowhere, and consequently somewhat lacking in conviction to the unimaginative native mind.

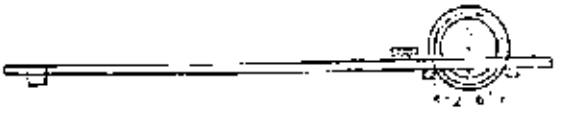
The cask footbridge idea was accordingly attacked with enthusiasm by the S. & M. at Secunderabad, as they were in the above position of having a wet gap of about 160′ at their disposal, together with a number of 54-gallon casks quite inadequate to cross it with the ordinary heavy bridge. Experience soon showed that the type suggested was not entirely satisfactory in details—for one thing, 108-gallon casks are not obtainable in India—and experiments followed to see if it could not be improved upon and adapted to local conditions.

As a result of these experiments, which have continued on and off for a matter of a year and a-half, I can now offer the details of what we consider an improved version.



PLAN OF ONE BAY.

ELEVATION (looking from XX)



SECTION B.B.

FIG. 1.

The 1907 pattern, from which we started, suffered from the following disadvantages :—

I. The lashings, as shown in the figure, are very difficult to put on properly so as to make a good job of it, and take an inordinate time. To describe the deficiencies of a fancy lashing on paper is an almost impossible task, but anyone who tries to reproduce the above figure for himself will very soon discover what they are.

II. The roadway is put on so low with reference to the casks, that only about half the buoyancy of the latter can be utilized before it sinks under water. This prevents the bridge being loaded up to anything like its full capacity.

In the "Secunderabad" pattern (described later) it is claimed that :—

I. The lashings are perfectly simple (being ordinary "square lashings"), and it is as easy to make a good and tight fit of the cask to the gunnels as it is in the ordinary heavy cask pier.

II. The roadway being on the top of the casks, the last available pound of buoyancy can be utilized, and a much heavier load carried. For instance, the 1907 pattern will only carry one man per 4′, while the "Secunderabad" pattern, with but 18 lbs. more buoyancy per foot-run, will carry more than twice as many.

The following table will show at a glance the relative points of the two patterns in a span of 120′ :—

Span.	Pattern of Br. dgs.	Materials Required.							Details.			Remarks.
		Casks.		Timber.			Lashings.					
		108 Gall.	340 Gall.	18″×2″×24′ (a) 12″×3″×16′ (b)	4″×6″×24′ (a) 4″×8″×16′ (b)	20′ (a), 12′ (b) Chesses.	2″×8″	1½″×36″	Lateral Intervals between Piers.	Buoyancy per Ft.-Run. lbs.	Man carried on Span.	
120′	1907 (*a*)	10	—	31	20	21*	80 (approx.)		12′	90	30	From *R.E.J.* '07.
	Secund (*b*)		24	50	24	12″ or 36†	64	36	10′	108	72	From Experim.

* Roadway, one plank wide.

† ,, three planks wide (as usually made, and as shown in diagrams and photos).

Further advantages claimed for (*b*) are ease and celerity of construction, and greater stability in the water.

The bridge shown in the photos was made against time at an

inspection, and the following were the times for the various operations :—

Forming rafts on shore	19 minutes.
Launching and warping to place	11 ,,
Connecting up rafts and completing ...	19 ,,
Total, from command "Prepare to Form Piers" till bridge open for traffic	*49 minutes.*

Span, 160'. Working party, 8 N.C.O.'s and 96 men.

The bridge was made from one end only, and the approaches at that end were bad and the bank steep.

As a test the working party was then sent across the bridge at the double. This produced no effect on it. Next, to simulate the effect of a strong current, a rope was attached to the middle of the bridge and hauled on by all the men. The upstream anchors of course dragged; then the attachments of the bridge to the shores carried away; the bridge assumed a nearly semi-circular form, and was towed downstream without any further damage. It was finally straightened again in about five minutes by merely hauling on the upstream anchor cables, and was as good as ever. It was perfectly passable at any time, even when semi-circular.

Note.—Between the photos and the diagrams a slight discrepancy may be observed as regards the chesses. This is due to the fact that we had not enough 11' chesses to complete the entire bridge as in the diagram, and so had to make some rafts with 7' chesses instead. In such cases two overlapping 7' chesses took the place of one 11'; there was no other difference.

LIST OF STORES REQUIRED FOR EVERY 20' OF CASK FOOTBRIDGE.

20' = ONE 10' RAFT + TWO HALF INTERVALS OF 5' EACH.

Casks, 54-gallon	4
Gunnels (round spars about 15' × 5" diameter) ...	4
Tie baulks (,, ,, ,,)	4
Cross pieces (4' lengths of same)	4
Chesses, 11'	6
Lashings, 2"—48'	8
Lashings, 1½"—36'	6

It greatly facilitates quick work, if before commencing operations the gunnels and tie baulks can be marked with chalk, paint, or a notch at two points 10' apart and equally distant from the ends, so as to give distance apart of casks, bung to bung, in piers and rafts.

The accompanying drill, compiled as far as possible on the lines of "Cask Bridging" in the *Manual*, together with the two diagrams, describes the method of construction fully.

Forming Rafts in Slow Time.

Twelve men and one N.C.O. form one "Raft Detachment." The working party falls in, with the water on its left, in column of detachments in double rank, the N.C.O. (Detachment Commander) on the left of the front rank.

TELL OFF YOUR DETACHMENTS FROM THE FRONT. — The Commanders take a pace to their front, turn to the right, and tell off their detachments :—

No. 1 Raft.
No. 2 Raft, etc.

FRONT RANKS "A" PIERS.

REAR RANKS "B" PIERS.

NO. 1 RAFT, STAND AT EASE.

NO. 2 RAFT, STAND AT EASE.

"A" PIERS, ATTENTION.

"B" PIERS, ATTENTION.

FROM RIGHT OF EACH DETACHMENT, NUMBER. — Both ranks of each detachment number off from 1 to 6.

NOS. 1 & 6 GUNNEL MEN, REMAINDER SLING MEN.

GUNNEL MEN, PROVE.

SLING MEN, PROVE. — On each man's number being called he will lift his left arm to the full extent above his head, and keep it there till next number (or down) is called.

I.

PREPARE TO FORM PIERS.

The gunnel men (1 & 6) bring up one gunnel each and lay them down at right angles to the bank, about 3′ apart.

Nos. 2 each bring up four 48′ 2″ lashings (slings), uncoil them, and lay one at each end of each gunnel.

Nos. 3 bring up two cross pieces each and lay them in between each pair of gunnels.

Nos. 4 and 5 bring up one cask each and place them, bung up, 10′ apart, bung to bung, between the ends of each pair of gunnels.

II.

Nos. 1 & 6 then bring up one tie baulk each and lay them down at right angles to the ends of the gunnels, between themselves and their corresponding numbers of the other pier.

Nos. 2, 3, 4, bring up one 11′ chess each and lay in two piles parallel to the tie baulks, and on the side of them and the raft nearest the store.

No. 5 bring up three 36′ 1½″ lashings each and place on top of the piles of chesses.

Each detachment then falls in on its two piers, A & B, Nos. 1 & 6 at opposite ends of the gunnels; Nos. 2 & 3, 4 & 5, at opposite ends of the casks, the whole facing inwards.

GUNNELS.

Nos. 2 & 4, 3 & 5, lift up the gunnels and place them on the casks between the second and third hoops, with the 10′ marks in line with the bungs.

Nos. 1 & 6 hold the ends of the gunnels to steady them while the slings are being fixed.

SLINGS.

Nos. 2, 3 4, 5, each tie one end of each sling to the end of each gunnel with a clove-hitch vertically above the swell of the cask.

Nos. 2 & 4 then place the two cross pieces across the gunnels on the opposite side of the casks from the clove-hitches, and above the swell of the casks.

The sling men then pass each sling round underneath the cask nearest to it, haul taut as possible, and square-lash the cross pieces to the

gunnels where they cross, taking two turns of lashing and two frapping turns, and then making fast each sling with a half-hitch on the end of its cross piece.

TAKE FRAPPING TURNS. The sling men, with the remainder of each sling, take two complete frapping turns in opposite directions round the four standing ends formed by the two slings of each cask and hold on.

PREPARE TO ROCK AND HEAVE. The sling men take a short pace backwards, place their left feet on the gunnel opposite them, and hold the end of the sling taut.

ROCK AND HEAVE. The sling men, assisted by Nos. 1 & 6, rock the piers from side to side, and take in as much slack as possible of the frapping turns of the slings.

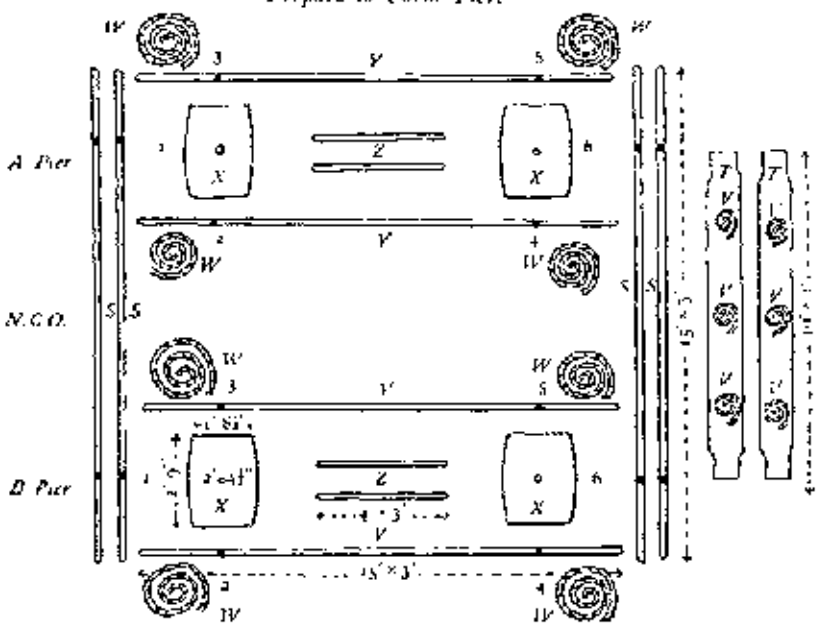
STEADY. The sling men remove their feet from the gunnels, holding slings taut.

MAKE FAST. The sling men make fast each sling to its own gunnel with a half-hitch close to the original clove-hitch from which it commenced. This must be done without the slings being allowed to slacken. The casks should now be quite tight up against the gunnels.

CHESSES. Nos. 2, 3—4, 5, lift three of the chesses on to the middle of each pair of gunnels, placing them at right angles to the gunnels, with half the chess on each side of the pier. The three chesses to be parallel and a couple of inches apart, to leave room for the lashing to pass between them.

Nos. 1 & 6, assisted by the other numbers as may be necessary, then each take one 1½″ lashing and attach it with a clove-hitch to each gunnel, close up to the chesses, and on his own side of them. These lashings are then each carried over the nearest chess, then under the gunnel, then over the centre chess, then under the same gunnel, then over the last chess, and finally made fast each to its own gunnel with a clove-hitch. The remainder of each lashing is then coiled up and left; it is again used later in the junction with the adjacent piers.

Diagram of Stores as they should be laid out on Command "Prepare to Form Pier."



S	*Tie Baulks* 15' × 3"	(4)	*X*	*Casks, 54 gallns.*	(4)
T	*Chesses*	(6)	*Y*	*Gunnels* 15' × 3"	(4)
V	15', 36' *Lashings*	(6)	*Z*	*Cross Pieces* 4' × 3"	(4)
W	2', 48" ,,	(8)			

The piers are now complete, and it remains to form them into rafts.

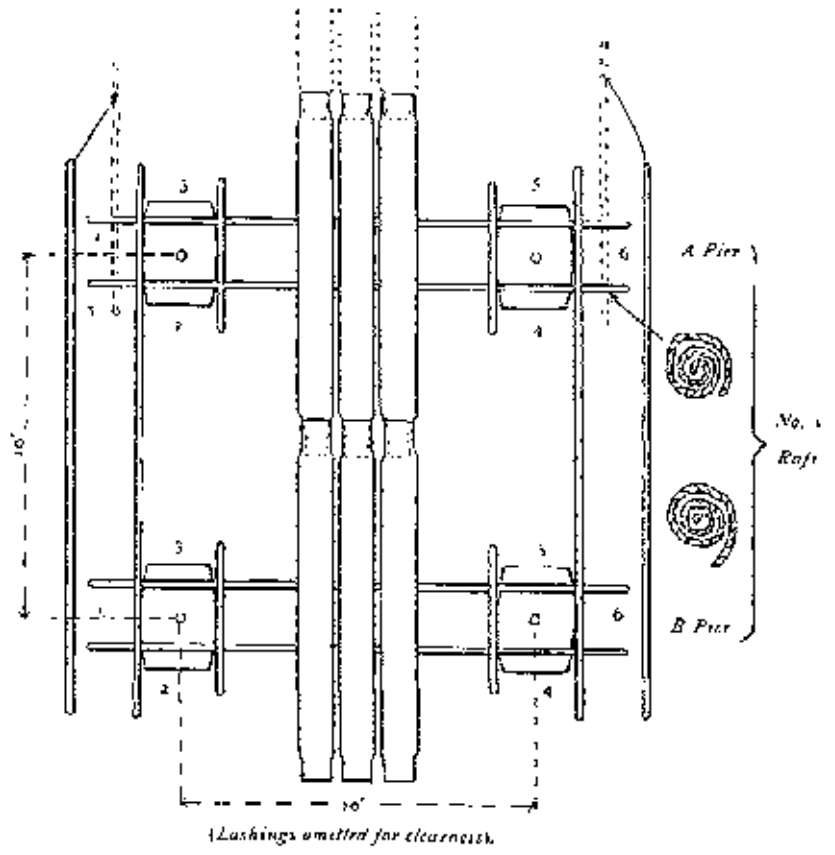
MAKE SQUARE. The N.C.O. in charge of each detachment then sees that the two piers are the correct distance apart and square by measuring the diagonals, bung to bung.

FORM RAFT. The two Nos. 1 then lift up one tie baulk between them and place it across the ends of the four gunnels, outside the clove-hitches of the slings, with the marks on baulks and gunnels corresponding. The two Nos. 6 do the same at the other end of the raft.

The sling men of each pier then lash the tie baulks to the gunnels where they cross each other, using the remainder of the slings and finishing off with a clove-hitch.

Nos. 1 & 6 meanwhile lash the inner ends of the chesses of each pier together where they overlap in the centre of the raft. The remainder of the two 36' lashings used for attaching the chesses to the two inner gunnels of the raft is sufficient for this.

Diagram of one Complete Raft of Cask Footbridge.



The raft is now complete, and ready for launching to take its place in the bridge.

PREPARE TO LIFT —LIFT. The 12 men of the raft detachment take posts at the corners of their respective piers, and lift on word of command, carrying the raft on their shoulders.

LAUNCH. When the raft is in the water, all men leave it except the N.C.O. and the four gunnel men. The latter take posts one at each corner of the raft with a boathook or oar. The N.C.O. sees that the two remaining tie baulks and two remaining 1½" lashings are placed on the raft, takes his place in the centre, and gives the word to shove off.

The four gunnel men haul, pole, or row the raft into its final position in the bridge, and attach it to the previously placed raft, and at a distance of 10′ from it, by means of the two tie baulks and two lashings, which are on the raft.*

They then assist the following raft to attach itself to their raft in a similar manner.

The outer tie baulks of the raft at each end of the bridge are similarly lashed to two pickets driven into each bank.

The remainders of the 36′ lashings which were left on the outer gunnels of each raft are now used to connect the overlapping ends of the chesses of each raft with the chesses of the rafts on each side of it.

The operations are now complete, with the exception of placing anchors and cables and dressing bridge.

* In cases where there is not much current an expeditious method of "rafting" is to haul a 3″ rope as taut as possible across the gap (buoyed at intervals if necessary), and attached to holdfasts in each bank.

When the first raft is launched the gunnel men "warp" it across at once by means of this rope to its final position at the far bank. The remaining rafts follow in succession in like manner and attach themselves each to its predecessor, until the bridge is completed to the near shore.

SHEERNESS WATER SUPPLY.

We are indebted to the Director of Fortifications and Works for the following interesting Reports by Colonel T. J. W. Prendergast and Lieut.-Colonel B. E. Morony, R.E.:—

Early History.—Since the year 1782, and possibly before, the garrison of Sheerness has drawn its water from artesian wells, from which the area enclosed by the land front of the defences, and now containing the garrison recreation ground, hospital, etc., derives its name of the Well Marsh.

At this point the London clay is found at the surface, and extends to a depth of 338′, below which are tertiary beds of various coloured sands, some of them mixed with loam or clay, and known as the Oldhaven, Woolwich, Reading, and Thanet beds (see *Plate, Fig.* III.).

The latter rest, at the depth of 500′, on a chalk bed, the depth of which has never been ascertained.

The old well—or No. 1, as it is now called—is said to have been dug in 1782, but there are no records to show whence water was obtained previous to that date. Rain water must have been used, supplemented by shallow wells.

It is probable that experience at Queenborough Castle, about 2 miles off, told the engineers of the day that, in order to obtain water at Sheerness, it would be necessary to pierce the London clay, which would be found to be over 300′ thick. At any rate, a well 6′ in diameter, and brick lined, was dug through the London clay, and it is evident that when the excavation had nearly reached the water-bearing sands, the remaining layer of clay was pierced, and water rushed into the well and must have risen nearly to the surface.

There are no records to show whether the well was pumped out to allow of the completion of the brick steinings to the base of the clay; but this seems highly improbable, as for many years water was drawn by a bucket worked by hand and horse-power, and it is much more likely that work was stopped as soon as water entered the bottom of the well.

Difficulties caused by Sand.—9″ Bore Pipe, No. 1 Well.—In 1855 it was found that sand had filled up the lower part of the well to a height of 110′ from the bottom, and that the supply of water was diminishing, and it was decided to drive a 9″ bore pipe through the sand in the well to the water-bearing strata below. This pipe was carried from 167′ to 480′ below the surface, that is to say, it penetrated 142′ of the water-bearing sands.

First Steam Pump.—In 1858 a single throw pump of 6″ diameter with 3′ stroke was fixed in No. 1 Well, the suction being 167′ below the surface. This pump was driven by a vertical high-pressure non-condensing engine, by spur and pinion gearing.

In 1861 the sand had risen 12′ higher in the well, and the water level in July and August was 131′ below ground.

Enlargement of No. 1 Well.—In 1862 it was decided to clean the sand out of the lower part of the well and enlarge a portion of the well so as to form a larger reservoir; and recent operations have shown that the brick steining was domed out from 6′ to about 9′ diameter, from 165′ below the surface to a depth of 265′ (see *Plate, Fig.* I.).

In 1864 the well was still giving trouble, sand was causing much damage to the pumps, and water was short. From a series of observations made, extending over several months, it was found that the sand in the bottom of the well was continually on the move; when much water was pumped the sand rose high in the well; when little or no water was pumped it sank again, the fluctuations extending over a depth of more than 100′; the 9″ bore pipe had been broken and twisted (a good deal of it had been removed in cleaning out the well in 1862).

It was then decided to put in a new 12″ bore pipe through the sand, etc., at the bottom of the well to the water-bearing beds below. An incident which occurred while this was in progress showed how the sand moved. The C.R.E., Sheerness, in a letter dated 2. 9. 64 to D.W., states that on August 26th, 1864, while boring was going on for the 12″ pipe, the sand suddenly blew up from the bottom of the shaft, the 12″ bore pipe rose 7′ or 8′ bodily and then sank again immediately to 3′ or 4′ below its former position. A man was killed in this accident, and the boring operations were abandoned.

No. 2 Well.—In 1868-9 it was decided to sink a new brick well alongside the old one to act as an additional reservoir, and to enable two separate sets of pumps to be used, as the set in the old well was constantly injured by sand.

The new, or No. 2, well was carried down to a depth of about 200′, terminating in the London clay. For a depth of 40′ it was made with iron cylinders 6′ in diameter, then the same diameter was carried on in brick to a depth of about 100′, at which point the well was domed out to 9′ diameter, which was carried down to the bottom (see *Plate, Fig.* II.).

Heading between the Wells.—The two wells, 16′ apart, were connected by a heading, brick lined, of egg-shape section, 6′ high by 4′ at the broadest point. In this heading there is a brick partition with an iron door, and under the door a 12″ C.I. pipe with a sluice valve and opening gear worked from the surface, the object of this arrangement being to allow of water passing from No. 1 into

No. 2 Well, when it rose sufficiently high in the former, while any rush of sand could be excluded.

9" Bore Pipe, No. 2 Well.—Sand continued to give trouble, and got into both the new and the old well, and in 1877 it was decided to put down a 9" bore pipe from the bottom of the new (No. 2) well into the chalk. The boring came on chalk at 301', and after the tube had been carried 4' into it, the bore hole was carried on unlined to a depth of 806', at which point the boring was stopped, as a good supply of water had been obtained.

Absence of Sand, No. 2 Well.—This bore is clear throughout its depth to this day. It is stated in several reports that no trouble has been caused in No. 2 Well by sand, as the supply of water is obtained from the chalk. This is probably misleading, as the water evidently passes down from the Thanet beds along the outside of the lower portion of the bore tube, or through fissures in the chalk caused by the boring operations, into the bore hole and thence up the inside of the bore tube, and in this way the sand is filtered out of the water.

Dockyard Well.—Analyses of the water, which is soft, also show that it does not come from chalk springs. It is not believed that any water is obtainable from the chalk, in proof of which may be mentioned the case of a well in the dockyard. In the process of boring, water was met with at various depths in the sand beds, but in the hope of obtaining a better supply from the lower greensand supposed to be under the chalk, the bore was carried to 1,500' below the surface, at which point the water disappeared, probably owing to a fissure in the chalk having been struck. The boring was stopped and the tube blown up with dynamite at 450', and water drawn from that depth.

From the study of various geological reports the conclusion has been arrived at that the lower greensand has run out, or been reduced to a very thin stratum, under Sheerness, and that it would be in vain to hope to obtain a supply of water by penetrating through the chalk to unknown depths.

False Bottom, No. 1 Well.—To return to No. 1 Well. In order to keep down the sand which was constantly rising, a false bottom of 7' diameter was fixed, at 160' down, in 1882, made in four segments of C.I., tongued, grooved, and bolted together, of 9" thickness at the centre and 6" at the sides, and built into the walls. A 6" valve was fitted in one segment, by which water could be admitted into the upper part of the well. The removal of this false bottom in 1906 was a work of considerable difficulty.

No. 2 Well Boring.—When the boring in No. 2 Well was completed, the water stood at a level of 70' below ground. This level had sunk to 120' by 1884, and to 137' in 1887. In 1884 it took 2½ hours to pump 10,000 gallons, and the water was lowered 13' in the well;

24,000 gallons could be pumped in 6 hours 40 minutes, lowering the water 32′. In December, 1888, the average daily consumption, 11,000 gallons, was pumped in 3 hours, lowering the water 28′; 20,000 gallons could be pumped in 5 hours, lowering the water 32′.

Steam Pump, No. 2 Well.—In 1887 a single-throw pump 6″ diameter and 3′ stroke, driven by a horizontal high-pressure non-condensing engine of 7-H.P., was fixed in No. 2 Well, and is still in use, but it is hoped that it will be shortly replaced by a modern 3-throw pump. The suction is 197′ below surface, and the pump delivers 4,000 gallons per hour.

The water level in No. 2 Well continued to fall at the rate of about 4′ per annum, and it was frequently necessary to augment the supply from the Dockyard and Town Waterworks.

Proposed Storage Tank.—Early in 1904 proposals were submitted for an additional high level storage tank, in order to maintain a reserve in case of fire or temporary stoppage of the pump, and to facilitate supply to the higher cisterns in the barracks.

Existing Storage.—The existing storage consists of a brick tank of 12,000 gallons capacity on the ground, built in 1829. In 1859 a circular iron tank of 15,000 gallons capacity was built over it, 30′ above ground, and this tank was added to in 1874, bringing its capacity up to 25,000 gallons.

Water Famine, 1904.—During the summer of 1904 there was almost a water famine in Sheppey. The yield from the town, dockyard, and W.D. wells was below the average, great difficulty was experienced in supplying the garrison, and the strictest economy had to be enforced. The water level in No. 2 Well dropped to 185′, or to 15′ from the bottom of the well, which was often pumped dry a dozen times a day. It became evident that the proposed storage tank would be of little use without sufficient water to pump into it, and the question arose as to the best means of increasing the supply.

Decision to clear No. 1 Well.—Various schemes for new wells and improvements to the old ones were carefully considered, and it was finally decided to clear out No. 1 Well, the main advantage which this course promised being the large reservoir which this fine well would afford if it could be put into serviceable condition.

On the other hand, nothing was known of the condition of the well below the false bottom, trouble from sand blows was to be anticipated, and there were no data to show to what extent pumping in No. 1 Well, while the excavation of sand and *débris* was in progress, might lower the level in No. 2 Well.

If it had been found that the water in No. 2 was being diminished by the pumping in No. 1, the scheme must have been abandoned, as the water in No. 1 Well could not have been used while excavating operations were in progress, and no other source of supply could

be reckoned on even temporarily. However the first few hours' pumping in No. 1 Well showed that there was no corresponding fall in the water level in No. 2, and all cause for anxiety on this point was removed.

Allotment of Funds, 1904–5.—£2,000 had been allotted in 1904–5 for a new storage tank, but in view of the above considerations the service was altered to improvement of water supply, and £4,000 for the years 1904-6 were allotted for the clearing of No. 1 Well and the sinking of a new bore tube at its foot (if the existing bores were found to be useless), a sand filter (to keep down sand at the bottom of the well), provision of new pump and gas engine, a high level 12,000-gallon tank, new quarters for the waterworks attendants, new engine house, etc.

The work of clearing No. 1 Well was entrusted to Mr. Batchelor, a well sinker of great experience. As there was no definite information as to the conditions below the false bottom, it was impracticable to make a lump sum or measurement contract, and the work was done by day labour, the plant being paid for at £17 per week.

This may appear expensive, Mr. Batchelor's bill amounting to £2,300, but the money was well spent, as his well-trained and experienced workmen were able to cope with the difficulties encountered, and the operations were carried out smoothly and without any sort of accident or mishap.

Clearing of No. 1 Well.—Mr. Batchelor commenced work in No. 1 Well on November 27th, 1905, by removing the old pumps, girders, etc., and fixing concrete blocks to support 12" × 12" pitch pine baulks, from which a pair of 12" lift pumps were suspended in the well. The pumps were driven by a 14-H.P. traction engine by means of pinion and spur wheel gearing and countershafting. The crank pin of the second countershaft was connected to a pair of rockers, from which the pump rods were suspended.

The suction pipe was capable of extension by means of slides up to 10', beyond which another length of rising main had to be fitted.

Workmen were lowered and raised and *débris* pulled up by means of a winch, the steam for which was supplied from the W.D. boilers.

The removal of the false bottom and making good the staining was completed by February 16th, 1906, and the temporary pumps, throwing about 10,000 gallons per hour, were then got to work removing water and sand, until the latter began to clog the pumps, after which the sand was shelled out, until shingle was reached at a depth of 24'.

At various depths girders, chains, remains of staging, and other *débris* were met with and removed.

The shingle was shovelled into buckets and hoisted out, and when layers of sand were encountered, the shell was again brought into use.

In this way the well was cleared to the offset at 265′, and the brick steining was found in good condition except at the offset, where it is dry set and had given way, allowing clay to slide into the well. If this had not been remedied, the well would soon have been choked with clay and the flow of water altogether checked.

Broken portions of the 12″ pipe inserted in 1864 were found and removed, and the top of the first bore pipe, 9″ in diameter, which had been put down in 1855, was encountered at 263′. Both pipes were found to be choked solid with sand and *débris*, and no water was issuing from them.

In two neighbouring wells of very similar construction, from which the town water supply is drawn, the bore pipes are also filled up in the same manner, and water is only obtained through the floors of the wells outside the bores. Consequently it would appear to be useless to attempt to obtain water from borings into the Thanet beds unless special precautions are adopted to exclude sand, or the water is drawn out very slowly.

At Slough Fort a boring was sunk into the tertiary beds in 1902, but sand caused endless trouble until the speed of the pump was reduced, and since this was done there has been no trouble in obtaining the small supply required.

Old drawings showed a concrete slab at the level 265 which does not exist, but the well below that point is filled with coarse shingle, which must have been thrown in many years ago to keep down the sand, but ineffectually, as a large quantity of sand had passed through it into the upper part of the well.

