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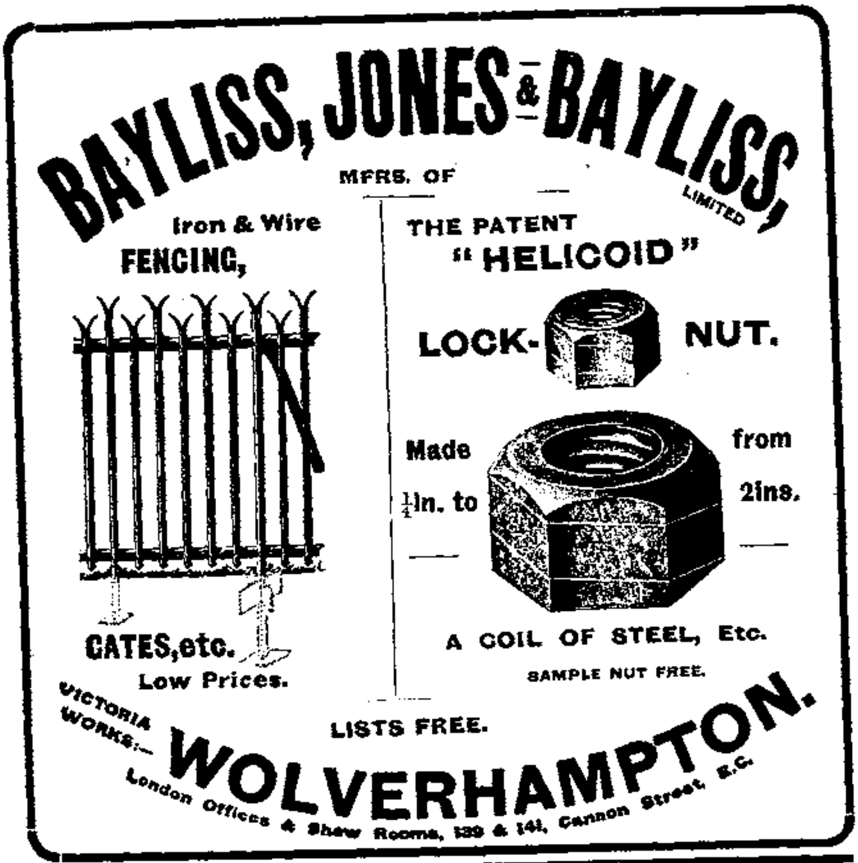

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TABLE SHOWING IN FT. THE HEAD OF WATER CONSUMED BY FRICTION IN EACH 100 FT. OF PIPE.

Delivery per Min. in Gallons.	INTERNAL DIAMR. OF PIPES IN INS.									
	½	¾	1	1½	2	2½	3	4	5	6
1	9·18	1·17	0·27	0·03	0·01	...	...	...	...	...
2	36·72	4·68	1·08	0·14	0·03	...	...	...	...	...
3	82·63	10·54	2·42	0·31	0·07	...	...	...	...	...
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6	...	42·16	9·68	1·23	0·28	0·09	...	...	...	...
8	...	74·96	17·21	2·19	0·50	0·16	...	...	...	...
10	...	117·12	26·90	3·42	0·78	0·25	0·06	...	...	...
12	...	...	38·73	4·93	1·13	0·36	0·09	...	...	...
15	...	...	60·52	7·70	1·76	0·56	0·14	...	...	...
20	...	...	107·59	13·70	3·14	0·99	0·25	0·06	...	...
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70	...	...	...	...	38·44	12·15	3·12	0·71	0·22	0·09
80	...	...	...	...	50·21	15·86	4·07	0·93	0·29	0·11
90	...	...	...	...	63·54	20·08	5·15	1·17	0·37	0·14
100	...	...	...	...	78·45	24·79	6·36	1·44	0·46	0·18
120	...	...	...	...	...	35·70	9·16	2·08	0·66	0·25
150	...	...	...	...	...	55·77	14·31	3·25	1·03	0·40
200	...	...	...	...	...	...	25·44	5·78	1·83	0·71
250	...	...	...	...	...	...	39·76	9·03	2·86	1·11
300	...	...	...	...	...	...	57·25	13·00	4·12	1·60
350	...	...	...	...	...	...	...	17·63	5·61	2·18
400	...	...	...	...	...	...	...	23·11	7·33	2·85
450	...	...	...	...	...	...	...	29·25	9·28	3·60
500	...	...	...	...	...	...	...	36·12	11·45	4·45

1. Electric Light Emplacement, with Fort Charles in background.

3. R.A. Store, Victoria Battery.

2. Railway in Submarine Mining Works.

4. Wreckage of N Barrack Hut.

EARTHQUAKE AT JAMAICA

NOTES ON THE JAMAICA EARTHQUAKE, 14th JANUARY, 1907.

I.—PORT ROYAL.

By CAPT. A. D. CARDEN, R.E.

To those who have been stationed in Jamaica, the accompanying photographs will give a fair idea of the extent of the damage caused by the recent earthquake.

As regards the coast line, a rough survey of the peninsular of Port Royal, made about a fortnight after the earthquake, showed that the shore had sunk and that the sea had encroached varying distances up to over a hundred yards all the way round from the Submarine Mining Pier by Nelson and Victoria batteries to the Lagoon (see sketch map at end).

The work of opening the Lagoon to the sea, unsuccessfully attempted some years ago by the Commodore of the Naval Yard, was accomplished on the 14th January, 1907, in the space of ten to twenty seconds; and so thoroughly that there is now a fair way, with upwards of three feet of water, extending about a third of the length of the lagoon. Port Royal, in fact, is now an island, united to the mainland only by the small bridge which is traversed by the military railway to Rocky Point.

Within a few weeks after the earthquake a small round pond was formed by silting up at the south-western end of the Lagoon (A in sketch map). This pond appears to be of considerable depth, notwithstanding that this end of the Lagoon was formerly quite shallow.

This is not the only instance of the formation of holes in the sand by the earthquake. Near the eastern end of the Palisadoes (the long spit of land which forms the southern boundary of Kingston harbour and at the western end of which is Port Royal) a series of fissures occurred in the sand parallel with the length of the spit. They were caused by the subsidence of the northern shore into the harbour. The surface being loose sand these fissures appeared merely as long furrows some two feet deep, but at intervals in the length of them small conical depressions were to be found. An ordinary walking-stick could quite easily be forced down into one of these depressions until it was completely buried, whereas a few feet away (but still in the main fissure) the stick would hardly go down more than a foot.

In connection with the subsidence of the foreshore at Port Royal it may be noted that the prevalent idea, that the great earthquake of 1692 caused a sinking on the harbour side whilst the land *rose* on the sea side, is entirely wrong. The fallacy probably started from a misreading of a plan of Port Royal showing the town before and after the great earthquake. (A copy is in the R.A. and R.E. Officers' Mess).

This plan was made in 1857, and shows the shore line as it then was. The line which marks the position of the shore immediately after the great earthquake has been almost obliterated, but it appears probable that the sea actually washed the walls of Fort Charles at that time. All the land to seaward of this wall was formed by the gradual receding of the sea in the years that followed. This receding has gone on continuously ever since; and now, though fifty to one hundred yards have been lost in this year's earthquake, there is still more land above water than there was in 1857.

It is a curious fact that prior to this last earthquake the receding of the sea—or the extension of the land—had apparently just reached its limit, for within a very few yards of the shore there was enough water to float a large ship, and it is difficult to see how any further extension of the land could have taken place.

Photo 1 shows the roof of one of the electric light emplacements. Before the earthquake this emplacement was some fifty yards from the sea; it is now nearly the same distance *in* the sea. Fort Charles, once commanded by Nelson, appears in the background. Though we had trained divers we had to obtain the services of divers from H.M.S. *Indefatigable* to salve the gear from this and another electric light emplacement; all our diving dresses, apparatus, etc., had been transferred to the Navy with the rest of the submarine mining stores. As may be imagined a week's immersion in sea water did the electric light gear no good. Some of the bolts and screws were all but dissolved.

Photo 2 shows a phenomenon which has excited considerable interest. On either side of the elevated portion of the railway seen in the photograph the sleepers remain apparently undisturbed in the ground. Unfortunately no one appears to have seen the contortion actually taking place. There were one or two men near the spot, but they were probably looking after themselves. There were quite a number of fissures in the ground to be avoided, and the sea washed up all round this spot, making it desirable to hurry away.

Several very sharp horizontal kinks were made in this railway line, which is about two miles long, but this is the only instance of the rails rising off the ground. The rails are by no means light—probably not less than 60 lb. a yard.

Photo 3 shows the R.A. store in Victoria Battery. The building was thrown about in a remarkable way, but does not show a crack anywhere. It does great credit to those who built it.

The whole of Victoria Battery was very badly wrecked. All masses of concrete and brick sank considerably in the sand on which the battery is built. The left-hand gun emplacement sank about 6½ feet. The shell and cartridge stores were flooded with about 2 to 3 feet of water, and a nice job the Native Company of Royal Garrison Artillery had to get everything out.

The native gunners were very useful also in getting parts of machinery, etc., etc., out of the water in our submerged stores. With the exception of crews for steamboats practically the whole of the R.E. Company was transferred to Up Park Camp, where there was enough work to occupy them for months; consequently we were very glad of the assistance of the gunners in saving what stores we could.

Photo 4 shows a portion of the wreckage of one of the R.E. Barrack Huts (X in sketch map). (Those who have been stationed at Port Royal will probably remember it as the "fever hut"—formerly the hospital). This hut was a single-storied building of wood and brick, raised off the ground on brick arches. Two large fissures were formed in the ground immediately under and running the whole length of the hut. The result was that the brick arches were thrown about in all directions, and the hut came down like a pack of cards.

The remainder of the barrack huts at Port Royal stood very well. The best design appeared to be the single-storied wood hut raised off the ground by short cast-iron columns resting on a concrete base covering the whole area under the hut. It is doubtful, however, if any building could have survived the shocks to which the "fever hut" was subjected. It is hard to expect a building to stand up when the ground departs from under it.

A good deal of discussion has taken place in the Jamaica papers as to the direction of the disturbance and its cause. A careful study of the damaged area as a whole might possibly lead to a theory which would have a large degree of probability, but it is doubtful if anyone has taken the trouble to collect the necessary data.

The most widely accepted idea is that probably the centre of the disturbance was under the ocean more or less south of Kingston. There certainly appears to have been a large fissure running more or less south from the eastern end of Kingston harbour, and the opening of this fissure may have caused waves of disturbance to travel eastwards and westwards. These waves no doubt broke up into subsidiary waves, which may have had any direction according to the varying resistances encountered.

There is no doubt that in Kingston it was the east and west walls of buildings which collapsed most readily. This was particularly noticeable in the churches, the east and west walls of which practically all came down; but very often the roof remained supported on the north and south walls. Boundary walls, too, often showed horizontal cracks (or fell altogether) when running north and south, but were cracked vertically if running east and west.

The sensations experienced by individuals appear to have varied considerably. Personally I was only conscious of a very violent vibration. The energy of it impressed me immensely, but I observed no wave motion; neither had I any difficulty in maintaining my balance. Others, however, speak of a very distinct wave motion.

Stories are told of persons being thrown to the ground by the shock while walking in the open, but I came across no authenticated case of this.

A very peculiar thing observed by many was a twisting motion—a species of wrench. And there is very direct evidence of this motion in a statue of Queen Victoria which stands at the entrance to the Parade Gardens in Kingston. This statue turned on its pedestal through an angle of some 20°.

II.—UP PARK CAMP.

By CAPT. G. F. B. GOLDNEY, R.E.

The barracks at Up Park Camp consisted, mainly, of two-storied brick buildings, averaging about 200′ long by 20′ wide, all running east and west.

The shock, which lasted about 7 seconds, was a very rapid oscillation, apparently with a general east to west direction, and finishing with a distinct jerk.

The result on the buildings was disastrous. Generally speaking, all upper storey walls running north and south were thrown down. There was a general tendency for them to fall towards the east; in nearly every case the end walls fell in this direction.

In the Officers' Quarters the floors collapsed under the weight of the brickwork of the partition walls, and the roofs subsided to the position of the floors. The men's blocks, being without partitions, remained standing, except the end walls, but were so hopelessly wrenched and cracked that they have all been pulled down. In all cases there was a tendency of the north and south walls to lean to the north, and in the Officers' Pavilions several of the north walls fell in that direction.

The hospital was about 300′ long, a single-storied building on brick pillars and arches about 9′ high. These collapsed, and the whole building fell to ground level. A fire started practically instantaneously in the centre of the wreck (probably from some drugs kept in the dispensary), and caused a good deal of the total loss of life in Up Park Camp.

There were only a few wood buildings, all small ones, in Up Park Camp; these all remained intact.

5. Hospital at Up Park Camp.

6. Chapel School at Up Park Camp.

HOSPITAL UP AT PARK CAMP

7. D Pavilion, Officers' Quarters, Up Park Camp.

8. Brigade Office, Up Park Camp.

D Pavilion

A large two-storied building, containing the Garrison Sergeants' Mess and quarters for 12 sergeants, had been finished in 1904. It was built in excellent brickwork, with P.C. mortar, and had a light wooden roof. It was cracked in every direction; hardly any walls remained plumb, and several partition walls were thrown down. The cracks in many places ran straight through bricks and not along the joints. This seems to prove that practically no brick wall, however good, in a two-storied building could have stood the shock.

The R.E. work immediately after the earthquake consisted in salvaging gear from ruined buildings, making camp arrangements (as all the troops and the hospital had to be put under canvas at once), and investigating damage to water supply and drains; the latter fortunately were practically undamaged below ground.

The Sappers, at the request of the Colonial Government, also undertook the work of opening up the Bank vaults, the branches of both the Colonial and Nova Scotia banks in Kingston having been wrecked. Several dangerous walls were pulled down or demolished with explosives, and a way cleared to the doors of the vaults.

After the urgent work had been completed, clearing the sites for rebuilding, pulling down wrecked buildings, and erecting a temporary hospital, offices, etc., were taken in hand.

Photo 5 shows the ruins of the hospital. The pillars standing are at the west end. All the woodwork from the centre to this end was destroyed by the fire. The low outbuildings and stores were much cracked, though they appear undamaged.

Photo 6 shows the ruins of the Chapel School. It was built on arches, which are seen in the photograph. All the walls above the floor collapsed.

Photo 7 shows D Pavilion, Officers' Quarters, the lower storey of which contained the R.E. Offices. This photo shows how the north walls fell northwards.

Photo 8 shows the Brigade Office, and the way the east walls fell eastwards. In this case the roof was shored up and the walls rebuilt in wood.

These last two photos were taken from the north-east.

A NOTE ON THE CALCULATION OF WATER PIPES.

WITH AN ABRIDGED TABLE FOR FIELD SERVICE USE.

By CAPT. E. N. STOCKLEY, R.E.

IT often occurs that a rapid calculation has to be made, at times when access to text-books is impossible, to ascertain what delivery may be expected from a length of pipe line which may be available, or to find what size of main and distribution pipes are necessary for the supply of a camp or cantonment.

Our Military Engineering books do not at present contain any information on this point; and books which might be obtainable give formulæ that are too complicated to work out quickly, or tables that are not as a rule in convenient form for the comparatively small quantities of water and small pipes which have to be dealt with.

It therefore appears to me that a short Table, such as is given below, may be of value to officers who have not already any simple method for getting at the same result. A reprint of the Table is given on a separate slip with a view to its being pasted at the end of the section on "Water Supply" in the *R.E. Field Service Pocket Book.*

This Table is abridged from one I have compiled for use at the School of Military Engineering (*Construction School Paper* No. 224). It shows the loss of head in pipes from ½″ to 15″ delivering 1 to 1,000 gallons per minute.

The following notes on the amount of water required, and the arrangement of mains and service pipes, may also be of some use, though they refer more to ordinary Barrack conditions than to Camps.

It is now agreed that all Military Buildings should be supplied on the constant system—that is, that cisterns should be abolished, except for a one day's reserve for the supply of boilers and sanitary appliances; and that all water for drinking, cooking, and washing should be drawn direct from the service mains.

This necessitates a much more careful balancing of the distribution system than was needed under the intermittent system of supply, when it did not much matter how quickly or how slowly the cisterns filled, so long as the amount drawn off was replenished some time during the 24 hours.

In order to avoid great irregularity of pressure at the taps, and uncertainty of constant supply, when the water is drawn from a town main, it is generally desirable to pass the whole of the supply for the Barrack or Cantonment through a service reservoir, situated at some convenient level which will command all the points of supply.

This service reservoir should not be of large capacity, as it is undesirable that any stagnation should take place. It need only hold sufficient to carry over the daily period of maximum consumption, with always a sufficient reserve to meet a sudden call for fire extinction. Half to one day's supply, with not less than 10,000 gallons for fire reserve, might perhaps be a suitable figure.

Up to the service reservoir the main need only be large enough to replenish the reservoir during the course of the 24 hours. From the service reservoir the distribution mains must be large enough to meet the maximum hourly demand.

