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CONTENTS.

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

PREVENTION OF CONDENSATION IN UNDERGROUND MAGAZINES.

By Lt.-Col. B. R. Ward, R.E.

Engineers in charge of Coast Defences are constantly being confronted by the problem of how best to remedy dampness in underground magazines. Hollow interior walls, dry packing laid against outside walls, and an asphalte covering to the roof—all necessary in their way as a protection against percolation—are, however, of no use whatever against the condensation of aqueous vapour in the air on the walls of the magazine.

The latest attempt to cope with the evil of condensation at Halifax, Nova Scotia, has been by means of specially constructed large ventilators which allow of a horizontal draught through the magazine.

This system was introduced by Colonel W. L. Marshall, Corps of Engineers, United States Army. Extracts from his report to the Chief of Engineers were published in the September, 1905, issue of this *Journal*.

Before describing the system as applied to the forts at Halifax it will be of interest to follow the history of previous attempts to cope with dampness due to condensation.

In Article 491, *Ordnance Regulations*, 1855, it was ordered that magazines should be opened for purposes of ventilation "every fine day."

The result of this practice in warm still weather was that the condensation of the vapour of water on the interior walls of magazines was unnecessarily increased; for warm air coming in contact with the cooler walls of the magazine occupies a smaller cubic content than when outside, and moisture that is held in suspension at the higher temperature is deposited as dew on the walls and floor of the magazine at the lower temperature.

Accordingly an *I.G.F.'s Circular*, Gen. No. 5/5252, D.W. No. 178, dated 26th August, 1870, adverted to in Clause 130 of *Army Circulars*, 1870, was drawn up and sent round from the War Office in order to explain the action of condensation and the principles that should govern the ventilation of magazines.

By following these instructions, and opening the doors of magazines at those times only when the dew-point of the external air was lower than the temperature of the interior of the building, it was hoped that the evil effects of condensation would be largely eliminated by natural ventilation alone.

These instructions have since been slightly modified, the most recent instructions being those contained in the *Regulations for Care and Preservation of War Material and for Magazines*, 1902, Section V., "Ventilating," paras. 102—123.

In countries where the range of temperature is not excessive, a system of natural ventilation based on the above instructions may possibly be successful in avoiding an undue amount of condensation.

In Nova Scotia, however, where the frost penetrates as far as 6 feet into the ground, and consequently the interior walls of underground magazines retain a low temperature far into the summer, the application of the foregoing system has not proved a success. In addition to this, the prevailing southerly winds are heavily laden with moisture.

Matters at Halifax accordingly appear to have gone from bad to worse, as might have been expected; and complaints were continually put forward by the local Ordnance officers as to the damp condition of magazines, until early in the eighties experiments were made to supplement natural ventilation by artificial heating.

The first means tried for artificial heating was hot water. This method is largely employed in heating private dwellings in Canada. At the lowest point of the system is a boiler from which hot water is kept circulating through a system of pipes arranged in the interior of the building. The objection to hot-water heating when used in private dwelling houses—namely, the excessive dryness of the air caused by it—was a strong point in its favour when applied to magazines; and as a matter of fact this system answered admirably.

Before the experiment was tried considerable doubt existed as to whether this system would prove a success. It was feared that, in the case of magazines with walls in actual contact with the cold earth outside, the walls would not be sufficiently heated to prevent the condensation of moisture. The success of the system shows, however, that the warmed air, penetrating the concrete or brickwork of the walls, raises the temperature sufficiently to prevent condensation.

The first hot-water heating apparatus was installed in an underground magazine at Halifax in 1885, and a record of observations was taken from August, 1885, to August, 1886. For the first 17 days the magazine was reported as damp; from that time onwards it appears to have been dry. Similar installations have since been made in at least three other magazines at Halifax.

When in working order this system is absolutely satisfactory. Considerable expense has, however, been incurred in upkeep, owing to the frequent bursting of the pipes. This has usually occurred through carelessness in allowing the fire to go out in very cold weather, the result being the freezing of water in the pipes and boilers.

This disadvantage of hot water led to further experiments in

heating systems. During the winter of 1904–05 a trial was made at the Lumber Yard of a hot-air furnace for forcing warmed and dried air into a magazine. The success of this trial warranted the erection of a hot-air furnace in one of the forts in the summer of 1905. The result may be said to have justified expectations.