During the 23 years No. 1 Well was closed down, the shingle may have settled and consolidated, at any rate it now holds the sand in check, and the special sand filter, which it was proposed to fix at the level 265, is not required. It was evidently useless to attempt to clear either of the old bore pipes or to make a fresh boring, as the latter would soon share the fate of the old ones and become clogged with sand.

Mr. Batchelor recommended the enlargement of the well to 9′ diameter to the base of the London clay, but this proposal was vetoed on account of the great expense that would have been involved, and also in view of the trouble that might be anticipated from sand blows when the bottom of the clay was reached.

A series of tests showed that water was coming in at 265 at the rate of 5,000 gallons an hour, and as it was clear and free from sand, it was decided to leave well alone and cease operations in the well; and the temporary pumps and gear were removed by September 1st, 1906.

Standpipe.—Before operations were commenced in No. 1 Well, water used at times to rise through a valve in the false bottom and

pass through the heading into No. 2 Well. The rest level in the well was therefore assumed to be about 150′ from the surface, and the well being cleared out to 265′, formed a reservoir containing about 34,000 gallons, into the bottom of which water enters at 5,000 gallons per hour, or twice the rate at which it can be pumped out by the new pump, delivering 2,500 gallons per hour.

It was therefore considered unnecessary to provide the proposed 40,000-gallon storage tank mentioned above, but it was still very desirable to produce greater pressure in the mains than could be obtained with the existing 25,000-gallon tank, in order to reach the high level cisterns in the married quarters, and for fire purposes. This was satisfactorily accomplished by erecting a standpipe of 4″ diameter (57′ above ground level and 15′ 6″ above the highest water level in the 25,000-gallon tank), which can be pumped through direct from either well.

The cost of providing and fixing this standpipe amounted to £65 10s. 5d.

New Pump in No. 1 Well.—No. 1 Well then had a rest of six months, from September, 1906, to March, 1907, during which time Messrs. Tangye fixed a 3-throw pump, bore 4½″, stroke 12″ in the well, designed to deliver 2,500 gallons per hour at a speed of 23 revolutions per minute. By means of iron girders fixed across the well and a winch to take the weight, the pump was put together and lowered section by section entirely from the surface. The end of the suction pipe was fixed at 248′ from the surface, and was fitted with a rose, consisting of two perforated cylinders one inside the other, specially designed to exclude sand. Stages were also fixed at depths of 6′, 50′, and 100′ below the surface and connected by vertical iron ladders secured to the walls.

The cost of this pump, including fixing, was £557.

Electric Motors.—By this time funds were nearly exhausted, only about £350 remaining out of the £4,000 allotted, to provide the power for the two pumps and rebuild or repair the engine house, and it was further considered very necessary to replace, by a more modern and efficient type, the pump in No. 2 Well, which was nearly worn out and of a very antiquated cumbersome pattern.

With a view to economy, not only in first cost but also in working expenditure, in maintenance, and in supervision, it was proposed to provide electric motors as the driving power in lieu of the gas engines authorized; the current to be obtained from the Sheerness Electrical Power Company, whose main run to a point about 200 yards from the pumping station.

The cost of providing and fixing one motor, inclusive of laying the necessary extension of cable, was quoted at £88, with a guarantee to maintain the plant in running order for two years, which—as compared with gas engines—would be a saving in initial cost of about £130 for each well.

The proposal included the use of automatic starting gear worked by a float in the storage tank which would ensure that the tank was always kept full, and—by the use of a resistance cut out gradually by a solenoid—obviate any danger of the motor being put to its full power too suddenly, so damaging the gearing or pump. Also no labour would be required for starting and stopping the motor.

It was estimated that the cost of working and supervision would not exceed—and might be considerably less—than it would be if gas were used.

The estimates also showed that an annual saving of at least £100 would be effected by providing a new pump in No. 2 Well driven by electricity (or gas), in place of the existing steam pump, which involved the employment of an engine driver and stoker, whereas one attendant would be sufficient to run gas engines or motors, and in the case of the latter, his whole time need not be devoted to the pumping station.

An objection that the extreme damp often experienced at Sheerness might be prejudicial to the efficiency of electrical plant, was answered by a visit to a private pumping station where a motor had been running quite satisfactorily in a very damp engine house for four years without any repairs or renewals.

Any risk of failure of water supply owing to a breakdown of the electrical generating station would equally apply if gas were used, but, in the case of the former, there will shortly be an alternative source of supply, viz., the dockyard, in which extensive electrical works are being installed.

The pump already fixed was fitted with fast and loose pulleys for belt driving, the countershaft to run at 95 revolutions. It was estimated that a motor of 7-B.H.P. to run 500 revolutions, could be arranged to drive the pump direct by means of toothed wheels, the step-down of the gearing being a trifle over 5 to 1.

Contract for Motor.—A contract was accordingly entered into with the Sheerness Electrical Power Company, which provided and fixed a 7-B.H.P. motor, manufactured by the Brush Electrical Engineering Company, type E 12, with float switch, starting switch, and rheostat, for £88 11s. 3d., this sum including the supply and fixing of a cast-iron spur wheel (in place of the pulleys on the countershaft of the pump), which was geared into a raw hide pinion on the motor spindle. There was also a guarantee to maintain the installation in working order for two years.

Speed of Pump.—The speed of the pump was arranged as follows:—

Revolutions of motor per minute	445
Teeth on pinion on motorshaft	19
Teeth on spur wheel on countershaft	85
Teeth on pinion on countershaft	16
Teeth on spur wheel on crankshaft	74

which gives a theoretical speed of 22·1 revolutions per minute of the pump. Actual trials show that the speed varies between 21 and 23 revolutions per minute.

Test of Motor and New Pump.—The motor was fixed by March 15th, 1907, and after some trial runs, which showed that everything was working satisfactorily, a 24 hours' continuous run was made on March 21st and 22nd, with the result that 2,800 gallons per hour were pumped, the water level having been reduced during that period from 170′ to 208′ below the surface, leaving a depth of 40′ of water above the suction of the pump.

No. 1 Well taken into Use.—The water having been analyzed and reported thoroughly good, No. 1 Well was taken into regular daily use on April 28th, 1907.

Cost of Pumping by Electricity.—The Electrical Power Company offered to supply the current at a flat rate of 2d. per Board of Trade unit, or on a sliding scale of 3½d. per unit for the first 100 hours' running of the quarter, and 1½d. afterwards, and courteously agreed to allow a decision as to which rate should be adopted to stand over until the motor had been in use for a quarter, by which time sufficient experience would be gained to determine which rate would be the more advantageous to the War Department.

The sliding scale was adopted as the more economical, as proved by the following figures. It was found by trial that the consumption of current per hour was 3·8 kilowatts to pump 2,500 gallons, or 1·52 kilowatts per 1,000 gallons.

On the sliding scale the consumption during the first 100 hours' running in the quarter is charged at 3½d. per unit, or at the rate of $1{\cdot}52 \times 3{\cdot}5 = 5{\cdot}32$d. per 1,000 gallons.

The remainder consumed is charged at 1½d. per unit, or at the rate of $1{\cdot}52 \times 1{\cdot}5 = 2{\cdot}28$d. per 1,000 gallons.

The consumption of water per quarter varies between 1,000,000 and 1,500,000 gallons. Taking first 1,000,000 as the amount pumped during the quarter, 1,520 units would be used in pumping. During the first 100 hours 380 units would be used at the higher rate of 3½d. and the remainder at 1½d.

The cost therefore would be :—

	£	s.	d.
380 units at 3½d.	5	10	10
1,140 units at 1½d.	7	2	6
	£12	13	4

At the flat rate of 2d. per unit the cost of the 1,520 units required to pump 1,000,000 gallons works out at £12 13s. 4d. Exactly the same as the sliding scale.

If 1,500,000 gallons were pumped, the figures would be:

Sliding Scale.

	£	s.	d.
380 units at 3½d.	5	19	10
1,900 units at 1½d.	11	17	6
	£17	8	4

Flat Scale.

	£	s.	d.
2,280 units at 2d.	19	0	0

or a balance of £1 11s. 8d. per quarter in favour of the sliding scale, which was accordingly accepted on the usual form of agreement.

Comparative Cost of Electricity and Steam.—During the three months in question the steam pump in No. 2 Well was not used at all, and it is possible to compare the cost of pumping by steam in 1906 with the use of electricity in 1907.

May, June, July, 1906, gallons pumped 1,385,000

	£	s.	d.
Pay of engine driver for 3 months	25	7	0
Pay of stoker	23	5	10
Coal (43¾ tons at 24s.)	52	4	0
Total	£100	14	10

May, June, July, 1907, gallons pumped 1,456,000

	£	s.	d.
Pay of motor attendant	25	7	0
Electric current (380 units at 3½d.)	5	10	10
Electric current (1,576 units at 1½d.)	9	17	0
Total	£40	14	10

The substitution of electricity for steam therefore causes a saving of at least £2.40 per annum.

Comparative Cost of Electricity and Gas. We have not such exact data for a comparison with the cost of using gas engines, but it is estimated that the gas bill would amount to £58 per annum, as against £62 for electric current; but this small difference should be balanced by smaller annual expenditure on repair and maintenance of motors, and the initial cost of the latter is under £180 (for two motors) against an estimated cost of £450 (for two gas engines). Also the use of automatic starting gear ensures that the storage tank is always kept full, and that pumping would commence directly any water was drawn from the tank, which would be a great advantage in case of fire.

Water Level in No. 2 Well.—No. 1 Well having been satisfactorily brought into use, after being abandoned for 30 years, attention was turned to No. 2 Well, to ascertain to what extent it could be relied upon as a second source of supply.

The water level had fallen 115′ (from 70′ to 185′ below the surface), at the rate of nearly 4′ per annum, and the pump was practically worn out.

As the well had been continuously drawn upon for many years, with an occasional rest only of a few days at a time, it was impossible to determine to what extent the above figures represented the true fall of the general water level of the source of supply. If it had been found that after a rest the water did not rise much above the 185 level, it would not be worth providing any new pump in the well itself, as the latter would be permanently dry in a few years, and in that case it would have been advisable to fix a bore tube pump some 50′ below the bottom of the well.

The latter course would be quite practicable (but it will be seen below that it was not necessary at the time), as it had been ascertained by sounding that the bore tube was clear to its full depth, *vide* paragraph above on "absence of sand in No. 2 Well."

The well (No. 2) was rested from April 25th, 1907, and the water rose steadily, till at the end of six weeks it reached the heading and flowed through into No. 1 Well. It was again pumped out on June 5th and then left at rest. This time the water rose to the heading in 12 days.

These results show that the fall of the water level in previous years was not so much due to a subsidence of the source of supply generally, as to the continual drain on the water-bearing strata round the bore, by which an ever-increasing area was denuded of water, and had to be filled up before there could be any rise in the well.

No. 2 Well.—The contract for clearing No. 2 Well, and for manufacturing and erecting new 3-throw pumps in it, was entrusted to Messrs. Warner & Co., of Walton-on-the-Naze, and their men arrived at Sheerness with the new machinery on the 29th of January, 1908.

The work of clearing the well of old stages, girders, and banks of timber used as temporary stages at different times, was first taken in hand, and, as some of these were fixed below the water level, the old pump was used to keep the water down until they had all been removed and holes in the brickwork made good.

The girders, etc., in the upper portion of the well were next taken out, also the old sluice valve fitted in the heading, and "opening rods" to same, which had been fixed to enable the valve to be manipulated from the top of the well.

After this, the old pump—consisting of heavy cast-iron standpipes and air vessel—was removed, leaving the well clear of all obstructions.

To support the new pumps, two massive girders were fixed into the well at a depth of about 142′ from the floor level, the new pumps being suspended from these girders. A strong platform of cast-iron gratings was fixed on these girders, and the new pumps were lowered on to the platform, connected up, and then lowered into position and secured to the girders by bolts.

The pumps consist of a head box, 9′ to 12′ lengths of standpipe (three lengths to each pump barrel), three gun-metal barrels, and one footbox. From the footbox one suction pipe is suspended, having a strainer of special design at its end, being at a depth of 198′ from the floor level. Half stages are also fixed at 4′, 50′, and 100′ from the floor level, and a vertical ladder is led from top to bottom platform, as in No. 1 Well.

These ladders and platforms have proved of great use, as any part of pump rods or rising main can be easily reached for repair or examination. With the old pumps there were no ladders; consequently, if an inspection had to be made or repairs carried out, it required a winch and overhead gear to lower a seat on which the workmen sat. It was also necessary to have two men on the winch, and a third on the first stage to guide the rope to which the seat was attached; now one man can descend either well to any depth, and carry out any small repairs without assistance from the top.

The driving gear on the top consists of a cast-iron box frame, carrying the crank and countershafts in bearings, and also supporting guide barrels for the crossheads. Each crosshead is connected to a crank by a connecting rod, and from the lower side of the crosshead the pump rods are hung.

In the well, at intervals of 12′, the pump rods pass through adjustable oak guides secured to girders, to prevent excessive vibration of the rods.

The caps of crank and plummer block brasses are all made adjustable to take up wear on brasses.

On one end of the crank shaft is keyed a cast-iron spur wheel,

having 71 teeth, which gears with a raw hide pinion on the countershaft having 15 teeth, and at the other end of the countershaft a cast-iron spur wheel, having 118 teeth, gears with a raw hide pinion with 19 teeth on the motor spindle.

With the motor running at 440 to 450 revolutions per minute, the above train of wheels gives a speed of from 15 to 16 revolutions of the pump per minute and an output of 2,150 gallons per hour.

While Messrs. Warner's men were erecting the pumps, the Sheerness Electric Power and Traction Company fixed the motor and connected it up to their existing main; they also fixed the switchboard with the necessary connections to the automatic switch on the storage tank.

The motor is a duplicate of the one driving pumps in No. 1 Well ("E 12" type), made by the Brush Electrical Engineering Company, of Loughborough.

By 20th March the machinery for No. 2 Well was completed, and since that date No. 2 has been used on Wednesday and Thursday, and No. 1 on Monday, Tuesday, Friday, and Saturday of each week, with a plentiful supply of water at all times.

After two days' pumping, the water in No. 2 Well rises and flows through the heading in about 30 hours, and after about 40 hours' rest—that is, from Saturday to Monday—the water in No. 1 Well is usually up to the heading. During the months of June, July, and August, after the heaviest pumping day (Monday), the lowest level reached was 199′ 8″ from floor level, leaving 48′ 4″ to be pumped before drawing air.

As the old pumping-house building was to be pulled down, a temporary shelter was erected over the wells to protect the machinery from dust, rain, etc., while a new pump room was built.

At the same time the old engine driver's quarters, boiler room, engine room, workshop, and store were pulled down, and after the roof was on the new pump room the temporary shelter was taken down, these operations being carried out without stopping pumping for one day.

The new building—37′ long by 18′ wide and 13′ high—is a well-lighted and convenient room, and forms a good workshop, as the benches, vices, and lathe from the old workshop have been erected in it.

	£	s.	d.
The cost of Warner's pumps was	417	0	0
The cost of No. 2 Motor was	99	6	3

including 100 yards of lead, and hand lamps for use in the wells.

The cost of new pump room was £168.

Three-Throw Pump and Motor for No. 2 Well.—The yield of this well was insufficient when it constituted the whole source of supply, but it should prove valuable in supplementing the yield from No. 1 Well, as it will only be used alternately with the latter and have frequent periods of rest, during which it is anticipated that sufficient water will collect to supply the garrison for a few days at a time, and justify the provision of a 3-throw pump and motor similar to those in use at No. 1 Well.

It is hoped that an adequate supply of water for the Sheerness garrison has now been assured for many years to come.

Contracts.—Two portions of the service were carried out under special contracts, viz.:—

(1). Clearing out old pumps, girders, etc., from No. 1 Well contractor, Mr. R. D. Batchelor. Total cost, £2,323 2s. 1d.

(2). Building quarters for engine driver and sluice opener—contractors, Frank Miskin, Ltd. Total cost, £564 19s.

The contracts for supplying and fixing new pumps were made by War Office as follows:—

No. 1 Well.—Messrs. Tangyes, Ltd. Total cost, £557.

No. 2 Well. Messrs. Warner & Co., Ltd. Total cost, £417.

The electric motors for driving the pumps were supplied locally by the Sheerness District Electric Light and Power Co. Total cost, £187 17s. 6d.

The remainder of the work, including erection of new pump room and taking down old buildings, was carried out by the triennial contractor and civil labour. Total cost, £447 18s. 8d.

The total cost of the whole service was £4,497 17s. 3d.

MOTOR CARS.

Lecture delivered in R.E. Institute on March 11th, 1909, by
MERVYN O'GORMAN, ESQ., M.INST.C.E., M.INST.MECH.E., M.INST.A.E.

As the subject is a large one I propose to limit myself to petrol cars. Let us consider the source of energy for a motor car, namely, the petrol. All liquid fuels of this type burn with air to produce almost exactly the same amount of energy per pound, viz., 20,000 British thermal units, and the amount of oxygen consumed is almost 3½ lbs. Accordingly, as fuel is bought per gallon, the denser the fuel, the more energy do we get into the tank of a car. This heavier fuel is also cheaper; so that, provided equally complete combustion is obtained, there is every inducement to the user to employ the densest fuel that he can burn without producing soot or smoke, or getting more than 2 per cent. of CO from his exhaust.

Now a horse-power hour is equivalent to 2,544 British thermal units, say 2,500.

Therefore 1 lb. of petrol should work a 25-H.P. engine for	0·32 hrs.
But the efficiency of the engine is only 25 per cent., thereby reducing the time for which the 25-H.P. is available to	0·08 hrs.
There is now the energy wasted in the car itself, which has only about 80 per cent. efficiency; so that 1 lb. of fuel will give us 25-H.P. at the road wheels for a period of only	0·064 hrs.
But 25-H.P. will propel a car at the rate of 40 miles per hour. Therefore the distance to be got (on Brooklands say) from 1 lb. of petrol is 2·56 miles per lb., that is 20·5 miles per gallon.	

In this paper I shall take the liberty of assuming that everyone, although familiar in a general way with the use of motor cars, has not, for one reason or another, made any detailed study of the subject. There is an engine, a clutch, and a gear box, which, if the back of the car be jacked up, cause the axle and its wheels to rotate. If the tires happen to be in contact with the ground, they push the ground backwards and the car forwards through one or a pair of push rods or radius rods. In cheapening things for the purposes of manufacture the forward parts of the back springs are sometimes used as push rods.

Effort of the Back Wheels.—It will be noticed that the back wheels begin their effort at that portion of their circumference which approaches the ground, and there is a reaction equal and opposite to this effort tending to raise the bonnet end of the car upwards. This effort is transmitted through the torque rod. If we suppose for a moment that a giant is holding the car in the air when its first speed gear is engaged, and is lifting it by its two back wheels only, so that the bonnet hangs vertically downwards, it will be seen that when the clutch is let in, the effort of the engine will slowly raise up the front of the car out of the perpendicular, and if the engine be powerful relatively to the weight of the chassis, it might eventually cause the car to rotate bodily, so as to bring the engine over the back seats. We need not prosecute this consideration any further; it simply shows to us that the torque rod which is fixed to the back axle tube is tending to lift the bonnet end off the ground when the engine works, a consideration which was sometimes disregarded in the early designs.

When the car is in its lowest gear, the torque of the engine is multiplied by the greatest multiplying factor, which may, for a 4-cylinder "4-inch" car, 25 by R.A.C. rating, be as much as 8·75 to 1. And so it happened that formerly when a single-cylinder "4-inch" engine was put in the back of the car, and when the gear box, the carriage body, and the driver were all so situated that their united centre of gravity was not very far in advance of the back axle, it became possible for a car which was being put to climb up a steep hill to place the driver in a position which, though disadvantageous as regards comfort, helped him to appreciate the magnitude and direction of the forces acting through the torque rod.

To come to figures. One cylinder of a modern "4-inch" car can exert an effort of 1,000 lbs. on its crank. If the lowest gear were in use, the tendency to turn the car over would be measured by a tangential pull of 164 lbs.,* exerted at the front axle, which we will say is 10′ from the back one. If the back wheels were held up by the giant, this would appreciably tilt a modern car weighing 3,000 lbs.; but with an old car of 5′ wheel base, with a higher gear reduction, and weighing 1,000 lbs., the backward somersault was always a possibility.

* Explosion mean pressure = 80 lbs. per square inch.
Number of square inches in a 25·6 R.A.C. rated engine cylinder = say 12·6 square inches.
Total pressure = say 1,005 lbs.
Length of leverage of crank, 2·25″.
Multiplication by gear = 8·75.
Total torque 1,000 × 8·75 lbs. at 2¼″.
Upward pressure at 10′ distance = 164 lbs.
Pressure at end of torque rod 5′ long = 328 lbs.

Were it not for the elasticity of the parts and the inertia of both the flywheel and the car as a whole, the effort would be transmitted in full through the torque rod, which, being about half the wheel base in length, or say 5′ long, might on the modern car transmit an upward pressure of about 328 lbs. on to the cross stay of the chassis frame to which it is fixed. In practice it will be found possible to make a car bounce considerably on its springs by simply clutching and unclutching rhythmically. The longer the wheel base, and the more the engine weight is kept forward, the less will this bouncing movement be felt.

This is one of the many causes that conduce to the "smoothness" of a car having a long wheel base. This must not be confused with the smoothness due to the smaller explosion reaction in a 6-cylinder car, to which as a rule is superadded the advantage of a long wheel base.

The Application of Brakes.—When the brakes are acting the opposite effect is produced, and the front end of the car is pressed strongly downwards on to the ground. This has an undesirable effect for cars having brakes on the back wheels alone, because whatever *steady* pressure is added to the front wheels is taken off the back ones, for the obvious reason that the total steady pressure on the ground cannot exceed the total weight of the car. The result of applying the brakes is therefore slightly to diminish the adhesion of the very wheels on which the driver depends for a good grip of the road. Braking on the front wheels will better illustrate this tipping effect on the car. This transfer of weight from the back wheels by braking is one reason why a better retardation may be obtained if the brakes are not applied so forcibly as to skid the back wheels. The other and chief reason is that once the wheels skid they make for themselves roller bearings out of the loose gravel, sand or stones, which may have been detached by the scraping action of the skid.

To Avoid Skidding.—From this consideration we learn the reason for a curious practical device in driving of which very few people know, called "chattering" the brake. As it is almost impossible to know the precise degree of pressure required for the best operation of the brakes, some drivers have learnt to avoid skidding and yet to get the desired retardation by "chattering," that is putting the brake quickly on and off by a rapid, but small, up-and-down motion of the foot. This tip for avoiding side-slip was given to me without explanation by Mr. Northey, of the Rolls Royce Company, and I have used it for a couple of years with undoubted advantage. The ideal arrangement is however to have brakes on all four wheels, and so use the whole adhesion of the car for stopping.

When I said that the total steady pressure on the ground cannot exceed the total weight of the car I was alluding strictly to the *steady* pressure (not to what, as an electrical engineer, I may call the "root-

mean-square-pressure"). I do not imply that the car cannot exert by reason of its motion up and down a pressure on the ground greater than its weight on the weighbridge. On the contrary, one regrets that this cannot truthfully be said, because it would be so much kinder to the tires and to him who pays for them. Momentaneous rises of pressure on the tires, to greater values than the car's weight, arise whenever the downward oscillation of the chassis is arrested by the action of the springs and the ground. This, of course, may occur two or three times a second in driving, and on a car 25 by R.A.C. rating it may amount to 700 or 800 lbs. (as indicated by the flexure of the springs), and so the walls of the tires are bent and unbent. This movement is additional to the bending with rolling, and adds its quota to the internal chafing which results in wear, heat, and eventual bursting. The lighter the car the less both effects. Good springing, by making the bending less abrupt, probably adds to the life of tires in some measure.

Weight.—I have rambled on to the question of weight. No one ever knows the separate weights of his chassis, carriage work, and accessories, or the distribution of weight on his car. Yet it is most valuable information. For example, the distance in which a car can be stopped depends almost entirely on weight distribution and not on the total weight.

If 0·6 of the weight is on the back wheels, the rate of stopping or retardation on dry level macadam may be as high as 9′ per sec. per sec. On travelling up a good hill more than 0·6 of the weight is thrown on the back wheels, and the retardation helped by the pull of gravity may go up to 10 or 11′ per sec. per sec. I give a table of stopping distances and times on a one in 15 hill up and a one in 50 hill both up and down. In the case of up-hills the total weight comes in, because a component of the pull of gravity is acting in addition to the adhesion. Mr. New has given a useful mnemonic for the distance of stopping in feet, which, if the speed is V miles per hour is $\frac{V^2}{8}$.

Acceleration.—Another matter in which weight is vital is in acceleration. The most pleasurable car to drive is one that accelerates well. It is a car with which it is easy to be virtuous. With such a car there is far less reluctance to slow down for corners, traffic, and villages, because one can so quickly get into one's stride again, and so keep both a good average pace and a clean license. I have suggested the name "liveliness" for the ratio of the number of horse-power available at the road wheels to the weight of a car in hundredweights. I used to think I drove a lively car myself since I took pains to reduce the weight and so to get a liveliness of "unity," that is to say, the car empty weighs 25 cwts. and the horse-power at the road wheels is 25. I calculated that the maximum rate of acceleration of a car (neglecting the transfer of weight) can actually

attain on dry level macadam to 12′ per sec. per sec.* but in fact nothing so great as this is got in practice save at the moment of starting.

I have found that my car (25 by R.A.C. rating), though it is thought it pulls very well indeed as cars go, gives me an average acceleration of:—

2·2′ per sec. per sec. between 10 m.p.h. and 20 m.p.h. on 2nd gear.
1·9′ " " " " " " " " 3rd gear.
1·4′ " " " " " " " " 4th gear.

These figures were obtained somewhat crudely by observing the speedometer and measuring with a stop watch the number of seconds between the readings 10 and 20; but they are sufficiently close to show that there is a vast difference between the maximum acceleration as limited by adhesion and the maximum as limited by other considerations. I find that the horse-power at the road wheels when worked out on the basis of my acceleration of 2·2 is only 12-H.P. after making allowance for rolling resistance and gear inefficiency. As the engine can give 33-H.P. on the brake at 1,300 r.p.m., it is necessary to see where all this remaining power goes to.

Flywheel.—The balance of the 25-H.P. which the engine is capable of giving is absorbed in accelerating the flywheel and other rotating parts.† The large amount of power (about 4·13-H.P.) required to accelerate the flywheel is worth noticing, because it may prevent erroneous deductions being made as to the horse-power of a motor-car engine from measurements made on acceleration only.

One of the practical deductions from all this, which I am bound to confess was new to me when the experiments were made, is that the

* Total weight = 25 × 112 lbs. = 2,800 lbs.; total mass = 87·5; weight on back wheels = 0·6 of the above weight = 1,680 lbs. Co-efficient of adhesion = 0·625. Total adhesion = 0·625 × 1680.
Maximum force possible = total adhesion = 1,050 lbs. pull.
Force = mass × acceleration.
Therefore acceleration $= \frac{F}{M} = \frac{1050}{87·5} = 12·1'$ per sec. per sec.

† *H.P. expended on Accelerating Flywheel.*—
8″ = time taken to accelerate.
150 lbs. weight of flywheel.
9″ radius of gyration.
4·7′ linear path of centre of mass per rev.
Force = mass × acceleration.
$\text{Force} = \frac{4·7 \times 50·8}{8} = 29·8$ lbs. pull.
$\text{Horse-power} = \frac{\text{foot-pounds per min.}}{33,000}$
$\text{Horse-power} = \frac{4575 \times 29·8}{33,000} = 4·13$-H.P.
650 r.p.m. at 10 m.p.h. = linear velocity of 3,050′ per min. = 50·8′ per sec.
1,300 r.p.m. at 20 m.p.h. = linear velocity of 6,100′ per min. = 101·6′ per sec.
1,075 r.p.m. at 15 m.p.h. = linear velocity of 4,575′ per min. = 76·25′ per sec.

wear of tires is not chiefly caused by accelerating, however violently, with even a car that gives 25-H.P. on the brake. The flywheel saves the tires; and it is only the man who races his engine before letting the clutch in who gets sufficiently rapid rate of working on his tires to wear them by skidding. You can get a rate of working at the road wheels far in excess of 25-H.P. by employing the energy of the flywheel, and it is here that the flywheel wears the tires. Accelerating before letting in the clutch is a very common fault, especially with owners of old cars whose engines are not flexible, and accordingly the difference in tire wear between an old-fashioned and a new type of car is noticeable. Any engine that stops as soon as its speed is lessened 30 per cent. naturally teaches its owner that the car must be started off on the energy stored in the flywheel—and just as it is almost impossible to apply a brake with precisely the force which will not skid the wheels, so it is equally difficult to let in the clutch sufficiently gently. The moral on the whole is avoid secondhand cars older than 1908, unless you are skilled enough to apply a new carburettor and to increase the gas passages and valves so as to get a good pull at slow speeds. This brings me to an additional reason why the rate of acceleration is low with many cars, namely, the slow response of most carburettors. As a rule the carburettor takes for each engine speed a certain time to settle down to its proper quality of gas for that speed.