It is usual to arrange the distribution mains to carry three times the average supply, *i.e.* to calculate for a distribution of the whole supply in 8 hours. But, as will presently be shown, this will not suffice for the service pipes for house supply, or for the supply of horse troughs, or for a camp distribution where the call for water is likely to come suddenly and the whole daily supply may be required in the course of an hour or two.

As a rule in Barracks it will be the fire supply that governs the size of the mains. The War Department does not insure against fire; so it devolves on us to assess the amount of protection which it is desirable to give, and to arrange this in reasonable proportion to the value of the property and the magnitude of the risk.

The supply required for fire protection may be 120 gallons a minute for a single hydrant covering an isolated unimportant building. But more usually 120 gallons will be required for each of 2 hydrants covering the ordinary barrack buildings; and in special cases supply for 4, 6, or 8 hydrants at 120 gallons each may be required.

If sufficient head is available, the water will be supplied to the defined number of standposts with a residual head sufficient, when that number are in use simultaneously, to throw water over the highest buildings with enough force and volume to quench a fire. For this it is necessary that the head at the hydrants, when the mains are delivering the maximum amount of water estimated to be required, shall be not less than

60 feet for single-storeyed buildings,
80 feet for double-storeyed ,,
100 feet for three-storeyed ,,
125 feet for four-storeyed ,,

A fire system giving such a residual head is often impracticable; and it is more usual for the fire hydrants to be arranged to deliver the water to fire engines with a residual head of 5 or 10 feet only, and to depend on fire engines to force the water on to the fire.

For extinguishing small outbreaks of fire in the early stages internal fire mains, even if of small capacity, are of great value. Fire buckets may be found half-empty just when required; but an appliance, known as the 'Bucket Fire-Extinguisher' and consisting of a number of buckets inside a small water tank with movable cover, is specially designed to meet this difficulty. Automatic sprinklers are also most useful, and they have been fitted in some of the large storehouses recently built.

All such arrangements must, however, be regarded as subsidiary, and will not affect the need for the provision of adequate protection by external fire-hydrants.

The fire mains having been laid out, the distribution pipes are merely a number of short branches taking the water to the various points where taps are required. When the amount of the domestic supply only is considered the loss of head in the mains will be found to be small; and, to ensure fair equality of pressure and supply, the distribution pipes may be arranged to use up excessive head in the branches so that the residual head at any tap shall not be less, nor very much greater than, 5 feet.

The following points will govern the size of the distribution branches and service pipes. The supply for each $\frac{1}{2}''$ tap may be taken at 3 gallons a minute and for each $\frac{3}{4}''$ tap at 5 gallons a minute. It may be assumed that only a reasonable proportion of the taps will be in use at a time. Thus for a cottage, such as is provided for the married soldier, a supply of 5 gallons a minute might be taken; and only one quarter out of four might be expected to be drawing at the same moment. For a bath some 30 gallons may be required in about 3 minutes; so that for any small house where a bath is fixed it will be desirable to allow 10 gallons a minute. For a commanding officer's quarter 15 gallons a minute may be required, and for a larger house 20 gallons or more.

For the watering of horses it is necessary that the troughs should be filled up practically as fast as the horses can drink. A horse likes drinking from a full trough, and will hesitate to drink if the water supply runs short and lets the trough become nearly empty. A horse drinks 2 gallons at a time and should be allowed 5 minutes to drink. In a permanent stable it would be convenient to be able to water the horses in three reliefs. Take as an example a 30-horse stable: 10 horses will water at a time, and they will drink 20 gallons in 5 minutes, *i.e.* 4 gallons a minute is the supply required, and this is equivalent to delivering the whole daily supply of 8 gallons per horse in one hour. Neglect of a careful estimate of the maximum requirements of troop stables has often led to trouble; and in some cases it may be necessary to have a special service tank for the stable supply in order to save expense in mains.

Working back to the larger trunk distribution mains the irregularity of draft of water becomes less noticeable, and it will be sufficient to allow for a distribution of the full daily amount per head in 6 or 8 hours.

The amount to be allowed per head requires careful consideration in each case. At Aldershot the amount now being consumed is about 18½ gallons daily per head, taking horses=1 adult, and children=½ adult. But in more modern barracks, with a full equipment of baths, sinks, and sanitary appliances, a greater consumption must be expected; and where there happens to be an unusually large proportion of officers and families the regulation figure of 20 gallons per head will be clearly insufficient. The London water supply is now at the rate of 36 gallons per head, and shows an increase year by year with the improved sanitary education of the people. Rather than allow the use of water in the army to be discouraged by regulations and prohibitions, we should, I think, provide an ample supply, encourage to the utmost the free use of baths and lavatories, and give all that can possibly be required for laundries, sanitary conveniences, and all other legitimate purposes.

For a Camp supply the amount may vary from 4 to 10 gallons per head, and 8 to 12 gallons per horse, according to the permanency of the encampment and the climate. Water is likely to be drawn off within the space of a few hours in the morning and evening, so that possible delivery in 2 to 4 hours is advisable. Since water troughs will not be so liberally provided as for permanent stables, it will be sufficient to arrange to water all the horses in one hour.

In all distribution systems, whether for camps or cantonments, the object should be to provide, without extravagant cost, a constant service giving continuous supply under adequate pressure at all points of the system at all times of the day or night.

The working out of a satisfactory system entails a good deal of careful consideration. But it is greatly facilitated by the use of labour-saving tables, which enable the mind to be concentrated on the main lines of the system, without attention being continually diverted to calculate out formulæ, as is necessary if such tables are not available.

I therefore offer these notes and the attached Table in the hope that they may be of some use, especially to those who may be called upon to work out water schemes under field service conditions.

WATER SUPPLY PIPES.

TABLE SHOWING IN FEET THE HEAD OF WATER CONSUMED BY FRICTION IN EACH 100 FEET OF PIPE.

Delivery Gallons per Minute.	INTERNAL DIAMETER OF PIPES IN INCHES.									
	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	4	5	6
1	9·18	1·17	0·27	0·03	0·01	...	...	...	...	...
2	36·72	4·68	1·08	0·14	0·03	...	.	...	...	...
3	82·63	10·54	2·42	0·31	0·07	...	...	...	...	...
4	146·90	18·72	4·30	0·55	0·12	...	...	...	...	...
5	229·52	29·28	6·72	0·86	0·20	0·06	...	...	...	...
6	...	42·16	9·68	1·23	0·28	0·09	...	...	...	...
8	...	74·96	17·21	2·19	0·50	0·16	...	.	..	...
10	...	117·12	26·90	3·42	0·78	0·25	0·06	...	...	...
12	...	...	38·73	4·93	1·13	0·36	0·09	...	...	...
15	...	...	60·52	7·70	1·76	0·56	0·14	...	...	...
20	...	...	107·59	13·70	3·14	0·99	0·25	0·06	...	...
25	...	...	...	21·40	4·90	1·55	0·40	0·09	...	...
30	...	...	...	30·82	7·06	2·23	0·57	0·13	0·04	...
35	..	...	...	41·94	9·61	3·04	0·78	0·18	0·06	...
40	...	...	...	54·78	12·55	3·97	1·02	0·23	0·07	...
45	...	...	...	69·34	15·89	5·02	1·29	0·29	0·09	...
50	...	...	...	85·60	19·61	6·20	1·59	0·36	0·11	0·04
60	...	...	...	...	28·24	8·92	2·29	0·52	0·16	0·06
70	...	...	..	...	38·44	12·15	3·12	0·71	0·22	0·09
80	...	...	...	..	50·21	15·86	4·07	0·93	0·29	0·11
90	...	...	...	..	63·54	20·08	5·15	1·17	0·37	0·14
100	...	...	...	...	78·45	24·79	6·36	1·44	0·46	0·18
120	...	...	...	...	...	35·70	9·16	2·08	0·66	0·25
150	...	...	...	...	..	55·77	14·31	3·25	1·03	0·40
200	...	..	...	..	...	...	25·44	5·78	1·83	0·71
250	...	...	...	...	...	..	39·76	9·03	2·86	1·11
300	..	...	..	...	...	...	57·25	13·00	4·12	1·60
350	...	...	...	...	..	...	..	17·63	5·61	2·18
400	...	...	...	...	...	..	...	23·11	7·33	2·85
450	...	...	..	...	...	...	...	29·25	9·28	3·60
500	...	...	...	...	...	...	...	36·12	11·45	4·45

FERRO-CONCRETE PIER AT SINGAPORE.

By LIEUT. W. D. BEATTY, R.E., AND CAPT. C. E. P. SANKEY, R.E.

THERE can be little doubt that ferro-concrete is one of the most important materials that an engineer has to work with at the present day. So, in spite of the fact that a masterly article on ferro-concrete pile construction appeared in last February's number of the *R.E. Journal*, it is thought that a short account of a similar work, though on a very much smaller scale, would not be out of place. It might indeed be regarded as a sequel, because that article referred to a comparatively large piece of work carried out by a firm of civilian contractors under the supervision of experts in this material, and this deals with a small service in an R.E. Division executed by coolie labour and under no more than the usual superintendence to be found in such a case.

The work to be performed was as follows:—The pier head at Siloso, one of the forts on the island of Blakan Mati, Singapore, had become very shaky and in fact had partially collapsed. This pier head consisted of a timber decking on wooden piles, and was approached by a roadway of 1″ timber on old rails supported on concrete piers the outermost of which was in a very bad condition. The rise and fall of tide was about 10′—12′.

The funds allotted to this service in 1905–06 were originally intended to provide iron screw piles, but permission was obtained by the Division Officer, Lieut. C. E. P. Sankey, to substitute ferro-concrete. After the pier had been designed and the first two piles cast, this officer was ordered home, and the work was carried out by Lieut. Beatty. The labour available consisted of Chinese coolies under their own 'mandors,' supervised by the Military Foreman of Works of the Division, Staff-Serjt. Reid; a few sappers from the 41st (Fortress) Company, R.E., were also occasionally available.

The pier was only used by steam launches and boats; and in consequence of the small size of the vessels coming alongside, it was not considered necessary to brace the piles. The decking joists were well bedded into the last concrete pier and helped to stiffen the pier head.

Several trial bore-holes were sunk to ascertain the nature of the ground, which proved to be a sandy clay under a bed of mud of varying thickness with a certain amount of boulders and coral. Although these holes showed that piles 24′ in length would hardly be long enough, it was decided to make them all this length because longer ones would have been difficult to handle besides necessitating a larger pile driver. As a matter of fact the possibility of being able to lengthen ferro-concrete piles appears to be one of their most important characteristics.

Two sizes of pile were used—9″ by 9″ and 12″ by 12″, of the usual design. The rods used were ¾″ and ⅞″ for the 9″ piles, and 1″, 1¼″ and 1½″ for the 12″ piles, the variety in size being due to the fact that these iron rods were already in store. As these rods were in 12′ lengths and the piles 24′ long, they were welded into lengths made up of 6′, 12′, and 6′, so as to avoid a weld in the centre of the pile. This precaution is probably unnecessary. They were bound together at a constant interval of 8″ with ⅛″ flexible steel wire, and were secured to the cast-iron shoe. These shoes proved to be rather too pointed as the piles were liable to glance off small boulders.

The casings were designed to be taken apart and used again. During the processes of lacing with wire and filling with concrete the rods were kept in position by means of wooden templates removed one by one as the concrete reached them. These templates would appear to be an easier method of keeping the rods in their right places than hooks.

The aggregate for the concrete consisted of granite chippings to pass a ¾″ ring, and contained on the average 41% of voids. The matrix was crushed granite, forming a sand of various sized grains, and cement, mixed in equal proportions to ensure water tightness; and the amount was calculated to fill the voids in the aggregate. The boxes used were as follows:—

Aggregate	1′ by 1′ by 1′
Sand	1′ by 1′ by 3½″
Cement	1′ by 1′ by 3½″

A measured quantity of water was also calculated and used in each gauge. To avoid premature setting only 1 cub. ft. of concrete was made up at one time, the rate of mixing being so regulated that each gauge was ready just as the last was being finished. Whenever work was stopped the remains of the last gauge were thrown into the sea.

The piles were fourteen days in the cases and at least one month old when driven. The first pile was cast vertically, the remainder horizontally. There is no doubt that the latter method is the better, the piles having a smoother surface in addition to being cast more easily and quickly. The first two horizontal piles were cast on the shore; but the others were made on a gridiron, with their heads pointing out to sea, thus being in the most advantageous position for their removal to the work. The fact that piles were sometimes covered by the rising tide soon after casting seemed to have no ill effect. The vertical pile took four hours to cast; the horizontal ones one hour, reduced to half an hour when the coolies had had some experience.

The method of taking the piles to the site was rather unusual. If a pile of these dimensions be considered as a horizontal beam supported or suspended and its strength calculated, it will be found that its own weight is more than sufficient to bring a most dangerous strain upon it (see Appendix). It was therefore decided that it would not do to pick them up in the middle, and that even supporting them in two places would be hardly sufficient to avoid undue strain and consequent cracks in the concrete, resulting in leaks.

The following method was therefore adopted for moving the piles into their position :—Two barrel piers, connected by distance pieces, supported a 12″ baulk that was pivoted at its centre on a 2″ steel bar. This raft was placed in continuation of the gridiron and the pile moved on to the baulk, to which it was lashed, the baulk itself being also secured by lashings in a horizontal position. The raft was then moved to the pier head and moored, a rope was secured to the head of the pile from the top of the pile driver, and the baulk revolved to a vertical position; the lashings were then cast off and the pile lowered into its place. This method, besides preventing any strain on the pile, was found most convenient for moving these comparatively heavy weights. A 1-ton crab, bolted to the pile driver, proved sufficient to lift the 12″ piles weighing nearly 3 tons each.

Some difficulties were experienced with the raft. The barrel piers were originally lashed with ropes, but these stretched and soon rotted and timber fastenings had to be substituted. The baulk was also placed too high at first, and the loaded raft turned turtle during a slight swell: the pile, being securely lashed, was not lost, but it was only got into position with considerable trouble. On one occasion the back anchor of the raft dragged as the pile was being raised and the pile engine was nearly capsized on to the raft, an accident that was only prevented by the rope round the pile being cut just in time.

The pile driver was specially built for the work, but presented no unusual features. It was supported on the remains of the old pier head, strengthened where necessary with jungle poles. The monkey used for the first few piles weighed 5 cwt., but a 17-cwt. one was subsequently borrowed from the Tanjong Pagar Dock Company. The piles were driven till a 10-ft. blow with the 5-cwt. monkey made them sink $\frac{1}{4}''$ or less, or till a 6-ft. blow with the 17-cwt. monkey drove them $\frac{3}{4}''$ or less.

It was found difficult to drive the 9″ piles in their right position, especially if boulders or corals were met with. It would probably have been better to have used nothing but 12″ piles, as their greater weight makes them in this sense much easier to handle.

In one instance a large block of coral was met with, 6″ below the surface, through which the pile could not be driven. A hole was bored through this with a 6″ boring chisel and the obstacle luckily proved to be only 3′ thick. A 9″ pile was afterwards driven easily through this hole.

Although the weight of ferro-concrete piles makes them more difficult to move about, it is of assistance in driving them and in keeping them in position, and as regards ease of driving they compare favourably with wooden ones. No disintegration was apparent after driving.

The helmet used on the top of the piles to hold a stuffing of sawdust was originally made of wood, but as this quickly split up an iron one was substituted. A timber dolly (of 'ballow') fitted in the top of the helmet, and when the head of the pile got below the foot of the pile driver a long dolly was used.

Many of the piles had to be driven so far that they required lengthening, the front ones so far indeed that only at dead low water were their heads sufficiently clear to enable them to be reached. None however had to be driven any further after lengthening.

For lengthening the concrete was cut away from the top of the rods for about 1′, and new rods were cut to the required length. It had originally been proposed to join these rods with screwed collars, but owing to expense the following method was used instead. Iron piping sleeves, 18″ long, were passed over the ends of the rods and rust joints made with iron filings and sal-ammoniac. This proved quite satisfactory though the soundness of the method is possibly open to doubt. The rods were then laced as before, the casing put in position, and the concrete filled in.

The decking joists were well built into the tops of the piles and secured with angle irons. The decking was composed of 3″ 'ballow' boarding. Wooden fender piles (of 'russak') were driven outside the front concrete piles, the outside ones being left long and shaped into bollards.

The strings for the landing steps were in store; they had been intended for some other purpose but not used. They were supported under water by a steel joist, which was treated with one coat Portland cement and two coats coal tar to prevent rust as far as possible.

The end concrete pier of the roadway was reconstructed, and the whole roadway remade of ferro-concrete with expanded metal in place of the old timber decking.

It must be admitted that the design is not as wholly "ferro-concrete" as might have been wished, but financial considerations made it essential to use as far as possible the material in store. Moreover, it was considered desirable to keep the pier open for use; and as a matter of fact traffic was never interrupted on it during reconstruction, though at times the pier head was distinctly dangerous at night.

The amount allotted originally was £360 with the dollar at 1s. 10d. As the dollar was between 2s. 1d. and 2s. 4d. whilst the work was being carried out, this estimate ought to have been increased to about £400. This sum would have proved sufficient to provide the iron screw piles, but probably insufficient to drive them; and decking, even for the pier head, would have been out of the question. As it was the work cost £405, and this not only entirely reconstructed the pier head but the roadway in addition. The cost of the pier head alone was £315; and as the work was largely experimental and all the plant had to be improvised, it would appear that this form of construction is cheap in prime cost as well as in upkeep.