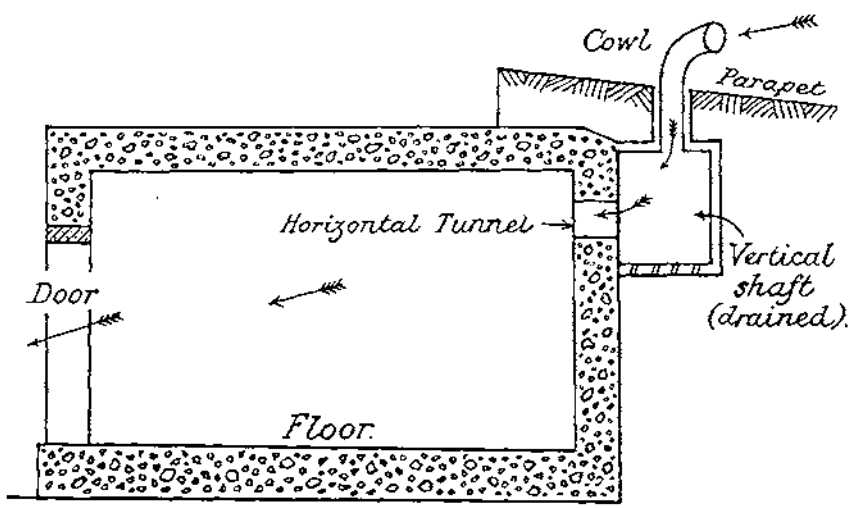
The hot-air system did not keep the magazine so thoroughly dry as the hot-water system; but the magazine was sufficiently dry for practical purposes, and the hot-air system possessed the following advantages over the other:—

(*a*). A cheaper installation, and less cost in maintenance.
(*b*). No risk of damage by frost.
(*c*). No skilled labour required for working.

It may here be incidentally mentioned that artificial heating for prevention of condensation is only required in the summer time; the fact that the temperature of a magazine in winter is higher than that of the outside air being sufficient to account for the absence of condensation during the winter months. The risk of damage by frost—and such damage has taken place at Halifax on several occasions—should therefore never occur, if the fire is only kept lighted during the summer.

The real disadvantage of either hot water or hot air is the expense of installation, upkeep, and fuel. A further set of experiments was therefore carried out last summer, in order to try the system of natural ventilation devised by Colonel Marshall.

The main idea underlying Colonel Marshall's system is that a draught of air should be passed right through the magazine. This can be done by piercing the wall of a magazine with a horizontal tunnel, some two feet in diameter, connecting with a vertical shaft sunk in the parapet just outside the magazine.



A removable cowl, such as is used on board-ship, is placed over this vertical shaft, and may be turned in the direction of the wind, when a current of air is forced in the direction shown by the arrows.

If the direction of the wind is such as to pass through the magazine more naturally in the opposite direction—*i.e.* from the door to the vertical shaft—the cowl should be removed. The wind passing over the vertical shaft extracts the air and causes a draught from the magazine through the vertical shaft to the outside.

From the experiments carried out during the summer of 1906, at No. 1 Magazine, Fort McNab, Halifax, it would appear that good results attend this system of through ventilation if put in operation with the wind anywhere between north-west and north-east. As soon as the wind gets south of this sector the magazine, including all ventilators, shell-lifts, cartridge-lifts, etc., should at once be closed.

The system just described involves a departure from existing regulations and designs in the following particulars :—

(*a*). No observations of dew-point are required.

(*b*). Small vertical shafts surmounted by rotating cowls are superseded by a horizontal tunnel of considerable section leading into a vertical shaft outside the magazine.

(*c*). Means must be adopted for sealing all openings to the magazine in damp or warm still weather.

Colonel Marshall's report, referred to above, is of special interest to officers engaged in the design or construction of magazines.

It shows that good results have actually followed the application of the "through draught" system in two of the New York forts. It explains clearly why small vertical shafts, such as are provided in our existing magazines and type drawings, are so ineffective. These small openings increase rather than reduce condensation, a similar system of pipes being actually in use near Chicago for irrigation purposes.

It also emphasizes the difficulty of applying the "dew-point" regulations, and draws attention to the futility of the theory that magazines should be opened only when the outside air is at a lower temperature than the air in the magazine. The true aim, on the contrary, should be to regulate a "through draught" in the magazine, so that the temperature of the walls should be kept as high as it is possible to keep them without risk of condensation.

Colonel Marshall's system is a revolutionary one; and if experience proves it to be successful in practice, it will necessitate considerable changes in our type drawings of magazines and also in the "ventilation" section of our Magazine Regulations. To quote from the words of his report—"All existing methods and rules should be cast aside, at least so far as to allow methods of ventilation to be provided on the broad principle that air when not saturated will absorb and

remove moisture at any temperature; and if passed over objects, masses, or walls in sufficient volumes will soon reduce these walls to the same temperature as the air."