I shall leave the flywheel question now with only the remark that an elementary calculation shows that the flow of energy into a 150-lb. flywheel is at the rate of 5-H.P. for a speed variation of 5 per cent. on the 25-H.P. car I have been considering.

Number of Cylinders.—From considering flywheel effects we are naturally led to a kindred question—what are the merits and demerits of multiplying the number of cylinders?

With one cylinder the impelling force is necessarily supplied in jerks separated from one another by three idle intervals. A large flywheel is needed to prevent the whole car from feeling the interruption in the effort. This is generally supplied, and protection is got for the tires in this way, but it must not be supposed that the engine reaction can be got rid of; on the contrary, it may even be accentuated by an excessive flywheel.

With 2-cylinder vertical engines—which are nothing like twice as "smooth" as 1-cylinder engines—we are placed on the horns of a dilemma. Either the crank is so made for purposes of balance that one piston is up when the other is down, when we get the explosions irregularly spaced (that is two exploding intervals followed by two idle intervals)—or we get the cranks so made that both pistons are up and both down together, in which case the explosions—and therefore the reactions—are quite evenly spaced in time; but the car suffers from the vibration caused by the pistons not balancing one another in any way. The only plan for getting the advantage of

both systems with two cylinders is the "opposed" engine, where the cylinders are horizontal and face one another. The system works wonderfully well and is quite sound, but fashion has temporarily chased it off the market.

Fashion has similarly been unkind to 3-cylinder engines. If the vertical arrangement of cylinders alone be considered, the 3-cylinders should excel the 2-cylinders far more than these latter do the 1-cylinder class. Four vertical cylinders allow of evenly spacing the explosions and give a very fair degree of balance, but for slow running at no-load a very good carburettor indeed is wanted to secure the quietude which people have been led to demand since the spread of 6-cylinder designs. This exceeding quiet when the car is standing is a luxury which must be paid for either by carburettor excellence or by using more cylinders; the former is the cheaper plan, but the good carburettor is hard to find.

Six cylinders have the one great merit of developing a given degree of power with explosions of only two-thirds the size produced by four cylinders; accordingly the reaction of the engine is diminished. Add to this the fact that the smaller explosions are one-third more frequent, and we get two effects operating to secure that the engine reaction shall approximate to a steady continuous force. I do not think that the saving of tires by using six cylinders is at all important except with engines of large power—over 40-H.P. by R.A.C. rating.

Stopping Distances in feet. Up 1/15 hill.	Speed. Miles per hour.	Time taken in 1/10 secs. for a retardation of 11′ per sec.	Stopping Distances in feet.		Speed in m.p.h.
			Up 1/50 hill.	Down 1/50 hill.	
·25	1	1	·25	·25	1
·5	2	2	·5	·5	2
·75	3	2·5	·75	·75	3
1·25	4	3·75	1·25	1·25	4
2	5	5	2	2·15	5
2·9	6	6·5	3	3·5	6
3·5	7	7·5	4	5	7
4·75	8	9	5·5	6	8
6	9	10·5	7	7·5	9
7·5	10	11·5	8·5	9·5	10
9	11	13	10	11	11
10·5	12	13	12	13·5	12
12·5	13	15	14	16	13
15	14	16·5	16·5	18·5	14
16·75	15	17·5	19	21·5	15
19	16	19·0	22	24·5	16
21·5	17	20·0	24·5	27·5	17
24	18	21	26·5	30·5	18
27·5	19	22·5	30·5	34	19
30	20	23·2	34	38	20

Stopping Distances in feet. Up 1/15 hill.	Speed. Miles per hour.	Time taken in 1/10 secs. for a retardation of 11′ per sec.	Stopping Distances in feet.		Speed in m.p.h.
			Up 1/50 hill.	Down 1/50 hill.	
34	21	24·8	38	41·5	21
37	22	25·8	41	46	22
40	23	27	45	50	23
44	24	28·2	49	54	24
48	25	29·5	53	58	25
51	26	30·5	57	63	26
55	27	31·6	61	67·5	27
59	28	32·8	66	73	28
64	29	34·2	70	78	29
68	30	35·2	75	84	30
73	31	36·4	80	90	31
78	32	37·5	86	96	32
83	33	38·8	92	102	33
88	34	40·0	97	108	34
93	35	41·1	104	115	35

NOTE.—$S = \frac{1}{2}$ ft². $V^2 = 2$ fs.

PURCHASER OF SMALL CAR.

1. Capital cost, say £250.

2. Annual cost, say 3d. per mile for 5,000 miles = £62 10s. per annum.

First look up official trial results and disregard all other trials and statements, especially statements by wealthy men, who have it from their coachmen who have been told so with inducements from the maker.

Then make a list of possible cars at the possible price that have performed well, and merge all fads, viz., prejudice against horizontal engines, or against accumulator ignition, or chain drive, or method of springs, etc.

Then write for catalogues of the more promising to see what the price includes, noting if the apparent cheapness is due to very small tires and no sundries being included.

Then look at the transmission: clutch, gear box, ignition, back axle, brakes, and their adjustment, as these are far more likely to be defective than the engine.

Then, as high cost of running is what you do not want, and liveliness is what you *do*, consider weight in relation to power.

To get an idea of power try R.A.C. rating. $\left(\text{H.P.} = \frac{D^2 N}{2{\cdot}5}\right.$ where D = diameter of cylinders in inches and N = number of cylinders$\left.\right)$.

THE TRAINING OF TERRITORIAL FIELD COMPANIES, ROYAL ENGINEERS.

By CAPT. F. W. BRUNNER, R.E.

THE guiding principle of a National Army is that the individuals of which it is composed should be allotted, for purposes of war, to the tasks for which their civil pursuits best fit them. No man therefore should be enlisted into the Territorial Royal Engineers who would require to be taught the technical portion of his duties after enlistment.

If high qualifications are insisted upon recruits may come in slowly at first, but in all probability, when it is realized that the Corps is not easy to enter, good men will come forward, and the commanding officer will be able to pick and choose.

If the company is carefully recruited from intelligent artizans—the actual proportion of the various trades hardly seems a matter of great importance, provided that the useful ones, carpenters, smiths, bricklayers, etc., are well represented, and the men are of good physique—its *personnel* would have little to learn as Sappers, from an engineering point of view, beyond the application of their technical skill in the particular directions required for war. Most of this knowledge could be imparted by lectures in the winter evenings, illustrated by diagrams and models, and supplemented by a study of textbooks at home.

The equipment in use could be taught in the same way. For all practical purposes it differs, from similar appliances used in civil life, only in its adaptability to varying circumstances and to the necessity for mobility.

In fact, in order to take the greatest advantage of the limited time available for practical training, nothing should be left to be done out of doors which can equally well be done in the drill hall or at home. For instance, in the case of pontooning, intelligent men can see how the various parts of the equipment fit together on the barrack square, and can learn the duties of the various numbers from a book or in a lecture. They will then be in a position to form bridge in quick time, with very little further instruction when they get to the water.

There is no mystery about warlike engineering operations. A military bridge is only a bridge, which has to be constructed more or less hastily, to pass soldiers over some obstacle. The details of its

construction consist merely of ordinary artificers' work. The processes of putting a village or farm enclosure in a state of defence, are very simple tasks in their engineering details.

In all these operations, what is required beyond the technical skill, which the civil artificer possesses, is the tactical knowledge necessary to apply it, to execute orders intelligently, to anticipate them, thereby saving precious time, or to act without them on emergency.

The first thing a Sapper has to understand is that the object of his work is to enable the infantry to win the battle. It is as untrue to say that a skilled artificer is a made Sapper as to say that a Bisley marksman is a made infantry soldier. Both have learnt the elements of their trade, but both have still to learn to apply their knowledge to particular conditions.

The application of this knowledge calls for a high state of efficiency in officers and non-commissioned officers, but it would be wrong to argue that it is sufficient for them to have the knowledge The word "anticipate" is the keynote, and it applies not only to the commanding officer, but, in a greater or less degree, to all his subordinates.

The knowledge must be instinctive if it is to be relied on in the stress of battle, and it is hardly too much to say that not a moment will be wasted if the whole of the limited amount of time available for field training be devoted to its acquisition, with the exception of that necessary for elementary military training and musketry.

But, it may be asked, where is the necessity for the Royal Engineers to have all this tactical knowledge? Are there not a General and Staff whose duty it is to issue orders to everyone?

The reply is that it is impossible to foresee and provide for everything in orders. All the General and his Staff can do is to give the correct impulse to his troops, to arrange preliminaries, and to assign objectives. After this has been done, it is the duty of the subordinates—in a greater or less degree according to their seniority—to exercise their initiative in order to meet and take advantage of the varying incidents of the fight.

Admitting, then, the necessity for tactical knowledge, the next point to consider is how it is to be acquired.

We sometimes read, in the accounts of a campaign or battle, that works were constructed with much labour and were never occupied. When we do read this, it is not difficult to imagine the engineers constructing elaborate earthworks during the period before the war in some out-of-the-way field, while the rest of the army was engaged at manœuvres elsewhere. They may have devoted the utmost zeal in the design of their works to ensure protection and to provide for invisibility and fire effect, but all their labour will be worse than useless if the tactical use of the works has not been studied.

Mutual co-operation is the secret of success in war. Hence, the best way to study tactics practically is to take part in combined operations,

since it is only in these that the working of each arm of the Service can be watched in relation to the others.

Before considering what is to be learnt from these operations, it is necessary to have a clear idea as to what constitute the battlefield duties of the Royal Engineers.

In the defence—and this of course applies to the defensive portions of a battlefield where the general action is offensive—their duties are, speaking generally, to co-ordinate the defensive measures taken by the other troops. While the artillery and infantry provide their own cover, it is the duty of the engineers, assisted probably by working parties from the reserves, to strengthen *points d'appui*, to arrange communications, to carry out or prepare for any necessary demolitions, and generally to execute any work which requires special technical skill, or which does not obviously fall to the share of a unit allotted to a particular portion of the front.

The greater portion of this work can be provided for in orders, and tactical knowledge on the part of the engineers, although very important, is not so vital as it is if they are to do their share in the offensive portion of the field.

Here, after they have been detailed with the troops told off to make an attack and have heard the general instructions communicated, they may receive no further orders until some decisive stage of the action has been reached.

Their efforts in the attack would be directed towards :—

(i.). Strengthening tactical points as the fight progresses, which would be of use in case of a check or reverse.

(ii.). Clearing away obstacles, if required, before a position is assaulted.

(iii.). Taking part in the strengthening of a position gained against a counter-attack in force.

It is in (i.) that tactical knowledge comes most into play.

The business of the infantry soldier is to keep steadily pressing forward, his eyes fixed on the objective and with no thought but to reach it.

The Sapper's duty is to aid him by selecting and artificially strengthening localities in rear of the line as it advances, which will act as supporting points in case it is driven back. If a counter-attack is temporarily successful, a few loopholes knocked in the walls of a farmhouse enclosure and a few obstacles skilfully placed may be of incalculable advantage.

Places strengthened like this will form rallying points, into which the supports and parties of the firing line falling back will gather. They will stand out, to use a metaphor, like rocks in the sea as the tide sweeps on. Some of them will be engulfed, others will remain until the tide recedes again. All will aid in sapping the force of the

counter-attack by attracting bodies of the enemy by their fire, and those that hold out will materially assist in regaining the ground that has been lost.

To use another simile, the engineers should act like the half-backs of a football team, stopping dangerous rushes and backing up the forwards as they press on again.

In the above work the infantry will take part to a greater or less extent, and this is where the vital importance of combined operations comes into play. The engineers must learn that the infantry cannot be unnecessarily employed on works without the energy required for vigorous offensive action becoming exhausted; the infantry must know that there are limits to the amount of work a small engineer unit can do unaided.

The only way in which this mutual understanding of one another's duties can be obtained is by working together and constantly interchanging ideas. It matters very little in peace manœuvres if there is overlapping, but in war it means waste of energy, and this may involve the loss of a battle.

We are now in a position to consider how combined operations can be used to the best effect as a means of education.

It was pointed out above that it is in offensive action that tactical knowledge finds the most scope. It will therefore be most useful for our purpose to consider the action of the engineers in the attack.

Let us suppose that the field company is attached to a brigade, to which has been assigned a certain portion of the enemy's front as an objective. The O.C. Company will attend, with other commanding officers, to receive the General's orders and to hear any explanations he may give as to the manner in which he proposes to carry out his intention. The G.O.C.'s instructions may or may not indicate some special task for the engineers. In all probability they will not, since the incidents of the fight cannot be foreseen. We will therefore consider the latter case.

When the troops advance to the attack, the engineers should follow up the firing line, moving probably with the supports, and study the ground from the point of view of its capabilities for defence.

As the line moves forward, many accidents of the ground will present themselves, which could be made strong for defence with the expenditure of a little time. But it would obviously be waste of time to strengthen a locality simply because it lends itself to the purpose.

Whenever such a place is noted, then the C.O. should say to himself, "If we were to do some work there, what would be the effect on the operation?" If the reply is none the place is evidently of no value and should be left alone. If any junior officer or N.C.O. asks why it is neglected and is told the reason, he will already have learnt something useful. Sooner or later however some locality will present

itself, say a farm enclosure or group of buildings, the defence of which might be of great value if the enemy were to make a sudden effort.

There are many points which must be decided mentally before the question whether the place should be defended or not is answered in the affirmative, *e.g.*, is the ground to the front favourable for all arms of the enemy to co-operate in the counter-attack? Is the place screened from the enemy's probable artillery positions? Is the configuration of the ground such that his guns could continue firing until the infantry got within assaulting distance, or would they have to cease while it is still at a distance? And so forth.

If the weighing of these *pros* and *cons* resulted in a balance or advantage in favour of the defensibility of the place, the question should be decided in the affirmative.

The next point to decide is whether it is necessary to employ the whole of the unit, or only one or two sections. The unit, or selected portion of it, should then proceed to the place as soon as the firing line has advanced sufficiently far to allow of its getting there.

While this movement is taking place, a report should be sent to the G.O.C. saying what is being done. It is very important that this should not be neglected, not only in order that the whereabouts of the company may be known in case it is wanted, but also that its action may be discussed at the Conference. It is only in this way that the other arms will learn what the engineers have been doing during the day, and hence will understand what their duties are and what assistance they may expect from them.

The difficulty of bringing home to troops the importance of co-operation is that the result of its failure does not become apparent during peace operations. For instance, if in actual warfare infantry find that they cannot get on, they instinctively turn to the guns for help in overcoming the opposition. In peace operations they do not feel the want, as they are not suffering from the enemy's fire, and individual soldiers may go through a whole day's fight without enquiring what their own artillery is shooting at.

Similarly infantry, when forced to fall back, does not feel the want of artificial cover, because there are no bullets flying about. It is only in similar circumstances, in action, that the leaders begin to say to themselves, "If only we had some strong point to rally the men to, we might hold on until reinforcements come up and enable us to push on again." Then the importance of having these points prepared becomes apparent; not so much possibly on account of the intrinsic value of the fortifications, as the fact that they afford something tangible to hold on to, and that there is probably a nucleus of men already in occupation.

Having arrived on the spot, the situation should be explained to the men and the unit distributed, tools being laid out and all prepara-

tions made for starting work. Each N.C.O. in charge of a party of men should satisfy himself that each man knows exactly what he has to do, and officers should move about, correct mistakes, and ask questions, etc.

The O.C., having seen what work has to be done, may consider that there is too much for his unit to carry out without assistance. In this case he should send a further report to the G.O.C., who would decide whether the work is of sufficient importance to render it necessary to detail, from the reserve, a working party to help.

It may not be possible to carry out all the stages above described, since at a field day the attack is generally carried through with more rapidity than it is in real warfare. The O.C. must watch the progress of the fight, and, when he sees that a more advanced position has been won which would have to be retaken by the enemy before the one on which he is engaged could come into play, he should collect his unit and push it forward to repeat the process in another place. Or, before this new position has been carried, the Sappers may be required for the duties under (ii.).

Finally, the unit must be at hand to take part in the strengthening of the ground when a decisive phase of the action has been reached. This will be when a position has been gained where the troops must pause for a time, either because they are exhausted or because ammunition and supplies are deficient.

The operations discussed above do not exhaust the list of those upon which Sappers can be usefully employed during peace manœuvres. In fighting among woods, and in enclosed country generally, sign-posts are required to prevent reserves, supports, etc., losing their way. Then there are minor bridging operations and the destruction of bridges.

The latter must always be a "paper" operation. The points to remember are that everyone concerned in the work should know and be able to explain what has to be done, and that the necessary tools should be at hand and the required time have elapsed before the bridge can be assumed to have been destroyed.

The restoration of bridges is also unfortunately a "paper" operation in most cases. The same rules should be followed, and if there is bridging equipment available, a temporary bridge should be thrown alongside the one supposed to be destroyed.

The golden rule to follow in all peace operations is that it is a great deal better to do too much than to do too little. If someone else's preserves are invaded he will probably complain, and the point will be decided once and for all by higher authority.

It is sometimes argued that manœuvres are of little use to engineers because they cannot actually do any work; bridges cannot be destroyed, walls cannot be loopholed, and so on. There is of course something in this argument, but it must be remembered

infantry do not use ball ammunition, and yet umpires can estimate the effect of an infantry attack. There seems therefore no reason why the effect of defensive measures, taken or neglected, should not be estimated when considering the result of a counter-attack.

So much for combined operations.

When the unit is acting by itself, the imagination must be called into play, and the fact borne in mind that all military operations, except the most elementary, are meaningless unless they are considered in relation to the action of other arms of the Service besides that engaged.

In such circumstances, instead of men being able to see for themselves what the other arms and the enemy are doing, the O.C. must describe what is supposed to be going on. A defence scheme can next be gone into in greater detail. Or some other military engineering operation can be worked out, *e.g.*, the site for a bridge can be selected and the type of bridge, to be constructed, chosen. Then sketches can be made, parties told off to select and make lists of timber, and others sent to the nearest villages to collect details of tools and materials available.

It is not necessary for the whole unit to be present at these exercises. A few officers and N.C.O.'s are quite sufficient; and if officers of other branches of the Service can attend, so much the better. In fact much can be learned by two or three officers of different arms from each other during the course of an afternoon's walk. For instance, let them suppose an attack to be in progress over the country through which they are walking against an imaginary enemy in position. The infantry officer will describe what his men are doing and the positions that have been reached.

The Sapper may then say, "In that case I shall get to work there." The infantry soldier may reply that this would be useless, since, if the troops were driven back, they would be forced to retire in another direction. The gunner might then point out that the place is a dangerous salient, with reference to the probable position of the enemy's guns, and would be untenable, and so on.

In this way discussions will arise which may be of great value to each, although none of the three has much knowledge or experience. The proverb about the "blind leading the blind" is a hindrance to education if taken to be literally true. Three blind men will get on better together than one will by himself, if each of them knows *something* of the road.

In the preceding pages, only the battlefield duties of Royal Engineers have been considered. Their other duties—in connection with camps, improvement and upkeep of communications, and so forth—are of relatively less importance. They are moreover more akin, both in principle and detail, to work with which a large proportion of the *personnel* will no doubt be familiar in civil life.

Another point to be remembered in connection with this class of work is that a great deal, which is carried out by the regular Sapper, may be left to units of the Territorial Force to do for themselves, since there will be a large number of men in the ranks with a knowledge of trades.

Speaking of the Territorial Force generally, it seems to the writer that the time officially available for training is necessarily so limited that every opportunity should be seized to supplement it. The Force must become part of the National life if it is to be a success, *e.g.*, it should be impossible for a sergeant in the Territorial Force to find himself junior to a private in his corps in the workshop.

As regards officers, the formation of officers' clubs at each divisional headquarters would do a great deal to foster the acquisition of military knowledge by stimulating the informal discussion of military subjects between officers of different arms. Why should not some of our rich men, who are not in a position to take commissions themselves, come forward and supply the wherewithal to start these ?

The Territorial Force is a new institution with its traditions to make. The Regular Army has suffered much in the past from the idea that it is not good form to "talk shop" when officers meet for social intercourse. It is to be hoped that the officers of the Territorial Force will not fall into the same error.

Finally, there is a great *rôle** for the Royal Engineers on the modern battlefield, but they will never play it as it should be played if they are content to "plough a lonely furrow" during peace, a mistake which the Engineers of more armies than one have made in the past.

* *Note.*—An article entitled "The Fourth Arm," by the late Colonel Mark Bell, V.C., C.B., A.D.C., which appeared in the *Journal of the R.U.S.I.* for December, 1897, should be read by all who are interested in this subject.

SECTION-CLOSING APPARATUS ON A SINGLE LINE OF RAILWAY.

By Lieut. G. C. V. Fenton, R.E.

A system of closing intermediate block signal cabins on a single line of railway has been invented by Messrs. McKenzie & Holland, Ltd., and one of their installations is in use on the Cambrian Railway.

There are three block signal cabins, Talyllyn, Treifeinon, and Talgarth, and of these the second is kept open only during certain parts of the day, when the traffic is very heavy and this station is required as a crossing station. The general working of the single line is by Tyler's electric-train tablet block system, and the three stations mentioned above are equipped as ordinary tablet stations, and are also crossing stations for trains. At Talyllyn and Talgarth extra and special instruments, which will be described later on, are installed, and these make it possible at night, or with light traffic, to close Treifeinon, and to work one long section between Talyllyn and Talgarth, with a "through" tablet taken from one of these special instruments, ignoring the intermediate station altogether. A special arrangement has to be made in case any shunting is required at Treifeinon during the time the signal box at that station is closed. In order that perfect safety may be ensured it is essential that it is impossible for a "through" tablet to be withdrawn from either of the long-section tablet instruments while a "short-section" tablet is out from any of the instruments which refer to the short or intermediate sections between Talyllyn and Talgarth. Similarly, when it is required to return to the short-section working, it is essential that all the "through" tablets be returned to their proper instruments, before any tablets can be withdrawn from the ordinary tablet instruments.

At Treifeinon, when it is required to shut the tablet station, the crossing loop has to be shut, and the points set for running on one line only, and also all the signals pulled off for "line clear" in both directions, and special arrangements have to be made to overcome the interlocking in the lever frame to enable this to be done. For this purpose a special lever, which is illustrated in *Fig.* 1, is provided. When this lever is in the normal position, all the points and signals are so arranged and interlocked, so as the station can be used and worked as an ordinary crossing tablet block post, and the one key, called the "short key," can be removed from the double key lock shown at the base of the lever, and when this key is so removed, the

lever cannot be moved from the "normal" position. To enable the lever to be moved to the middle position, it is necessary to unlock this by inserting and turning the short key, and the whole can then be moved in the usual manner to the middle position. This pulling over of the lever to the middle position removes the interlocking and enables the signalman to set the points for through

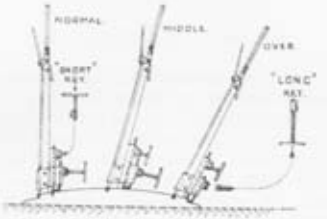


FIG. 1.

running on the single line, to cut out the loop line, and to pull off the home, starting, and distant signals in both directions. As soon as this has been done, and all the operations are complete, the lever can be pulled to the "over" position, and the other key—which is called the "long key"—can be turned and removed from the lock, and when this key is so removed, the lever is locked in the "over" position.

A switching-out instrument, shown in *Fig. 2*, is provided at Treifeinon to receive these keys when they are removed from the lever frame.

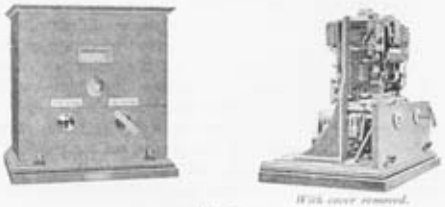


FIG. 2.

When the "short key" is in the electrical instrument and turned in the left-hand keyhole, the two ordinary tablet instruments are in working between the station and Talyllyn and Talgarth, and the word "disconnected" appears in the upper space. The removal of the "short key" from this instrument disconnects the ordinary tablet

Fig 1 & 2

instruments, and the insertion of the "long key" connects the special tablet instruments between Talyllyn and Talgarth, and thus switches out Treifeinon. As will be described in the method of working, no switching in or out of Treifeinon can take place without the co-operation and consent of the signalmen at Talyllyn and Talgarth, and when any tablet is out of any of the instruments in either method of working, it is impossible to withdraw the "short key" or "long key" from the instrument.

A switch instrument is also provided at both Talyllyn and Talgarth, as illustrated in *Fig.* 3. A brass handle is provided, as shown, with an

FIG. 3.

arrow on the face of it. When working with Treifeinon, this arrow points to the left-hand label, which is marked "short section," but when the intermediate station is switched out the handle is turned until the arrow points to the right-hand label, marked "long section."

Method of Working.—Considering first the ordinary working in progress—in this case the "short key" will be in the Treifeinon switching-out instrument. It is required to close Treifeinon and to work with the long-section instruments between Talyllyn and Talgarth. As soon as the signalman at Treifeinon has received the "train-out-of-section" signal for the last train that is to work over the short sections, he asks the signalmen at Talyllyn and Talgarth by telephone if they are ready to close his station, and, having received their consent, turns the "short key" in the instrument as far as it will go, and then asks them to press the plungers on their ordinary tablet instruments. When this has been done, a small disc, marked "lock off," appears at the central round indicator window in the switching-out instrument. This indicator can be plainly seen in the diagram (*Fig.* 2). As soon as the indicator shows "lock off" the short key can be removed from the switching-out instrument. Unless all the tablet instruments connected with the short sections are normal in all three signal boxes, it will be found impossible to remove the lock from the "short key," and as no train is allowed in a section without a tablet, it ensures there are no trains between Talyllyn and Talgarth when the signal box at Treifeinon is to be closed. When the "short key" is removed from the electrical instrument, all the tablet instruments are disconnected, and hence no tablet can be removed.

The "short key" is then used to unlock the special lever, as already

described, and enables the signalman to set the points and signals, and to remove the "long key" from the lock on the lever. The "long key" is then placed in its proper keyhole in the switching-out instrument, turned as far as it will go, and is locked in by so doing.

Each of the end switches at Talyllyn and Talgarth are provided with a small key, or "tapper," as it is termed, and the "switching-out" instrument at Treifeinon has two "tappers," all of which can be clearly seen at the bottom of the fronts of each instrument in *Figs. 2* and 3. When the signalman at Treifeinon has inserted the "long key" in his instrument, he asks the signalmen at Talyllyn and Talgarth to hold down the tappers of their end switches, and he himself depresses both the tappers on his switching-out instrument, and this indicates "lock off" on the end switches. On seeing this indication the signalmen at Talyllyn and Talgarth turn their switches from "short section" to "long section," and then press the plungers on their long-section tablet instruments. This causes the indicator on the switching-out instrument to change from "disconnected" to "connected," and on seeing this the signalman at Treifeinon may shut up his signal box, as the closing is effected. "Through" working can now take place between Talyllyn and Talgarth. A picture of the long-section tablet instruments is shown in *Fig. 4*.

With cover removed.

FIG. 4.

These long-section tablet instruments are made to work with square tablets instead of the ordinary round ones, so that there will be no chance of confusing them, and they are also a clear indication to the engine driver to which section they refer and how far he is free to go without changing his tablets.