A great part of the success of the work can be attributed to the interest taken in it by the Military Foreman of Works, and his aid in working out the various details was invaluable.

APPENDIX.

CALCULATIONS FOR LIFTING PILES.

Take for example the 9" × 9" pile, 24' long, with four $\frac{3}{4}$" iron rods at the corners. Assume that this pile is picked up by a sling in the middle. Each half can then be considered as a cantilever of length 12', and the M_{ff} at the point of support will be $w\frac{(144)^2}{2}$.

The weight of a ferro-concrete pile may be taken at 140 lbs. per cub. ft. Hence the weight per inch run will be 6·56 lbs., and the M_{ff} works out to 68,040 inch-lbs.

Using the notation and formulæ given in *Reinforced Concrete* by Buel and Hill, pp. 6—22, we have for a concrete, with matrix 1—1, one month old,

$$E_c = 2{,}900{,}000 \text{ lbs.}$$

Ultimate compressive strength = 2,750 lbs. per sq. inch

„ tensile „ = 275 „

E_s for wrought iron = 29,000,000, hence $e = 10$

$b = h = 9''$

$A_s = A'_s = 2 \times \frac{\pi}{4}(0{\cdot}75)^2 = 0{\cdot}88$

$d_1 = d_1' = 2{\cdot}375$

$y = 4{\cdot}5$, by symmetry

$v = t = 4{\cdot}5 - 2{\cdot}375 = 2{\cdot}125$

$I_s = 2 \times 0{\cdot}88 \times (2{\cdot}125)^2 = 7{\cdot}98$

$I_c = 9 \times 9\frac{3}{12} - 7{\cdot}98 = 538{\cdot}8$

$g = \frac{538{\cdot}8}{76{\cdot}8} = 6{\cdot}752$

$c = \frac{6{\cdot}752}{7{\cdot}752} = 0{\cdot}871$

$f_c = 68{,}040 \times 4{\cdot}5 \times \frac{0{\cdot}871}{538{\cdot}8} = 494{\cdot}98$, which is far more than concrete can be expected to stand.

Suppose, however, that the pile is picked up in some better manner. Three or more slings are no good, as it would be extremely difficult to so adjust them that they each took their proper share of the load, and no workman could be expected to do this.

The only other method with slings is therefore using two. A simple calculation will show that the most advantageous position is when the slings are nearly ¼th of its length from each end of the pile, and for all practical purposes this can be adopted. Each outside cantilever is now 6 foot long, and the M_{ff} will be ¼th of what it was previously, *i.e.* 17,010 inch-lbs. Thus f_c will be reduced to 124 lbs. per sq. inch, nearly. Although this is within the ultimate tensile strength, namely 275 lbs. per sq. inch, yet the factor of safety is little more than two; and it must further be remembered that these calculations are for a dead load only, and make no allowance for the extra stress brought on by the inertia of the pile due to a sudden lift.

The greatest danger lies in the possibility of any failure not being apparent. The iron rods are ample to take the tensile stress; and the only result of an overload would be to cause hair-cracks, in the tension side of the concrete, which will become invisible when the strain is removed. These cracks will however readily admit water, and the reinforcement may be rusted away. This will be particularly the case with piles that are to be driven in water.

Some interesting experiments that confirm these ideas are quoted on pp. 17 and 19 of the book referred to above, and it may be noted that so experienced an observer as M. Considère was apparently deceived as to the presence of these hair-cracks.

THE ADMINISTRATIVE COURSE AT THE LONDON SCHOOL OF ECONOMICS.

By Bt. Major C. W. Gwynn, c.m.g., d.s.o., R.E.

The experimental course of instruction in commercial and business methods for Army officers, given during the first six months of this year at the London School of Economics, was such a new departure that some account of it may be of interest.

The London School of Economics is itself a modern institution of about ten years' standing. Its main functions are:—

1. To give theoretical instruction in business methods, administration, organisation, and other subjects which in general are acquired by practical experience, to students either engaged in or about to enter business life.
2. To be a school of research in all branches of economics and sociology.

The School is now affiliated to London University, and the number of students is increasing so rapidly that considerable additions are to be made to the building, which is situated in Clare Market between the Law Courts and Kingsway.

The busiest time for the School is during the winter months, when the evening classes are attended by great numbers of railway employés and others engaged in practical work.

There are 3 terms in the year, roughly speaking of 10 weeks each, in the months January to March, April to July, and October to December.

The Army Course just completed extended over the first two terms and included 20 working weeks, with 4 weeks vacation at Easter. It is understood that the next and probably all future Courses, if there are any, will be held during the two winter terms.

The Army Class consisted of 31* officers and was treated as a

* Representing:—

R.A.	8
R.E.	2
Guards	1
Infantry of the Line	8
A.S.C.	11
Indian Army	1

Of these 3 R.A. and 2 Infantry represented the A.O.D.

11 officers had previously been through the Staff College at one time or another.

The average age of the Class was 39 years, the oldest member returning his age as 47 years. For the second experimental course, which is to commence this month, the age limit is 35 (37 for Staff College graduates), and preference was given to candidates with some administrative experience.

separate unit, a special course of lectures, which no other students attended, being arranged.

It was naturally a difficult matter to decide on a syllabus of instruction, to be given entirely by civilian lecturers who had no means of determining beforehand the special requirements or attainments of the students; while the representatives of the War Office on the Advisory Board were equally in the dark as to the aims and methods of the lecturers.

A provisional syllabus was put forward by the School, but great latitude was allowed for modifications proposed either by the Staff or by the Class as the Course proceeded. A considerable number of minor modifications were actually thus made, but they tended rather to alter the importance assigned to various subjects than to introduce radical changes.

The underlying principle on which the arrangement of the syllabus depended was to give instruction in the wider problems which affect civil business life rather than in particular details. At the same time the sources from which detailed information could be obtained were indicated. It was left to the students to draw their own inferences as to how far the knowledge they obtained could be applied to Military problems.

The subjects naturally arranged themselves into two groups:—
(1). The more purely practical, such as Accounting, Law, etc.
(2). The more general and theoretical, such as Economics and Currency.

The hours of instruction at the School extended from 10.30 a.m. to 5 p.m. for 5 days each week (Saturday being an off day), but only 2 hours were devoted to lectures to the whole class. The remainder of the time (except 1 hour for lunch) was allotted to discussion with the lecturer of points arising from the lectures or in papers done by the students. For these discussions the class was divided into groups of various sizes according to the subject, and the groups attended according to a time-table.

It was at first thought that groups not having appointments with the lecturers would attend the School to work there at the problems and essays set by the lecturers. It was soon found, however, that the accommodation at the School was too limited for this. Moreover, the time available there was not nearly sufficient for the working out of papers. It was therefore arranged that officers should be left to make their own arrangements for working out papers and that only officers who had group appointments with the lecturers should attend at the earlier and later hours. The bulk of the class assembled for the general lectures given from 12 noon to 1 p.m. and from 2 p.m. to 3 p.m.

A further modification for subsequent Classes has been recommended which, while leaving the hours of general lecture as they were, will tend to more personal instruction and to greater elasticity in arranging appointments with lecturers to suit individual students.

The actual number of hours work required to get through the papers set by the lecturers varied of course from week to week and with individuals; but it must, in all cases, have greatly exceeded the nominal working hours of the Course, without including the time spent in reading books recommended by the lecturers.

The following subjects were included in the syllabus:—

(*a*). Accounting.
(*b*). Transport by Land.
(*c*). Transport by Sea.
(*d*). Commercial Law.
(*e*). Economics.
(*f*). Currency.
(*g*). Statistical Methods.
(*h*). Commercial Geography.
(*i*). Public Administration.

At the end of the Course an examination was held. For this purpose (*b*) (*c*) and (*e*) (*f*) were grouped together, and no examination was held in (*h*); there were therefore 6 papers. These will probably be published, as is done in the case of the Staff College entrance papers.

For the experimental Course there was a strong desire on the part of the Staff to minimise the importance of the final examination and to attach more value to the work done during the Course, in fact to discourage competition and to encourage education. This will probably continue to be the policy in subsequent Courses.

The instruction given in the above subjects can only be roughly indicated in the following notes.

(*a*). *Accounting.*—60 lectures were given by Mr. L. R. Dicksee, M. COM., F.C.A. (formerly Professor of Accountancy at Birmingham University and Lecturer on Accountancy and Business Methods at the L.S. of E.). In future courses, when a preliminary acquaintance with the subject will be expected from students, the number of lectures will probably be reduced to 40.

The lectures covered the general theory and practice of bookkeeping by double entry; the organisation of accounts in relation to administration; methods of preventing fraud, with the examination of typical cases of fraud; the working of branch and head office accounts; stores accounts; various modern developments of bookkeeping, the "card," and "loose leaf" systems, etc.; systems of paying wages both from the accountancy and administrative standpoint; company accounts, with the interpretation of published balance sheets and auditors' reports; systems of auditing accounts, with their limitations; internal staff audit and external professional audit. Weekly papers were set in this subject.

(*b*). *Transport by Land.*—40 lectures were given by Mr. W. T. Stephenson, B.A. (15th Wrangler of his year at Cambridge, for 9 years on the staff of N.E. Railway, and now Lecturer on the Economics of Transport at the L.S. of E.).

The lecturer dealt in some detail with the ordinary working and administration of an English Railway, giving the main differences in the working of those of other countries. He explained the peculiar features of Railway finance with its bearing on the rates charged by Railways; and the relation of the Army to Railways in time of Peace, showing the economic justification of the reduced charges made, and how they may be arrived at.

The service of an Army by Railways in War was dealt with chiefly from the basis of South African experience. The general principles which govern the proper control of traffic were explained; and the necessity of the maintenance of the proper relation between the Administrative Staff, which brings troops or stores to the Railway for movement, and the Technical Railway Staff, which carries out the movement, was insisted on.

Canal transport and mechanical or horse transport on roads, as alternatives under certain conditions to Railway services, were discussed.

It is probable that in future courses this subject will be dealt with on a slightly different basis. Perhaps more material will be available for the study of the working of Railways in past campaigns.

Occasional papers were set in this subject.

(*c*). *Transport by Sea.*—4 lectures were given by Mr. Douglas Owen (formerly secretary of the Alliance Marine Assurance Co., and one of the Governors of the L.S. of E., who makes a special study of Marine Transport).

The lectures gave an account of the various classes of docks with their characteristics; ship measurement; Lloyd's Agency; and Lloyd's register, with its system of certificates and inspections, etc.

No papers other than the final examination were set.

(*d*). *Commercial Law.*—24 lectures were given by Mr. H. W. Disney, B.A. (Hertford College, Oxford, Lecturer on Law in the L.S. of E., author of the *Law of Carriage by Railway*).

The intention of the lectures was to give a good working knowledge of the various ordinary legal points which arise in the course of business, in order to prevent the inadvertent commission of illegal acts and to show when it may be worth while to seek legal assistance. The general law of contract, laws governing sales, laws relating to carriers both by sea and land, agents, bills of exchange, bankruptcy, etc., were dealt with and illustrated by weekly problems.

(*e*). *Economics.*—20 lectures were given by Mr. H. B. Lees

Smith, M.A. (Professor of Economics at University College, Bristol, and Lecturer on Public Administration at the L.S. of E.).

These gave a general introduction to the science of Political Economy. Certain modern Economic problems were afterwards examined, such as the unemployed question, the organisation and aims of Trade Unions, production on a large scale, systems of paying wages (including premium systems), and other modern developments in the relations between labour and capital.

Mr. Sidney Webb (who has been one of the most prominent members of the London County Council since 1891, and is the author of many books on social questions, including the *History of Trades Unionism*) gave 3 additional lectures on Trade Unions.

Occasional essays were set on this subject.

(*f*). *Currency*, etc.—12 lectures were given by Mr. H. S. Foxwell, M.A. (Fellow of St. John's College, Cambridge, Professor of Political Economy at University College, London, Teacher of Banking and Currency at the L.S. of E.). These covered a general account of the various currency systems and problems; the bimetallic controversy, etc.; the theory of banking; the nature and uses of bank reserves; an explanation of Foreign exchanges and international financial relations; some account of the Stock Exchange, with the causes of financial crises, trade depression and inflation; and all the questions affecting the money market.

Three very exhaustive papers were set on this subject during the course.

(*g*). *Statistical Methods.*—10 lectures were given by Mr. A. L. Bowley, M.A. (an authority who ranks second only to Sir R. Giffen, Teacher of Statistics at the L.S. of E., author of *Elements of Statistics*).

These covered methods of collecting statistics; their uses and limitations when collected; the presentation of statistics in tabular and diagrammatic form; the drafting and arrangement of statistical reports; the danger of false deductions, with explanations of common errors.

Problems were set in connection with each lecture.

(*h*). *Commercial Geography.*—The course consisted of about 10 lectures by Mr. H. J. Mackinder, M.A. (Director of the L.S. of E., late Reader in Geography at Oxford).

The modern geographical method of studying a country was explained, showing the necessity of considering the relation between geography, geology, and meteorology, also the advantage of graphical methods in bringing out this relationship; the method of connecting statistical and other information with deductions that might be drawn from geographic premisses; the presentation of statistical information on maps; the necessity of studying the geographic whole before considering the topographic details.

As an exercise, and in place of an examination, officers were required to prepare reports on the products and communications of certain countries on the above lines. It was found however that the time taken over these reports was disproportionately great, and in future courses some modification will probably be made in the work done on this subject.

(*i*). *Public Administration.*—3 lectures were given by Mr. Graham Wallas, M.A. (Corpus Christi College, Oxford, Chairman of the School Management Committee of the London School Board, Lecturer on Public Administration at the L.S. of E.).

The lectures gave an outline of British Constitutional History since the Restoration in its bearing on the development of the civil service and army re-organisation; and of the history of parliamentary and treasury control.

No papers other than the final examination were set in this subject, to which, in future courses, it is probable that much more time will be allotted.

The above is of necessity a very brief summary of the subjects dealt with, but it is hoped that it will suffice to give the general trend of the instruction.

In every case the lectures gave a complete analysis of the subject and no study of text books was required. References were, however, given to books in which the subjects could be more fully studied or be approached from different standpoints. Most of these books have been acquired by the R.E. Library in London, and a list is given below.

It would not be legitimate, even if it were possible, to offer an opinion on the probable practical utility of the Course.

It must, however, be clear that an entirely non-professional course of instruction, such as has been described, cannot in itself constitute a Staff training in the sense that the Staff College Course does. But as an intellectual exercise, and as a means of widening the field of view by giving an understanding of the civilian standpoint and business methods, the Course must be of value to a staff officer of any description.

It need hardly be added that the Staff of the School did everything in their power to make the Course interesting and pleasant.

APPENDIX.

LIST OF BOOKS RECOMMENDED BY LECTURERS AND ACQUIRED BY THE R.E. LIBRARY.

Transport.

The Railways and the Traders, by W. M. Acworth.
The Elements of Railway Economics, by do.

Law.

Mercantile Law, by Stevens.

Economics.

The Principles of Political Economy, by C. Gide.
Elementary Political Economy, by E. Cannan.
The Economics of Industry, by A. Marshall.

Currency, Etc.

A Money Market Primer, by G. Clare.
The Country Banker, by G. Rae.
Lombard Street, by W. Bagshot.
Money, by W. S. Jevons.
The Stock Exchange, by C. Duguid.

ARMY ECONOMICS.

By Capt. J. W. S. Sewell, R.E.

I.—The Influence of Economic Causes on the Evolution of Modern War.

At the dawn of history we find two ruling estates in a nation, the Clerical and the Military, contending for mastery. In Egypt a compromise was apparently effected by the enthronement of a Sovereign who was elected by the military and then ordained a Priest by the clerical estate. But, in general, the quarrel between these two estates has been as continuous and natural as that between cat and dog; and to this quarrel historians have paid great attention, because during the earlier and more virile history of a nation these estates have contained the ruling caste.

But during such period of national history the clerical estate has in all ages drawn to itself the great brains of the race (hence the saying "the pen is mightier than the sword"), until a point has been reached where the community has become dissatisfied with narrow-minded class legislation and has determined to throw off the yoke of that estate. Such epochs have always supplied the subject matter for the final chapter of a book on the History of the World.

The causes, course, and consequences of such revolutions have followed certain definite lines. During the period of the clerico-military regime trade has been extended to supply the growing demand for luxury, that inevitable consequence of civilisation; and, as a result, a commercial estate has arisen, which has quietly and gradually accumulated strength in numbers, wealth, and leaders of scientific ability. The revolution has then been either destructive or constructive, violent or peaceful, according to the action of the older estates. In either case the commercial estate has eventually secured the predominance.