The Canadian Government has approved of the application of Colonel Marshall's system to four of the Halifax forts. A decisive test as to the value of the system will probably be possible during the summer of 1907.

The following regulations have been locally approved as a guide to the N.C. Officers in the various forts who will have charge of the experiment.

MAGAZINE VENTILATION.

(Colonel Marshall's System).

RULES FOR OPENING AND CLOSING OF MAGAZINES.

MAGAZINES TO BE CLOSED when the following conditions hold :—

1. Generally throughout the winter, except on days when there is a brisk breeze and clear weather, and the temperature is well above the mean annual temperature,—say 45° Fahr., the mean annual temperature of Halifax being 42° Fahr.
2. When it is still or calm weather.
3. When the air is filled with fog or mist.
4. Generally at night and after 2 p.m.

MAGAZINES TO BE OPEN under the following conditions :—

Whenever there is a wind exceeding 5 miles an hour and the temperature is above mean annual temperature (42° Fahr.) with no fog, mist, or rain accompanying.

N.B.—During the period April to September inclusive Magazines should not be opened up unless the direction of the wind is somewhere between North-West and North-East.

A Personal Experience of
*THE EARTHQUAKE IN JAMAICA.**
14th JANUARY, 1907.

By Col. E. D. Malcolm of Poltalloch, c.b., late R.E.

After much arrangement there was a great agricultural conference in Jamaica, and the lords of the cotton business—growers, buyers, brokers, shippers, spinners, with men of science of many sorts, some coming direct from England, others from various West Indian Islands—arrived safely by the s.s. *Port Kingston* on Friday, January 11th, 1907. Various trips had been arranged for the Friday and Saturday, and on Monday the conference began.

I had been expecting a party to arrive on Friday to view the cattle-grazing part of the country in the west, but the railway journey of some 80 miles proved to be too serious a matter, though an inhabitant could have assured the delegates that every mile would have furnished fresh delight. Be that as it may, I had arranged to go to Kingston on Monday the 14th, partly to attend the conference, partly to attend a big ball which the Governor was giving on the 16th, but chiefly to take my passage home on the 17th.

The 14th was a lovely day, beautiful even among the glorious days of the Jamaican winter, and I, with my son and man-servant, made the journey into Kingston in the greatest comfort. On arrival I was met by a young coloured clerk of a big Kingston firm, who took over my heavy luggage and accompanied my man-servant to the wharf, while my son and I drove off to the house of the Chief Justice of the island, who had kindly invited us to stay with him.

Just as we got to the outskirts of the town, we heard a violent rumbling behind us, as of a tramcar on the rampage, and wondered why our coachman did not get out of the way. Then I noticed two or three bricks roll quietly on to the road, and immediately, with three loud explosions, the top of a brick-built church tower, opposite to which we were, fell down, but nothing touched us. Even then, we did not at once realise what had happened, for we had felt no shock—an experience which, I subsequently learned, was common to many who were in carriages at the moment. Nothing very serious seemed to have happened, except the fall of the tower, which we mentally ascribed to unskilful workmanship; but as we continued

* A letter to "The Scotsman" written on board the s.s. *Port Kingston* on 31st January, 1907.

our drive we soon began to see marks on every side which loudly proclaimed "Earthquake."

For some time it seemed as if the damage was slight, but on arriving at our destination we found our host's house in ruins; the back, front, and one side wall were down; the roof, deprived of support, was touching the ground; and one unfortunate young lady had been hurt, though, I hope, not seriously. Our hostess was naturally most anxious about her husband, who was holding Court in the town, and lost not a moment in starting off in her carriage to search for him. To her unspeakable relief, she met him a short way from home, and heard from his own lips that, although the wall of his Court-house had fallen out, he himself was absolutely unhurt.

I now determined to return to the harbour, and, on the road, was saddened to see the smoke of big fires, which, working with the breeze off the land, rapidly extended towards the sea. When nearing the business part of the town, we were assured that the streets were impassable; but nevertheless, though not without considerable difficulty, I managed to reach the ship, and found it transformed into a vast hospital, from which I gazed upon the most appalling fire I have ever witnessed. For two whole days the conflagration raged without apparent slackening, and had not completely burned itself out when the ship left on Friday, the 18th, at 4 p.m.