So long as a square tablet is out of either of the tablet instruments, it is impossible to remove the "long key" at Treifeinon by any means whatever, and hence it is evident that, until the section between Talyllyn and Talgarth is clear of trains, no alteration can take place in the position of the points and signals at Treifeinon, by the levers in the signal box. Hence it is necessary to provide special

FIG 4

provisions for shunting at that station while it is closed, to avoid delay in putting off a wagon at Talyllyn loaded with goods for Treifeinon and bringing it on by a later train after the station is re-opened. This is arranged by a special toggle gear and ground frame, shown in *Fig.* 5. The siding points—which it is necessary to work for shunting purposes—are fitted with this patent toggle gear, which is shown in *Fig.* 5 in the three positions. Position A is when the points lie normal; position B shows how the points are operated from the ground frame independent of the signal box; position C

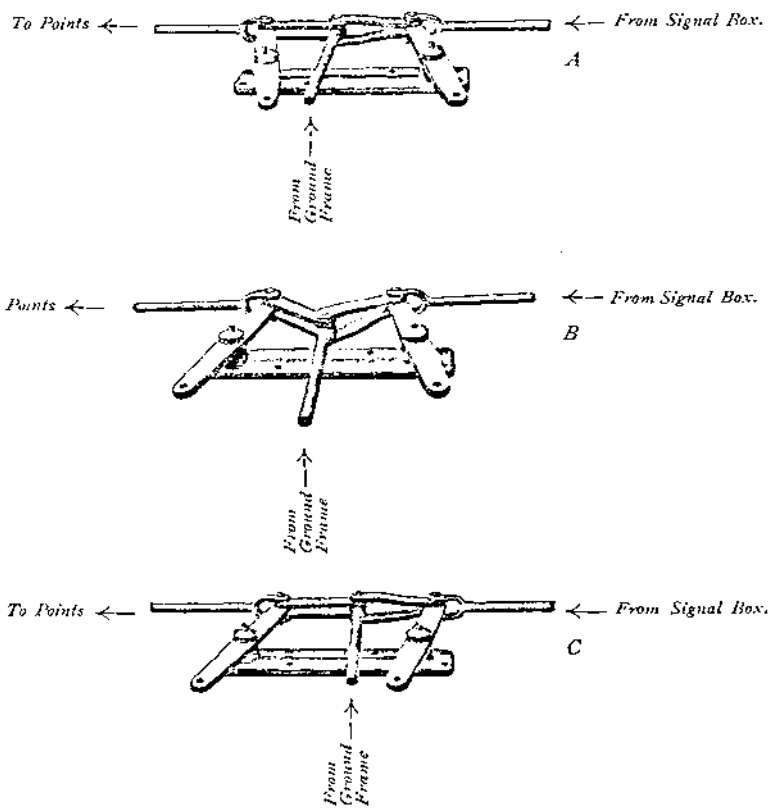


FIG. 5.

shows the points operated from the signal box direct. The ground frame contains three levers (or more, if necessary), and is fitted with a lock which can only be released by inserting into it the square tablet carried by the driver of the train on the long section. When this tablet is so placed in the lock, the levers are free to be worked from the ground frame, independent of the signal-box levers; but before the tablet can be withdrawn from the lock all the levers must be returned to their normal position in the ground frame, and this ensures all the points being properly set for the through road

before the driver can proceed with his train on its journey. In a similar manner to the working of the ground frame independently of the signal box, the connections between the ground frame and the toggle gear are so arranged, that the points can be worked from the signal box in the ordinary way when it is open, without any extra connections or disconnections being made.

When it is required to re-open Treifeinon, the signalman at that station asks the signalmen at Talyllyn and Talgarth by telephone if they are ready to open the short sections. On receiving an affirmative reply, he turns his "long key" in his switching-out instrument as far as it will go and asks the other signalmen to press the plungers on their long-section tablet instruments; this causes the indicator at his station to show "lock off," and he is enabled to withdraw the key from the instrument. He then inserts it in his lever in the locking frame, pushes it over to the middle position, replaces all his levers in the normal position, pushes his special lever over to the normal position, and locks it by the "short key." He next withdraws that key, which he inserts in his switching-out instrument in its proper key-hole and turns it as far as possible. Finally, he asks the signalmen at Talyllyn and Talgarth to hold down the tappers of their end switch instruments, and he himself holds down those on his switching-out instrument. When this has been done, the indicators on the end switches show "lock off" and the signalmen turn the handles on these instruments from "long section" to "short section," and press the plungers on their ordinary tablet instruments. This causes the indicator on the switching-out instrument at Treifeinon to change to "disconnected," and the short-section tablet instruments are now in working order.

A very similar apparatus is provided to work on single lines of railway worked by the electric train staff, the long section being worked by the tablet instruments as described, while the ordinary electric-train staff working is used for the short sections.

The special feature of this installation is that the extra instruments do not require any additional wires, but can be fitted up on the same line wire as is used for the short-section tablet instruments.

The time taken in opening and closing Treifeinon signal box is at the most a matter of two minutes.

When required, the makers can arrange to fit the locking keys direct on to the lever frame, but the separate lever, illustrated in *Fig.* 1, is considered the most suitable arrangement when there is space for an additional lever in the frame.

A similar arrangement can be constructed to enable two or more intermediate stations to be closed if required.

The information in this paper, and the diagrams and plates illustrating the same, are given by the courtesy of Messrs. McKenzie & Holland, Ltd.

MEMOIR.

THE LATE COLONEL GODFREY HILDEBRAND, R.E.

By Colonel W. L. Greenstreet, late R.E.

On the 27th of last March, there suddenly passed away at his residence at Hartley Court near Longfield in Kent, Colonel Godfrey Hildebrand, Retired List, R.E., who in a quiet unostentatious way had done a large amount of highly useful work for his Queen and country.

The Hildebrand family has been connected with the Army for about a century and a-half, the great-grandfather of the subject of this memoir having come to England from Saxony in 1763, in order to take up an appointment in connection with a cavalry regiment known as King George's Black Horse. His grandfather also served in both the Essex and Sussex Fencibles, whilst his father, the Rev. J. B. Hildebrand, had, as a young man, held a commission as ensign in the 35th Foot, and as such was present at the Battle of Waterloo, for which he received the Waterloo medal.

Godfrey Hildebrand was born at Kibworth on October 18th, 1844, his father being at the time Headmaster of Kibworth Grammar School. His mother was the daughter of Capt. David Ross, R.N., who had been a shipmate of William IV., and who was provided by the Sailor King with a lucrative appointment at Deal, and, upon his death, with a tablet to perpetuate his memory in old Deal Church.

After being educated at Marlborough—where he was sent in 1859 and where he gained various prizes, and became, before he left, Captain of the Modern School, a Prefect, and, in 1861, Modern School Scholar—Hildebrand passed direct into the R.M.A., Woolwich, at the winter examination of 1861, joining at Woolwich in February, 1862.

Both at Marlborough and at Woolwich he was a member of the first cricket eleven, and at Marlborough he was also one of the football 20. This did not however interfere with his work, and in 1864 he passed out high up, obtaining his commission in the R.E. on his 20th birthday in 1864.

After leaving Chatham he was posted to Aldershot, where he remained for about nine months, and whilst there—on the 26th September, 1867—he married Margaret, daughter of William Lake,

Esq., of Gravesend, and in the following December sailed with his wife for India, being posted, on arrival there, to Roorkee. By this time his character was probably pretty well formed, and it changed but little in after years. Combined with a high sense of duty, great straightforwardness and manliness of character, and the gift of a strong practical common sense, there was considerable intolerance of anything of the nature of bombast, unreality, or folly, together with a power of satirical expression, which made him somewhat feared by those of his contemporaries who did not know him well; and amongst those, who both knew and valued his high mental and moral qualities and his kindness of heart, gained for him a friendly soubriquet indicative of his power of applying a moral sinapism to what he thought the errors of his associates. A good example of his kindness of heart, is shown in the hospitality with which both he and his wife received the writer of this memoir and his wife on their arrival at Roorkee two years after Hildebrand had first been posted there. Not only did they rescue them from the discomforts of the Dak Bungalow, but they also hospitably entertained them until they could get properly settled.

Hildebrand was at this time an Assistant Engineer in the Saharanpore Division of the Buildings and Roads Branch of the P.W.D., having charge of various buildings and many miles of road. In the inspection of these the writer sometimes accompanied him, and was surprised at the fluency with which he conversed with the natives and the grip which he had obtained of the details of the work during the short time he had been employed upon it.

That his immediate superiors held a like view of his capacity is evidenced by their employing him at the end of 1870 to make a survey for a railway line to Roorkee, a work which was most successfully carried out, although entirely out of the line of his previous employment, and when the line was subsequently constructed by the railway engineers, they adopted Hildebrand's route with only slight alterations.

In 1872 Hildebrand was posted to the Military Works Department, and placed in charge of the Chakrata Road Division, with the duty of constructing a new military road from Saharanpore to Kalsi, at the foot of the hills, a distance of about 51 miles; and subsequently the 25 miles of partially completed hill road from Kalsi to Chakrata were added to his charge. It was an important and difficult work, involving the bridging of the Ason River and innumerable smaller streams both in the hills and the Terai, as well as the alignment and construction of a road through the Siwalic range of hills. The bridge over the river Ason, costing about $1\frac{3}{4}$ lakhs of rupees, was a fine and important work, and one of considerable difficulty, as the river is liable to sudden high floods, for which provision had to be made. The bridge consists of 10 brick arches of 50′ span, to cross the

main channel of the river, and a subsidiary bridge of timber to cross a second channel 100′ wide; and various difficulties regarding the soil and the influx of water into the foundations, which it was necessary to carry to a considerable depth, had to be met and overcome.

Hildebrand remained in charge of the Chakrata road till 1876, when, on the practical completion of the work, he received the thanks of Government and a step of departmental promotion, and went home on furlough.

On his return to India in November, 1877, he was placed in charge of the Umballa Division Military Works, and there too had a special work of considerable importance to carry out, viz., the water supply of the Umballa Cantonment.

He obtained his Captaincy in the Royal Engineers in December, 1877, having already been a local captain for more than a year.

Early in 1881 Capt. Hildebrand joined the Staff of the Inspector-General Military Works as Secretary of the Defence Committee, thus beginning the special fortification work with which during the rest of his service he was chiefly associated. He held this appointment till March, 1882, when he returned to England, and subsequently commanded the 12th (Depôt) Company at Chatham for a year, being then given some special duty to perform under the War Office till March, 1887. Hildebrand had been promoted Major in October, 1884, and on his return to India in 1887 he was posted to Beluchistan as Superintending Engineer. Here however he only remained till the autumn, when he was again required on the Staff of the Inspector-General Military Works for defence works, on which he was employed till he finally left India in 1891.

His services at this time were as valuable and important as they were arduous, as he had practical charge of the reorganization of the defences of India—both inland and coast—at a time when the importance of the work had come to be thoroughly recognized.

Amongst the defence schemes which passed through his hands, and on which he had to advise the Defence Committee, was that for Quetta, of which he entered carefully into all the details both of design and construction; also the remodelling of the defences of Bombay, Calcutta, and Rangoon; the defences of the Sukkur Bridge, commenced in 1889 and completed in 1891, and the defences of Rawal Pindi, Sher Shah, and Attock. Moreover, in addition to these larger works, the designs for numerous defencible posts in cantonments, and the defence of large and important bridges came under his review, and required his careful consideration as advising officer.

All these matters necessarily involved not only heavy and constant office work, but also a very large amount of travelling from one part of India to another.

As some of these works were in charge of the writer, it may not be out of place to mention how frequently he was impressed by

Hildebrand's quickness—when visiting and inspecting the work—in grasping the points of a situation and in deciding upon the best way to deal with it, and also by the accuracy of the memoranda about it which subsequently came from his office, although he took nothing but mental notes, trusting to a strong and accurate memory, which never seemed to fail him.

Major Hildebrand became Lieut.-Colonel in 1891, and on his reversion to home service the same year, was appointed C.R.E., Newcastle-upon-Tyne Sub-District, where he remained till the end of June, 1894, being chiefly employed on work connected with the re-armament of the Northern Defences.

From July, 1894, to the end of 1896, Colonel Hildebrand held the appointment of Assistant I.G.F. at the War Office, and after being placed on half-pay for nearly a year, was appointed D.I.G.F. in August, 1897, a post which he held for nearly five years, *i.e.*, till the end of May, 1902, when he retired from the Service, having been promoted substantive Colonel in November, 1897.

Colonel G. Hildebrand's work at the War Office, which was principally connected with defences, and especially the re-armament of the coast defences, is pronounced by the officers under whom he served as having been in every respect excellent, and one of the most distinguished of them comments upon the prompt action and willingness to accept responsibility which lay behind his quiet manner, and the able way in which the entire business of his office was carried out. For his valuable services at the War Office he received a Distinguished Service Pension.

In the year 1906 Colonel Hildebrand was appointed one of the Directors of the Army and Navy Co-operative Society, and regularly attended the meetings of the Board, having been present at one of their meetings only two days before his sudden death. At the last annual meeting of the Society, the Chairman, Lord Ebury, referred to his loss as follows :—

"Since the financial year expired, no longer indeed than a month ago, we have had to deplore the painfully sudden death of our colleague, Colonel Godfrey Hildebrand. Although he was the latest addition to our Board, he had long established a firm hold upon our regard by the soundness of his judgment and the urbanity of his disposition."

The deceased officer was one of a family of 15, of whom six have done good service for their country in India, four of them in the Army. He leaves a daughter and several sons, two of whom are in the Army, one being a member of his father's Corps.

Colonel Hildebrand, who was a loyal member of the Church of England, and took great interest in his Parish Church and its work, was buried on the 31st March, 1909, in the churchyard of Hartley Church, in a quiet and beautiful spot close beside the home in which he had been living for the last few years.

TRANSCRIPT.

THE FIELD TRAMWAY OF THE RUSSIAN 2ND ARMY AT HSIPINGAI.

Epitome of an article by Lieut. Freigang in the September, 1907, number of the *Eenzhenernee Zhoornal.*

DURING the latter part of the Russo-Japanese War, when the Russian troops, after Mukden, took up the main defensive position at Hsipingai, they made considerable use of field narrow-gauge tramways. Each of the three armies had a separate line which served its own particular area, and proved of great value for the transport of stores, the rapid evacuation of sick and wounded, and to some extent for the carriage of passengers.

For supplying the three armies with railway material, rolling stock and other equipment, a special depôt for light railways was established at Tsitsikar. Here the stores were brought direct from Russia and were issued on requisition to the officers in charge of the respective tramways.

The material and rolling stock for each of the three lines was identical, and in each case horse traction was used, but in the case of the 1st and 3rd Armies there was not the same urgency as in the construction of the 2nd Army line, and this latter was also much less costly than the others, because in its construction the troops were assisted neither by railway troops nor by Chinese hired labour, and also because no special assignment of horses was made for traffic purposes, but ordinary transport units belonging to the army were detailed for this duty. For these reasons especial interest attaches to the details of the construction and working of the 2nd Army line, which form the subject of this article.

In July, 1905, with the object of securing regular transport of stores for the 2nd Army, it was decided to construct a narrow-gauge tramline from Siding No. 84,* on the East China Railway, to the town of Maimaikai, and if possible to continue it towards the right flank of the Hsipingai position, as far as the village Lamatenza. The line would thus pass along the rear of the whole position of the 2nd Army, connecting points which were about 20 miles apart. In Maimaikai there were concentrated the Staff, the headquarters of various departments, and also extensive Supply Depôts.

On the 28th July the order was given to carry out a reconnaissance of the proposed line, and four days later a survey party of 14 rank and

* The 2nd Army occupied the area lying immediately west of the East China Railway.

file under a specially detailed officer, Capt. Fetting, began this work, which took only two days, and on the 3rd August they had carried the reconnaissance to the western gates of Maimaikai. Taking the shortest practicable route, the distance covered was 10½ miles. The axis of the line was marked by 160 pickets, placed at intervals of 117 yards (50 sazhens). In spite of every effort having been taken to make circuits of hills and nullahs, this section was a very difficult one, requiring six bridges across dry nullahs, and the grading of one descent and three ascents, of which one, in the third verst, was double the normal slope. The ground was clay and in places very swampy.

Owing to delay in obtaining the necessary stores from Tsitsikar, work could not be commenced before the 16th August.

The permanent way consisted of steel rails and steel box sleepers of the Dolberg system; two rails and two sleepers were joined together to form one link, which was either straight or curved. The links were of three sizes, 1½ mètres, 2½ mètres, and the so-called normal of ·75 mètre. Shorter lengths were also issued for use in crossings, switches, etc. The rails were fastened to the sleepers by means of rivets, passing through the foot of the rail and the sleeper.

The rails of each link were fitted at one end with hooks and at the other with buttons, in each case attached to the outer side of the flanges. The links were joined together by passing the hooks of one link underneath the buttons of the succeeding link. The gauge was ·7 mètre, weight per foot of the links 22½ lbs., and height of rails 80 mms.

The cross-over ways consisted of (i.) ready-made crosses and (ii.) special switch links, the points being worked by hand. In the centre of the cross was an open space where both rails were disconnected, and herein the writer notes a fault in construction; when trolleys were travelling rapidly the wheels passed over the space safely, but with slow motion, and if the horses were pulling unevenly, it was the cause of many derailments. It is recommended that a short piece of hinged rail in the centre of the cross would be an improvement.

For rolling stock there were trolleys of two systems:—Debal and Putilov. These arrived in pieces and were put together on the spot by squads specially detailed. They consisted of iron frames decked with longitudinal planks, and fitted with low sides and 12 vertical stanchions. At both ends were small platforms, to one of which was fitted the break. The frames rested on freely moving bogies, each with four solid wheels of 12″ or 15″ diameter. The breaks were of special design, working with chains and shoes.

The difference between the Debal and the Putilov trolleys was that in the latter the uprights were of wood and in the former of iron, which made these trolleys heavier, but incomparably stronger. The Putilov break chains were better welded.

The trolley platforms measured 14′ by 4$\frac{11}{12}$′. The carrying strength of each trolley was given as 38½ cwts., but in practice it was limited to 32 cwts. (100 poods). For attaching the horses on each side of the trolley were four hooks, to which the chains of the splinter-bars were fastened by means of pins. On the splinter-bars were traces which hooked

on to hames on the horses, and hames were also connected to the front side stanchions of the trolley. Each trolley was drawn by two horses, one on each side, this arrangement being considerably more convenient than if the horses were in front. The breakmen stood on the front platforms and the drivers on the back; occasionally one man performed both duties, but this proved to be inconvenient, leading to many collisions and derailments. On portions of the line at ground level derailments caused little harm, even if the trucks were travelling rapidly, as the wheels sunk into the earth, which acted as a brake.

In addition to the permanent way and rolling stock there were received from the depôt at Tsitsikar a complete telephone equipment for maintaining communications on the projected line of 20 miles, complete sets of carpenters', joiners', fitters', painters', and blacksmiths' tools for use in the park, also railway tools for making and repairing the line, stores necessary for equipping stations, lighting and oiling materials, and also books and forms for use of the future railway service. All of this was stored in special trucks at Siding No. 84, where a new broad-gauge siding was made especially for use of the construction parties of the narrow-gauge line.

It having been decided to construct the line entirely by military working parties, on the 21st August the G.O.C., 2nd Army, sent four battalions to the scene of the work. These battalions were distributed along the interval between Siding No. 84 and Maimaikai, and were billeted in the nearest villages.

The total distance of 16 versts was divided into four sections, each of four versts or 40 pickets. From the 12th and 6th East Siberian Sapper Battalions, parties, each of 1 officer and 10 men, were allotted to these sections as superintendents and instructors, and a separate party, consisting of the 13th Company of the 6th Rifle Regiment, with 16 Sappers was allotted to the park for unloading trucks on the broad gauge, fitting together the trolleys, and dealing with all stores as they were unloaded.

The first section (pickets 1 to 40) was considerably greater than any of the others, as it included all the terminus and park lines, and consequently, at first, only the main line and a few necessary sidings were constructed.

The following is a general description of the work:—

(1). The formation of the road. As a firm foundation was necessary, first of all drains were cut on both sides of the picket line along the whole length. These drains were 14′ apart, and each was $2\frac{1}{2}$′ wide at the top; in depth they varied up to about $3\frac{1}{2}$′. If the excavated earth was dry enough it was thrown on the road and well rammed until it was firmly settled.

In very moist places sand was used as ballast, which was fetched from the banks of the river Sancha-ho, at about $1\frac{1}{4}$ miles from Siding No. 84. If ramming and ballast failed to keep down the subsoil water, cross drains were cut and wooden pipes laid under the road, causeways were built up with brushwood, or the road was built up with planks placed both longitudinally and across the line, the paths on the sides for the horses

being also made of planks. It was only in the first section that the swampy nature of the ground made this work necessary; in the others it was found sufficient merely to ram the earth thrown up from the side ditches.

(2). Simultaneously with this work the inclines were graded. Of the three ascents and one descent, all required quite an insignificant amount of work except the ascent in the third verst from Siding No. 84, which required such a large quantity of work that it was eventually decided to re-align the road, making a kind of zigzag.

(3). The permanent way was then laid on the completed roadway. The links were brought up on trains of trolleys. The line was laid by a special party of infantry, with a small detachment of Sappers, under an officer, at the head. If the side drains had not yet been cut, a man was sent ahead to the next picket to mark the line. Otherwise this was shown by the drains. Each man of the construction party moving in file carried a link from trolley to railhead, laid it, and then returned to the trolley on the other side of the line. The method practised in the first section of laying the rails before the side drains had been completed was soon found to be inconvenient.

(4). After the construction party there followed another whose work it was to straighten and level up the links, and ram the earth or ballast under the sleepers with wooden rammers.

(5). While this was going on the construction of bridges and level crossings was carried out. The crossings were 14 yards in width and were made of seven, or in places liable to specially heavy traffic of nine, planks laid longitudinally along the line. Of the bridges, the shorter ones were supported simply on beams laid across the gaps, but the longer bridges were made with trestles or piles. Two pile bridges, made near Maimaikai, were on the retirement of the Russians handed over to the Chinese authorities.

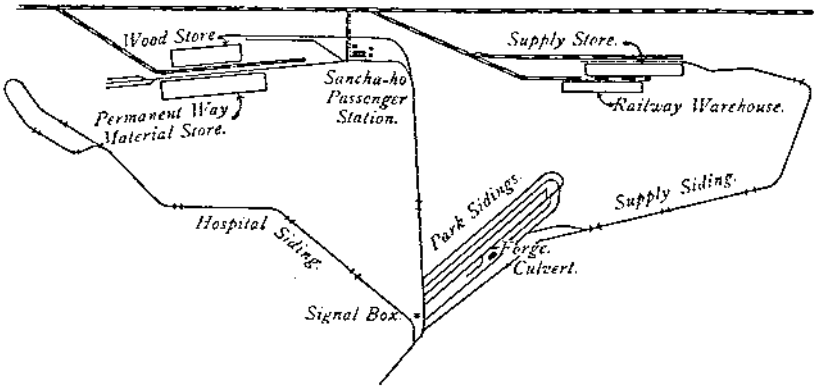
(6). In addition to the work already mentioned, it remained to construct the station buildings, wagon-sheds, goods-shed, forge, signal-boxes, dug-out shelters for the troops employed on the line, and, lastly, the telephone lines, of all of which further mention will be made later on in the details of the construction and working of the line.

On the 22nd August work was begun in laying the station and park lines. First of all a line was laid from the broad-gauge siding to the place decided on for the starting and arrival points, and two sidings for marshalling the trolleys loaded with the permanent-way stores for the main line. On the same day the officers in charge of the other three sections inspected their sections with a view to deciding how their work should be organized.

On this day also, by order of the Commander of Communications of the 2nd Army, the 38th Cart Transport unit arrived at Siding No. 84 with 2 officers, 156 rank and file, and 565 horses, detailed for hauling the construction trains loaded with timber and railway stores. There also arrived one company of the 54th Minski Regiment, in strength 2 officers and 128 rank and file, which formed the advanced party of a Traffic Battalion, which was to be formed of detachments from all the corps of the Army. This Traffic Battalion was destined to supply (i.) breakmen

for the trolleys, (ii.) maintenance gangs, (iii.) working parties for work in the park, and (iv.) men for guard duties, in conjunction with the 13th Company of the 6th Rifle Regiment.

Siding No. 84, E. China Railway.



The head office of the line was formed considerably later, but in these first days, by the force of necessity, an improvised office was formed at Siding No. 84 for carrying out the necessary correspondence with troops and departments, for publishing orders for the following days' work, detailing working parties and notifying changes in *personnel*.

On the 23rd August the station lines from Siding No. 84 as far as the arrival points were completed, the new narrow-gauge station being named Sancha-ho, and also four park sidings, each about 600 yards in length, while the main line was carried forward to the bridge over the Sancha-ho, a distance of about 2 versts ($1\frac{1}{3}$ miles), and the excavation of the side drains proceeded steadily. That the construction did not proceed more rapidly was due to the fact that neither men nor animals were as yet accustomed to the work. As the natural ground was found to be unsuitable for carrying the line, a special carrier was arranged for drawing sand from the bed of the river to act as ballast.

On the 24th August a small bridge $15\frac{3}{4}'$ in length was built, and the line was laid as far as picket No. 40, *i.e.*, to the end of the first section. In order not to delay the trains carrying rails and ballast, most of the timber for the bridges was sent on ahead in Chinese carts, by unmetalled roads. This arrangement was carried out throughout the construction of the line.

On the 25th the line reached picket No. 60, while the roadway was completed as far as Maimaikai, and all the men thus set free were put to work on the bridges throughout the whole line.

Meanwhile railway stores continued to pour in at Sancha-ho, and as the trolleys were put together by the park working parties, more sidings had to be constructed to accommodate them.

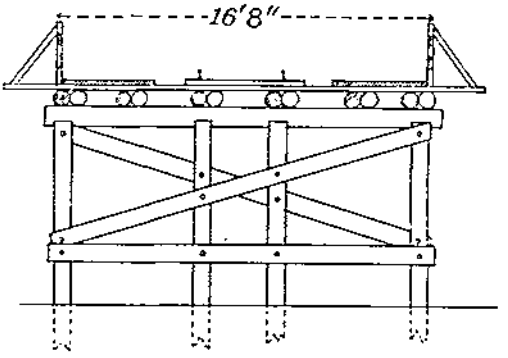
On the 26th August the line reached the end of the second section, and a siding about 470 yards in length was laid at "Siding No. 1," a point about half-way between Sancha-ho and Maimaikai. In the first section the line was levelled and rammed and the level crossings laid down,

which last were found to be urgently necessary, as cross traffic was already beginning to damage the permanent way.

By this date the numbers of the Traffic Battalion had been made up by detachments of weak and otherwise unfit men to 489, and these were formed into three companies for work on the line. The establishment of officers included four infantry officers as battalion staff and three company commanders. These troops forthwith commenced their duties as breakmen and maintenance gangs.

By this time the Commander of the Army had decided that the line should not stop at Maimaikai, but should be carried on as far as Lamatenza for the conveyance of supplies and sick of the three corps stationed to the west and south-west of that village. On the 26th August a party consisting of one officer and six men began the reconnaissance of this section and completed it in three days.

On the 27th August the work of levelling and ramming was carried forward in the second section, and the permanent way was laid as far as picket 100. Here the work had to stop for a time for want of material, which was due partly to the fact that the Tsitsikar depôt was busy with the equipment of the lines of the 1st and 3rd Armies, and partly that the proportion (30 per cent.) of curved links supplied had largely exceeded local requirements. This pause gave an opportunity of energetically pressing forward the work on the bridges, and during this period the following bridges were made:—No. 3, 21′ in length, near the proposed Maimaikai Station; No. 4, a temporary trestle bridge, 22′ in length, near the south gate of the town, and a permanent pile bridge 7.4′ in length at the south-west angle. At the same time the ascent in the third verst was made easier, as it was found that with fully-loaded trolleys it was difficult to surmount.



Section, Pile Bridge.

In Sancha-ho station during this period the station and park lines were finally arranged and completed, and the construction of goods-shed, wagon-shed, stable, forge, signal-boxes, and various necessary buildings was begun. All these were completed in three to five days, except the goods-shed, which was still unfinished on the 10th September. These buildings were very simple huts, built entirely of wood and roofed with planks.

As large working parties were no longer required, on the 29th August two battalions were sent to rejoin their commands.

About this time various officers with special technical knowledge of the work began to arrive from various regiments, and were gradually allotted to the duties of maintenance, traffic, and park.

On the 30th August a fresh consignment of material arrived and was unloaded, and on the 31st the line was completed up to Maimaikai Station, 12 versts (8 miles) from Sancha-ho. Here a siding, 350 yards long, was laid, and a little further on a branch was carried to the chief supply depôt, which was situated inside the town. By evening of this day the line had arrived at the southern gate.

From the 1st September the work was divided into two groups, (i.) the completion of the line up to the west gate and (ii.) the construction of the new line from there to Lamatenza.

The new line, in length nearly 11½ miles, was marked by 173 pickets and divided into two sections. Each section was placed in charge of a Sapper officer, with one technically qualified officer to help him. Four battalions from the nearest army corps were detailed as working parties and were distributed among the sections and billeted in the nearest villages. Each section was also given 15 Sapper instructors. The character of the ground was most favourable; the line ran along a plain, and only in five places was it necessary to throw small simple bridges across shallow nullahs.