Then has followed a tendency to decadence, partly as a concomitant result of the growth of luxury, partly because of the loss of virility consequent on the repugnance to war felt by a commercial community with a wholesale dread of the effect on its pockets. It is, however, an irony of fate that the really great wars of the world have usually been forced on nations during the governance of a commercial estate, owing to the action of the same cosmic forces that gave predominance to such estate. In the preceding stages of national history, one of its chief grievances was that it had to suffer from the dynastic wars which arose from the personal quarrels of Sovereigns; or from the clerical principle, *divide et impera*, necessitating the setting by the ears of two Feudal Chiefs who were getting dangerously powerful; or from civil wars arising from the disagreements of Sovereign, Church, and Army.

But such wars were insignificant as compared to those gigantic upheavals which have arisen from the trade rivalry of two commercial States. Lust for trade expansion carried the armies of Egypt across the Arabian desert to Syria, Mesopotamia, and even to India. The Punic wars are a household word to-day. It is perhaps hard to say how far the wars of Alexander and Napoleon were due to the personal ambition of the leader, how far to economic conditions; but it was the danger to British trade which drew this nation into those Titanic struggles of the Napoleonic era to the full extent of its power and resources. Subsequent to her success in the Punic Wars, Rome extended her empire in accordance with the growing demands of trade, reaching northward to the forests of Germany and to the famous wall of Hadrian in Britain. Then came the long conflict between the Northern races of Europe and Rome or her successors, the Latin races, beginning with piratical attacks on Roman trade; continuing with more civilised strife for trade routes and trade outlets between the Northern and the Latin races, only occasionally interrupted by the union of the combatants to repel the growing threat to their common interests of the Moslem races; and ending, after 1,500 years, with the decay and exhaustion of those Latin races and the triumph of the Teutonic races over both Latin and Moslem in the struggle for existence.

During the period of exhaustion following the Napoleonic Wars, the commercial estate, generally by methods of peaceful evolution, acquired in most European countries a position of predominance leading to an entire alteration of the lines of cleavage. Past is the period of that tortuous diplomacy which in the pre-Napoleonic period sought to maintain a state of unstable equilibrium in the forces disposing toward war. To-day is the era of great Commercial Powers. The statesman of to-day cannot hope to stem the cosmic forces driving the nation along the path of trade expansion. He can, at best, only to some slight extent control and guide those forces. His chief duty is to keep the nation to that one road, that is to say to prevent wars having any other object than the clearance of the right of way. To-day we do not fight for glory or for honour; we fight for our national existence only, and the breath of our national life is trade.

Napoleon's dictum, that the English are a nation of shopkeepers, has often been quoted and discussed in a manner that shows little insight into the true interpretation of the remark, viz., that in England the commercial estate is predominant. It was so then, it is so now, and the saying showed a clear understanding of the influences which mould history. The Commercial Estate of England then as now was working for the benefit of its trade in seeking to overthrow the Military Estate of France, which was interfering with the trade of the world. The commercial estate having seized the reins of government in Great Britain, proceeded next to secure the predominance of trade in the entire world. This predominance was so great shortly after the close of the Napoleonic era that there appears to have been insufficient scope for the national energy; and moreover British trade did not receive the necessary stimulus of *competition*. Hence befel a somnolence of business instincts; and it is only recently that we have been awakened to the fact, not only that competitors have started in the race, but that they are actually passing us with the momentum of their start.

Further, our national energy has found an outlet in certain forms of philanthropy—not invariably well guided—such as the protection of weak and apparently ill-governed peoples. To-day this forms a factor in the national character which cannot be neglected; which indeed is *often* apparently incompatible with the advancement of our trade, and which is as puzzling as it is incomprehensible to our rivals.

So frequently have genuinely philanthropic undertakings resulted in great commercial benefit, that to foreigners as a whole, and even to many of our own people, the English character appears to be transparently dishonest and entirely self-seeking; and as a result it is loathed with the contempt which is the just portion of the hypocrite. Thus, whilst the fact of our trade expansion renders this country an object of bitter envy, some of the sources of that expansion have caused envy to be accentuated with hatred, the resultant being a powerful force disposing towards war.

Let us now survey the present situation. In the extreme West the American nation is proceeding fast along a road which happily does not meet those of other nations as far as the eye can see, that is the development of the internal trade of the Americas. This road was staked out by them clearly under the peculiar cognomen of "The Monroe Doctrine." The statesmen of other great commercial powers have hastened to withdraw all claims to small rights of way crossing this road.

In the Far East we have recently witnessed a trade war in which Russia and Japan strove for the markets of Manchuria. The Treaty of Portsmouth called time on the first round; but it is a safe prediction that those who witness later rounds of the Titanic trade struggle between Mongol and Tartar will, on looking back, regard the war of 1904-05 as a mere introductory sparring match.

In the Old World the trade rivalry of two great commercial Powers, England and Germany, has already arrived at a stage of acute antagonism, where the increasing output of the two communities is rapidly becoming too great for the trade outlets. Daily approaches the moment when one of the two peoples must and will seek to impose its will on the other by means of force. Nor will there prevail, to prevent this, either the well-meaning efforts of philanthropists, who endeavour to induce the disputants to submit their differences to a hypothetical court of arbitration with no power to enforce its decrees, or the restraining hand of governments, fearful of war but unable to resist cosmic forces or to repeal the laws of Nature.

What will be the eventual outcome of either of these great trade wars, none can foretell. Only of this much we may be certain, that other communities will be caught in the eddies thrown off by the swirl of the main conflict; and sad will be the fate of the community that enters the arena of strife unprepared to fight as a community. To have hope of survival nation and army must be identical.

Of recent years an Estate of Labour has arisen. But its interests are so palpably identical with those of the Commercial Estate that there is little real fear of the commonweal being seriously endangered, either by those who dream of the possibility of some Utopian Commune which is in reality antagonistic to the Laws of Nature, or by those self-seekers who desire to use the power of Labour to establish the methods of Tammany. The interests of Labour demand a free outlet for trade, and thus add to the cosmic forces driving a Community into the great struggle for existence, in which for all time the final appeal must be to Force.

We are frequently told that war is a crime. War *per se* is no more a crime than death is a crime. We may deplore both death and war, but both are inevitable results of cosmic forces, the outcome of natural laws, and as such above human judgment. Even as in the vegetable world we see the creation and multiplication of life resulting from death, so in the history of communities war is often necessary for the establishment of security, peace, and prosperity. But, just as we struggle with nature for the postponement of death, so do statesmen rightly seek to postpone the appeal to the Court of War.

The only sure means of avoiding war with States is, however, for all concerned to submit themselves to a Central Authority, and to give that authority sufficient power to enforce its decrees on any litigant. Where such a Union can be effected, not only is internal peace secured, but the resulting gain in strength as against any external attack is a powerful factor in the prosperity of the Union. In the German Empire we have a wonderful example of an increase of prosperity by leaps and bounds as a result of the creation of such a union with a powerful head. On the other hand we may regard the case of the United States in 1860 as an example of insufficient power being granted to the Central Authority, resulting in four years of a bloody and expensive internal war.

In the numerous alliances and *ententes* of European Powers we see the desire for such Unions. But without a powerful Central Authority treaties must eventually yield to the clashing interests of the respective parties; and so the work of Hague Conventions, inasmuch as there is no compelling power behind their decrees, must prove powerless to prevent great wars in which Nations struggle for existence.

We may truly regard the dynastic wars of the medieval ages as matters of the past. But for the reasons given, we must anticipate as possible, even probable, great struggles for existence, in which rival Nations appeal to Force to decide the issue; and for such possibilities we must be prepared.

II.—ECONOMIC IN THEIR ORIGIN, MODERN WARS DEMAND ECONOMIC PREPARATION.

We are told that "Twice armed is he who has his quarrel just." As regards the struggles foreshadowed above, where each side is struggling for national existence, the question of right becomes intricate. But no soldier will deny that "Thrice armed is he who gets his blow in first." To effect this, it is necessary that every possible preparation for war shall have already been made during the period of peace.

This preparation includes the organisation of an army, the training and education of staff and of combatant arms, and the business training of the auxiliary departments, etc. The whole is comprehended in the term "Economics," which may be defined as the science of producing the most efficient results with the means at disposal.

This state of preparation must be acquired by a systematic application of business methods. Officers sometimes say "Leave business to the departmental branches: strategy and tactics are our rôle." They fail to see that the art of war is inseparably bound to the science of preparation. It is easy for the student to admire the concise orders of Moltke and to blame the diffuseness of those of Gyulai; but if the German Army had not been systematically trained in one school of thought, no reliance could have been placed in subordinate leaders to so interpret the orders of the Supreme Command as to produce united action; the orders must of necessity have been more voluminous and thus have damped the initiative of the subordinate. It has been observed that the orders of Wellington in the Peninsula show a steady tendency to increased brevity as the army became a trained organism.

The first branch of economics to be studied is Organisation. As I have previously dealt with this subject in these columns, it will now be passed over with only this remark, that we should all remember the imperative necessity for decentralisation with a view to cultivating the initiative of subordinates. It must be admitted that this is difficult inasmuch as it is contrary to the instincts of human nature. But it will be agreed that ideal troops are those which not only have the cohesion and spirit of self-sacrifice that can only be engendered by rigid discipline, but can also act intelligently on their own initiative when they stand alone ; and where is a man so much alone as in the firing line? That such results can be obtained was proved by the Light Division in the Peninsula, by the skirmishers of Napoleon, and finally in 1870 by the German company officers and troop leaders, whose conduct of their work was a redeeming feature in the dubious major tactics employed in that campaign.

The Franco-German war was for the Germans a triumph of economic principles. Most wars have produced a Napoleon, a Wellington, a Lee, or a Skobeleff, whose genius for war has constituted that moral factor which will always rise superior to all difficulties. But in the Franco-German war no great genius emerged. The war was won by scientific preparation and the good level standard of the subordinate officers. The machine had been constructed on scientific principles, it was kept well oiled, and only required to be given a start in the right direction. It did the rest at times in spite of the Supreme Command. Moreover, the gears were machine cut and therefore of even strength ; there were no teeth of any superlative degree of excellence, but there were no weak teeth ; every one could be relied on. A good level standard in subordinates is of more value than a good average ranging from brilliancy to stupidity ; for the strength of a machine is not its average strength, but the strength of its weakest part.

This section of economics—that is, the organisation and training of the combatant arms—is the charge of the General Staff, who may be confidently relied on to produce efficient results, if they are not only supported by superior authority, but are also not hindered by stupid passive resistance on the part of the material to be trained. The best way to assist the Staff in producing efficiency is for each of us to introduce business methods into our own little sphere of responsibility : for only by the willing co-operation of all can efficiency be attained. Reform will never be effected by hysterical abuse of the army system in general and superiors in particular, as in the case of a certain notorious pamphlet published during the South African war.

But although the training and organisation of the first line involves economics in the broad sense of the word, it will be recognised that such work cannot in peace be made "productive," nor can it be conducted on such economical lines as are possible in civil business. For example, it will hardly be denied that interior economy, even the training of the rank and file, could be conducted in peace with equal efficiency, and even with less expenditure of energy, by a smaller number of officers than the necessities of war render it imperative to retain.

Behind this first line, however, there is a vast amount of work carried out in war of which the public, and even many officers, have little or no conception. If this work is to be so conducted as not to involve a check to that momentum in the first line which is the true basis of victory, previous training and organisation are essential. If it is to proceed smoothly without causing anxiety to the commander-in-chief, such training must be of the soundest description : it must in fact involve a thorough knowledge of economic principles in every rank, at any rate to the extent to which such principles affect their work. Here the similarity to the economics of civil business becomes more marked, and a knowledge of such economics becomes the best groundwork for the training required in the auxiliary departments of an army.

III.—ECONOMICS AS AFFECTING THE CORPS OF ROYAL ENGINEERS.

Leaving other corps to work out their own salvation, it is proposed to discuss the extent to which economic principles affect the Corps of Royal Engineers, and to suggest for consideration applications of these principles which may assist in obtaining efficiency.

As our *raison d'être* is War, we must first consider what are the functions of the Corps in War. Here again it must be realised that the rôle of the Corps is of a twofold nature.

First there is the Field Engineer, whose duty is somewhat indefinable, but may be briefly summed up as that of generally "pioneering" (in the widest sense of this word) the way for the army, both on the march and in action. He must assist the General Staff by adapting to the necessities of the moment the latest developments of science, and that frequently in a manner that cannot even be foreseen. The organisation best adapted to this end has recently been very fully discussed in the *R.E. Journal*, and lies outside the scope of this article.

But besides this function the Corps has duties to perform on the Lines of Communication, of which the extent and responsibility are not always fully realised. It is frequently here that the most solid work has to be done, work that involves driving officers and men to the breakdown point, work too that has none of the glamour of first line work but is none the less essential to the welfare of the army.

Of course it is realised by all that there are camps and hospitals to construct; water supplies to be laid on; railways, roads, and bridges to construct, repair, and maintain; defensible posts of every description to devise and erect, etc., etc. But it is also the duty of the Corps to come to the assistance of every arm, corps, or department which has reached the limit of its ability, and this not infrequently involves work of the most unexpected and peculiar nature. A R.E. Officer may find himself called on to run a factory, a mill, an electric power station, or a steamer: one has even been seen acting with distinction as a Mayor and Corporation.

Now, although it is the aim of education that a man should know "something of everything, and everything of something," it is obviously impossible that any man should know everything of everything. It will also be conceded that it is rarely possible at short notice to obtain for a special work the services of a man who combines with the qualifications of an officer the expert knowledge of such special work. What is required is in reality the art of management. The common sense and the knowledge of handling men, which are essential to this art, are the natural result of an engineering training. Expert subordinates can usually be obtained with facility. But the manager must be equipped still further, to the extent of obtaining the best possible results, that is maximum efficiency. This entails a knowledge of economics, the keynote of which is comparative statistics.

Before passing to an explanation of this method of control, it should be observed that the Engineer officer has considerable advantages over officers of other arms as regards economic training; for his work in peace, being to a very large extent of a productive nature, also demands economic training in order that the best results may be obtained with the means at disposal. To him a study of economics is of present as well as of prospective benefit; he is rewarded for the toil of such study in the immediate present, whilst officers of other corps can only look for their reward to a visionary future.

Perhaps the best method of illustrating what is meant by comparative statistics is to take an example of their application in the management of a large industrial corporation. Railways have been selected as an example because such corporations have for many years past kept a most careful and systematic record of their finances, and these records are available for inspection and analysis. Professor Walter L. Webb, in his book *Railroad Construction*, defines economics as follows:—

> "Railroad economics means the application of systematic methods of work *plus* experience and judgment, rather than a dependence on judgment unsystematically formed. It makes no

pretence to furnishing mechanical rules by which all railroad problems may be solved by any one, but it does give a general method of applying principles by which an engineer of experience and judgment can apply his knowledge to better advantage. To the engineer of limited experience the methods are invaluable; without such methods of work his opinions are practically worthless; with them his conclusions are frequently more sound than the unsystematically formed judgments of a man with a glittering record. But the engineer of great experience may use these methods to form the best opinions which are obtainable, for he can apply his experience to make any necessary local modifications in the method of solution. The dangers lie in the extremes, either recklessly applying a rule on the basis of insufficient data to an unwarrantable extent, or, disgusted with such evident unreliability, neglecting altogether such systematic methods of work."

This definition applies equally to economics generally. Thus economics implies the use of the recorded experience of our predecessors.

In promoting a project for a new railway the first question is "What is the prospective revenue?" The standard of rates is more or less fixed by those of other lines in the country, and the amount of traffic may be estimated roughly from the density of the population of the district to be tapped, or with more accuracy from the actual statistics of industrial and agricultural output.

Statistic records next show that (in the United States) working costs average 64% of the gross revenue. From the remaining 36% it is necessary to deduct the interest on debentures, transfers to reserve fund, etc.; and the balance will be available for dividends. From these data it may be ascertained what is the maximum amount that may be expended in construction; and it will be necessary to design a road which will not cost more than that amount. It will be observed that the question is, not "What will *a* railway cost?", but "Can we build a railway (of a suitable nature and giving a suitable route) for such and such an amount?"

Suppose this railway has been constructed. The General Manager knows that he has to work his line for a sum not exceeding 64% of the gross revenue. This working expenditure is next divided into certain main heads, on each of which statistic records show that a certain fixed percentage of the whole expenditure will necessarily be expended. To illustrate this the following figures from Professor Webb's book may be quoted, giving the practice on American railways:—

1. Maintenance of way and buildings: extreme range for five years 1·2 %	20·662 %
2. Maintenance of equipment: extreme range 1·834 %, a tendency to increase	16·892 %
3. Conducting transportation (*i.e.* running costs): a tendency to diminish	57·793 %
4. General expenses: nearly constant	4·653 %
	100·000 %

In a similar manner the above main heads are subdivided into 53 subheads. With such comparative statistics before him, it follows that at any moment the General Manager or the Head of a Department can at once locate any extravagance or excessive expenditure. In such a business it is obviously impossible in any other way to make certain that a maximum output is being obtained from the personnel and material at disposal.

Many subordinates can produce apparently economic results by personal energy and driving power so long as the number of their subordinates is not too excessive for personal control. But when they rise to higher posts, and the numbers employed by them are beyond the possibility of this personal control, they fail, because they cannot apply economic methods, which would enable them to decentralise work and, whilst obtaining effective control, to spare time and thought to improvements and extensions of their business.