Nothing could, I think, exceed the sadness of Tuesday and the following days. The terrible uncertainty as to who had been taken and who left hung like a pall over everything. Wealthy men found their all destroyed; business premises, books, etc., burned by the fire, even when the buildings had withstood the earthquake; their private houses levelled to the ground; no shelter even for those members of their families whom they had been able to collect. Husbands were seeking in vain for their wives, and wives for husbands; mothers for children, and so on. Why dwell on all this.

I can only say that the agony of those days cannot be exaggerated, any more than can the miraculousness of many escapes. The large hotel of Myrtle Bank was ruined. The greater part came to the ground at once, and what was left standing was brought down by the subsequent shock. The Constant Springs Hotel, though generally standing, is split from top to bottom in many places. The King's House, the residence of the Governor, was made unsafe to live in, so that all his large party had to camp out in the garden. The barracks at Up Park Camp were totally destroyed. I mention these few cases to convey an idea of what the damage was among other less solidly built constructions.

Tidings came also of the further subsidence of Port Royal, which we were able to verify, on steaming out, by seeing a small grove of cocoanuts with the salt water half way up their stems. Then we heard of most serious damage to Newcastle, the barracks for white

troops up in the hills behind Kingston. It was soon found, too, that the whole telegraph system of the city, and much of the island, was disorganised; the three submarine cables to the outer world were broken, apparently about three miles out to sea.

To keep order—for I may say that looting began very early—there was only a small force from the West Indian Regiments and the police, a force which, as we all know, is never more than strong enough to cope with ordinary conditions. I can assure you that blessings—or the other thing—many and strong were heaped upon those who had removed the naval and military forces from the island. Fortunately the American Navy in the shape of two cruisers and a torpedo-boat put in an appearance, bringing prompt help and sympathy from the American people, which was greatly appreciated. Still all wanted to know "Where are our own people; where, at least, that ship that was to be at hand at a moment's notice?" She was expected on Friday night, but had not appeared at 4 p.m. of that day, when the *Port Kingston* left, a whole day after her advertised time. In the meantime a body of over sixty men had to my own knowledge to be landed from our ship no less than three times to help to keep order.

The effects of the earthquake reached to my own place, some 80 miles from Kingston, where the church wall was cracked and the house of a neighbour was destroyed. The telegraph has already brought to this country more details than it was possible for us to know before we left the island. The steamer, by the way, had a narrow escape. My servant, who was on the wharf, describes the feeling as a rough shaking in all directions at once, and then three heavy kicks, during which the steamer reared up into the air. Luckily she did not hit the wharf in falling back, or the consequences might have been most serious.

It feels like an impertinence to praise the Governor, and the conduct of the officers of the *Port Kingston*, who worked, oh so willingly! without rest until absolutely exhausted, or indeed of the wounded, who next day were got off the ship into a hospital improvised out of a goods shed and whose courage and calmness were on the whole very remarkable. I saw the Governor on board the *Port Kingston* at 5 a.m. on Tuesday morning, and I have since heard that, though practically without sleep for forty-eight hours, he everywhere set to all a golden example of coolness and courage.

I am sure that while I write large subscriptions are being collected for the sufferers in this calamity. I earnestly hope, however, that the relief will not be confined to Kingston alone, as I know that damage was done far outside, and I earnestly plead the cause of the ruined rich. I hope and trust that it will be remembered that the rich, who with hardly an exception have seen their all swept away, have done their best to give work to the poor. If they can be helped by

moderate loans or gifts to make a fresh start, their character and energy will enable them to pull round in a short time; but the haberdasher or dry-goods merchant, for instance, must have some place in which to bestow his wares before he can import them from outside. Two well-to-do men, with increasing businesses, who are returning on board this steamer, ruined, have told me their stories, which, after all, are only typical of many others. One, who had just enlarged his premises, and had installed the newest machinery, awoke that morning with every hope of entering upon a period of increased prosperity. The other has a wife and large family, who are now coming home with free passages, destitute of everything except what they stand up in, while a poor child has both legs broken. Each of these men employed quite a large number of intelligent blacks, who were absolutely dependent upon their employers. Surely the best way to help the blacks is to help the masters, who had their all destroyed in six short seconds.

I must add that, before I left Jamaica, I received an assurance that my own property had escaped without damage of any kind, so that I cannot be accused of pleading for myself. All I wish to do is to state the case for a certain class of sufferers which is occasionally apt to be overlooked.

DOUBLE ENTRY FOR ORDINARY COMPANY PAY ACCOUNTS.

By Major D. Brady, R.E.

It is suggested that the following method of keeping Company Accounts would be more satisfactory than that now recognized.

In the examples the entries have been shortened to save room. In actual practice a sufficient description of each transaction should follow the formal words.