On the 1st September the permanent way of the original line was completed and a pile bridge was begun, to take the place of the trestle bridge, across the wide dry ravine near the southern gate, in length 74½′.

On the new line work began in the formation of the roadway, and, by the light of previous experience, the breadth was increased from 14′ to 17½′, and the ditches were made wider and deeper.

On the 2nd September this work continued, while on the original line traffic was opened for supply loads, with the stipulation that it should not interfere with the construction of level crossings and of the station works at Siding No. 1 and Maimaikai. The line to Maimaikai was connected throughout by telephone, but at first only two telephone stations were opened—at Sancha-ho and the Supply Depôt.

On this day three maintenance gangs were formed from Sappers and the men of the Traffic Battalion, and stationed at Sancha-ho, Siding No. 1, and Maimaikai. Each gang consisted of a road master, two gangers, two skilled labourers, and 13 unskilled labourers. The road masters, gangers, and skilled labourers were Sappers, and the remainder infantry. The gangs were made responsible for keeping the line in repair, *i.e.*, levelling, packing, replacing links, and inspection of crossings and bridges. Each gang was equipped with picks, shovels, spanners, and other railway tools.

Regular passenger and goods traffic began on the line as far as Maimaikai on the 5th September, and for this a time-table was drawn up, in accordance with which two pairs of goods trains and one pair of passenger trains were despatched from each end of the line daily, the passenger trains being timed to coincide with the passenger trains on the broad gauge.

The service of the line was managed by two experienced officers who acted as traffic superintendents, while to each of the three stations and to the Supply Depôt there were assigned, from the Sappers and infantry of the Traffic Battalion, station-masters, assistants, telephonists, and signalmen.

The composition of a goods train was fixed at a maximum of 75 trolleys, and that of a passenger train at one closed carriage and three trolleys for baggage. The carriages were ordinary trolleys covered with tarpaulins and fitted with seats.

At this time the necessity of more transport animals became evident, and a second unit (the 39th) was detailed, consisting of 1 officer, 88 rank and file, and 320 animals. It was posted at Maimaikai and worked towards Sancha-ho.

Meanwhile, on the 5th September the work on the new line which had been stopped by heavy rain started afresh, and passing over two bridges, Nos. 5 and 6, of a total length of 70′, which had already been finished, reached picket No. 106, where it was again stopped for want of material. This having been got over by moving an unnecessary siding from Sancha-ho, the line was carried on into Lamatenza itself.

From the 6th to 9th September three more bridges, Nos. 7, 8, and 9, of total length of 77′, were completed, a siding about 580 yards in length was laid at a projected station, "Siding No. 2," station huts were put up and connected by telephone with the central station Maimaikai, the pile bridge at the southern gate was finished, and the whole line was now ready for traffic. All the construction troops were sent away, and there remained only the Sappers, the Traffic Battalion, and the company of Rifles.

On the 9th September the line was opened with ceremony by the G.O.C. 2nd Army, and on that day there arrived the 1st Company, 3rd Railway Battalion, in strength 3 officers and 140 rank and file, to assist in working the traffic.

On the 10th September the last consignment of stores arrived from Tsitsikar, and a siding about 470 yards in length was laid into the local Supply Depôt at Lamatenza.

The total length of main line was about 21 miles, and of sidings about 4½ miles. About 4 miles of the line was laid on ballast and 1½ miles on planks. There were 12 bridges of an aggregate length of 420′, 60 level crossings, 1 storehouse, 1 wagon shed, 1 stable, 1 forge, 1 cookhouse, and 5 station buildings of various sizes.

During the construction period there were despatched along the line from Sancha-ho 393 trolleys with supply stores, 300 trolleys with construction materials, and 32 trolley-loads of passengers, each drawn by a pair of horses or mules.

As to the cost of the line, out of an allotment of 310,000 roubles, only 27,661 roubles 71 kopeks were spent, owing to the economical methods employed in the work. It should be mentioned that working pay was issued to the troops at the following rates:—Company commanders, 3 roubles per diem; junior officers, 1½ roubles; N.C.O.'s, 50 kopeks; men, 20 kopeks. (1 rouble = 100 kopeks = 3 *shillings* and 2 pence).

Turning now to the arrangements for working the line—in the first

place the head office was carefully organized under Capt. Fetting, the commandant of the line. His staff consisted of an officer in charge, a secretary for office work and correspondence, three clerks, and three draftsmen.

The park was in charge of a railway officer, with a technically-trained officer as his assistant. He had four skilled N.C.O.'s in charge of the following sections:—(i.), Timber; (ii.), permanent-way materials; (iii.); rolling stock; and (iv.), general stores. The working parties detailed from the 13th Company, 6th Rifle Regiment, and from the Traffic Battalion, were divided into gangs for the following services:—Inspectors of trolleys, fitters, carpenters, lubricating hands, smiths and hammermen, and trolley-builders.

The traffic was in charge of a traffic superintending officer, with two officers as assistants, one of whom was responsible for the telephones. The railway company supplied 5 station-masters with 7 assistants, 10 guards for luggage trains with 10 assistants, and 30 breakmen for passenger trains. The breakmen for luggage trains were taken from the Traffic Battalion.

The maintenance service was under the superintendence of a railway officer, with two technical officers as assistants. The line was divided into two sections, and three maintenance gangs were allotted to each of these sections; these gangs were quartered within their own areas, at first in tents, but from the beginning of the cold weather in specially built dug-outs with stoves. The men employed on the traffic service were always in huts, which were built with special view to winter requirements. A battalion of the Zhitomir Regiment was detailed to hold itself in readiness to assist in case of large working parties being required for extraordinary work, but their services were never required.

As the traffic had increased, the 14th and 15th Pack Transport half-units were detailed to work on the line, each with an establishment of 1 officer, 83 rank and file, and 163 animals. The transport units were then disposed as follows:—The 38th and 14th at Sancha-ho, and the 39th and 15th at Maimaikai. The 38th and 39th worked towards Lamatenza with loaded trolleys, and the other units brought back empty trains, the trolleys being linked together in twos and threes.

On the 14th September two new goods sidings were laid, one near Siding No. 1 for the supply park of the 6th East Siberian Corps, and the other to the supply park of the 1st Composite Rifle Corps.

The new time-table was arranged as follows:—For goods traffic there were run three trains daily, Nos. 1, 5, and 7, the first two of 60 trolleys each and the third of 50. No. 1 worked to the stations in the second section (10th Army Corps, the Composite Rifle Corps, and the Composite Cavalry of General Mishchenko); No. 5 worked to Maimaikai exclusively (10th Army Corps, the force of General Gregov, and the Chief Supply Park of the 2nd Army); No. 7 supplied Siding No. 1 (the 6th Siberian Corps). Trains Nos. 2 and 6 were empty return trains. For passenger traffic there were two double trains, Nos. 3 and 4, and Nos. 8 and 9, the first pair going over the whole line and the others only to Maimaikai. The trains crossed at Siding No. 1, and departures and arrivals

synchronized with the trains on the broad gauge. In course of time, as the passengers to Lamatenza increased, a third part of train No. 9 was allowed to go over the whole line. The composition of each passenger train consisted of three covered trolleys, which would accommodate 40 men, and 7 trolleys carrying either baggage or 15 rank and file each. The goods trains travelled at the rate of 2½ to 4 miles per hour, and the passenger trains 5 to 8.

From the 14th September a journal was kept in each station, in which were entered details of every train, showing the number of trucks, horses, and rank and file, and also a register of telephone messages received and sent.

Between the 17th and the 20th September two more sidings were made, one from the Supply Depôt at Maimaikai to the quarters of the Commandant of Communications, and the other, across a newly-made trestle bridge, 25′ in length, which spanned the town ditch, to the headquarters of the army.

The construction of a line past Maimaikai made possible an excellent arrangement for transporting sick and wounded to Siding No. 84 for transfer into the hospital trains. With this object, at a point selected near the south gate of the town, a siding 230 yards in length was laid and a platform erected where the sick could be collected from the neighbouring hospitals and entrained. This was completed by the 21st September, and from this date began a regular service of hospital trains. At first it was intended to transport the sick in the empty return trains, but in view of the possibility of infection and also on account of the approach of winter, it was decided to fit up 40 trolleys specially for this service. This was done by enclosing three sides of each trolley with tarpaulins and placing felt or straw mattresses on the floor. A special hospital train, "No. 4 *bis*," was arranged to travel in rear of No. 4 passenger train.

About this time it was found that the stock of supplies which had been accumulated was sufficient to last for some time, and some of the supply trains were made available for transport of stores for the troops, Red Cross and Officers' Messes. The staff was officially remodelled, extra clerks were detailed, and also an accountant and two surgeons. The latter opened dispensaries and began sanitary inspections of men and buildings.

The line remained open for traffic until the 3rd November, during which time it is calculated that it conveyed 20,000 men, including 4,000 sick, and over 7,000 tons of stores.

The work in the park consisted chiefly of repairs to trolleys and harness. The breaks required considerable repairs owing to the defective welding of chains and the softness of the wood on the shoes. The break-platforms also suffered considerably from collisions. Damaged rails were generally replaced and not repaired, as there was a large reserve of spare links. Carpenters' work included the fittings of passenger and hospital cars, furniture, etc., for stations, offices, and quarters.

The cost of working the line for two months amounted to only 5,149 roubles, out of an allotment of 34,000 roubles.

On the 4th November, in consequence of the departure of the army to the north, the dismantling of the line commenced.

Two infantry battalions were detailed to assist in this work, and were allotted one to the railhead and the other to Siding No. 84. The dismantling was divided into daily tasks of 5 to 6 versts each, and separate parties were told off to dismantle (i.) the line, (ii.) the station buildings, bridges, and level crossings, and (iii.) the telephone line.

As a protection against the Khankhuzes, now that the troops had departed, two sotnias of Orenburg Cossacks were detailed, and these patrolled along the line and to south of it by day and night. By night, infantry outposts and patrols were also posted. The command of the rear guard was entrusted to General Tolmachev.

The method of loading up the permanent way was as follows:—A train was brought up and its trolleys were placed along the line at intervals of 60 links, measuring back from the railhead. All except the head one were lifted off the rails and placed on the side of the line. The links were then dismantled until the first truck was loaded, when it was sent down the line and the next one lifted on the rails and loaded up in its turn, and so on. In this way the whole line was dismantled in seven days, only sufficient sidings being left in Sancha-ho station to accommodate trucks which were required for transferring the stores to the broad-gauge siding.

The work of the battalion stationed at Siding No. 84 included unloading, sorting and loading stores for return to Tsitsikar, and afterwards the dismantling of the trolleys.

After this the men of the Traffic Battalion were gradually returned to their units, and the Railway Company and other corps departed, and finally on the 23rd November a small office staff moved with the commandant to Bukhai station, where the work of making up reports, accounts, etc., was carried out. This was finally completed by the 17th December.

In conclusion, the following points may be mentioned as having been brought out by practical experience in the working of this line:—

(1). These lines may more safely be laid in continuation of, rather than at right angles to, the lines of communication of an army, since, in case of an unexpected retirement, in the former case it is more easy to remove the stores, or at any rate the rolling stock.

(2). Troops liable to be employed on this work in war should be instructed in it in peace time.

(3). The permanent way should be laid at ground level as far as possible, rather than on embankments or in cuttings. It is better to work round slopes than through them. Side drains are of course necessary.

(4). When preparing the surface it should be well rammed.

(5). The use of ballast is only necessary where the ground is swampy.

(6). The best method of carrying the line over marshy ground is on planks. Here the planking need not be continuous, so long as each plank supports at least two adjacent sleepers.

(7). The width between drains should not be less than 17½'.

(8). The earthwork must be completed before the line is laid.

(9). The class of rails used was too light, and consequently the rails frequently became bent and the couplings disconnected. An improved coupling is suggested for the rails, in which, in addition to the hook on the outside of the rail, there should also be a projecting plate on the inside, so that the flange of the succeeding rail should fit between this projecting plate and the hook.

(10). The alteration required in the crossover ways has already been mentioned.

(11). All bridges must have a breadth of roadway of 19¼', and double planking for the horses is obligatory. The road-bearers may be so laid that the links of the permanent way may rest directly on them. In case of large pile bridges, the preparation at first of temporary trestle bridges is necessary, in order to cause no delay to construction of the line.

(12). A combination of the two kinds of trolleys might be designed which would contain the advantages of both. This would include the breaks of the Putilov trucks and the iron standards of the Debal. Wooden standards are invariably stolen for firewood.

(13). Special trucks for carrying long spars should be provided.

(14). An arrangement is suggested by which the horses could more readily be unhitched and reversed. The ends of the splinter-bar could form hooks which would catch rings on the trolleys and be secured to prevent them from falling out.

(15). Special stretchers or mattresses for serious cases of sickness should be provided.

(16). The practice of sending trains in pairs for ordinary traffic is recommended, but in a retirement, when trains are very large and little punctuality is required, it was found best to send them singly.

(17). Trains worked by 30 or more men should be in charge of officers.

(18). In all large stations, where there is much goods and passenger traffic, the station-masters should be officers.

(19). There should be two men to each truck, as the driver cannot manage the break.

(20). All traffic on these lines should be conducted if possible by day. If night work is obligatory, passenger and heavy goods traffic should be reduced to a minimum, and passenger trains should always precede goods trains. Special trains should never be allowed.

(21). A single telephone is sufficient for the whole line, but a central exchange station is obligatory.

(22). A special establishment of horses is not obligatory, but all the transport establishment must be placed directly under the orders of the commandant of the line, both for discipline and supply.

These notes are from 2½ months' experience of working a horse-traction tramway; possibly longer experience might have revealed further requirements.

F. E. G. SKEY.

REVIEWS.

SOME NOTES ON SUB-DRAINAGE AS APPLIED TO THE ANTI-MALARIAL CAMPAIGN ON THE ISTHMUS OF PANAMA.

The following are a few notes on an article by H. Simms in the *Annals of Tropical Medicine and Parasitology*, issued by the Liverpool School of Tropical Medicine in February, 1909:—

The article contains the results of the practical application of sub-drainage in the Isthmus of Panama. The climatic conditions of that region are unusual, the rainfall averaging 180", and the rainy season lasting from May to December. The methods used for ordinary agricultural drainage are unsuitable.

For anopheline extermination, the main object is to remove surface water and all puddles formed by "seepage water." All wet places should be thoroughly dried every 10 days.

Up to 1905 every effort had been directed towards the extinction of yellow fever, and any drainage which had been attempted was for the purpose of removing large bodies of water. The camps and neighbourhood were at this time swarming with anophelines, and the percentage of sick in December, 1905, was 9·36. Systematic measures were now commenced, to endeavour to reduce the casualties from malaria. These measures consisted of:—

1. Cutting all vegetation growing in wet places.
2. Confining all water to open channels, and the copious use of crude oil.
3. Screening of buildings and cutting all vegetation within 600' or 700' of houses, this distance being considered to be about the limit of flight of the anophelines.

The maintenance of the open ditch system was found to be very costly on account of the damage done by heavy rains, the rapid growth of tropical vegetation, and the necessity for the lavish use of larvicides. It was therefore decided to introduce some more permanent method, which would be cheaper to maintain. "Tile" drainage was the method selected, and the work was started at the end of 1906.

The following table indicates the percentage of employees suffering from malaria in the months of March and August, 1906–7–8. The fall in the percentage in the latter year, when the drainage work was well under

weigh, is very marked. March is the end of the dry season and August the month in which the fever rate is highest.

Year.	March.	August.	Annual Average of Deaths per 1,000, based of Returns for August.
1906	6·32	9·01	10·55
1907	4·16	5·33	5·05
1908	1·23	3·43	2·44

It is stated that the breeding areas which give the greatest trouble are "seeps" on the sides and at the bases of the hills, and from water following small areas of impervious strata. Such places are difficult to locate, and if overlooked will breed enough anophelines to seriously affect the health of any camp in the vicinity.

The general problem seems to have been to lay a pipe so that a considerable torrent of water could pass over it without causing erosion, and also so that the pipe should be able to carry away every drop of water in a few hours after a flood. Such pipes had, of course, to be capable of passing a considerable amount of silt.

The "tiles" or pipes used were of three sizes, 4", 6", and 10", porous and unglazed. It was found that a 6" pipe would pass silt at a slope of 1 per cent. and a 10" pipe at one of ½ per cent. If a flatter slope were given, flushing would be necessary. If the "tiles" were laid for "seepage" water, and not on main lines, a slope of ½ per cent. was found adequate.

The main pipe, or "tile" line, would usually follow the course of some small stream, the feeders from the side seeps joining into it. In laying the main line, care should be taken to straighten it as much as possible, and thereby increase the fall in the pipe. If this fall however exceeds 5 per cent., it was found desirable to introduce breaks or "falls" so as to reduce the velocity of the surface flow in flood time.

The "tiles" should be 2' 6" below the bed of the stream, carefully graded with joints ⅛" to ¼" opening. They should be firmly bedded in crushed rock on all sides, with at least 4" of this material on top.

If the scour is great, extra precautions may be necessary. All branch drains should be laid the same way and connected to the main lines by Y junctions. Care must be taken to deal with roots of trees which may interfere with the pipes.

Great care is necessary, before commencing work, to accurately determine the direction of the flow of the water below the surface. This should be done by means of borings or trial pits. This is an important point, as it is essential that all water should be intercepted. In some cases, if the line of fall is very steep, parallel lines of pipe laid deep and close together will be required.

Cost.—Transport and wages are expensive on the isthmus. A good labourer receives $1.80 a day (7s. 2d.). Sometimes the work laid in inaccessible valleys, and roads had first to be made; and in some cases rock had to be transported by train. The average cost of the "tiles" laid worked out to 35 cents a foot (1s. 5d.), of which 1s. 3d. represents the first cost of the tile, leaving a balance of 2d. for labour, etc.

'G.W.'

THE LIFE OF MAJOR-GENERAL SIR CHARLES WILLIAM WILSON, K.C.B., ETC., R.E.

By COLONEL SIR CHARLES M. WATSON, K.C.M.G., ETC.—(Murray, 1909).

The life of Sir Charles Wilson well deserved to be written, and no one could be more competent to write it than Sir Charles Watson. He was not only a warm personal friend, but has an intimate knowledge of Egypt and of the events in which Wilson played so considerable a part. The story is told in a plain, straightforward way, with discretion, but with no undue reticence, and the author is able to borrow freely from Wilson's diaries and letters. These extracts add much to the vividness and the literary charm of the book, for even as a young subaltern making entries in his diary, Wilson wrote with force and style. There is a page of admirable description of his journey across the Isthmus of Panama, on his way to British Columbia, where he was to be employed on the Boundary Commission of 1858.

Wilson was not one of the men who "have greatness thrust upon 'em" by the happy accident of being concerned in some memorable feat of arms. On the contrary, it was his ill-fortune not only to have his name associated with a deplorable failure, but also to have to meet a most discreditable attempt to make him the scapegoat.

In the course of his career his employment was singularly varied, but this was not because of his own restlessness or ambition. Although his services were in constant demand, because he did so well whatever he had to do, the only case in which he seems to have volunteered them was for the survey of Jerusalem in 1864. This was a very modest enterprise at the outset. It was a mere preliminary to a better water supply, which Miss Burdett-Coutts wished to provide, and it was not to cost more than £500. The officer in charge of it was to pay his own expenses, Turkish obstruction was anticipated, and it is not surprising therefore that several men had already declined to undertake the work before Wilson offered himself. He had been at school at Liverpool under Conybeare and Howson, the joint authors of *The Life and Epistles of St. Paul*, and his interest in the problems which Palestine presented, seems to have been largely due to Howson's influence. But things were apt to grow in Wilson's hands, and an immediate result of his work at Jerusalem was the establishment of the Palestine Exploration Fund, of which he was one of the leading spirits for the rest of his life.

In 1869 he was placed in charge of the Topographical Department at the War Office, and, when it was separated from the Ordnance Survey in the following year, he was made Director of it. The only officer employed under him at that time was the present Lord Cromer. Wilson set himself to make the Department more adequate to the work required of it, and it is characteristic of him that, in the scheme which he submitted to Mr. Cardwell in 1872, he proposed that a general officer should be brought in over his head. This was the beginning of the Intelligence Department, in which

he continued to serve till 1876, when he was appointed Director of the Ordnance Survey of Ireland. It was while he held this latter appointment that he was employed as Consul-General in Asia Minor and in connection with the Expeditions to Egypt and the Sudan.

The three chapters which deal with the Nile Expedition, are those to which readers will be apt to turn first. They give a full and lucid statement of what took place, supplementing Wilson's own book, *From Korti to Khartum*, and clearly indicating the causes of the failure. In Wilson's opinion there were four main causes—the delay of the British Government in making up its mind; the deference shown to the Mudir of Dongola, who did his best to obstruct the expedition; mismanagement in sending up the boats; the insufficient supply of camels, which involved a 10 days' halt at Jakdul. "During October, November, and December the purchase of camels was stopped and recommenced about half-a-dozen times," and when they were needed for the desert column, there were not enough of them. In August Lord Hartington had written to Mr. Childers:—"I think that in itself Wolseley's appointment may be an economical measure. He has a great aversion to embarking on a large expenditure for land transport, which would be the most costly of all preparations."

As regards the delay at Gubat, for which Wilson was responsible, Sir Charles Watson shows not only that there was good reason for it, but also that there is no ground for supposing that it affected the result. "Had the steamers left Gubat three days earlier, Khartum would have fallen three days earlier. That would have been all the difference." Even if Wilson had been able to carry out his instructions to the letter—to show the redcoats in the streets of Khartum, and bring them away, leaving three officers to assist Gordon—it would not have enabled the starving garrison to hold out for another six weeks. Lord Hartington, who had the best means of judging, entirely exonerated Wilson and praised him highly. So did Sir Lintorn Simmons, who characterized with refreshing vigour "the dastardly act" of trying to make a scapegoat of him, and whose letter, printed now for the first time, is well worth reading.

It is needless to dwell on the good service which Wilson rendered subsequently at the head of the Ordnance Survey and as Director-General of Military Education. Repeated visits to Palestine and three years of employment in Asia Minor had given him an almost unequalled knowledge of that part of the Turkish dominions. He edited Murray's handbook of it, and the list of his lectures and papers, mostly connected with this subject, occupies more than three pages of this book.

Sir Charles Watson has earned the thanks of his brother officers by this valuable addition to the gallery of Corps Worthies.

E. M. LLOYD.

NOTICES OF MAGAZINES.

JOURNAL DES SCIENCES MILITAIRES.

March 15th, 1909.

The article on 3-gun batteries is continued. The batteries should be worked in 3-battery groups. The ammunition wagons should be common to the group and be allotted to the batteries composing it as needed, as, according to French Staff ideas, "certain batteries, which cannot be chosen in advance, will have to maintain a fire far heavier than peace practice would lead one to suppose." It will be impossible to replace casualties till the first burst of fire is over, and on account of the small numbers actually engaged as gun crews, this burst will not be of long duration. Transport should be organized on a battery or a group basis, under a special transport officer, thus setting free the battery commander to attend entirely to his battery.

Turning to higher organization, "advanced guard" artillery is suggested. It is a principle that artillery should be pushed into action to cover the infantry advanced guard from the beginning of an action, provided that there are enough troops of other arms to act as escort. This means that a general may legitimately bring his second division artillery into action in support of his first division, before any of the second division infantry is engaged. Continuing this idea, the frontier corps might reasonably be supported by the artillery of corps from the interior, while the latter are being mobilized and brought up. More particularly this applies to reserve divisions, of which the most to be expected is that they will crush the enemy by sheer weight of numbers when brought up at the decisive moment. A reserve is intended to be used to the last man in the forward movement. Even if these divisions had artillery, there would be no room to bring it into action with them. If there were, very little could be expected of reserve artillery unfamiliar with their guns, their officers, and each other.

It is said that one of the lessons of the Russo-Japanese War is that Suvaroff's doctrine of the decisive effect of the bayonet has been proved wrong, when compared with Napoleon's remark "Fire is everything, the rest nothing," even though the latter referred more particularly to artillery.

French, Germans, and Japanese in their new regulations agree that infantry is the principal arm in action, and that the offensive is essential to victory. In infantry attacks, "morale" is the first factor in success. It forms three-quarters of a soldier's value.

An illustrated article on the periscope for the use of field artillery is given. As artillery now makes such great use of indirect fire, a periscope is considered almost a necessity to get good results.

April 15th, 1909.

A further instalment of "Automobilism" considers its application to ammunition transport. Remembering the enormous consumption of ammunition in Manchuria, it is necessary to have a large supply close at hand. The French carry 500 rounds per rifle and 500 projectiles per gun. The principal park for supplying this amount is kept about a day's march behind the main body, so as not to hamper its movements. After an action the ammunition wagons must cover this distance twice—full going, and empty returning—and, if possible, the double journey should be done in one march. Twenty-five miles is the limit for horse-drawn vehicles, and these therefore must not be more than about 12½ miles distant from the troops. The use of motors would increase this limiting distance considerably.

The reduction possible by substituting motors for horses, in the various services mentioned in this series of articles, would be about 2,000 men and 4,000 horses. The cost would be about £400,000 per army corps, to buy a complete plant, without any system of using civilian vehicles. To get full value from such a service, it would be desirable to have a special section of the General Staff, which would make all the necessary arrangements.

An attempt has been made in Austria to follow dirigibles with motors, but the former easily outstripped the latter. The same nation has tried a three-wheeled motor cycle for laying telegraph wires.

Following the lead of Brazil and Chili, the Argentine Republic has adopted the Krupp model of quick-firing field artillery, in spite of a report, by a commission of officers, in favour of the French Schneider model. In the Brazilian tests the French gun was unfortunately destroyed in a fire, and could not be replaced in time. Later however the two types competed in the Peruvian trials, which resulted in the French gun being chosen. In the case of Chili, the officer, in whose hands the choice rested, was of German origin. Mexico and Bolivia have adopted the French gun, and Uruguay has not yet finally made its choice.

General von Bernhardi has lately published a book on cavalry. The principal reforms he suggests are:—(1), More initiative for cavalry commanders; (2), a less definite allotment of cavalry, so as to allow corps engaged on siege work, for example, to send their cavalry to join other corps; (3), more open formations; (4), dismounted action; (5), more modern regulations for drill, etc.—suppressing those movements which are impossible off the parade ground. These changes should all be based on Frederick the Great's maxim, "Prussians should attack always and everywhere."

May 1st, 1909.

There is a further instalment of the article on "3-gun batteries" in this number. The ministerial solution of the artillery question is a compromise. The number of guns is increased from 92 to 120 per army corps. They are organized in three regiments—two 9-battery divisional regiments and one 12-battery corps regiment. There is also some talk of forming "reinforcing" batteries with a very weak regular nucleus.

The two schools of thought, between which the compromise has been made, are those who compare the French and German artillery (i.), by batteries, (ii.), by guns. Since a Commission has declared a 4-gun superior to a 6-gun battery, the first party are satisfied with opposing 24 French 4-gun batteries to 24 German 6-gun batteries. The second party however clamours to increase the batteries to six guns, and to thus equal the total number of guns possessed by Germany. They forget the difficulties of ammunition supply and the impossibility of one man commanding six quick-firing guns in action. There would also, at times, be considerable difficulty in finding space to bring 144 guns per corps into action. The various theoretical solutions propounded, such as two lines of guns, one firing over the other, are hardly practicable in a "war of manœuvre," as opposed to a "war of positions." Many people, too, when comparing the French and German methods of fire, forget the considerable differences in the two equipments.

The present instalment of "Instruction of an Infantry Regiment," deals with night fighting. When considering European warfare too much stress should not be laid on the many night attacks in South Africa and Manchuria. In both cases movements were much slower than would be the case in Europe. Large bodies of troops will probably make preparations during the night for an attack at dawn, but actual night fighting will only take place between small bodies such as outposts, in order to achieve special missions, such as seizing important points.

The principal characteristic of attacks at night will be simplicity in their plan and object. Complicated manœuvres are impossible, although false attacks to distract the enemy's attention from the threatened point will be useful. Cyclists are the best means of communication on account of their speed and silence.

Defence at night must be carefully arranged for. It is not a bad plan for outpost troops to occupy momentarily the positions which they would take up in case of a night attack, when going on duty. All ranks would thereby become acquainted with them. All arrangements ought to be made by daylight and not left to the hurry and confusion of an attack. Wire entanglement is the best obstacle. Fire, though practically prohibited to the attack, is the best means of defence; care should be taken to keep it low. The best method of meeting an attack is by a counter-attack, as a small determined party can easily defeat a much larger body at night by surprising them in flank. A trick, recommended by Marshal Bugeaud, is to occupy at night a position a little in rear of that occupied by day, so that in case of attack the enemy will strike uselessly at the day position and lay himself open to surprise from the retired night position.