Although a large corporation has been taken as an example, it is only because from its very nature the pressure of economic forces has compelled the application of systematic methods to the extent of developing a science. Similar methods should be applied to all productive undertakings.

It is unfortunate from a Corps point of view that, owing to the nature of Army finance, much of our work escapes economic audit, and thus we do not effectually feel the pressure of economic forces. For instance, the costs of some Engineer services are necessarily debited to so many heads of expenditure that it is impossible for an auditor to collate them all and ascertain the true cost of such a service: consider for example the charge of military labour to Vote 1, civil labour to Vote 10, military transport to Vote 6, ordnance stores to Vote 8, etc., etc.; whilst fixed charges and supervision escape notice entirely.

There would appear to be no reason, however, why a R.E. Officer carrying out productive work other than by contract should not keep for his own benefit a true account of expenditure. He can easily, and presumably does, obtain an estimate for the value of his output; this would form the credit side of his account. On the debit side come fixed charges, supervision and office expenses, upkeep of plant and buildings, labour, material, cartage, also fuel and oil if he is employing machinery. Let us consider these in turn.

Fixed Charges.—These comprise interest and depreciation on capital value of plant and buildings.

Supervision and Office Expenses.—Either a fixed percentage on labour costs may be debited, if the cost of one service is being considered; or, for a year's account, a sum may be fixed for each of the staff which would represent the salary of such a subordinate in civil life. A rough guess will have to be made at the value of the item for stationery.

Upkeep of Plant and Buildings.—There is usually a definite allotment for this purpose, besides expenditure buried in Part III. Services or concealed by the employment of military labour. These latter items should be isolated.

Labour.—Civil labour calls for no remark; and the vexed question of military labour need not be regarded as a difficulty, if it be remembered that the employment of each R.E. artisan obviates the employment of a civilian of a similar trade. Sapper time should therefore be debited as if it were civilian artisan time, that is usually at 8d. to 9d. an hour. As matters stand it might be possible to cover a large deficiency in output of civil labour by the use of military labour which would not be brought to debit; and it is to be feared that the output of military labour is not always of an economically efficient nature.

Material, Cartage, Fuel, and Oil.—These present no difficulty; but a charge should be debited for tools, etc., supplied from Ordnance stores free of charge.

If such an account be kept it will prove by far the most effective check to show whether a staff is too large for the output; whether the proper tale of work is being exacted from employees; whether material is being wasted, etc. A series of such accounts would however be necessary to show by comparison whether the percentage of total cost spent on upkeep of machinery, etc., is in excess or not. The annual allotment takes note only of the *existence* of certain plant and buildings, not of their *output*.

Again comparative statistics are necessary to show what is the fair proportion of total cost which should be represented by interest on capital value of buildings and plant. This is necessary to ensure that full "duty" is being performed by each machine.

Comparative statistics are of course essential for the preparation of estimates, but the extent to which they may be made use of is not very widely realised. Mr. T. E. Coleman, in his excellent pocket book *Approximate Estimates* (3rd edition), devotes a chapter to this subject, which may be confidently recommended to those in search of information. He enumerates and describes the following methods of estimating:—

1. By detailed bills of quantities.
2. By rough quantities.
3. By cost per foot cube.
4. By cost per square.
5. By proportional values.
6. By cost per unit of accommodation.

The first is the system with which every R.E. officer is familiar. Whilst it is the most accurate, it is very laborious, and requires a good deal of time. But it is often necessary to form estimates at a very short notice, and without the necessity for such extreme accuracy.

Estimates per foot cube are of course very rough.

Estimating per square is a sound system, combining economy in clerical cost with fair accuracy. It is hoped that the study of this system will some day form part of the curriculum of the young officer.

For the executive engineer anxious to check the output of his artisans, the system of proportional values should prove of great assistance. This system teaches the average relative costs of labour and material for each trade. Suppose, for example, a bench is being constructed. The cost of material expended is known of course: if the cost of labour is in excess of its proper proportionate value, suspicion is at once aroused as to the amount of work done by the artisan. This system further tells us the average percentage of the whole cost of (say) a house which should be allotted to any one trade. This is useful in two ways:—Firstly, it puts a check on our own sense of proportion when designing, and prevents, for example, overdoing or underdoing fittings: secondly it enables us to estimate total costs when the cost of the work of one trade is known.

The unit system is a system of the future. It is now known, for example, what an infirmary should cost per bed, a workhouse per inmate, etc. It would be an ideal system for Army Estimates, if a fixed sum per soldier could be allotted to responsible officers to meet the cost of the various services:—so much for training; so much for clothing; for equipment; for rations; for housing, etc. Administration costs for dealing with stores would be allotted at a fixed percentage of the turnover: and so forth. At present however this idea must be regarded as Utopian.

In conclusion, there are two economic principles frequently overlooked in this country:—Firstly, that it is sound economy (though for extraneous reasons it may be impracticable) to undertake any reconstruction or extension of which the prime cost is less than the capitalised value of the benefit accruing therefrom. This is the true criterion by which to test the advisability of replacing old buildings or plant by new.

Secondly, it is necessary, when undertaking works of construction, to allow for future developments of engineering science. There is a grave tendency on the part of British engineers and artisans to turn out work regardless of economic factors, as if such work were to be for all time the last word in its line. Of course all work should be good of its kind, but it is not economic to indulge in an unnecessarily high class of work. We do not for instance put the same class of work into a cart shed that we do into a mess building: but there is a tendency to design or specify too expensively.

The Army is still waiting to welcome as a benefactor of the race the man who will design a hut which will last just as long as required, and will fall down at once when it has served the immediate purpose for which it was erected. In exactly the same way the artisan is a nuisance who on being told to make a packing case constructs an excellent box good for fifty years.

It is easy in the struggle for the best to miss the good. *Le mieux est l'ennemi du bien.* Progress in science is making such giant strides that the engineering marvel of to-day may be obsolete and discredited in a very few years. We should therefore be very careful not to tie the hands of our successors by embarking on heavier and more expensive construction than is absolutely necessary. We all see and complain of this tendency on the part of manufacturers, but it is not improbable that the beam requires to be plucked from our own eyes.

TRANSCRIPT.

TACTICAL NOTES ON THE RUSSO-JAPANESE WAR.*

1. Introduction.

Success is generally considered to justify the means. But in the study of the Manchurian Campaign it will be noticed that many methods of attack successfully adopted in the earlier battles were discarded in the light of later experience.

It must be remembered that the success of the Japanese was mostly due to the spirit of their soldiers, whose training, self-confidence, intelligence, and courage can hardly be overpraised.

Their methods of fighting were considerably influenced by the peculiar circumstances which characterised the campaign, and are not therefore to be blindly followed under different conditions. Thus the beginning of the campaign was characterised by an excessive caution in the use of artillery. This was due to the mediocrity of their guns in accuracy, range, rapidity of fire, and mobility. (The small Japanese horses were unsuited for transporting artillery).

The Japanese also hesitated to employ their cavalry at any distance from supporting infantry, as they were conscious of the superiority of the Russian cavalry assisted by horse artillery.

2. General Remarks on the Operations.

At the beginning of the campaign the Russians, who were numerically inferior, resolved to avoid a decisive engagement and to fall back from one defensive position to another until their strength should be so much increased by the arrival of reinforcements that they could adopt an offensive rôle with some prospect of success.

They thought this stage had been reached in October, 1904, when they attacked the Japanese centre and right on the Shaho. They were however repulsed with loss and driven back over the river, where they entrenched themselves for the winter.

In March, 1905, the Japanese made a frontal attack on these hastily improvised works at Mukden.

The Russians at Liaoyang, on the Shaho, and at Mukden, occupied positions which, according to European ideas, were not suited to their numerical strength. Their defences, instead of forming a connected line of resistance were split up into groups, consisting of fortified villages in

* From an anonymous article in the June, 1907, number of the *Jahrbücher für die deutsche Armee und Marine.*

the plains and fortified summits of the hills. Each of these groups was attacked by an independent Japanese force, so that the operations at Mukden and similar places consisted of a number of engagements, between single brigades and divisions, which in all extended over a distance of 110 miles.

3. Employment of Reserves.

The Russians on the Shaho and at Heikoutai persisted in confining themselves to passive resistance; and this naturally influenced the tactics of the Japanese, and encouraged them to proceed against their opponents with much greater boldness than would have been possible in the face of a more enterprising enemy. If their advance was checked, the Japanese were able to throw the whole of their reserves into the firing line without troubling to protect their flanks.

This unhesitating use of their reserves was not confined to the main reserve of the army but was characteristic of the attacks by brigades and divisions.

In fact, at the battles of Mukden and Liaoyang every available man was in the firing line; and Kuroki on 31st July, 1904, at Yangtzuling did not keep any men in reserve, although he exposed his whole line to a counter attack.

It was very different with the Russians, who were very chary of employing their reserves. At Yangtzuling there was an entire division not engaged, and on the 24th July, 1904, they retired from action although they still had a brigade in reserve.

4. Flanking Movements.

In their main attacks and in their minor engagements the Japanese attacked the defence along the whole front and also on one or both flanks.

Even against fortified positions the frontal attack was no mere holding movement, but was pushed home with all available strength; whilst to the flanking forces generally was left the duty of supporting the frontal attack by their fire, and of consummating the victory by threatening or destroying the enemy's line of retreat.

It was a noteworthy feature that even the most pronounced feint was pushed home as strongly as possible. The Japanese were convinced that it was necessary to push these feints to within decisive range, and to so occupy the defender that it was not possible for him to transfer troops from one portion of the line to the other. A very good example of this was the fight early in March, 1905, when the 5th and 8th Divisions, in spite of heavy losses, prevented the Russians from leaving their position to oppose the III. Army, which was engaged in an effort to outflank them.

The Japanese discovered that, apart from the advantages inherent in flank attacks, the value of enfilade fire had considerably increased owing to the greater precision and rapidity of fire of modern firearms. Thus at Telissu the few Japanese guns were able to silence the Russian artillery after they had held out a long time against a frontal fire. At Pienling

(31st July, 1904) the fire of a group of 7 or 8 men compelled two Russian companies to retreat, and thus enabled the frontal attack to succeed.

If it was impossible to outflank the enemy at the beginning of an engagement, a portion of the reserve was ordered to advance regardless of loss and occupy some position which would enable them to open an enfilade fire on the enemy's fire trenches during the frontal assault.

In cases where a direct frontal attack had to be made without co-operation on the flanks (II. Army, 1st March, 1905) the losses were very heavy; and from 5th to 8th March, 1905, the frontal attacks at Yangshihtun and Kankuantun (Mukden) failed in spite of the magnificent bravery of the attacking troops.

If an unusually large number of frontal attacks succeeded in this campaign, it may be ascribed to the weakness of the defence, to the dead ground in front of the works facilitating the assembly of the assaulting troops, or to the numerical superiority of the attacking artillery.

On the whole the lesson to be learnt is that a frontal attack against a well-defended position involves very heavy losses and therefore an attempt should always be made on one or both flanks.

A further lesson is, that it is necessary to engage the enemy strongly along the entire front by an energetic demonstration in order to prevent him sending troops to the main point of attack from portions less threatened.

A third lesson is, that flanking or enfilade fire is now of such value that every attempt should be made, both by the defence and the attack, to obtain possession of positions from which small bodies of troops can maintain a heavy enfilade fire on the enemy's forces.

5. THE USE OF CAVALRY.

The war teaches us little new about the use of cavalry; because the Japanese were very deficient in this arm, whilst the Russians showed great lack of enterprise in their employment of mounted troops.

The duties of cavalry may be divided as follows:—

(*a*). Reconnaissance.
(*b*). Co-operation on the Field of Battle with other Arms.
(*c*). Execution of Raids.

(*a*). *Reconnaissance.*

From the beginning of the campaign until the battle of Liaoyang the front of the Japanese Army was covered by a cavalry screen. Engagements with the enemy's patrols were frequent, and in these the men fought dismounted.

Although the Russian patrols succeeded occasionally in piercing the Japanese cavalry screen, yet as a rule the latter were able to veil the movements of the main army and also to carry out the usual reconnaissance duties, obtaining a fair amount of intelligence regarding the movements of the Russians.

From the battle of Liaoyang to the end of the war the two forces were in such close contact that the infantry outposts had to carry out the reconnaissance duties and the cavalry had only to protect the flanks.

(b). Co-operation on the Field of Battle.

The best example of the use of cavalry on the battlefield is offered by the battle of Telissu. Here the Japanese infantry, who were engaged in a direct frontal attack, were unable to advance further against the Russian position; but two Japanese squadrons turned the Russian flank, dismounted, and opened fire on the Russian infantry, who were compelled to retreat, thus causing the entire army to retire. With this exception the cavalry accomplished very little, although the country west of the railway was very open and highly favourable for cavalry action.

The Japanese cavalry was so weak numerically that they were always on the defensive, while the Russian cavalry displayed very little initiative and neglected many favourable opportunities to attack. An energetic cavalry leader on the Russian side would have found many golden chances of action in the stubborn fights south of Liaoyang, where every man in the Japanese reserve was pushed into the firing line; but in actual fact the large Russian cavalry brigade was held in check by a very weak Japanese brigade, which only suffered to the extent of two men wounded.

During the Russian retreat after the battle of Liaoyang, however, their cavalry did excellent service, as they kept the Japanese in check for 70 hours and so enabled General Kuropatkin to retreat in perfect safety.

Throughout the campaign the Russian cavalry did their fighting dismounted and the Japanese had to do the same.

Had the Russians tried to envelop the Japanese flanks many opportunities for attack would have accrued to them.

There is no doubt that the Japanese victories lost much of their effect owing to their weak cavalry, and had they been stronger in this arm at Mukden they would probably have been able to check the retreat of the Russian Army until the pursuing Japanese infantry could come up and surround it. It is from these failures that the value of efficient cavalry may be estimated. However brilliant the Japanese victories the fruits were always meagre, as the Russians never failed to make good their retreat.

Modern firearms make it possible to occupy such an extended position that only mounted troops can be assembled at the critical point in time to take advantage of any opportunity that presents itself.

As regards the shock tactics of cavalry no experience was gained during the campaign as to whether greater results might have obtained by the use of the *arme blanche.*

(c). Raids.

The few raids carried out by cavalry had no effect on the course of the operations.

In May, 1904, the Cossacks made an ineffective raid round the Japanese right flank. In January, 1905, another raid of some importance was executed, in which General Mischtschenko, with from 5,000 to 10,000 Cossacks and six batteries of horse artillery, attempted to cut the Japanese communications and destroy the magazine at Yingkou. Though it was well planned, the raid failed because it was so slowly executed. The commander of the line of communications received ample warning and was able to make all preparations for its repulse.

Several of the Japanese raids were successful. Lieut.-Colonel Nagamana set out on the 9th January, 1905, with 270 men, and on 7th February destroyed the railway bridge over the Shuihsiho a long way in rear of the Russian army. On the return journey this detachment attacked a superior force of Russian cavalry (3 squadrons with 2 guns) and defeated them, capturing 1 gun. This is the only instance of an attack by mounted troops.

Cavalry raids against hostile lines of communication, if they are to succeed, must be conducted with secrecy, rapidity, and determination.

6. FIELD ARTILLERY.

The Manchurian Campaign is the first in which both forces possessed large numbers of modern guns. It is therefore not surprising that great attention has been given to the employment of the artillery in this war, and that many of the methods observed in peace manœuvres were found to be mistaken.

From the reports received, it seems that the Japanese were not satisfied with the actual effect of their artillery fire, though they consider the moral effect was very great.

As regards the Russian artillery up to the battle of Liaoyang only 7% of the Japanese casualties were caused by artillery fire, while in the battle of Mukden this percentage rose to 15. The increase may be accounted for by the improved shooting of the Russians, as also by the fact that the ground was frozen so hard that the Japanese could not entrench themselves. It cannot be maintained that the effect of the Japanese artillery was any less.

In considering statistics regarding the effect of artillery fire, it must not be forgotten that more actual deaths are caused in proportion to numbers hit by artillery fire than by infantry fire. The dead are quickly interred and no record of the cause of death is kept, whereas the wounded in hospital are carefully examined and the cause of their wounds recorded.

When the artillery had a good target within effective range the losses inflicted were very heavy. In the attack on the Motienling Pass a Russian column, advancing in close order to within 3,000 yards of a Japanese battery, lost 300 men in a few minutes. In the battle on the Shaho 3 Japanese batteries opened fire at 1,000 yards on the retreating infantry and caused 450 casualties. (This seems, however, rather a poor performance under the circumstances). At Telissu the Japanese were able to put a number of the Russian guns out of action.

The examples generally show that good effects can only be obtained with well-equipped and efficient artillery, and then only at medium ranges.

The moral effect of artillery fire was always great. This was of the greatest value to the attacking infantry, because this moral effect prevented the defending troops from putting their heads above the parapets and consequently the accuracy of their rifle fire suffered considerably. A good example is the attack on Terayama (11th October, 1904), where the Japanese artillery fire forced the Russians to take cover in a sunken road, and the attacking Japanese infantry covered the last 700 yards practically without loss.

The effect of artillery fire against material was very slight. In the I. Army not a single gun was put out of action, although many of the carriages were damaged.