May 15th, 1909.

A short account of the reorganization of the Russian Army is given. "The Committee for the Education of the Troops" has already published several training manuals and has others in preparation. The artillery section is studying a manual on the use of hand grenades, and the question of field search lights has been considered by the Inspector-

General of Engineers. Each army corps is to have three 75-c.m. projectors, and each infantry regiment a 35-c.m. projector. A 75-c.m. projector is to be allotted to every brigade of horse and field artillery. The latter are to practise in peace time firing over the heads of their own infantry. Officers' pay is to be increased. The syllabus for cadets has been improved, and a foreign language is now compulsory. In European Russia it is German, in Siberia and Turkestan, English. An article on mines, based on the Siege of Port Arthur, has appeared in the Russian Engineer Journal. The most important part to protect by galleries is the caponier. The best depth for these is about 24', as this ensures freedom from chance interruption by howitzer shells. If money is available, another system 48' down is desirable in some cases. To carry out mining operations, it is estimated that, for a face consisting of three forts, 150 miners are needed. If work is to be carried on day and night, 450 men in three shifts should be detailed.

The series of articles on the 3-gun battery is concluded. The proposals are summed up. The tradition of allotting a fairly even proportion of guns to each army corps, and spreading them evenly over the country, should be abandoned. The artillery should be concentrated on the frontier, and told off to the various corps as circumstances on the spot render desirable. In action the guns should be divided into two groups, one to overwhelm the hostile artillery, the other to support the infantry attack. The Japanese have come to the conclusion that reserve units of artillery and cavalry cannot be relied upon. The 3-gun battery organization could be easily expanded in war to provide two batteries, per peace battery, in which all important positions would be filled by regulars.

"Combination" is the subject of this instalment of "Instruction of an infantry regiment." "All tactics," according to Dragomiroff, "resolve themselves into combination in action." This was recognized by both Kuropatkin and Oku in their instructions to their men. The sole object of the other arms is to help the infantry to accomplish their task under the most favourable circumstances. On the march, cavalry is the principal arm in reconnaissance. Infantry supports should be under the cavalry commander. When attached to a column however so as to give local protection, the cavalry takes second place, and should be disposed as the column commander wishes. On outpost duty cavalry should be under the orders of the outpost commander; but in practice the squadron attached to each infantry division has usually too much to do to be of much use on outpost duty. The Japanese system of small bodies of infantry—to which a few cavalry are attached to act as "points," flankers, and orderlies to keep touch and carry messages—is best in circumstances where there is a lack of cavalry. In action cavalry will find plenty of opportunities for surprising shaken infantry, guns without sufficient escort or on the march. Probably a squadron is the largest body which can be usefully worked together for such exploits.

H. L. WOODHOUSE.

Nature.

April, 1909.

Panama Canal (*p.* 197).—For some time past alarming reports have been in circulation as to the work on the canal, and especially as to the stability of the proposed great dam at Gatun. Three years ago it was settled that, taking everything into consideration and under the special conditions that prevail on the Isthmus of Panama, it was desirable that the canal should have locks in preference to being made throughout at the sea level. About three months since, a Commission was appointed by President Roosevelt to enquire into the safety of the Gatun dam and generally to report as to the works. The findings of this Commission are a full endorsement of the scheme and works as now being carried out, and an expression of confidence in the engineers entrusted with this work. The dimensions of the locks, as finally settled, are to be 1,000′ in length and 110′ in width. The cost of the canal is estimated at 72 millions sterling, whereas a sea water-level waterway would cost upwards of 100 millions, and would take several years longer to construct than the lock canal, which, it is hoped, will be finished in about five years. About 50,000 men are now employed, and yellow fever and other diseases common to a tropical swamp have almost entirely been stamped out.

Mount Wilson Observatory, California (*p.* 209).—The 60-inch reflecting telescope has now been erected at Mount Wilson. The mirror was successfully cast in France, and figured and polished at Pasadina. The difficulties connected with the transport of the mirror and mounting, to the summit of Mount Wilson, were great. The telescope is now mounted in a 50-foot dome. Dr. Ritchey is at present on a visit to Europe, arranging for the casting of the disc for a still larger reflector—100″ in diameter—which has presented considerable difficulties.

The Æther of Space (*p.* 322).—By Sir Oliver Lodge.—When a steel spring is bent or distorted, what is it that is really strained? Not the atoms—the atoms are only displaced; it is the connecting links that are strained—the connecting medium—the æther. Distortion of a spring is really the distortion of the æther. Matter can only be moved. Contact does not exist between the atoms of matter as we know them; it is doubtful if a piece of matter ever touches another piece, any more than a comet touches the sun when it appears to rebound from it; but the atoms are connected, as the comet and the sun are connected, by a continuous *plenum* without break or discontinuity of any kind. Matter acts on matter only through the æther. But whether matter is a thing utterly distinct and separate from the æther, or whether it is a specifically modified portion of it—modified in such a way as to be susceptible of locomotion, and yet continuous with all the rest of the æther, which can be said to extend everywhere, and far beyond the bounds of the modified and tangible portion—are questions demanding, and it may be said in process of receiving, answers. (The whole of this article is most interesting and well worth reading).

TRANSATLANTIC WIRELESS TELEGRAPH (*pp.* 233 *and* 264).—Professor Marconi has published in the above-mentioned two numbers of *Nature* a detailed account of the invention and progress of the new telegraphy. In seven years the useful range of "wireless" has increased from 200 to 2,500 miles. He gives details and sketches of the new station at Glace Bay. The aerial was large and consisted of a vertical portion in the middle, 220′ long, supported by four towers and attached to horizontal wires—200 in number—each 1,000′ long, extending radially all round, and supported at a height of 180′ from the ground by an inner circle of eight, and an outer circle of 16 masts. (The natural period of this aerial gave a wave length of 12,000′). The capacity employed was 1·8 microfads, and the spark length $\frac{3}{4}$″. Improvements have been made by the adoption of air condensers, composed of insulated metallic plates suspended in air at ordinary pressure. These prevent the dissipation of energy, and a very appreciable economy in working, resulting from the absence of breakages in the dielectric, is effected.

Messages can be transmitted across the Atlantic by day or by night, but there exist certain periods, fortunately of short duration, when transmission is at times ineffective. This occurs in the morning and evening, when, due to the difference in longitude, daylight or darkness extends only part of the way across the Atlantic, the received signals are weak and sometimes cease altogether. It would appear as if illuminated space possessed, for electric waves, a different refractive index from dark space, and that in consequence the electric waves may be refracted and reflected in passing from one medium to the other. This difficulty would not be experienced in telegraphing over equal distances from north to south.

In the same manner as there exists periods when signals are unusually weak, there exist other conditions, especially at night, which make the signals abnormally strong.

W. E. WARRAND.

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

January, 1909.

The operations immediately before the Battle of Liao-Yang, with an appreciation of the situation just before the battle, are the part of the history of the Russo-Japanese War studied in this number.

MILITARY BALLOONING IN GERMANY (*continued*).—The conditions to be fulfilled by Parseval No. 2, before the Government would purchase it for military use, were:—

1. That it should accomplish a 10 hours' journey.
2. That it should be able to rise to an altitude of 1,500 mètres, and remain one hour at that height.
3. That it should have a measured speed of 11 mètres per second (about 25 miles per hour).

4. That it should be possible to inflate it anywhere without the need of a shed to protect it.
5. That it should be possible to carry it rapidly and easily from place to place before inflation, or after having been deflated.

During the trials the balloon was carried on carts to the inflating apparatus, and was ready to start in 4½ hours. The maximum speed attained was 26 miles per hour, and it obeyed the horizontal rudder very readily.

The following description of the Gross No. 2—taken from the *Allgemeine Automobil Zeitung*—is given. The balloon possesses a keel (*Kielgerust*), which is suspended from the gas-bag, and in the centre of which is carried the propeller. The new position of the propeller is regarded as a great improvement upon French dirigibles, in which it is fixed to the car. This had a tendency to turn the balloon over lengthways, which had to be counteracted by the vertical rudder. The propeller is of aluminium and has three arms, and power is transmitted to it by means of a steel wire belt, which is lighter than gearing. A ventilator, destined to supply the air-bags with air, is also situated on the keel, and an arrow-shaped prolongation of the keel, towards the rear, serves as a steadying surface and also carries the horizontal rudder. The principal steadying surfaces are placed towards the rear of the balloon at the height of its axis, and the vertical or elevating rudders are also attached to the keel towards the front of the balloon.

The third type of dirigible is the rigid or Zeppelin type. The history and description of each of the successive balloons, as well as an outline biography of Count Zeppelin himself, are given. The Count's first ascent took place in 1863 in a captive balloon belonging to the Army of the Mississippi; his studies on dirigibles date from the Siege of Paris in 1870, and his experiments, from his retirement from the Würtemberg Army in 1890. His first dirigible saw light in the summer of 1900, but after three successful ascents, in which a speed of 7½ mètres per second was reached, lack of funds put an end to the experiments. In the winter of 1901 the Kaiser awarded Count Zeppelin the Order of the Red Eagle (1st Class), and gave him the help of the Ballooning Section.

It was not however till November, 1905, that the second balloon came into existence, but unhappily, after a successful ascent in January, 1906, when the dirigible landed at Leutkirch, it was destroyed by a violent tempest during the night.

The undaunted inventor however began building his third model the same year, and received a grant of £25,000 from the Reichstag. His first ascent in it took place in September, 1907, but in December a violent storm sunk his floating shed, damaging the balloon. By the time it was raised, May, 1908, Zeppelin No. 4 was being built.

This dirigible is 135 mètres long and 13 mètres in diameter, and has a volume of 15,000 cubic mètres. Each of its Daimler motors generates about 114-H.P. It has two cars and can carry six passengers. It is steered in a horizontal direction by means of two vertical surfaces symmetrically situated at either end of the gas-bag, and vertically by

means of a sliding weight. Two large horizontal surfaces on a level with the longer axis of the balloon serve as steadying surfaces.

The conditions to be fulfilled by this dirigible were :—

1. To accomplish a journey of at least 400 kilomètres (250 miles) in 24 hours.
2. To land on terra firma (not water) at the end of the journey.
3. To carry sufficient water, oil, and petrol on board for the whole journey.
4. To attain an altitude of 1,200 mètres at least, so as to be out of gun range.

On the 29th June, 1908, the balloon made a 12 hours' journey over Switzerland with a speed of 35 miles an hour. Finally, on the 4th August, the 24 hours' journey was accomplished and the airship came to rest in a meadow near Echterdingen, where a few hours later it was completely destroyed by a gale. In spite of this cruel blow, in the very hour of his success, the intrepid Count was not downhearted, but set to work at once to reconstruct a new model. On the 7th November, accompanied by the Crown Prince, he made the first ascent ; a few days later the Emperor himself was present at the trials, and conferred on Count Zeppelin the Order of the Black Eagle ; on the 11th the *Berliner Tageblatt* announced that Count Zeppelin's invention had been purchased by the German War Office.

Thus on the 1st January, 1909, there were six balloon sheds in the possession of the German Army.

Two new types of airships are being constructed by the Siemens-Halske Society and the Technical College of Danzig, and a society known as the "Deutscher Luftschiffer Verein" has been formed at Mannheim, with the following objects :—

1. To make Germany the leading nation in the matter of aerial navigation.
2. To create ports for airships all over the Empire.
3. To carefully look out for, and improve such natural refuges against storms as exist for airships, and to build artificial ones.
4. To seek to make use of balloons for scientific aims, or for the exploration of unknown lands.
5. To prepare special maps for the use of aerial navigators.

Amongst the uses made by the Germans of their military balloons, the experiments made on throwing explosives from airships on the Tegel Range are mentioned, and the article finishes by quoting from the *Kriegstechnische Zeitschrift* on the "Tactics of Airships," a review which has already appeared in this paper.

THE STATE OF THE CHINESE ARMY IN JULY, 1908.—The Chinese Army consists of :—

A.—New organization :—

(*a*). The regular army, or Lou-kiun.
(*b*). The police, or Siun-djin-kiun.
(*c*). The auxiliary police forces, or Siun-fang-toué.
(*d*). The imperial guard, or Hou-wei-kiun.
(*e*). The gendarmerie, or Djin-tcha-toué.

B.—Old organization :—

(*a*). The Manchu Army of the Eight Banners.
(*b*). The Chinese Army of the Green Standard.
(*c*). The Mongolian and Tibetan Militia.
(*d*). The rural militia.
(*e*). The special guards of the mandarins.

In time of peace the armed force of the Chinese Empire has an establishment of 660,000 men and 930 guns, but of these only 120,000 men of the Lou-kiun are armed with modern rifles and guns. These, together with some police—50,000 in all—and some 50,000 Mongolian Horse, form an efficient force of 170,000 men, to defend a nation of 400 millions. Further, the Mongolian Horse could only be called upon to serve with their own consent, and it is highly improbable that this would be obtained.

If all goes well however, in 1913 this figure will have risen to 400,000, by 1920 to 1,185,000, and by this date the railway system of China will be completed. To attain such a result much money will be required, and the whole of Chinese administration and finance will have to be altered.

It must however be remembered that the changes which have taken place since 1903 are remarkable. The army is now held in esteem, and the numerous military schools are frequented by the sons of mandarins; patriotism and a martial spirit are rapidly developing in the Chinese youth, and the Viceroys—stimulated by the example of Yuan-shi-kai, the organizer of the Northern Army—are following in his lead.

The army no longer consists of an assembly of contingents, each obeying its local Viceroy only, but is a national army under a central government, which has telegraphs and railways at its disposal. It cannot as yet however compare with European armies; desertions are too numerous, discipline is not strict enough, the armament is not uniform, the auxiliary services are hardly created, and the sums given for ammunition are still very small. Nevertheless, the Chinese Army is beginning to be of importance and will increase in value if the War Office continues in its efforts to train officers, and succeeds in putting matters on a firm financial basis.

Military Automobiles in Germany.—A new armoured motor car, which carries a machine gun, six to eight men, and can attain a speed of 60 to 80 kilomètres per hour, has recently been presented by the experimental section of the lines-of-communication troops to General von Lincker, the Inspector-General. If it passes its trials satisfactorily, more such cars will be at once constructed.

The vehicles used by the experimental section of the lines-of-communication troops comprise the following self-propelled vehicles :—

(1). Twenty-five heavy cars with internal combustion engines.
(2). The Siemens Schuckert train of five carriages, the energy being generated by petrol engines on one car and being transmitted electrically to each of the others.
(3). Four steam traction engines. This park can carry 183,000 kilos., and 158 other self-propelled vehicles are subsidized by the Government, and would be capable of carrying loads up to 945,000 kilos.

A. H. Scott.

RIVISTA DI ARTIGLIERIA E GENIO.

January, 1909.

SERVIA.—*Present Condition of Servian Fortifications.*—*Il Militär Wochenblatt* of the 12th January publishes the following notice by a travelling correspondent of the *Invalido Russo* who has lately made a journey in Bosnia and Servia:—

There are at present four fortified places in Servia—Nisch, Pirot, Saitschar, and Wranja.

Nisch has all the old forms of citadels with seven bastion fronts, now of small importance, besides two groups of old Turkish fortifications (Winik and Goriza) and three forts of modern construction (Ramara, Markow-Kale, and Detljak). It is proposed to reduce Nisch to an entrenched camp. Similar proposals are made with regard to Pirot, which is surrounded by five forts and some redoubts and batteries with very weak profiles, constructed at the time of the war of 1885.

Saitschar is surrounded by three groups, each consisting of three modern forts, constituting a complete entrenched camp.

Wranja was fortified some years ago with 20 works of varied strength.

Between Nisch and Bjela Palanka there is a complete system of works which were constructed or repaired during the war of 1885, and are to-day of little value.

The modern forts are nearly all of the same type; they are of bastion tracing, and consist of two long faces at a very obtuse angle and two short flanks. The profile is of a permanent character, and the forts have many traverses and local casemates, some of which are armoured. Each fort is calculated for a garrison of from 1 to 1½ infantry companies, and for an armament of 12 guns. Latterly a great deal of work has been executed on the fortifications.

FIELD ARTILLERY AND THE LEBEL RIFLE IN THE MOROCCO CAMPAIGN.—The *Internationale Revue über die gesamten Armeen und Flotten* publishes in its pages in October last an article on the action of the various arms used in the fighting in Morocco, from which we extract the following short notices concerning the field artillery and the Lebel rifle:—

According to this notice the fire of the field artillery had not the efficacy that was expected, because the enemy never appeared in masses, but always in a scattered and movable formation against which it was difficult to regulate the fire.

It is also reported that the French fire method (consisting of fire with shrapnel concentrated on a restricted zone, which is supposed to have a moral effect in European warfare) does not produce any impression on these fanatical Mussulmen. The guns of 75 mm. are also shown to be too heavy and of insufficient mobility; an instance is given of an action, against the Mdaras, in which the field artillery did not succeed in following the other troops.

As regards the Lebel rifle, the critics are not satisfied with its ballistic power, and in addition to this both the mechanism of the repeating action and the bayonet are considered not to be entirely satisfactory.

The repeating action fire was only found useful by the Foreign Legion, who, knowing the enemy's methods, delivered their fire with calmness; this was not the case with the other soldiers, who, firing too rapidly, exhausted their ammunition in a short time, and were not able to have it replaced owing to the difficulty of bringing up reinforcements. The bayonet was also found to be defective, being too long and an impediment on the march, especially when running. The wounds produced by it rarely placed the enemy *hors de combat*, and when meeting any obstacle it was easily bent. It was found, after the action of the 15th May, that almost all the bayonets of a battalion of the 1st Regiment of the Foreign Legion were unserviceable, some being bent almost at right angles.

The Russian-Japanese Campaign, 1904.—By D. Luis Fernandez de Cordova, Colonel, Typographic Establishment, De Fortanet, Madrid, 1908.—During the last war in the Far East several foreign missions followed the operations, being attached to one or other of the belligerents. The Spanish Commission, which was attached to the Russian Army, was presided over by Colonel D. Luis Fernandez de Cordova, a distinguished officer who died on return to his country, after being promoted major-general and nominated Aide-de-Camp to the King.

His brothers have now published his reports under the title of "Memoirs." These Memoirs are contained in two volumes with an atlas. One of the volumes is dedicated to the Chief of the General Staff, and is preceded by a biography of the author written by D. Juan Perez de Guzmán, Member of the Royal Academy of History.

In the 21 chapters, into which the book is divided, Colonel Cordova has recorded, in a brilliant style, his journeys, the countries, costumes, and impressions of the regions through which he passed, narrating and commenting on all the actions and important episodes of the Russian Army at which he was present.

His well-considered observations, always interesting, induce one willingly to read the 400 pages of this volume, which concludes with a chapter containing general considerations, with special reflections on each branch of the army.

The other volume contains the author's diary, in which are recorded his impressions of the various military dispositions, and details relating to the mission which he directed. The diary is illustrated with numerous sketches.

February, 1909.

Pneumatic Antennæ.—It is frequently, and under many circumstances, found convenient to make use of long antennæ, which have to be of sufficient strength to fulfil the requirements of the work for which they are necessary. Such antennæ may be used for flag or other light signalling, or for other purposes, such as communicating with ships from the shore.

But the difficulty, hitherto found almost insuperable, of combining in one pole or mast the two conditions of length and facility of transport, has limited the employment of such means of communication, and has

substituted for it other methods—such as the telephone and telegraph—to which it is not always possible to have recourse.

To meet this difficulty, the use of pneumatic antennæ has been suggested, which would combine in one organ the two opposite characteristics referred to above, and which could be most usefully employed for wireless telegraphy in the field.

It is, in fact, well known that the long poles or masts used for the transmission of the hertzian waves, are, owing to their height, very difficult to manage and to transport over undulating ground. These difficulties may easily be overcome with the short pneumatic tubes of which the following is a brief description. The pneumatic pole consists of:—

(1). A tube, or air chamber, of gummed cloth or canvas, closed at the two extremities and perfectly air-tight. This is furnished with a small tube and copper screw, attached at the base to a hand pump which forces the air into the chamber. At the lower end there is a covering of canvas attached to a wooden ring, which is fixed to any convenient basement.

The height and the diameter of the mast may vary according to the purpose for which it is required. Practically it is not convenient for it to exceed 12 mètres in height, which corresponds to an average diameter of 20 centimètres.

Before placing the mast in position the tube is stretched along the ground and is inflated with a pneumatic pump. It is then raised to a vertical position and secured to pegs fixed in the ground.

When the mast is lowered, the air is allowed to escape, and the tube can be rolled up so that it can easily be carried on a man's shoulder, on the saddle, or in a carriage of any kind. The weight of an antennæ or tube, 12 mètres in length, is about 30 kilograms.

AUTOMOBILE FOR CHASING DIRIGIBLE BALLOONS. — The *Rheinische Metallwaren-und Maschinenfabrik* of Düsseldorf has lately constructed a semi-blinded automobile, armed with a quick-firing gun of 50 mms. The carriage is provided with a motor of 60-H.P., and its strength allows it to traverse any difficult ground and to climb slopes up to 22 per cent. According to the Berlin correspondent, the average velocity of this motor would be about 50 kms. an hour, which would be sufficient to follow the course of a dirigible balloon. In exceptional cases it might attain a speed of 70 kms.

The carriage and the wheels are protected on all sides with armoured plates 3 mms. in thickness. The seat for the driver is as usual in front. The gun is placed in the centre and attached to the chassis of the car, and exactly in its centre of gravity. The box for the ammunition is placed behind, and forms a seat for the gunners.

The gun can be pointed, at will, in any direction and at any angle, and is furnished with an hydraulic brake. The supply of ammunition consists of 100 cartridges for shrapnel or for shell. Each shrapnel contains 40 grammes of explosive, 128 bullets of hardened lead of weight 8 grammes, and 27 of 9 grammes.

The weight of this war automobile, ready for the march with gun,

ammunition, oil, water, etc., and with five men, is 3,000 kgs. The longest range of the gun is about 7,800 mètres, with an elevation of 43°.

Drawings are shown of the automobile and cannon. The French periodical, *la Vie Automobile*, observes that in its estimation it would be difficult, with carriages of this description, to follow over any ground the capricious evolutions of a modern dirigible.

GERMANY.—*Transport Service with Mechanical Traction.*—The following notice is taken from the pages of the *Streffleurs Militärische Zeitschrift* of October, 1908, regarding the mechanical trains organized by the chief engineer, Müller, appointed by the Prussian Minister of War.

One of these convoys, composed of seven carriages with a load of 30,000 kgs., made an experimental journey from the 8th to the 24th July, 1908, travelling 1,600 kms., corresponding to a daily journey of 110 kms.

The same periodical refers to the appointment of 52 retired officers of infantry, field artillery, and motor reservists of the troops of communication, to form a nucleus of a corps of officers of the reserve, for the troops attached to the transport service by mechanical traction. The new organization provides for the detachments which would be constituted in time of war. These detachments would essentially be in depôts or offices for repairs.

It is not proposed to utilize the officers as conductors of the trains. Such officers as have acquired practical experience in the use of transport automobiles of any kind would be employed as required for the technical organization of the mechanical trains, and also in providing for the maintenance of such carriages.

The corps of Motor Volunteers has not any connection with the new institution.

AERIAL NAVIGATION.—From the November number of the *Marine-Rundschau*, the *Rivista Marittima* extracts the following remarks on the navigation of dirigibles :—

In aerial navigation up to the present time the problem of the identification of places has been considered a negligible quantity ; but since the creation of the dirigible, and the possibility of following a route through the air independent of the wind, the study of the art of navigation in the air has become necessary. Aeronautics may be divided into astronomical and terrestrial. For the astronomical department many studies and experiments have been made, which show that owing to the balloon itself being above the observers, there exists a greater possibility of error in the observations and in estimating the altitude. With reference to this it may be mentioned that the Zeppelin airship has an aperture above the car and across the balloon, which is of great assistance for observing the stars. Astronomical navigation is most useful, as dense clouds obscure the view of the earth.

For aerial navigation convenient maps should be designed to show up special points, such as the confluence of rivers, the chimneys of manufactories, railway crossings, places especially illuminated at night, etc., etc. The maps should also indicate the prevailing winds of each locality

and good points for anchorage sheltered from the wind. Both for convenience, and in order to diminish the weight, the maps may be reduced in size by means of photography.

An International Aeronautical Confederation exists to which Belgium, France, Japan, Italy, Austria, India, Russia, and Spain belong, and a Commission has been nominated by it for the tracing of aeronautical maps, with the following indications :—

(1). For fixing the position at night—lighthouses and beacons; signalling stations; manufactories which keep up continual fires during the night; railway stations; towns; and other places brilliantly illuminated.

(2). Places for a secure anchorage; stations for the production of electricity; marshy lands; places sheltered from the wind.

(3). Indications for the prosecution of the journey and for obtaining assistance; gasometers; places for the preparation of hydrogen; places where a representative of the International Aeronautical Confederation can be found, etc., etc.

Other auxiliaries for aerial navigation are photographs of the districts traversed. The journal quoted above gives some methods for reading such photographs, which at the first glance are somewhat difficult to understand owing to their unusual perspective.

A method, explained by Dr. Elias, but which has not yet been experimented with practically, is also referred to, of showing the velocity and the direction of the wind, and thus rendering aerial navigation possible without a map, when in sight of the earth.

Finally, it is most important that there should be a careful study of the atmospheric conditions and of their changes (wind, temperature, clouds, rain, etc.).

March, 1909.

BULGARIA.—*Orders for Guns.*—The *Militär Wochenblatt*, of the 23rd February, states that the 84 batteries of field artillery ordered in 1906 from the Creusot factories, and also the mountain batteries ordered from the Krupp firm, have all been delivered and distributed to the troops.

Another important order which should be completed before the end of the current year comprises 9 mountain batteries of 4 guns each and 9 batteries of 4 howitzers of 10·5 cm., which are to be supplied from the Creusot works; 34 mitrailleuses, ordered from German factories; and 144 other mitrailleuses, ordered from Russian factories.

Orders have also been issued for the following war material, which has to be delivered in the same space of time :—Ammunition for all the guns existing in the service and for those recently ordered, 200,000 tents, and numerous equipments for pioneers and for sanitary services.

The payment for the material, to be consigned during the year, will be made by an extraordinary allotment of 32 millions of francs, granted by the Sobranje during the last session.

JAPAN.—*Heavy Artillery Gun Practice.*—Reference is made in the journal mentioned above of the 6th March, to the exercises for heavy artillery,

which are due to take place during the current year near Nagasaki, and which will be commenced towards the middle of May.

The programme will be prepared by the Inspector of Artillery and examined by the Minister. The 5th and 6th Regiments of heavy artillery and the battalions of Nagasaki and of Sasebo will take part in the practice.

Coast Armaments.—In the same journal it is mentioned that, since 1906, works have been constructed both strengthening the existing fortifications and also for new fortifications, of which the following are noted:—Works at Kilau, on the two banks of the passage that leads from the Pacific to the Bay of Osaka; the strong fort of Shimonosaki; the works at Yura, in the island Awaji; the strong fort of Hiroshima, near the military port of Kuro; works at the military ports of Sasebo and Maisuru, and in the Pescadores Islands and at Tsushima. All the forts are armed with guns on the latest system. The construction of the fortress of Keelung, in Formosa, was commenced in 1890 and ended last year. Only the fortifications on the Bay of Tokio are not yet ready, and will require two years more to complete. These, as regards their armaments, will be superior to all the others.

On the completion of these fortifications, the programme of 1896 will have been entirely carried out.

Review of Books and Periodicals.—*Notices on the Austro-Hungarian Army.*—By Lieut.-Colonel Felice Santangelo.—These two books add to the valuable publications which the War School places at the disposal of officers, and by works of a similar kind our great military institute acquires a new title of value in bestowing instruction on the whole of the army.

The two pamphlets meet a requirement, which has been much felt, by answering various questions which have been referred to the War School, since the institution of preparatory courses for senior captains. They naturally have a value, and are of use outside the special purpose for which they are published; and they will be of great advantage, and will be well received by all officers who desire to extend their knowledge in this special branch, viz., the military organization of our neighbours.

The two studies are not in any way exhaustive, and one would not wish that they should be so, and they do not treat of the various special matters relating to the armies to which they refer. They have only the scope of giving a summary idea of what the army is in peace time, and of the condition in which it will probably be found in time of war. The two pamphlets, within fixed limits, are rich in information and data, the materials are arranged in order, and the whole work constitutes a clear and complete record. An index at the beginning of each pamphlet, and numerous quotations in the successive pages, serve as a guide to those seeking for fuller information.

The two pamphlets are not placed on sale to the public, but only to the several commands, and to the officers, who are required to keep the copies which they have obtained, and not to show them to persons unconnected with the army.

Original Types of Small Houses and Economical Villas.—By Engineer I. Casali. 420 pages with 327 drawings. Price, 5 lire 50 centimes.—In 1906 Lieut.-Colonel Icilio Casali published—by means of the photo-lithographic laboratory of the Minister of War—a valuable *Study of Plans of Small Houses and Economical Villas*, which was reviewed in the pages of this journal in the same year.

The publication—made for the benefit of the sufferers from the Calabrian earthquake and the eruption of Vesuvius—realized by its sale more than 1,000 lire; of this sum, 913 lire was made over, some time ago, to the Minister of the Interior for the use of the military engineers at Rome who had the administration of the said publication; the remaining sum, amounting to more than 100 lire, was given for the benefit of the subscriptions for the disasters in Calabria and Sicily.

The first editions having been completely exhausted, the editor, Hoepli, had the happy idea of republishing the work as one of his well-known collection of manuals. The author has increased the number of plans and drawings, and added many new solutions, the work so constituted forming a rich and varied series of the original work.

Each study in the *first part* represents the solution of a supposed problem, having a series of houses, commencing with modest lodges for small families—designed for a single story—and advancing gradually to houses of two or three stories, with quarters for two or more families in each flat.

With regard to the villas—which constitute the second part—the series is progressive, commencing with modest constructions, which may indifferently be styled villas or small houses, and progressing to edifices of larger size—with proportional increase in the æsthetic and architectural design.

The work is intended to provide for various requirements, and to give designs for a house or a villa of solid and pleasing appearance, which will satisfy the needs of the class of the tenants likely to occupy it. The series concludes with two types of buildings for schools—elementary or professional—in which are shown the relative previsions for educational buildings, and for the gymnastic apparatus belonging to them.

The appendix, which closes the work, contains the rules and regulations which have been issued during the last few years with regard to the construction of buildings, houses, villas, etc.

The intrinsic value of the work, its accuracy and modest price, are a sufficient recommendation for it.

EDWARD T. THACKERAY.

RECENT PUBLICATIONS OF MILITARY INTEREST.

APRIL, 1909.

(*Published Quarterly*).

THE following extracts from the list compiled by the General Staff, War Office, are published in the *R.E. Journal* by permission of the Army Council.

HISTORICAL.

HISTORY OF CANADA, 1763—1812. By Sir C. P. Lucas, K.C.M.G., C.B. 360 pp., with 8 maps and plans. 8vo. Clarendon Press, Oxford, 1908. 12s. 6d.

This is an interesting publication, and one in which is set forth succinctly the first 50 years of Canada's history as a British possession.

The origin as well as the operations of "Pontiac's War," the Indian war which began in 1763 and continued until 1766, are lucidly stated.

The chapter dealing with the causes of the American War of Independence contains well-reasoned references to colonization, and the relations of the Mother Country to the Colonies. The account of the American War of Independence is a useful addition to the literature, which treats of that unfortunate conflict.

The various treaties and conventions whereby it was sought to demarcate the boundaries of Canada are dealt with in chronological order in an appendix.

THE CAMPAIGN OF 1800 AND THE PART TAKEN IN IT BY THE ARMY OF GRISONS (La campagne de 1800 à l'armée des Grisons). By Lieut. Henri Leplus, Historical Section of the French General Staff. 480 pp., with 9 maps and sketches. Paris, 1908. Chapelot. 8s.

This is a complete and carefully compiled account of a campaign which is not widely studied in England, though it has points of considerable interest.

DUMOURIEZ AND THE DEFENCE OF ENGLAND AGAINST NAPOLEON. By J. H. Rose and A. M. Broadley. 350 pp. 8vo. London, 1908. Lane. 21s.

Beginning with a brief *résumé* of the early life of Dumouriez, this volume follows his career in closer detail after the conclusion of his tour of office as Commandant of Cherbourg (1778—1789). Here he created a great naval arsenal, and devoted much time to schemes for the invasion of England, in which the Isle of Wight figured prominently. He proposed to land in the island 24 battalions, one regiment of dragoons, and eight companies of artillery in shallow draught fishing boats, each carrying 60 men; this force he estimated could embark in two hours, and, by beaching each vessel as it arrived, disembark in the same time. This advanced guard, sailing from Cherbourg, was to be followed by further contingents embarking at Brest, St. Malo, Havre, and Boulogne, bringing the total invading force up to 70,000.

The action of this main body was to depend on circumstances: the first intention was to land in the Southampton Water, mask Portsmouth, and march rapidly on London, with the alternative of landing at Rye, joining the Boulogne contingent there, and thence moving swiftly on the capital.

The absence of the French Fleet at the critical moment was one of the principal reasons why this plan was never given a trial.

The Revolution gave the Commandant of Cherbourg, then 50 years of age, a wider scope for his energies. In June, 1791, he was given military command of the five Departments at the mouth of the Loire, and in March, 1792, became Foreign Minister, in which capacity he is accused of provoking war with Austria. This position he held only till June of the same year, when he rejoined the army on the Belgian frontier, in a subordinate appointment. Lafayette's downfall in August, 1792, saw the promotion of Dumouriez to supreme command of the Army of the North. A man of wonderful capacity for instilling enthusiasm into his subordinates, he so far inspirited his army of veterans and volunteers, that, after twice breaking in panic, they eventually made a firm stand at Valmy. The advance of the Duke of Brunswick was checked, with remarkable effect on the history of Europe.

The strategy and tactics of Dumouriez at Jemappes in the following November were severely criticized by Jomini: but he defeated the Austrians, and the effects were again far-reaching.

Defeated at Neerwinden in March, 1793, his enemies in Paris gained the upper hand, and sent Commissioners to him at St. Amand to depose him from his command. He refused to accept the decision, and arrested the bearers of the message; but after he had entered into negociations with the Austrians, his army deserted him and he fled, eventually finding an asylum in England.

Here he *offered* his services to the War Office, and appears to have been for some time in receipt of pay from the British Government. His intimate knowledge *of* the French Army, and his previous study of the question of invading England, made his advice on the subject of a Defence scheme of the greatest value: while his hatred for Bonaparte acted as a spur to his efforts.

His detailed scheme for the defence of our coast is given in full, and is of great interest.

He anticipated having to deal with about 50,000 hostile troops, and to meet them he proposed to divide England into six military districts, and the 600,000 men then available in England into divisions of about 12,000 each: some *to* be stationary, to oppose landings, others to be mobile and to be ready to concentrate rapidly at threatened points. He draws particular attention to the dangers of a purely passive defence.

The maps are good, but a plan of the Battle of Valmy on a larger scale than the one provided would have been an improvement.

THE LIFE OF JOACHIM MURAT (1767—1815). Vol. I. (Joachim Murat (1767—1815)). By Prince Murat, with an introduction and notes by Paul Le Brethon. 550 pp., with portrait and facsimiles. 8vo. Paris, 1908. Plon-Nourrit. 6s.

This work is of considerable interest, as it contains a number of documents and family papers which throw a clear light upon the career of the unfortunate King of Naples, and upon the campaigns in which he took part. The first volume deals with the early portion of Murat's career, up to 1801, and more especially with the campaigns in Italy and in Egypt.

ENGLISH AND FRENCH (Anglais et Français). By General Zurlinden. 152 pp. 8vo. Paris, 1908. Lavauzelle. 2s. 8d.

The author of this book is the famous French ex-War Minister. In the first part of the book he points out that, although England and France have been constantly at war in the past, the time seems to be now not far off when they may be fighting side by side as in the Crimea. The writer has therefore thought it would be of interest if he gave his countrymen some idea of the special qualities which the British race has displayed in past wars. For this purpose he has made a special study of the Histories of England written by Hume and Lingard, and he places the result of his labours before his readers. In the second part of the book General Zurlinden deals with the Battle of Fontenoy, upon which he professes to throw fresh light. In the third part the writer discusses the Battles of Ligny and Waterloo, and explains what he thinks were the causes of the French disasters in 1815.

INFLUENCE OF FORTRESSES IN MILITARY OPERATIONS; THEIR ADVANTAGES AND DISADVANTAGES, AS ILLUSTRATED BY THE EXAMPLE OF THE VENETIAN QUADRILATERAL (Schädlicher und nützlicher Einfluss der Festungen auf die Kriegführung). By P. Rath (Captain, Austro-Hungarian General Staff). 316 pp., with 4 maps. 8vo. Vienna, 1909. Seidel. 6s.

This work deals with the many campaigns centring round the Venetian fortresses, from the time of Napoleon, 1796, up to the modern events of 1865, when Venetia was finally wrested from Austria.

Apart from opinions as to the value of fortresses on a campaign generally, the actual fate of the various fortresses of the Quadrilateral is interesting. To take the case of Mantua, for example, this place changed hands five times, while the statistics show remarkable variations in garrisons, investing force, and relative proportion of one to the other.

THE LIFE OF HENRY PELHAM, FIFTH DUKE OF NEWCASTLE, 1811—1864. By J. Martineau. 334 pp., with index. 8vo. London, 1908. Murray. 12s.

This book contains an interesting and careful biographical study of the Duke of Newcastle, who held the important offices of Secretary of State for War in Lord Aberdeen's Coalition Government of 1852 and Colonial Secretary in Lord Palmerston's Administration of 1859.

From a military point of view the greatest interest centres in the correspondence which passed whilst he held the former office and was responsible for the preparation for, and conduct of the Crimean Expedition. It is clear that this War was due to popular clamour and not to any political necessity, but it is equally evident that the Government was as ignorant of the state of the Army as they were ill-informed of the theatre of war, defences, and strength of the enemy. The advance into the Crimea was determined on in opposition to the judgment of both the English and French Generals and Admirals who were on the spot and whose military and naval experience was allowed to count for nothing.

In the famous despatch of the 29th June, 1854, urging the advance upon Sebastopol, the Duke only acted as spokesman for the Cabinet, but for the subsequent communications to Lord Raglan he is solely responsible, and it is evident that he failed to realize the great difficulties of the situation in which the latter was placed. The Commander-in-Chief was inundated with letters of advice and warning, even on small matters of detail, which must have seriously handicapped him in attending to the more serious matters which urgently demanded his closest consideration.

Too late it was realized by the responsible Minister that the expedition, despatched more or less as a flying column, and equipped as such, was in reality a serious undertaking, demanding the resources of a well-equipped army, supplied with all the necessaries for a long winter campaign and the siege of a formidable fortress.

That the result of the expedition was not as disastrous as it might have been was due to the endurance and pluck of the Army in the field, and not to the foresight of those responsible for the hardships to which it was subjected.

As Colonial Secretary the Duke of Newcastle appears to have profited by the experience of the Crimean War. During the war in New Zealand in 1861 he writes to Colonel Gore Browne, the Governor:—

"Each succeeding mail from New Zealand has more and more convinced me of the danger of laying down at this distance any precise instructions, either for your guidance or that of the military authorities. . . . I should be running a great risk of complicating the already serious difficulties of the Colony if I attempted to regulate affairs by didactic despatches which require more than two months for their transmission."

Mr. Martineau adds:—

"Would that the same temper had oftener been displayed by other chiefs in letters from the Colonial Office."

THE PANMURE PAPERS. Edited by Sir J. Douglas, Bart., and Sir G. D. Ramsay, C.B. Vol. I., 515 pp.; Vol. II., 533 pp. 8vo. London, 1908. Hodder & Stoughton. 24s.

The large selection of letters which have here been brought together deal mainly with the later stages of the Crimean War, during which Lord Panmure held the office of Secretary of State for War in Lord Palmerston's Ministry formed in February, 1855.

The moment at which Lord Panmure was summoned to the administration of the War Department was one of great national stress. The Army of the Crimea had reached the lowest depths of misery, and that Lord Panmure fully realized the cause of this may be seen in a paper written by him shortly after taking office, in which he says:—

"Our Army is a mere aggregate of battalions, . . . The regimental system is as nearly perfect as it can be. The system by which an army should be provisioned, moved, brought to act in the field and in the trenches, taught to attack or defend, is non-existent. All that was done in the Peninsula by the Duke of Wellington was frittered away and lost by a false economy forced upon us by successive Governments, and which we never have had the courage to resist.

Having noticed the defects in the Army system then in force, he at once set about establishing a better order of things in the Crimea and devoted special attention to matters vitally concerning the efficiency of an army in the field—"land transport, scavenging, sanitation, commissariat and the medical department."

The result was that the second winter spent on the heights of Sebastopol was very different from the first, and the army passed to a condition of efficiency both in camp and in the field. From the correspondence which took place between the Secretary of State for War and the British Officers who successively commanded the Expedition, it will be seen that too much credence was given by the former to camp gossip and idle rumours, with the result that the latter, although already heavily burdened with responsibilities, and surrounded with troubles due to the short-sightedness of the Government and to no fault of his own, was still further hindered in his onerous task. The editors of these papers point out that the letters now made public modify considerably the view which Kinglake took of the relations between Lord Panmure and Lord Raglan, but it appears that the practice of softening the harsh tone of the official communications by private letters of a friendly description was not satisfactory and did not entirely remove the impression that the Government was dissatisfied with him.

Nevertheless, Lord Panmure may justly be said to be one of the first who helped to reform the British Army in accordance with the requirements of modern warfare, and the impression conveyed of him is that of an exceptionally able administrator. To anyone who wants to know the inner history, diplomatic and military, of the Crimean War this publication will prove of the greatest value, as also to the student of the evolution of the British Army. It was under Lord Panmure's administration that the Office of Chief of the Staff was originated.

These papers should be read in conjunction with "Life of the Duke of Newcastle."

THE INDIAN MUTINY, 1857. A Sketch of the Principal Military Events. By Capt. F. R. Sedgwick, R.F.A. 160 pp., with 5 maps and 4 appendices. 8vo. London, 1909. Forster & Groom. 5s.

This book has been written to meet the want of military students of a concise account of the purely military events in India in 1857-58. It shows much more clearly than do fuller histories of the Mutiny the connection between the different series of operations, and the use made of the widely divergent bases of operations in the North-West, East, and South for concentration upon the area of revolt.

The accounts of many actions won against overwhelming numbers teach the effect of audacious leading against Asiatics, and show how possible and necessary it may be in such warfare to act in defiance of generally accepted rules.

The book opens with an Introduction on the subject of Small Wars, and closes with a brief consideration of the effect which the existence of the present system of railways in India might have had upon the progress of the campaign.

FRONTIER DETACHMENTS (Grenz-Detachements). By General v. Verdy du Vernois. 393 pp., with maps. 8vo. Berlin, 1908. Mittler. 8s. 6d.

This is a reprint, under a new title, of the first part of the author's "Studien über den Krieg" (Studies of War), which was published in 1892. It deals with the situation and events near the frontier during the early stages of the war of 1870-71. The general situation is first passed under review, and the tasks devolving on the various detachments near the frontier are then discussed.

THE LEADERS OF THE GERMAN ARMIES IN 1870 (Le haut commandement des armées allemandes en 1870). By Lieut.-Colonel Rousset, former Professor at the French Staff College. 340 pp., with a map. 8vo. Paris, 1908. Plon-Nourrit. 3s.

The author of this book is well known in English military circles, as he gave a lecture in London last June in connection with the organization of artillery for the Territorial Army.

In publishing this volume, Colonel Rousset has endeavoured to show that the German victories in 1870 were principally due to good fortune, and were not gained by any great strategical skill or tactical superiority. He certainly succeeds in exposing grave dissensions among the Prussian leaders and serious errors in the conduct of the campaign, but he does not appear to have made sufficient allowance for Moltke's difficulties nor for the fact that many apparent mistakes were committed deliberately, as a result of the evident incapacity of certain French generals.

At the same time, Colonel Rousset has made it quite clear that the Germans owed a great deal to good fortune, and that the mistakes made by the French leaders were quite extraordinary, and are most unlikely to be repeated. He has performed excellent service for his country by showing that there is no cause for Frenchmen to despair of the result of a future war, provided that a true military spirit be kept alive in France.

The book draws practically all its material from German sources, and many of the extracts and quotations are of great interest, especially the appendix dealing at considerable length with the memoirs of Prince Kraft von Hohenlohe-Ingelfingen. The importance of these memoirs has been overshadowed by those of the Prussian Chancellor, Prince Hohenlohe, but they are nevertheless of great value, as they give a clear insight into the methods adopted by Germany in preparing for war, and into the thoroughness of her preparations.

Colonel Rousset's work is most interesting, and can be recommended to all students of military history, and more especially of the Franco-German War of 1870–71.

THE RUSSO-JAPANESE WAR, 1904. By Capt. F. R. Sedgwick, R.F.A. 192 pp., with 12 maps. London, 1909. Swan, Sonnenschein & Co. 5s.

This book belongs to the *Special Campaign Series* and covers the same period as the two parts already issued of the *Official History of the Russo-Japanese War*, but in value cannot be compared to the latter.

INFLUENCE OF THE EXPERIENCE OF THE SIEGE OF PORT ARTHUR UPON THE CONSTRUCTION OF MODERN FORTRESSES. By A. von Schwartz. Translated by the General Staff, U.S.A. 178 pp. Royal 8vo. Washington, 1908.

The author, a lieutenant-colonel in the Russian Engineers, was responsible during the siege for a considerable section of the defences on the north-east front, so that his comments may be taken as those of an eye-witness with a professional knowledge of his subject.

Chapter I. deals with the main features of modern land fortresses, and points out some peculiarities of the German and French systems as compared with the Russian.

Chapter II. describes the plan of the fortress of Port Arthur under three headings, viz. :—(1), The original plan ; (2), modifications and alterations before the war ; and (3), the condition of the fortress during mobilization and throughout the siege.

The defensive works, according to the original plan, were to consist of a row of coast batteries, a line of land fortifications on the advanced heights (divided into the north-east, north and west fronts), and a central enceinte surrounding the old city.

The armament was to consist of 541 guns and 40 machine guns. The west front was considered the weakest, owing to want of mutual support and the proximity of commanding heights at short range from the north-west.

In 1899 Colonel Velichko worked out a revised plan for the defence of Port Arthur, which was rational enough, but which, owing to various unforeseen circumstances, was not carried out in its entirety before the outbreak of the war.

Chapter III. describes the condition of the fortress at the beginning of the investment, and the strength and armament of the opposing forces. The outbreak of hostilities found the defences in a state of unpreparedness, which necessitated hasty additions during mobilization. The "work was done with feverish haste and with no semblance of order, and the quality suffered in consequence."

The chaos which existed at Port Arthur on the outbreak of the war was due to the absence of a preconceived plan of action in the event of a sudden mobilization.

Some of the most glaring of the defects were the weakness of the defences of the Ta-ku-shan and Hsiao-ku-shan Hills, the insufficient distance ($\frac{3}{4}$ to $2\frac{1}{2}$ miles) of the forts from the centre of the city, the exposed positions of the interior communications, absence of field-railways, balloons, underground telephones, observation stations, etc., etc.

Chapter IV. quotes incidents in the siege to prove the importance of advanced positions and constant observation of the intervals between forts and the necessity for covering such intervals with rifle fire.

Chapter V. discusses the question of the length of the intervals between forts. In the author's opinion these intervals should not exceed $1\frac{1}{3}$ miles, in order to ensure adequate mutual support from rifle fire.

In Chapter VI. the author emphasizes the need for field-railways in the interior of fortresses to facilitate the transport of ammunition and engineer material.

In Port Arthur, during mobilization, 12,000,000 lbs. of engineer material had to be carried along a line of defence 12 miles in length. There were no railways, and the roads, by which the carts moved, were exposed to the enemy's fire.

Search lights played but a secondary part in the defence of Port Arthur, owing to the insufficient number available and the lack of practice in using them. The siege, however, demonstrated their great importance.

Chapter VII. gives the strength of the garrison of Port Arthur as originally intended and as it was during the siege.

The garrison was originally fixed at 11,300 men, or 1,130 men per mile of perimeter.

When the investment began, the garrison numbered 41,016 men, of which 34,503 were combatants fit for duty, 4,189 non-combatants, and 2,324 sick in hospital.

Including the naval brigade and citizen companies, the total force amounted to about 50,000 men.

Chapter VIII. deals with details of the construction of modern fortresses.

In Chapter IX. the author suggests a plan for a fortress based on the lessons to be learnt from the Siege of Port Arthur.

Chapter X. concludes with the statement that the Siege of Port Arthur "showed decisively that the fate of a modern fortress is decided on the line of forts."

Good maps and diagrams are attached.

POLITICAL.

THE RIVALRY OF RUSSIA AND ENGLAND IN CENTRAL ASIA. By M. Grulev. 380 pp., with 3 maps (1 coloured). 8vo. St. Petersburg, 1909. V. Berezovski. 6s. 3d.

The author served for 14 years on the General Staff in Central Asia and the Far East.

The professed object of this book is to educate Russian public opinion to some grasp of the danger of a forward policy in Central Asia. That expert opinion has undergone a change as a result of the disastrous outcome of the policy of adventure in the Far East is proved by a quotation from Kuropatkin's book on the recent war. The originator of the Kushk Branch and the founder of the Termez Post is now of opinion that "the recent sacrifices and risks in the Far East should make Russians pause to think, when led away by dreams of an outlet on the Indian Ocean, an attempt to gain which would lead to a war with Great Britain even more useless and horrible than the late war with Japan."

The first seven chapters are devoted to a statement of the problems in Central Asia from the point of view of a Russian staff officer. In the last two chapters an appeal is made to the Russian Government to abandon its traditional policy and to content itself with the development of the resources of Russian Central Asia, where Ferghana, the greatest cotton-producing district of the Empire, is without roads, while money has been squandered on works of purely strategic object like the Kushk Branch.

It is a matter for regret, in view of the laudable object of the book, that the author in these last chapters has not fairly stated and faced the main problem. He contents himself by proving by means of copious extracts from an English writer that the Indian Empire cannot be conquered by an expeditionary force equipped with pack transport.

The first chapters contain much of interest.

The author is of opinion that while owing to transport difficulties the main effort against India can never be directed through the Pamirs, still in case of war a diversion should be made on this line by a force of the strength of a brigade of rifles with mountain artillery to cause the British to detach from their main front. He bases this opinion on the supposed direct connection between the first occupation of the Pamirs by Russia and the general revolt of the frontier tribes in 1897.

A gloomy picture is drawn of the State of Bokhara. Russian protection, limited by the policy of non-interference in civil administration, has proved an unmitigated evil. During the 36 years the Protectorate has lasted, the condition of the country has grown steadily worse. The people are powerless to rebel against the over-taxation of a government which is supported by the Russian garrisons at Charjui, Kerki, and Termez. Meanwhile the revenue is wasted by the Amir in maintaining a useless army, and squandered by the district officials in large studs of Arab horses and enormous harems.

The author thinks that a Russian railway through Persia to the Gulf would only be of value to Russia if she had command of the sea. Under present conditions it would be a convenience merely for British trade. He advocates the continuation of the line from Julfa by Tabriz, Teheran, and Meshed to Kushk. It is stated that the miserable conditions now ruling in Persia cause the long-suffering people to pray for Russian intervention. "In a stroll through the bazaars of Teheran, the continual cry of the people is heard:—'O Allah, when will there be an end to all this? When will the Russians come?' And the cry grows daily louder and more persistent." The author is unable to believe that the present policy of co-operation in Persia can last long, though the "two European powers now seem to be impartial spectators imbued with mutual *official* trust" It will be news to English readers that some of the employees of the Indo-European Telegraph Company in Persia are officers of the Indian Army.

Similarly the information regarding India is often inaccurate. We read that the Indian Government quarrelled with the Maharajah of Kashmir in 1895 and took over the government of the country. The *Civil and Military Gazette* is quoted as "the recognized official organ of the Commander-in-Chief in India."

With regard to our military policy towards the frontier tribes the writer says: "The more these tribes fight with the English the keener does their taste for rebellion become. They willingly take up arms once more and use their experience to foment disaffection among tribes less experienced and less decided in character."

The map of Central Asia is clear but inaccurate.

NAVAL.

GERMANY'S FLEET IN BATTLE (Deutschland's Flotte im Kampf). By Capt. Graf Bernstorff, German Imperial Navy. 208 pp. 8vo. Minden and Leipzig, 1909. Wilhelm Kohler. 3s.

The writer conceives a war between Germany and Great Britain, brought about by the Government of the latter country presenting an ultimatum demanding that Germany should abandon her position in the *tri plice* and offering in return certain guarantees as regards the North Sea and Baltic littorals and the integrity of the German Protectorates.

The German Government answers by declaring war, which declaration is preceded by the despatch of mine ships to the English Channel and a submarine to the Straits of Gibraltar. Much damage is done to British war shipping by these means, and in the great naval battle which takes place off Heligoland between the two belligerents, the British Navy is defeated, and the remnants seek shelter in British ports, pursued by the crippled German fleet. An allied Power to Great Britain, presumably France, interposes her fleet between the flying British ships and their pursuers, and so prevents the utter downfall of Great Britain.

The story is graphically told and written by an officer on the active list of the German Imperial Navy; it is possible that his ideas regarding the extensive use of mines and submarines in war reflect those of the German naval authorities on the subject.

STRATEGICAL AND TACTICAL.

MODERN WAR (Der Krieg in der Gegenwart). Unsigned article from the *Deutsche Revue*. January, 1909.

This article, popularly attributed to Field Marshal Count Schlieffen, created some sensation owing to the German Emperor's reference to it in his New Year's speech.

A translation of the article appears in the February number of the *National Review*, and is divided into two portions; the first tactical, the second political.

The following is a summary of the first portion.

The Peace of Frankfort put an end to the struggle between Germany and France in appearance only.

One of the two opponents invented improved weapons, but could be sure that the other would before long discover still more perfect ones. The only endeavour has been to obtain, for the impending war of revenge, some advantage over the outwitted enemy by means of a superior weapon. In the course of years there have been moments when one of the two opponents thought to have attained his object, when it only remained to him to utilize the favourable moment. There were, however, other considerations, and owing to hesitation the enemy was allowed to make good the lost ground. The other powers have not been able to remain indifferent spectators of this competition, but it has been enough for them to profit by the experience and outlay of the others. Not only in Europe, but also in the Far East and West the Franco-German quarrel has resulted in most armies being equipped with arms of great efficiency and of almost equal value.

The author describes the murderous effect of modern firearms, and points to losses of 68 per cent. in France and 90 per cent. in Manchuria. The technique of arms has had great triumphs, but the object of all the Powers, namely, a diminution of the difficulties of war and superiority over the enemy, has not been attained—on the contrary greater difficulties and more serious drawbacks have been produced. It is easy enough to say how the foe is to be swept down, but how to escape annihilation one's self is not easy to determine. A complete change has become necessary in tactics, for those of Frederick and Napoleon would lead to the troops being swept off the face of the earth. It is not even possible to overpower the enemy by dense lines of skirmishers. It is only by the use of the cover afforded by trees, walls, houses, and ditches, by elevations and depressions, that the infantry soldier can get near his foe. Lying, kneeling, and standing alternately he must, without exposing himself, endeavour to hit the small target presented;

he must beat down the hostile fire with his own, then quickly take some new cover and commence the struggle anew. But whatever cover the terrain may offer, sooner or later he will be separated from the enemy by an open space; if this be narrow the assailant may dash across it, but if it be broad he must seek cover with the help of his spade and advance from one line of trenches to another, and, if necessary, by night.

It is the business of the artillery to help the advance of the infantry and to destroy the enemy and his cover, and as it is not so easy to hide guns as men, an attempt has been made to protect the former with shields.

In order to get sufficient cover to fire in security and to advance rapidly, the infantry soldier requires elbow-room, and he can only fight effectively in thin lines with not more than one man to the mètre. Other lines follow at some distance and draw together when cover permits of it. They are needed to replace losses and to meet unforeseen occurrences. It is only for the final attack that the reserves which have followed steadily in rear come up to the thin front line. Thus a direct result of the improvement in firearms is a great extension of fronts. Up to 40 years ago 10 men per pace was considered normal, while in the war in East Asia in 1904-5 it was usual to allot three men per mètre, or even less at a pinch. Neither of the opponents had any preconceived theory—these extended fronts were brought about by force of circumstances, and there is little doubt that the same thing would occur in a European war. Armies of the strength of those which fought at Sadowa and Gravelotte will take more than four times as much room.