The effect against trenches was practically *nil*, and hardly justified the expenditure of ammunition.

JAPANESE EMPLOYMENT OF ARTILLERY.

The Japanese artillery throughout the war was inferior to their opponents in range, mobility, and rapidity of fire; and they had therefore to be cautious in their use of it. This accounts for the fact that they opened fire at very long ranges (5,000 to 6,000 yards), and seldom approached within effective range of their target even to support the infantry attack. It also explains their preference for indirect fire and their dislike to changing position.

LONG RANGE FIRE.

The increased accuracy of modern guns made the Japanese very cautious, and misled them into engaging the enemy's artillery at distances beyond the effective range of shrapnel. A change of artillery positions in daylight seemed too dangerous, and so they were unable to give their infantry the desired support. To a certain extent also these distant positions were forced on them by the nature of the country, which to the east of the railway is characterised by broad valleys across which they had to fire. An advance under these circumstances would only place their guns in an undesirable position; and at Yangtzuling 4 Japanese batteries, which attempted to advance to within effective range, were put out of action in a few minutes.

During the latter part of the campaign their confidence increased, and they did not hesitate to advance in support of their infantry. At Heikoutai, for instance, the mountain battery of the 5th Division, which opened fire at 3,000 yards, advanced over open country to support the infantry until the guns were within 1,800 yards of the enemy. At Mukden the artillery of the III. Army advanced to within 1,500 yards of the Russian line in spite of heavy losses, and thus enabled the infantry to occupy several important rallying points in their advance.

The old maxim still holds good, that no consideration of losses must deter the artillery from giving the infantry as much support as possible.

CHANGING POSITION BY DAY.

This was avoided as mucn as possible on both sides, as even at long ranges shrapnel fire continued for only a short period must have great effect on so favourable a target as a battery.

At the battle of the Yalu one battery lost all its horses while limbering up, and at Telissu and Tashihchiao the Japanese batteries that tried to co-operate with the infantry advance were rapidly put out of action. On

10th March 4 Russian guns retreating from Mukden were brought to a standstill by the fire of 6 Japanese batteries, only one gun succeeding in getting away.

On the other hand there are also examples of occasions when the guns were able to move in open country without suffering severe loss. At the Shaho, for instance, 2 Japanese batteries crossed without casualties a zone of ground covered by artillery fire.

However dangerous a change of position may be in open country, yet circumstances may render it essential to run the risks.

As a rule, however, artillery should wait till nightfall before changing position.

ARTILLERY PREPARATION.

The campaign confirms the experience of South Africa in showing that the artillery preparation must not be regarded as an independent and disconnected part of the attack.

It is only under very exceptional circumstances that a well-entrenched artillery can be completely silenced. As a rule, when the hostile fire becomes too hot the guns are temporarily withdrawn, but open the contest anew as soon as the fire slackens.

The infantry attack must therefore be started without waiting for the result of the artillery duel; and all that the infantry can expect is that their artillery will entirely occupy the attention of the hostile batteries during the actual advance.

MASSING OR DISPERSING GUNS.

The campaign offers no example of guns massed in large numbers. This was chiefly due to the fact that a position suitable for more than 6 batteries was seldom met with.

In spite of this, and although visual signalling was hardly employed at all and telephones were very little in demand, the number of good observing stations available resulted in but little difficulty being experienced in controlling and directing the fire of a large number of guns.

The fire control of the artillery of the Japanese I. Army gives a good example of this. There were 24 batteries (144 guns) extended over a distance of 8 miles and divided into 5 groups. From 26th February till 7th March the fire of all these guns was controlled by a colonel on the staff from a central observing station.

The Japanese were not very much in favour of having their artillery distributed over several positions, although this had the advantage of offering a less favourable target to the enemy, and also gave them a greater choice of positions and so enabled them to employ enfilade fire on several occasions.

If the Japanese could exercise such control with their limited means of communication, European nations should be able to achieve even better results. It is unwise, however, to be too sanguine on this point, as in close country communication is generally difficult and it is seldom that a clear target is obtainable.

COMMUNICATION.

The want of a well-organised system of signalling was greatly felt during the war. Several remedies were improvised but they were not very satisfactory.

All the telephones possessed by the artillery were incessantly employed; and the Japanese are now providing for an increased number of instruments and also for a complete signalling equipment.

COVER.

Cover for guns is of the utmost importance.

The introduction of smokeless powder has facilitated the use of natural cover; but guns are often betrayed by their flash, which is greater with Russian and Japanese guns than with those using cordite. Screens of straw or reeds will do much to minimise this evil.

The Japanese usually dug gun pits for their guns, and at least provided trenches for the detachments. This not only reduces the casualties whilst working the guns, but also enables the detachment to get completely under cover if the fire becomes too deadly.

The Russians at first were inclined to despise cover, but they soon learnt its value and followed the Japanese example.

INDIRECT FIRE.

In the early part of the campaign the Japanese as a rule made a very extensive use of indirect fire. But they changed their methods in the light of later experience.

The Russians, on the other hand, were not in favour of indirect fire at first, but found themselves compelled to adopt it later on.

The prevalent opinion as regards the advantages and disadvantages ot indirect fire were confirmed by the experiences of the campaign. Indirect fire certainly reduces the losses in the detachments, but it also inflicts less loss on the enemy.

Towards the end of the campaign the Japanese preferred to place their guns just behind the summit of a hill, and thus simply conceal their men from the enemy's view. Details of the method adopted to control and direct the fire from such positions are not to hand, but it appears that elevation was obtained by clinometer and direction by a man standing at the trail.

It must however be remembered that in Manchuria the hills stand out in high relief, the line of the summit being very marked and the slopes generally concave. On rounded summits with convex slopes the above described positions would not have been available.

ARTILLERY FIRE AT NIGHT.

Constant artillery fire at night must be considered one of the characteristic features of modern warfare.

The Japanese regularly supported their night attacks by artillery fire. The Russian fire at night was as effective as by day. This was due to the greater skill and science exercised in fire control. The batteries remained for some time in one position and the range of every object in every direction was known. Moreover the skilful methods of controlling indirect fire are of great assistance in night firing.

HEAVY GUNS IN THE FIELD.

In the battle of Mukden the Japanese used 15-c.m. howitzers and 12-c.m. guns. The latter were placed on the flank, and were able to enfilade the Russian position. The IV. Army had also 28-c.m. mortars.

The new 15-c.m. howitzer proved of great value against the Russian protected batteries, and also in shelling the ravines and dongas in which the reserves were stationed. The 12-c.m. gun was of obsolete pattern, and did not do such good service. The effect of the 28-c.m. mortars did not come up to expectation.

CO-OPERATION WITH INFANTRY IN THE ATTACK.

An important characteristic of the Japanese attack was the close co-operation of artillery and infantry. All the guns would concentrate their fire on the point of attack, and supported by this fire the infantry advanced to the assault.

If this co-operation failed, the attack either failed or only succeeded with enormous loss. Thus at Shoushanpu (30th August, 1904) the 6th Division attacked before their artillery was ready and the attack failed. In the engagements round Yangshitun (5th to 8th March, 1905) the Japanese guns were unable to locate the cleverly concealed Russian works, and consequently there also the attack failed.

In the early engagements the Japanese gunners openly showed their disinclination to accompany their infantry under heavy fire; the infantry suffered heavy losses in consequence, and blamed this hesitation very strongly. Later on the artillery showed far more determination, and at Mukden the artillery of the III. Army advanced to 1,500 yards from the Russian line. In the attack on Kankuantun the mountain artillery advanced to within 1,200 yards of the Russian infantry and 2,400 yards of their artillery.

The moral effect on the defender of continuous artillery fire at effective ranges was so thoroughly appreciated by the infantry that they always desired the artillery fire to be kept up, regardless of losses inflicted on themselves, until they had either captured a work or else had displayed little flags to show that further support was not required.

The Japanese were of opinion that the losses from the effects of their own fire were very small compared with the losses due to the greater accuracy of the defender's fire when the latter was not interfered with by the shrapnel of the attack.

Experience shows that the attacking artillery can seldom hope actually to silence the defender's guns, and therefore the infantry must advance to the attack before the artillery preparation is finished. For this reason the infantry must have confidence in the ability of their own artillery to keep down the fire of the defence during their advance.

7. THE INFANTRY ATTACK.

RECONNAISSANCE.

A noteworthy feature of the Japanese attack was the careful preparatory reconnaissance of the ground over which the advance was to be made.

This was carried out by officers and men, selected for their intelligence and reliability, and carefully trained for these very duties in peace time. Their reports were always excellent.

The duty was facilitated by the fact that the Russians took no pains to conceal their position and were extremely careless in their outpost and patrol duties.

The knowledge of the hostile movements and dispositions gained by these reconnaissances amply justified the time expended in their execution.

Thus prior to the attack on Shihliho (12th October, 1904) an officer and two men went forward at dawn, advancing three times in succession to within 450 yards of the railway bridge, and reported that the enemy was strongly entrenched south of Shihliho, with 2 companies on the west, and 16 gun emplacements on the right and 8 on the left bank of the river.

EXTENSION OF INFANTRY IN ATTACK.

A new light was thrown on this question by the Manchurian campaign

In the early fights the firing line was extended to one pace, the supports following in close order.

After experiencing very heavy losses the Japanese abandoned all close formations, and both firing line and supports advanced in extended order with from 3 to 5 paces between every 2 men.

At decisive ranges the supports reinforced the firing line.

METHOD OF ADVANCE.

In this connection every method was justified which enabled the men to advance with the minimum loss, and the leaders were allowed the greatest freedom.

When exposed only to artillery fire the advance was generally made in line of company columns at 100 yards interval.

It was found that in this way the best use could be made of natural cover, whilst the troops were kept better in hand than a looser formation would have permitted.

As soon as they came within effective range a firing line was sent out in front. Great care was taken to maintain communication between the firing line, supports, and reserves, individual men acting as communicating points.

In this way the needs of the firing line as regards reinforcements or ammunition were quickly communicated to the rear.

The Japanese usually tried to advance to within 1,000 yards of the enemy's position without firing or taking cover.

The fire which the Russians opened on them at 1,500 yards was of little effect and was not replied to. The troops certainly suffered from artillery fire. But it was found that halting under this fire did not reduce their losses, whilst a continued advance had an excellent effect on the spirit of the attacking troops. It was only when the fire was exceptionally heavy that the advance was checked.

The attacking infantry only opened fire when the enemy's rifle fire became so heavy that the advance could not continue without severe losses. From this point the advance proceeded by rushes of sections or squads under cover of the fire of the rest of the line. The Japanese found that this covering fire distracted the attention of the enemy from the advancing sections, and that the deliberate aim of the opposing marksmen was much impaired. From 50 to 70 yards were covered by each rush; but as the fire became more deadly the rushes were shorter, and finally perhaps only a few paces would be covered at a time.

The following table, compiled from reports on the attack on Shihliho (12th October, 1904) gives an idea of the distance covered by each successive rush, and the number of rounds fired between the rushes:—

1st rush	147	yards.	30	rounds	per rifle.
2nd	,,	65	,,	15	,,	,,
3rd	,,	70	,,	15	,,	,,
4th	,,	68	,,	15	,,	,,
5th	,,	84	,,	15	,,	,,
6th	,,	168	,,	5	,,	,,
7th	,,	440	,,			
Totals		1,042	yards.	95	rounds per rifle.	

The last distance of 440 yards was covered in a single rush as the Russians had begun to vacate their position.

It will be noticed from the above figures that the necessary superiority of fire was obtained between the 4th and 5th rush and after this the rushes become noticeably longer. The necessity of obtaining this superiority of fire prior to the final assault is universally recognised in all armies.

In criticising the South African Campaign it has been said more than once that the British tried to gain a victory by their legs more than by their rifles. The same inclination was noticeable amongst the Japanese.

On the 12th October, 1904, the position of Chienchiaocheng was attacked and taken without establishing any superiority of fire. The Japanese advanced in three prolonged rushes of about 600 yards without even firing much in the pauses between the rushes. Similarly in the attack on Terayama (11th October, 1904) the enemy's fire was not first overcome, but the Japanese made a rush of 750 yards and then stormed the position.

But these are two exceptional instances, and in both cases success was due to the bad shooting of the Russians. Owing to the rapid advance the attack was a partial surprise; the commander of the Russian reserves showed no self-confidence; and the Russian artillery failed to bring any accurate fire on the advancing infantry, whereas the Japanese artillery was shelling the enemy's lines heavily throughout the advance.

Usually the Japanese held closely to the rule of establishing a superiority of fire before the assault was attempted. This superiority was generally attained some 500 yards from the enemy's position.

When the Russians held well entrenched positions the attack often failed, as at Shoushanpu (30th and 31st August, 1904).

When every effort to advance further failed, the attack was resumed under cover of night.

On the few occasions when the Russians were the attackers (Hondayama, 11th October, 1904, and Taling, 12th October, 1904) they attached no importance to obtaining superiority of fire, but advanced in close order, firing only occasionally. Consequently their attacks were usually repulsed with great loss.

The amount of ammunition consumed by continuous firing was enormous, and cases are not rare in which whole bodies of troops ran out of ammunition. At the beginning of the campaign the Japanese carried 200 rounds, but these were found insufficient. At Mukden many regiments had 500 rounds per man.

FIGHTING WITH THE BAYONET.

The campaign has undoubtedly shown that determined troops will always be able to hold on to a position until they are turned out at the point of the bayonet (*e.g.* Terayama, 11th October, 1904, and assaults of 2nd Division, 1st March, 1905, at Mukden).

DISTINCTIVE FLAGS.

The Japanese thoroughly realised the danger of being fired at by their own troops owing to the extensive front of modern battlefields and the similarity of uniform on both sides.

To reduce this danger to a minimum every battalion was supplied with a large flag and every company with a small one, so as to enable neighbouring troops to recognise them.

CONCLUSIONS.

From the above the following stand out as the most important lessons of the campaign :—

1. The great value of careful reconnaissance by the infantry, who will in future be called upon to perform much more than has hitherto been expected of them in European armies.

2. The advantage of an extended firing line at the beginning of an attack, and the poor effect of long range shrapnel fire on such a line, which can advance even to 1,000 yards of the enemy without a check.

3. The necessity of gaining a superiority of fire before advancing to the assault.

4. The need for a greater supply of ammunition.

5. The important rôle played by the bayonet in the final stage.

8. PIONEERS.

The Japanese army was very strong in pioneers, each division having three companies (756 men). They were much more used in the firing line than is the European custom, particularly in the attack on forts or villages, where they were entrusted with the demolition of obstacles, etc. They also took part in the actual fighting and were detailed to throw the hand-grenades and work the hand-grenade mortars. Consequently their casualties were very heavy.

A good example of the Japanese employment of pioneers is given by the attack on Yuhungtun (5th March, 1905), in which a detachment of pioneers accompanied every two battalions. They followed immediately behind the firing line, destroying all obstacles and assisting generally in the advance.

In night attacks they were provided with lanterns, and here also were chiefly employed in destroying obstacles.

When they were not required with the firing line they were usually attached to the artillery, and they did invaluable work in making cover and repairing roads, etc.

9. FIELDWORKS.

Never yet have defensive works played so great a part as in this campaign.

In the earlier battles the Russian defences were very clumsy and conspicuous, no attempt being made to conceal freshly turned earth. Such works of course gave but little protection.

A distinct improvement was made at Nanshan; and from this time forward the works were carefully adapted to the surrounding ground and well concealed, being generally sited on the forward slope of a hill and having good communication to the rear.

The Japanese were very different in this respect. No matter how tired and exhausted they were, they never neglected to entrench the positions they gained. The Russians on the contrary often deferred beginning work, and were attacked before they had provided any cover at all (*e.g.* Motienling and Yushulintzu).

The extensive use of trenches in the attack was also a novel feature.

Before beginning an attack the Japanese generally entrenched a position to repel counter attacks and to cover a retreat. This enabled them to throw their reserves into the firing line.

Similarly, the advanced posts of the enemy, when captured, were at once occupied as defensive and supporting points.

The firing line also entrenched themselves whenever they were checked for any length of time, and the use of the spade in the attack contributed largely to the Japanese successes.

10. MACHINE GUNS.

The Japanese started the campaign with very few machine guns, but they soon perceived how valuable they were to the Russians and increased their own number rapidly.

It was found necessary always to place them in well-concealed positions, as they were soon overpowered and silenced once they had been accurately located.

In defence machine guns were chiefly used to enfilade the enemy's attacking line, and they were often able to check the advance so thoroughly that the artillery of the attack had to be brought to bear on them before the advance could be resumed. In the attack on Hsiaokushan (Port Arthur, 7th August, 1904) the majority of the casualties (540 men) were due to the fire of machine guns.

In the attack machine guns are better placed on the flanks or in rear rather than actually in the firing line, where they offer too easy a target and are soon put out of action. As soon however as the position is captured they must be brought up at once, so as to be at hand to ward off any attempt at recapture.

It was seldom found advisable to group more than two machine guns together, for when grouped they at once drew on themselves the fire of the enemy's artillery.

They are particularly valuable in mountainous country, where troops are compelled to move in closer formation. At Penhsihu (11th October, 1904) 6 machine guns opened a sudden fire at a range of 1,400 yards on a column consisting of two battalions, and are reported to have caused 1,000 casualties.