Universal service was 40 years ago the speciality of Prussia, and no other State envied this narrow-minded military power; since 1866 and 1870 nearly all Powers have hastened to appropriate this secret of victory, and every healthy youth is sent to the colours. Germany and France have respectively 4,750,000 and 5,500,000 men. These numbers are, however, more or less imaginary, and the author depicts at length the inefficiency of the reservist suddenly drawn from private life. The numbers would not be united in a single fight, and the writer describes with some detail how little will be visible to the participant in a modern battle, and how the modern general will command in a roomy house surrounded by telegraphs and other signalling apparatus, with motor vehicles of all kinds at his disposal. He describes the course of a battle and the arrival of reports of the increasing strength of the enemy, coupled with demands for reinforcements, which the general will not be able to send, not only on account of the distance they would have to go, but on account of the lack of room in the firing line.

"The essential task of the leader is fulfilled when, long before the encounter is possible, he has pointed out to all armies and corps the lines of their advance and the points they are expected to reach day by day. The assembling for the combat commences when the men leave the railway.

"As the frontage is greater than formerly the troops will be able to march on fronts at least as great as those which they will occupy in the battle, and the concentration for the battle has lost a good deal of its former importance. Those corps which get into touch with the enemy will not be able to count on being supported. With 144 excellent guns and 25,000 excellent rifles each corps will be able to do at least 10 times as much as in the days of the muzzle loader. If a corps nowadays takes up a front three times as great as 40 years ago it is not splitting up its forces, but increasing its strength. With such a front it is well able to attack, to hold what it gains, to meet losses of 50 per cent. and yet to keep a reserve in hand for the final assault on the hostile position. Not, however, that it will be an easy task to advance from cover to cover, to creep up to the enemy's position, to persevere by night and by day, and to be ready at all times to repel a counter-attack."

All armies will not take part in the battle on the first day, and the battle of the future will last for several days, on each of which the commander will demand new sacrifices from those already taking part in it. The author refers to Leipzig, Le Mans, Orleans, and Mukden. "These long-drawn fights will be less bloody than those in the past; thus those in the Manchurian Campaign cost only 2 or 3 per cent. compared to the 40 and 50 per cent. of the days of Frederick and Napoleon, and the 14 days at Mukden cost the Russians and Japanese less than a few hours at Mars la Tour did the French and Germans.

"The Russo-Japanese War has proved that in spite of all difficulties a mere frontal attack may succeed, but its results will be only small, and the enemy, though he may

withdraw, will soon offer fresh resistance—and so the war drags on. Wars of this kind are, however, impossible at a time when the existence of a nation is dependent on the uninterrupted continuation of commerce and industry, and when a rapid decision is imperative in order to permit of trade machinery being again set in motion. Strategy based on wearing out the enemy is out of the question when the existence of millions of men means the expenditure of milliards. To obtain a decisive and annihilating result the front and one or both of the flanks must be attacked, and this is comparatively easy to carry out if one side is much stronger than the other. This marked superiority cannot now be always counted on, and in order to get the numbers for a strong flank attack, those opposed to the front must be reduced as much as possible, but never so much that they can only hold the enemy—it is imperative that the front be attacked. The quick-firing, long-ranging rifle is specially adapted for this purpose, provided the necessary ammunition be forthcoming, and it is better to have ample reserves of ammunition than reserves of men. Cartridges following the army in power-traction vehicles form the best and most reliable reserve, and the troops which formerly were kept in reserve in order to give the decisive stroke must now be moved to the attack of the flank from the very commencement. The stronger the troops available for this purpose the more decisive will it be."

The author lays stress on the importance of previous knowledge of the position of the flank, and describes how this reconnaissance—once the work of the cavalry—will in future be carried out by dirigibles and aeroplanes.

"The cavalry will now be free to bring the fire of its long-range carbines, its Maxims, and its artillery to bear on the rear of the enemy. It will have, however, to meet the hostile cavalry as before, ere it can carry out this duty; thus in the future, as in the past, artillery will have to fight artillery, cavalry cavalry (and balloons balloons), before they can in combination assist the infantry to win the final victory."

THE FRONTIERS OF FRANCE. 1ST VOLUME (Frontières Françaises. Tome premier). By Gustave Voulquin. 102 pp., with 14 maps and 14 engravings. 8vo. Paris, 1908. Bibliothèque Larousse. 1s.

This is the first of three volumes which are to deal with the defences of the French frontiers, and also those of the naval ports of France, Algeria, and Tunisia.

There is a preface by that distinguished member of the French Chamber of Deputies, Monsieur Pierre Baudin, in which it is explained that, at the present day, it is absolutely necessary that every Frenchman should have a general knowledge of the defences of his country, and at the same time should understand that no amount of fortification can render a country secure against attack, but, on the contrary, that the only true use of fortifications is as pivots of manœuvre for the Field Armies. It is with the object of enlightening the French "man in the street" on these points that this series of books is written. The present volume is divided into four parts. The first deals with the defences of the first line on the Northern Frontier, and the second part is concerned with similar defences on the Eastern Frontier, whilst in the third part a general description is given of the second line defences of these two frontiers, and the fourth part is devoted to an account of the Paris entrenched camp. The arrangement of each part is the same. First, the general configuration of the ground in each area is described, then the natural defences, and, finally, the artificial defences.

The volume is, of course, written on very general lines, but should answer its purpose well. The maps in the book are clear, and considerably elucidate the reading of the book.

ILLUSTRATIONS OF TACTICAL DETAILS FROM THE RUSSO-JAPANESE WAR (Taktische Detaildarstellungen aus dem Russisch-japanischen Kriege). Supplement to "Streffleur's Militärische Zeitschrift"—Part I. By Colonel Habermann and Capt. Nowak, working under the (Austrian) Chief of

the General Staff. 59 pp., with plans and landscape sketch in text, 6 appendices, maps, and photographs. 8vo. Vienna. Seidel. 1s. 8d.

It is explained in a preface to this work, that whereas the monographs on the Russo-Japanese War furnish a general outline of the campaign and are primarily intended for the study of higher leading, the detailed illustrations supply a want much felt by regimental and departmental officers.

The first portion of the book deals with the night attack of the Russians on the Motienling Pass on July 4th, 1904. The description of this operation is admirably clear, and is supplemented by excellent maps and sketches. A criticism follows.

The second portion is devoted to a description of the fighting around Mukden, taken from the diary of the Austrian Capt. Franz, who was attached to the 5th Japanese Division. Capt. Franz witnessed several infantry attacks from a position immediately in rear of the advancing Japanese troops, and gives a most realistic account of what he saw. The narrative is supplemented by some excellent photographs, with a note at the bottom of each to the page in the text which refers to the illustration.

Capt. Franz mentions the small effect of artillery fire and the fact that several Japanese soldiers were killed by grenades which they were carrying.

Officers who can read German will find this book of great assistance in bringing home to those under them some lessons of the most recent great war.

TRAINING AND EDUCATION.

Tactical Problems for Manœuvres and War Games (Taktische Aufgaben für Übungen und Kriegsspiel). By Major Immanuel. 3rd edition, re-written throughout. 431 pp., with 4 maps and 2 sketch maps in pocket. 8vo. Berlin, 1909. Mittler. 10s.

In this edition the number of problems has been reduced from 225 to 110, and a complete solution of each problem is given. The first 144 pages are devoted to the statement of the problems, the following 287 pages to their solution. The problems are practical and instructive, and the solutions are not merely dry answers, but lucidly reasoned appreciations. The detail given in the answers is throughout in accordance with the latest German official publications. The problems are divided into sections dealing with the following subjects:—Combats; entrenched positions; marches, reconnaissance, and screening; cessation of operations; outposts, quarters, and supply; minor operations; and guarding a frontier. Each section contains problems in which forces of different strength are employed. Except in the section concerned with minor operations, the forces range from a small mixed force (battalion, battery, and squadron) to an army corps.

Ten of the 61 problems in the first section refer to the battle of encounter. In most cases the problem is in duplicate, that is, it has to be solved by both the opposing commanders. Numerous cavalry problems are given, but the artillery are not separately considered. The four large maps which accompany the book are on a scale of about 1½ miles to the inch, and represent districts on the Franco-German and Russo-German frontiers.

The Science of Writing Orders in the Higher Command Staffs (Die Befehlstechnik bei den höheren Kommandobehörden). 2nd edition. Anonymous. 92 pp. 8vo. Oldenburg. Gerhard Stalling. 2s.

This exceedingly useful book on the writing of orders has been written for the use of candidates presenting themselves for examination for the Staff College, and for use in working out tactical schemes, during tactical tours, staff rides, and war games.

Some useful hints are given as how to solve tactical schemes, to write an appreciation, and to draw up orders.

Examples of orders issued by army, army corps, divisional, and cavalry divisional commanders for various situations are given in detail.

FORTIFICATION AND MILITARY ENGINEERING.

A STUDY OF THE RÔLE OF ENGINEERS IN THE FIELD (Étude sur le rôle du génie en campagne). By Lieut.-Colonel Klein. 238 pp., with 6 plates. Paris, 1908. Berger-Levrault. 4s. 4d.

The author of this book disclaims any intention of advocating the use of the defensive. On the contrary he declares that his object in writing is to show how the engineer can help his General by enabling him to occupy a considerable tract of country with a small force, thereby leaving more men available for the offensive. To illustrate his meaning the author takes the first three weeks of the Franco-German War of 1870-71 and, with the object of showing how *different* things might have been if intelligent use had been made of fortification, describes in detail the general situation of the opposing forces at the commencement of hostilities, the Battle of Weissembourg, the concentration of the French Army, and the Battle of Woerth. The last three chapters of the book are devoted to notes on the establishment of pivots of manœuvre, the preparation of the battlefield, and the utilization of the resources of the engineers.

The writer comes to the conclusion that, in order to enable the engineers to carry out their *rôle* properly on the battlefield, it is necessary to have (*a*) an officer in command of the engineers who can at once make up his mind how best to assist in carrying out the plans of the Commander-in-Chief; (*b*), an Engineer Staff who can recognize what engineer works are necessary to meet any tactical situation; and (*c*), a specially selected engineer *personnel*.

AERIAL NAVIGATION.

AERIAL WARFARE. By R. P. Hearne. 231 pp. 8vo. London, 1909. T. Lane. 7s. 6d.

This volume contains a detailed description of all forms of aerial navigation from its inception up to the present time, and gives recorded performances of dirigible balloons and aeroplanes. The author considers that the strides that have been made in aerial navigation during the last few years are so great that it is only reasonable to expect an extraordinary development within the near future. He maintains that the actual use of airships in war, even in their present state, would be very great, and that shortly a first-class power, wherever it may be situated, will not be able to do without them.

When a satisfactory pattern of airship has been designed the construction of a fleet of them will not be a costly or lengthy proceeding, but, the author holds, that unless a staff with practical experience in building and operating vessels is available, it will be impossible to construct anything of the sort at short notice.

Mr. Hearne discusses in detail the uses to which airships are likely to be put when introduced into practical warfare, and the damage which a small fleet could do with comparatively little risk. He concludes with a strong appeal for the formation of an Aerial Defence League, for which he thinks the time has now come. In the introduction Sir Hiram Maxim gives it as his opinion that eventually airships will stand a very poor chance against aeroplanes, but he fully agrees with the author in considering that flying machines have come to stay and "that measures should be taken to put us abreast with other nations."

The volume has numerous excellent photographs of the various types of vessels and is well worth study, though possibly from a military point it might with advantage have been somewhat curtailed.

INSTRUCTIONS FOR THE SERVICE OF MILITARY AEROSTATICS (Instruction pratique sur le service des Aerostats Militaires). Official. Three vols. of 90, 140, and 132 pp. respectively. 8vo. Paris, 1908. Lavauzelle. 6s. 6d.

These are the latest instructions on Aerostatics issued to the French Army. They are in three volumes and deal in great detail with all matters connected with military

ballooning, exclusive of dirigibles and aeroplanes. The first volume deals with the general principles of aerostatics and gives descriptions of all material. The second and third volumes contain chapters on—

"Manipulations de détail."
"Manœuvres sans gonflement."
"Gonflements."
"Manœuvres avec ballon gonflé.
"Transports de ballon gonflé"; and
"Ascensions Libres."

ORGANIZATION AND ADMINISTRATION.

THE GERMAN ARMY IN 1910 AND THE FRENCH ARMY AFTER THE RECENT CHANGES (L'armée allemande en 1910 et l'armée française d'après le projet du loi des cadres). By Capt. F. Culmann. 84 pp. 8vo. Paris, 1908. Berger-Levrault. 2s. 1d.

The author compares the number of the different units of both armies, and notices particularly the numerical superiority of the Germans in cavalry and artillery.

He then sketches the principles of French and German organization, and the changes resulting from the new law regulating military establishments in France.

Comparison is made of the number of infantry battalions existing at different periods in France and Germany, and the steady continuity of German policy is contrasted with the constant changes in France.

Separate chapters deal in detail with the comparison of French and German infantry, cavalry, artillery, and the question of machine guns and pom-poms is then discussed.

BOOKS OF REFERENCE.

MAPS OF EUROPEAN COUNTRIES USEFUL FOR MILITARY PURPOSES (Die militärisch wichtigsten Kartenwerke der Europäischen Staaten). Extracted from "Mitteilungen des Militärgeographischen Institutes." 238 pp., with 11 plates.

This is a useful summary of the principal maps in use in the various countries of Europe. The title of the map is followed in each case by a short paragraph giving particulars as to scale, style of execution, date of first issue, and method adopted for indicating differences of level.

MISCELLANEOUS.

TEXTS OF THE PEACE CONFERENCES AT THE HAGUE, 1899 AND 1907. Edited by James Brown Scott. 447 pp. 8vo. London, 1908. Ginn. 10s. 6d.

A useful book for the student of International Law, each text being conveniently printed with its English translation in parallel columns. There is an exhaustive index, which greatly adds to the value of the edition.

THE POWER TRANSPORT VEHICLE, WITHOUT RAILS, FROM A MILITARY POINT OF VIEW (Der gleislose Kraftwagen in Militärischer Beleuchtung). By W. Stavenhagen. 204 pp., with 11 plates. 8vo. Oldenburg, 1908. Stalling. 3s. 6d.

This book is described in the preface as a scientific treatise, in popular form, suitable for the study of officers of all arms, and for civilians conversant with military matters.

The contents are arranged in nine parts :—

Part I. is an introduction to the whole subject. Part II. describes the general principles of motor engines and the main characteristics of the different types of motor. The question of roads is discussed and some interesting figures are given for the coefficients of friction on various natures of roadway. This part concludes with some formulæ for the cost of running, tabulated according to speed, type of motor, and nature of the fuel employed.

Part III. is a history of the development of mechanical transport in various countries.

Part IV. deals with the employment of mechanical transport for military purposes. The history of some of the great campaigns from 1812 to 1905 is reviewed with a view to showing what great assistance an up-to-date mechanical transport train could have rendered in these wars.

The author then goes on to discuss the future of motor transport ; he considers that motor cars and motor bicycles will be of use for reconnaissance during the period of mobilization, while mechanical transport trains will perform great service in relieving the strain on railways at certain points, and in carrying on the work of supply, towards the frontier, from the points beyond which it becomes unsafe to use the railways.

For purposes of coast defence motor transport will be exceptionally useful, since there is often no railway available to hurry troops to oppose a threatened landing.

In field operations the greatest service that motor transport can perform is, however, the shortening of the road spaces of the supply columns. On this subject the author gives us some interesting calculations.

It is, however, in siege warfare that the author expects the greatest advantage from mechanical transport. Estimates are given showing the number of tons of ammunition that will be expended daily by a modern siege train, a total far in excess of the capacity of the horse-drawn vehicles available. Again, the materials for the construction of the siege batteries, which must be transported by night from railhead to the sites of the batteries, is estimated at 100 2-horse wagon-loads for one 4-gun battery. Hence for the construction of a line of batteries motor transport appears to be the only solution possible. It is suggested that motors on light rails should be used as tractors, and that in this way 400 guns with their ammunition could be placed in battery in one night.

Part V. contains some useful tables and formulæ. Parts VI. and VII. are appendices. Part VIII. is a supplement relating the progress of mechanical transport in Germany and other countries from 1907 to 1908. Part IX. contains diagrams and photographs of military motor vehicles.

SHEERNESS WATER SUPPLY.

FIG. I.

DIAGRAM OF NO. 1 WELL.

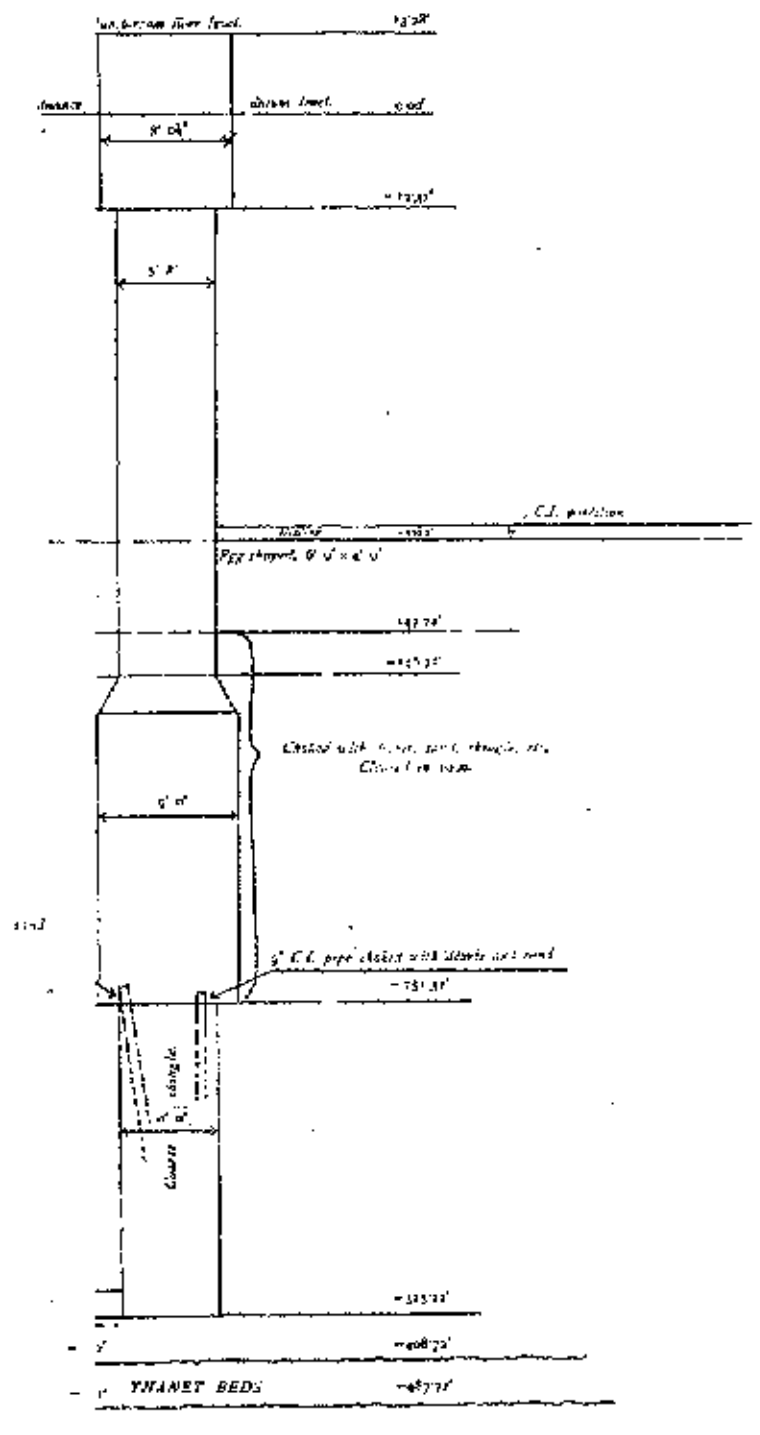


FIG. II.

DIAGRAM OF NO. 2 WELL.

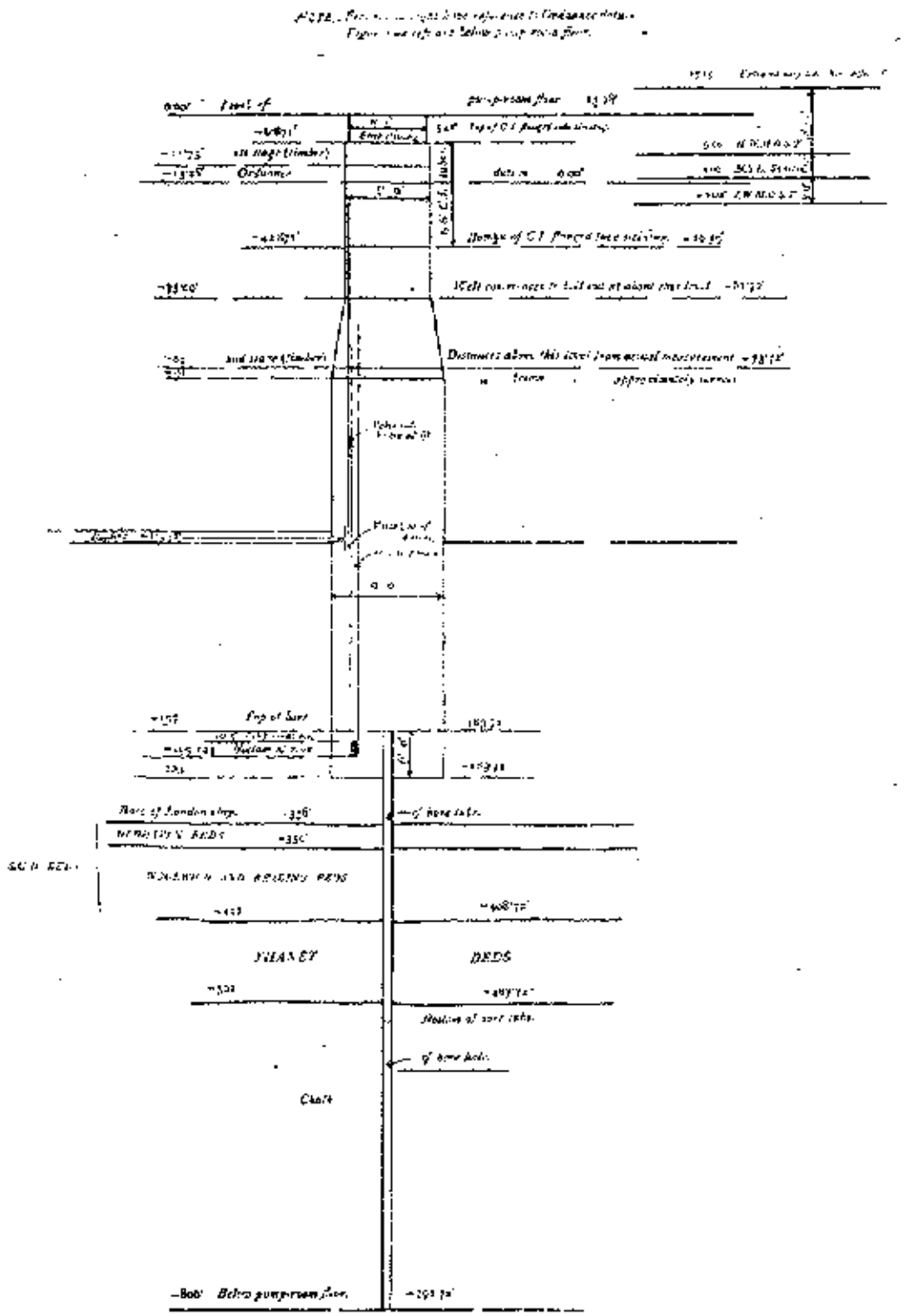
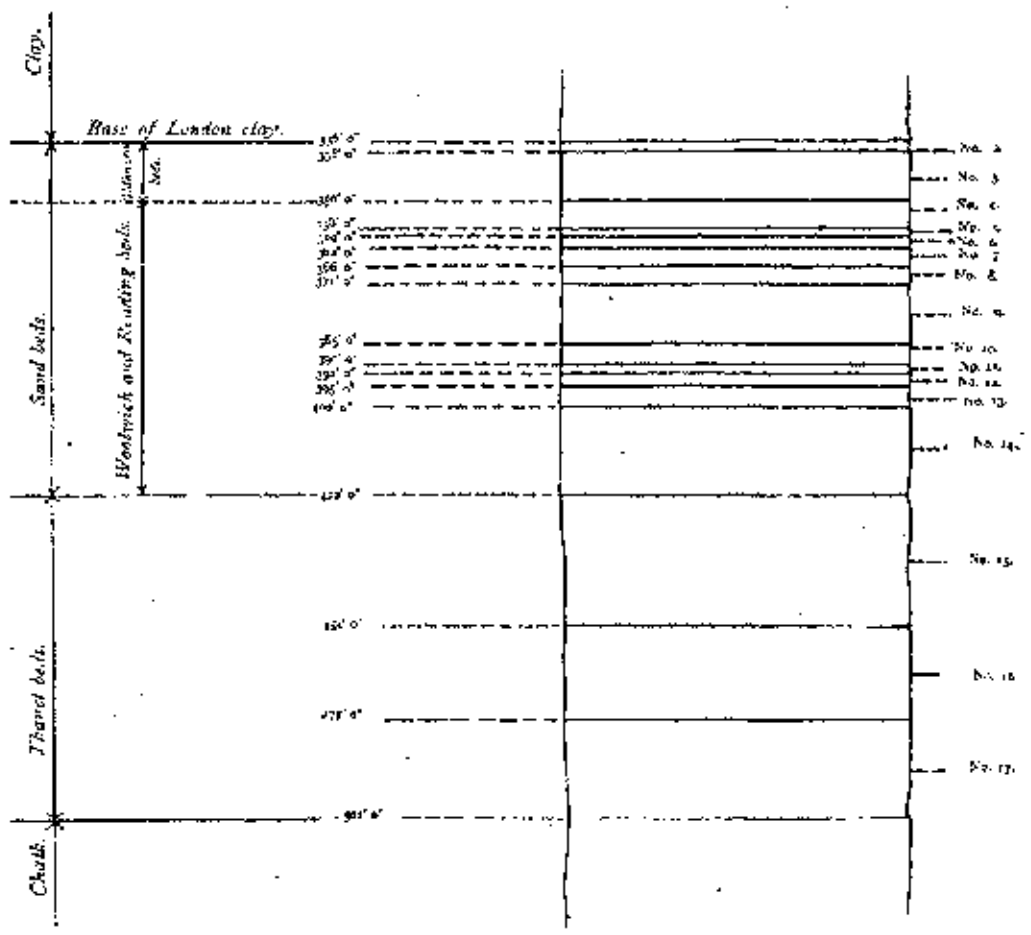


FIG. III.

DIAGRAM OF BORING OF NO. 2 WELL, SHOWING STRATA.



NO.	DESCRIPTION OF STRATA.	DEPTH, FT.
No. 1	Common clay from surface	336
,, 2	Black clay and sand	2
,, 3	Green sand and clay	12
,, 4	Grey sand	8
,, 5	Black sand	1
,, 6	Light clay	3
,, 7	Green sand	4
,, 8	Sand rock	5
,, 9	Green sand	14
,, 10	Grey sand	5
,, 11	Green loamy sand	2
,, 12	Dark grey sand	3
,, 13	Green sand	5
,, 14	Dark black sand	22
,, 15	Dark sand and rotten shells intermixed	32
,, 16	Soft sand rock	23
,, 17	Dark like sandy clay	24
,, 18	Chalk	305
		806

III Army

16th Corps

KUANDYATUN

3rd Armies

Boundary 2nd & 3rd Armies

R. Chaosuntai-ho

R. Chaosunta-ho

To Sta. Godzyadan.

CHANGTUN

1st Composite Rifle Corps

LAMATENZA

Siding

10th Corps

MAIMAIKAI

Army Staff

Supply Depot

Supply Depot 1st Comp. Rifle Corps

Maimaikai Sta.

Hospl Siding

Siding No 1

KARDYA

R. Tyaodzi-ho

6th Siberian Corps

Siding No 84

8th Corps

I Army

YINGIA

BAMIENCHEN

R. Tyaodzi-ho

R. Tsuni-ho

SHILIPU

HSIPINGAI

Hsipingai Sta.

Boundary

R. Tyaodzi-ho

DAVA

From Pabiatun

GENERAL PLAN
OF THE
HSIPINGAI POSITION
OF THE
2ND MANCHURIAN ARMY.

4 0 4 Versts