11. NIGHT OPERATIONS.

With the exception of the attack on Sankuaishihshan (12/13 October, 1904) night operations were only executed on a small scale, generally with the object of occupying some important point which could not be captured by day.

The rendezvous was usually within 1,500 yds. of the position to be attacked. This forms a marked contrast to the English attacks on Tel-el-Kebir, Magersfontein, and Stormberg, which were preceded by a march of several miles.

The night attacks may be divided into three classes:—

(1). When the advance by day had been checked within decisive range of the position, and the assault could only be executed under cover of night.

This was the usual case. Darkness robbed the defence to a great extent of the advantages of a prepared position. The attacking troops were close to their objective, were acquainted with the ground in the vicinity, and were spared the difficulties of a long preliminary night march.

(2). When night was utilised to cover an advance to within effective range.

In this case the troops entrenched themselves during the night; and if an opportunity for further advance was offered, they pressed forward and entrenched themselves in a second position. This method was adopted against Ershihchiatzu (12th October, 1904) and Hsiaokueihsingpu (7th March, 1905).

The assault under these circumstances took place at dawn. If it failed, the troops retired to the trenches again, and the hostile position was subjected to a concentrated fire throughout the day.

In both these cases the open and exposed ground in front of the hostile position made it impossible to advance to decisive ranges by day; and in both cases the confusion and uncertainty inseparable from night attacks were reduced to a minimum.

(3). When the night attack included a night march and an assault.

This method was adopted at Sankuaishihshan (12th October, 1904), as an attack by day involved very heavy losses.

The difficulties of keeping the right direction and of timing a simultaneous assault demanded the most careful and well-considered preparation.

The great care with which the preliminary reconnaissance was carried out deserves to be emphasised. The general reconnaissance was made by day, but a secondary one was carried out by officers at night. The latter was mainly concerned with locating obstacles and finding the best way to avoid them; this was not a matter of much difficulty as the Russian outposts stood stolidly in front of their trenches and were very little on the alert.

A night attack in force and involving a considerable march may very easily fail, and is seldom justified. It is better to advance as far as possible by day and assault by night, or else to advance by night and reserve the assault till dawn.

As a rule the formation for night attacks was the same as by day, the troops being divided into three lines.

1st Line.—A firing line in front; with a line of company columns, at 20 to 50 paces intervals, behind.
2nd Line.—A similar formation, 100 to 150 yards in rear.
3rd Line.—A line of battalion columns 200 to 500 yards in rear.

Before decisive range was reached the 1st line had formed into a single line.

Communication to flanks and rear was kept up by connecting files.

Pioneer sections were sent with the first line to demolish obstacles, and also with the 2nd and 3rd lines to throw hand-grenades.

As it was of the utmost importance to advance as far as possible without being discovered, the strictest silence was observed and shooting was forbidden, but all magazines were charged and bayonets fixed.

C. OTLEY PLACE.

REVIEW.

REPORT OF THE COLONIAL SURVEY COMMITTEE.

(Parliamentary Paper. No. 532. *The Surveys of British Africa.*— Wyman & Sons. 3s. 1d.).

This Report, the second since the Committee was instituted in 1905, deals with the work up to July, 1907.

The Committee consists of:—

Colonel R. C. Hellard, C.B., R.E., Director-General of the Ordnance Survey.

H. J. Read, Esq., representing the Colonial Office.

Major C. F. Close, C.M.G., R.E., Head of the Topographical Section of the General Staff.

The work of the past year is given as follows:—

Orange River Colony, 8,000 square miles.—The survey is based on the existing geodetic triangulation. A secondary triangulation, with sides averaging 10 miles, is made, and filled in by plane tabling. Scale—$\frac{1}{125000}$ (about $\frac{1}{2}$ inch to the mile). Personnel—Capt. L. C. Jackson, R.E. (in charge), Lieut. A. S. Redman, R.E., 4 N.C.O.s and 13 Natives.

The above work in two sections. The N.C.O.s each survey a field sheet 15 minutes square in about six weeks, giving about $5\frac{1}{2}$ square miles as daily progress.

The triangulation done by the officers shows great accuracy:—The mean triangular error for the year is 2·9 secs.; the greatest error at extremity of a chain of triangles (45 miles long) is 3 feet in latitude and 2 feet in longitude, as tested by closing on the geodetic work.

Cape Colony, 17,000 square miles.—The survey is based on the geodetic triangulation. Minor cutting up chains are run to give points for plane tabling. Scale—$\frac{1}{250000}$ (about $\frac{1}{4}$ inch to 1 mile). The work is being done by 6 officers seconded from their regiments, assisted by 7 officers attached during the non-training season. Capt. C. G. W. Hunter, R.E., General Staff, is in charge.

These officers work in pairs, each party being provided with transport. The work is executed in sheets in a systematic manner, and is checked and prepared for publication locally at an office in Cape Town. Thus a reliable military map is being produced in a very rapid and cheap manner.

East Africa.—As reported last year this Colony got into a muddle through want of foresight in survey matters, advertising for settlers before it had any maps on which to issue title deeds. A proper survey department under Major G. E. Smith, R.E., assisted by Capt. G. S. Knox, R.E., Lieut. E. W. Cox, R.E., and Mr. E. L. Waring is now at work, both on topographical and cadastral maps. Of the former, 2,400 square miles have been sketched (scale $\frac{1}{250000}$) and of the latter 870,265 acres have been surveyed (scale $\frac{1}{2500}$) during the year.

The triangulation, which should, of course, have been done long ago for the whole Colony, has now been begun, and considerable progress made.

Sudan.—The work is chiefly cadastral (scale $\frac{1}{2500}$), and is required urgently for land registration. The work was commenced in 1903; and in the absence of any triangulation or accurate traverse work to form a skeleton, the results were not altogether satisfactory. Now, however, system has been introduced and all cadastral work is preceded by theodolite triangulation or traverse. The plane tabling is done by natives, trained for the most part at the Gordon College.

Some triangulation for topographical maps has also been executed in some of the provinces; and a large number of reconnaissance sketches, from which it is hoped shortly to produce a useful administrative sketch map on the $\frac{1}{1000000}$ scale.

Capt. H. D. Pearson, R.E., is in charge, assisted by Lieut. A. E. Coningham, R.E.

The Gold Coast.—About 16,000 square miles of ½-inch and ¼-inch work has been done, and a considerable amount of cadastral work for gold mining properties. Owing to the nature of the country, triangulation is not feasible; but very accurate results have been produced by theodolite traverses, checked every 5 to 10 miles by astronomical azimuths.

Major F. G. Guggisberg, R.E., Director, assisted by Capt. C. B. O. Symons, R.E.

Northern Nigeria.—Capt. R. Ommanney, R.E., assisted by Capt. G. F. Evans, R.E., succeeded in fixing the latitudes and longitudes (telegraphic) of a number of towns in the interior. This work will prove valuable, in conjunction with Boundary Commission Surveys, in providing fixed points for the compilation of a map from reconnaissance sketches.

The survey work in *Southern Nigeria* and *Uganda* is under civil control. The results achieved do not compare favourably with those of the other Colonies mentioned.

This Report contains a number of index maps and other interesting and useful information.

E. P. BROOKER.

NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

August, 1907.

Review of Traffic Questions.—By C. Colson, Ingenieur en Chef, Ponts et Chaussées.—M. Colson's annual review traces with an unerring insight the course of the influences operating generally in the working of railways in France, Germany, and Great Britain, with occasional glances, by way of comparison, at those of the United States. Accounts in themselves are dry enough reading, but in the hands of an expert they can be made to yield very interesting information bearing on the problems which are constantly troubling railway managers.

The influences which affect railway working as a whole move in cycles (as has been demonstrated in connection with trade conditions generally), but of course the difficulty is to trace our position in the cycle at any particular moment and its bearing on the particular question at issue. It sounds like a platitude, for instance, to say that Railways should provide extra rolling stock and facilities in advance of a rush of traffic while prices are advantageous, instead of waiting until prices are high, need is great, and orders will, very likely, not be completed until the rush is slackening.

The universality of a traffic crisis in 1905–06 is reflected in the returns. But this can easily be understood when we remember that congestion on one system means an inadequate transfer at the frontier: traffic is then held back in order to bring pressure to bear for the return of rolling stock, and congestion is brought about at other points on the home system.

Again, when unexpected needs have to be met by chance methods, consignments have to be pushed forward without seeing very carefully to the loading or order of urgency; inexperienced hands have to be employed to supplement the normal staff: the work is not as well done, and traffic costs more to handle. It all sounds very like the kind of thing we have known to happen in war!

The law of the *répos hebdomadaire* produced a disturbing influence in France, particularly as regards getting trucks cleared. At first the legislature did not realise the impracticability of imposing a day's cessation of work weekly for all grades on the railways. This is now, however, being compromised.

It is remarked that any crisis furnishes the opponents of State working with an opportunity of blaming the Government, and the advocates of nationalization an opportunity of pointing out the faults of Company working. The truth is that administrations will cope with the difficulties well or badly according to their individual resources and ability.

It has been stated that J. J. Hill (of America) estimated that 220 millions sterling a year for five years were needed to bring the railways of the United States into condition to adequately meet their requirements. M. Colson thinks it doubtful whether the money could be raised and advantageously spent at this rate. In another part of the article he adverts to the difficulty of raising money on reasonable terms for railway purposes so long as industrial enterprises offer as high rates of interest as at present. The problem indeed is always in peace, just as much as in war, how to keep your rolling stock standing as little as possible; and that is the end to which all improvements ought to be mainly directed.

There are many astute remarks in the article. Indeed it must be from discriminating criticism of the results that we may learn how to improve operation, just as much as by intelligent anticipation of future developments we may secure means to be ready.

C. E. VICKERS.

ENGINEERING RECORD.

Vol. 56. *No.* 7.

THE TARRING OF HIGHWAYS.—The following reference to a report by a commission appointed by the French Minister of Public Works may be of interest:—

There are two methods of Tarring Highways in use to-day. In one the tar is applied cold, and is thinned with 10% of heavy or dead oil so that it can be absorbed; in the other it is applied hot without any admixture. The tar should be allowed to soak into the road as long as possible, but if absorption is not complete before traffic is admitted a light sprinkling of sand or dust should be applied.

The conditions requisite for successful treatment of a road surface are:—

(1). Road to have been recently put in order, well formed, and well drained. Tar does not last so long on a flat surface, and will not adhere to one that is moist.

(2). Before the tar is applied the surface must be carefully cleaned, so that the stone mosaic is exposed in a way that will permit the tar to penetrate into the road and so to speak anchor itself there.

(3). The best results are obtained by applying the tar only in dry weather and, if possible, only in hot weather.

(4). The tar must be spread to cover the entire surface.

(5). The tar must be allowed to dry out sufficiently so that the wheels of vehicles will not pick it out or skin off the coating.

Summer work is always satisfactory.

Autumn and winter work lasts fairly well on well-rounded and drained surfaces where the traffic is light. With heavy traffic it soon gets worn out, and tar in the act of disappearing produces a very disagreeable mud.

Tar Employed per Square Yard.—This depends upon the porosity of the road. From experiments in France it has been found that the minimum should not be less than 2 lbs. and the maximum not more than 4 lbs., which means ½ gallon per yard.

Tar too thickly spread may form a slippery surface, and tends to the formation of mud in winter.

Penetration.—In good work the penetration should be easily 1·25 to 1·6 inches.

Effect of Temperature and Grade.—Frost does not have any injurious effect on a tarred road. Excessive heat may make it soft and slippery, but this is generally due to bad work.

Tar should not be applied to a road having a steeper grade than 3 per cent.

Effect of Water.—Summer rain is favourable to tarred roads, and washing with copious supply of water does no harm provided it is done with judgment. The enemy of tar is persistent humidity.

Methods of Treatment.—Tarring with hot tar without any addition is the method usually employed. A mixture of ordinary tar with 10% of dead oil has been tried at Havre and Paris. The two systems are identical in the results, in both summer and winter. But the cold application is simpler, the apparatus is less costly, and the spreading is facilitated, while the presence of the dead oil has a useful drying effect. On the other hand the cost of heating is balanced by the greater cost of the oil.

Local conditions will usually determine the method to be adopted.

Liquid tar in its crude state should not be used; it penetrates but a small way into the road, especially in winter, remains upon the surface, and dries badly.

R. N. HARVEY.

MEMORIAL DE INGENIEROS DEL EJÉRCITO.

March, 1907.

SOME REFLECTIONS ON SEPTIC TANKS.—Articles on the subject of the septic tank system of treating sewage appeared in the *Memorial* during 1906 from the pens of Capt. Gallego and Capt. Cañizares.

Early this year the former officer published a separate pamphlet entitled "The production of gases, and ventilating shafts for septic tanks (a reply to Capt. Cañizares)," in which he combated the views of the latter. Extracts from this pamphlet are given. The conclusions arrived at are that gases are produced during the fermentation of the sewage under the action of the anaerobic microbes, that these gases are inflammable, and that arrangements must be made for carrying them off.

THE ECLIPSE OF THE SUN, 30TH AUGUST, 1905.—The Balloon Establishment of the Spanish Engineers took part in the observation of the eclipse, and articles on the subject have been frequently appearing in the *Memorial* since its occurrence. The present article, continued from a previous number, is by Lieut. Gonzalez and gives a résumé of observations made by different observers in various localities.

MILITARY LITERATURE (àpropos of *The Campaign of Prussia* by Major Ibañez Marin).—In the 16th and 17th centuries Spain possessed a very complete military literature and Frederick the Great confessed that he had drawn many of his tactical ideas from the *Reflexiones Militares* of the Marqués de Santa Cruz. The 18th and early portion of the 19th centuries were singularly barren in literature of this character; and though books on military subjects have been published in greater numbers during recent years, still only comparatively a small proportion of them are of value, and Spaniards have been compelled to turn to France for instruction.

The present article, which is continued in the April and May numbers, contains a very favourable criticism of Major Ibañez Marin's *Campaña de Prusia*, which analyses Napoleon's campaign of 1806.

OBITUARY: GENERAL DON EUGENIO DE EUGENIO.—This distinguished officer, who died at Madrid on the 13th January, 1907, entered the Engineer Academy in 1850. He took part in the African campaign of 1859–60, being specially promoted to the rank of captain for his services at the battle of Castillejos, and receiving honourable mention for his gallantry at the battle of Wad-Ras. He afterwards saw active service during the insurrections of 1869, and was promoted lieutenant-colonel for his services in the capture of Valencia in that year. He then turned his attention to topographical work and was responsible for most of the geodetic work which was carried on in Spain between 1870 and 1887. In the latter year, on promotion to the rank of colonel, he took over the command of the 1st Regiment of Sappers and Miners at Logroño. In 1893 he reached the rank of General of Brigade; and after filling the posts of Chief Engineer of Granada, and of the 1st Army Corps, and member of the Junta Consultativa de Guerra, he was placed on the retired list in 1900.

SCIENTIFIC CHRONICLE: REINFORCED CONCRETE.—A description of a large steel and concrete building which is being constructed in New York; and a note on W. B. Fuller's experiments on the proportion of sand and cement to be used in the making of concrete.

REVIEWS OF BOOKS.—"Lectures delivered at the Centro del Ejercito y de la Armada by Lieut.-Colonel of Artillery the Count de Casa-Canterac, 1904–5." These lectures, ten in number, have been appearing in the *Memorial de Artilleria*, and deal with field artillery. The first deals with the progress of the arm; the second with the conditions with which field artillery matériel should comply; the third and fourth with quick firers; the fifth and sixth with the organization of fire; the seventh and eighth with the necessity for the employment of light howitzers and heavy field artillery; the ninth and tenth with the tactical employment of field artillery. The author strongly recommends the adoption of field howitzers and heavy field artillery, which do not as yet form a part of the Spanish equipment. The lectures are well worth reading.

'M.'

NATURE.

August, 1907.

PEKIN TO PARIS BY MOTOR (*p.* 420).—The astounding feat accomplished by Prince Borghese, in his journey in a motor car from Pekin to Paris, points out the wonderful adaptability of the power-driven vehicle. The distance traversed is estimated at 7,000 to 8,000 miles, and the time occupied was 62 days, the daily average being 121 miles. When we deduct the time for pulling the car through loose sand and morasses, the speed seems almost incredible, considering that for half the journey there were practically no roads. Overwhelmed in a cyclonic dust storm, dragged through rivers, precipitated from a weak bridge into a fast-running river, immersed in bogs, the woodwork of the car on fire, and being nearly run into by a train on the Trans-Siberian Railway, were a few of the experiences of the intrepid traveller, any one of which would be sufficient to stop most people from continuing such a perilous journey.

MARS (*pp.* 422 and 446).—The observations of the North Polar cap of Mars at the Lowell Observatory during the period March—June, 1907, show that the snow-cap melted quite suddenly and extensively just as it did in 1903 and 1905 on practically the same date, the Martian August 22–23 (the planet's sidereal period being 687 days). Further, the first frost melted, and was followed by another fall a little later, again as it did in 1903 and 1905. This striking fact led Professor Lowell to investigate the subject mathematically, and he has demonstrated the existence of an atmosphere sufficient to retard the general deposition of frost by 19 days. He also states that the arctic and antarctic regions of Mars are actually warmer in the Martian summer than are ours, although the mean temperature of the planet, 48° F., is 12 degrees less than the mean temperature of the earth.

"HUNTING TRIPS IN BRITISH NORTH AMERICA" (by F. C. Selous, *p.* 415).—The author returns year after year with unabated zest to the roving life of his earlier South African days. He has shot wild goats in the Taurus, collected vultures' and eagles' eggs in Asia Minor, and in the volume before us gives an account of his experiences during several shooting trips in search of moose, caribou, and wild sheep. The book is well illustrated with photographs of migrating caribou traversing the scrub in well-beaten tracks, and others when swimming lakes or rivers. He complains that, though European sportsmen are prohibited from killing game in the central districts of Alaska, Indians armed with modern weapons can shoot animals of either sex or of whatever age which come in their way.

ENGINEERING AT THE BRITISH ASSOCIATION (*p.* 391).—Silvanus P. Thompson, in his presidential address, gives an interesting account of the "Interaction of Abstract Science and its Applications." The history of the electric motor is probably without parallel in the lessons it affords of the commercial and industrial importance of science. The query naturally arises: If a steam engine is still needed to drive the generator that furnishes the electric current to drive the motors, where does the economy come in? Why not use small steam engines and get rid of all intervening electric appliances? The answer lies in the much higher efficiency of large steam engines than of small ones. A single steam engine of 1,000 horse-power will use many times less steam and coal than a thousand little steam engines of 1 horse-power each, particularly if each little steam engine requires its own little boiler. The little electric motor may be designed, on the other hand, to have almost as high an efficiency as the large motor. The loss of energy due to transmission of current in mains of equal length is practically negligible. This is the abundant justification of the electric distribution of power from single generating centres to numerous electric motors placed in the positions where they are wanted to work.

WIRELESS TELEGRAPHY (*p.* 444).—The atmospheric absorption of wireless signals is found to be very great in the daytime. On some nights there is practically no absorption, but as the sun rises absorption comes on very rapidly, and in the West Indies increases sometimes a thousandfold in fifteen minutes.

During the past six months experiments have been made between Massachusetts and various stations, two types of transmitting apparatus being used. The first was an alternating-current dynamo giving 250 sparks per second and generating feebly-damped waves; the frequencies used were 200,000 per second. Messages were received very strongly at night time at Porto Rico and Cuba, and even officially reported on several occasions by naval vessels in the neighbourhood of Alexandria, Egypt, a distance of 4,000 miles; but no messages were received in the daytime.

With the second trial of longer wave-lengths and a frequency of 81·700 per second, the daylight signals were much stronger; and it was found possible to work in daylight between Massachusetts and Cuba, a distance of 1,700 miles, though at night signals were considerably weaker than when the high rate of frequencies were used. Between Boston and Washington, 400 miles, there is great daylight absorption at a frequency of 200,000, but almost no absorption at a frequency of 81·700.

W. E. WARRAND.

REVISTA DE ENGENHERIA MILITAR.

May, 1907.

SOME EXTRACTS FROM THE REPORT OF ENGINEER REGO LEINA ON HIS MISSION TO THE MINES OF CASSINGA IN 1898 (*cont.*).—One of the duties of the expedition was to make a triangulation of the district for the Mineral Exploration Syndicate of Angola in Bundambungo. The chief difficulty arose from the character of the country, a plain covered with dense forest. In Bundambungo the forest trees are very high, and a large number of men had to be employed in cutting them down. It was seldom that two fixed points could be seen from a third, and most of the work was done by traverse. Gold was discovered in 24 different places, in 22 in quartz veins, and in 2 instances in sands.

THE BARRACKS AT HALLE.—Précis of the description which appeared in the February number of the *Revue du Génie Militaire* of the new barracks at Halle, occupied by the 75th Prussian Field Artillery Regiment. It is illustrated with plans, and is interesting as showing the latest German practice.

THE ARMAMENT OF COAST BATTERIES.—Précis of an article by Capt. Pappalardo in the April number of the *Rivista di Artiglieria e Genio.* The author claims that the heavy howitzer is *par excellence* the weapon for use in coast batteries, with a secondary armament of 8-inch guns. As it is probable that in future the main attack on a coast fortress will be directed against the land fronts, the armament should be mounted so as to bear in that direction as well as over the water.

June, 1907.

FIELD WORKS CONSTRUCTED AT THE ENGINEER SCHOOL OF INSTRUCTION, 1906-7.—By Lieut. de Magalhães Correia.—Various types of trenches were constructed, but none of them are new. The German *Feldbefestigungs Vorschrift* seems to have been taken as the text book. As that book does not devote a word to the provision of head cover, except in the section dealing with Fortress Warfare, it is rather surprising to find the subject mentioned; its very great importance does not, however, seem to be realized.

THE ELECTRO-TECHNICAL CABINET OF THE MILITARY TELEGRAPH INSPECTION.—By Lieut. de Carvalho.—An electro-technical laboratory has recently been formed in the old convent of Penha de França in Lisbon for the purpose of testing the material acquired by the Military Telegraphs Inspectorate and of training officers in electricity. The necessary current is furnished by a battery of Tudor accumulators. There are three main groups of apparatus

(*a*) for the measurement of resistances
(*b*) „ „ „ „ capacities
(*c*) „ „ „ „ potential.

With the exception of two instruments by Hartmann & Braun almost all the apparatus seems to be British.

THE SERVICE OF THE ENGINEER INSPECTIONS.—By Capt. da Costa.—The author states that since the publication of his paper on Military Works in the May number of the *Revista* a commission has been appointed to study the existing system of executing Engineer Services and to recommend such alterations as will tend to simplicity and economy. He therefore continues his criticisms of the regulations.

'M.'

REVUE DU GÉNIE MILITAIRE.

August, 1907.

THE ENGINEERS OF THE GERMAN ARMY.—This is a short article, and does not contain any information that is not included in Colonel Ferrier's article, published in the *R.E. Journal*, January, 1906. The number of pioneer battalions is to be gradually increased from 21 to 29. The latter figure will be reached in 1910.

NOTES ON CALCULATIONS FOR FERRO-CONCRETE.—This is a digest of the official instructions which have been issued on the subject.

J. E. E. CRASTER.

CORRESPONDENCE.

ADVANCED POSTS AT WATERLOO.

SIR,

Erckman-Chatrian, in his *Waterloo* (edited by A. Ropes, p. 178), describes the English position before the battle as follows.

"Je trouvais que ces Anglais s'étaient très bien arrangés dans leur chemin pour défendre la route, et que leurs réserves, bien abritées sur le plateau, montraient chez ses gens beaucoup de bon sens naturel.

"Malgré cela, trois choses me parurent alors avantageuses pour nous. Ces Anglais, avec leur chemin couvert et leurs réserves bien cachées, étaient comme dans une grande fortification. Mais tout le monde sait qu'en temps de guerre on démolit tout de suite, autour des places fortes, les bâtiments trop près des remparts pour empêcher l'ennemi de s'en emparer et de s'abriter derrière. Eh bien, juste sur leur centre, le long de la grande route et sur la pente de leurs glacis, se trouvait une ferme dans le genre de la Roulette, aux Quatre-Vents, mais cinq ou six fois plus grande. . . . Les Anglais l'avaient garnie des troupes, comme une espèce de demi-lune—cette ferme s'appelait la Haie-Sainte—ce que nous avions de meilleur pour nous plus loin, en avant de leur aile droite, dans un fond, se trouvait une autre ferme, avec un petit bois (Hougoumont), que nous pouvions aussi tâcher d'enlever."

English accounts of the battle of Waterloo generally consider that it was an advantage to our army having these strong advanced posts in front of our line of battle; but after reading the above description of the position from a French soldier's point of view, it appears to be doubtful if such was the case. It was found to be impossible to supply La Haye Sainte with reserve ammunition, and its gallant German defenders were in consequence annihilated.

Colonel Chesney in his Waterloo lectures does not trace the details of this tremendous contest, but refers to the work of Sir J. Shaw Kennedy, in which, he says, this subject is treated with a clearness no other writer has reached. Sir J. S. Kennedy (p. 129) considers that the great peril, caused by the loss of La Haye Sainte and the denudation of the very centre of our line by the annihilation of Omptedas brigade, was "in a great measure the fruit of the vast importance of holding La Haye Sainte not having been seen, and the consequent neglect of its defences" (p. 123). "The spare ammunition should have been sent in the morning. What were 60 rounds per man for the defence of such a post during eight hours of fighting?"

Napoleon had an overwhelming force of cavalry. The third cavalry attack consisted of 77 squadrons, or about 12,000 horsemen, but owing to our advanced posts of La Haye Sainte and Hougoumont (1,000 yards apart) these horsemen could advance on a front of only 500 yards, as they were obliged to keep at some distance from the enclosures; therefore, twelve different ranks, two deep, had to assail in succession the allied force opposed to it. Their attacks were made on our "oblongs" with much enthusiasm and obstinacy for about two hours, and suffered such enormous loss as to render the French heavy cavalry inefficient for any great effort during the further course of the battle.

It is clear that our outposts were most useful against the enemy's great cavalry superiority; though no doubt, when La Haye Sainte was in the possession of the French, it gave them a secure position in the very centre of the Allied army and within 60 yards of that centre. It was at this stage that the great qualities of the Duke—coolness, judgment, and energy—were chiefly required and most fully displayed.

I have looked up Porter's *History of the R.E.*, also Siborne's *Waterloo Campaign*. The latter gives the number of Engineers and waggon-train, etc., as 1,240. But it would appear that only 2 companies of Sappers were with the Duke at Waterloo. One got mixed up with the panic-struck Belgians and disappeared; the other made a forced march from Bruxelles, but arrived too late on the field to participate in the action (Porter, Vol. I., p. 380).

Hougoumont from the first moment of its occupation was strengthened for defence, and every precaution was adopted which the means at hand suggested for contributing to the security of the place (Siborne, Vol. I., p. 344).

At La Haye Sainte, its little garrison of 400 men had done their best to strengthen their post with the very limited means at their disposal; unfortunately the mule laden with the regimental trenching tools had been lost the day before, so that not even a hatchet was forthcoming. The great barn door had been broken up for firewood, and the carpenters of the regiment had been ordered off to Hougoumont (Siborne, Vol I., p. 337), so that the place was never put into a proper defensible state.

W E. WARRAND.

RECENT PUBLICATIONS.

Waterloo Lectures: A Study of the Campaign of 1815. By Colonel C. C. Chesney, R.E. 4th edition.

Neuf Mois de Campagnes à la Suite du Maréchal Soult. Quatre Manœuvres de Couverture en 1813 et 1814: Pampelune; St. Sébastien; Bayonne; Bordeaux, Orthez, Toulouse. Par Lieut.-Colonel J. B. Dumas. (8vo. Paris).

Vom russisch-japanischen Kriege, 1904–05, von Oberst Fritz Gertsch. (12 mks. Künzi-Locher, Berne).

Die Kavallerie im russisch-japanischen Kriege, 1904–05, von Major Junk. (2·20 mks. Gracklauer, Leipzig).

Organisation und Ausbildung der Kavallerie für den modernen Krieg, von Lieut.-General v. Bernhardi. (1·75 mks. Mittler & Sohn, Berlin).

The Autobiography of a Military Great Coat. A story of the 1st Norfolk Active Service Company, 1900-01. By Harold Josling. ($7\frac{1}{2} \times 5$. 6s. Jarrold).

Ventilation, Heating, and Lighting, by William Maxwell. 2nd edition, revised and enlarged. (Sanitary Publishing Co.).

Modern Drainage Inspection and Sanitary Surveys, by Gerard G. J. Jenson. 2nd edition, revised and enlarged. (Sanitary Publishing Co.).

Architectural Hygiene, or Sanitary Science as Applied to Buildings, by Banister F. Fletcher and H. Phillips Fletcher. 3rd edition, revised. (Whittaker).

Agglutinants of all Kinds for all Purposes, by H. C. Standage. Constable & Co.).

Navigating the Air. A Scientific Statement of the Progress of Aeronautical Science up to the Present Time. By the Aero Club of America. ($8 \times 5\frac{1}{2}$. 6s. Heinemann).

The Problem of Flight, by Herbert Chattey. (10s. 6d. Griffin).

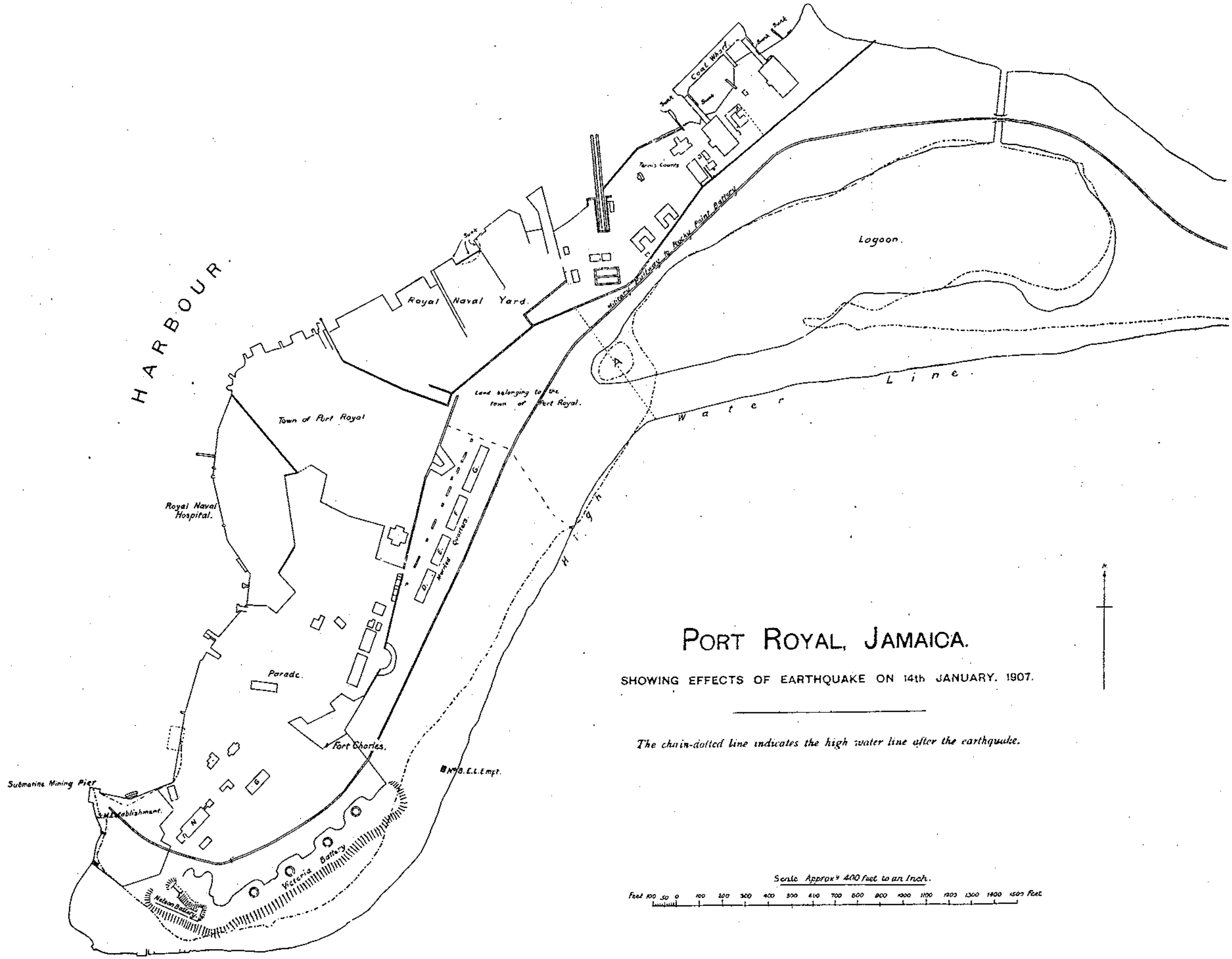
The Port of London and the Thames Barrage. A Series of Expert Studies and Reports. By T. W. Barber, M. INST. C.E., J. Dibden, F.I.C., F.C.S., and others. ($10\frac{1}{2} \times 7\frac{1}{2}$. 12s. 6d. Sonnenschein).

The Pattern Nation. Socialism, its Source, Drift, and Outcome. By Sir Henry Wrixon, K.C. ($7\frac{1}{2} \times 5$. 3s. Macmillan).

The Brahmans, Theists, and Muslims of India, by J. C. Oman. (14s. Fisher Unwin).

Les Allures du Cheval. Étude chronophotographique et mathématique, par F. Gossart, Lieut.-Col. d'Artillerie. (5 frs. Berger-Levrault, Paris).

The Game Animals of India, Burma, Malaya, and Tibet, by R. Lydekker. (9×6. 18s. Rowland Ward).



Port Royal, Jamaica.

SHOWING EFFECTS OF EARTHQUAKE ON 14th JANUARY, 1907.

The chain-dotted line indicates the high water line after the earthquake.