Numbers and letters have been used as references, instead of dates, so as to make the examples easy to follow.

(1). The Captain receives a cheque for the estimated requirements of the month, say £300. He at once pays it into his bank, and enters it thus—

In the Government a/c—
Cr. by Bank £300
In the Bank a/c—
Dr. to Govt. (per Chief Cashier) £300

(2). Week by week he cashes a cheque for pay-day, and enters it thus—

In the Bank a/c—
Cr. by Cash £60
In the Cash a/c—
Dr. to Bank..... £60

(3). Week by week he pays the Company. The Government is liable for the sums he pays, so the Government may be debited at once, instead of first debiting the men and then crediting them and debiting the Government. Thus—

In the Cash a/c—
Cr. by Govt. (paid to Co.)..... £60
In the Govt. a/c—
Dr. to Cash £60

(4). A certain sum is stopped from the men for their fund, known as the Company (Consolidated Stoppage) Fund (which will be referred to here as the Co. C.F.). The Government is liable for this to the men, and the men to the fund, so the Government may be debited at once as in the last item.

In the Govt. a/c—
Dr. to Co. C.F. £21
In the Co. C.F. a/c—
Cr. by Govt. £21

(5 and 6). At the end of the month the Government becomes liable to the Captain and others for various small sums for contingent allowance, postage, marking clothing, etc.; and these sums are paid to those entitled to them.

(5). But first a cheque must be cashed

As before in Bank a/c—
Cr. by Cash £1 5 0
In Cash a/c—
Dr. to Bank £1 5 0

(6). The cheque having been entered, the entries now are—

In the Cash a/c—
Cr. by Govt. (detail of payments in 1st column) £1 5 0
In the Govt. a/c—
Dr. to Cash (part 3 payments) £1 5 0

(7). There may be some sums due to the Government from the Co. C.F.—

In the Govt. a/c—
Cr. by Co. C.F. ..... 15s. 6d.
In the Co. C.F.—
Dr. to Govt. (damages) ..... 15s. 6d.

(8). There are some bills against individuals in the pay list, and the entries are—

In the Govt. a/c—
Dr. to Cash (part 2 payments) ..... 5s. 5½d.
In the Cash a/c—
Cr. by Govt. (shoemaker) ..... 5s. 5½d.

(9). The Captain of the Company draws cheques to pay the various bills payable from the Co. C.F.—

In the Bank a/c—
Cr. by Co. C.F. (names of payees)...Total £19 10 0
In the Co. C.F. a/c—
Dr. to Bank (particulars of bills, washing, groceries, etc.) .....Total £19 10 0

(10). The sale of refuse, or a grant from the canteen, or a donation or subscription, may give the Co. C.F. £3—

In the Co. C.F. a/c—
Cr. by Cash (particulars)..... £3 0 0
In the Cash a/c—
Dr. to Co. C.F. £3 0 0

If all these entries are traced in the ledger, and the accounts are balanced, the balances closing the accounts will be found to be—

BALANCE SHEET.

Liabilities.	£	s.	d.	Assets.	£	s.	d.
To Government	3	5	0½	By Bank.....	4	5	0
„ Co. C.F.	3	14	6	„ Cash and stamps...	2	14	6½
	£6	19	6½		£6	19	6½

These Balances, transferred to the opposite side, form the opening balances for the accounts of the next month.

But the Military Accountant, when he audits the accounts, may find something to correct.

(X). He observes that a man, by name Jones, who has left the company, has been overpaid 1s.

(Y). That Barrack damages have been overcast 6d.

(Z). And he disallows a half-penny, as a fraction.

He accordingly says that the Government credit balance is £3 5s. 7d., not £3 5s. 0½d. as shown.

(X). The Captain must collect 1s. from Jones, or from himself if he cannot get it from Jones, and enter it thus—

In the Govt. a/c—
Cr. by Cash (Obsn.) ..... 1s.
In the Cash a/c—
Dr. to Govt. ..... 1s.

(Y). The Captain must re-credit the fund from which the damage came, and debit Government—

In the Co. C.F. a/c—
Cr. by Govt. ..... 6d.
In the Govt. a/c—
Dr. to Co. C.F. (Obsn.) ..... 6d.

(Z). The disallowed fraction the Captain must make good himself (next month he may be allowed a fraction)—

In the Govt. a/c—
Cr. by Cash (Obsn.) ..... 0½d.
In the Cash a/c—
Dr. to Govt..... 0½d.

Now, on balancing again, the Balances will be—

BALANCE SHEET.

Liabilities.	£	s.	d.	Assets.	£	s.	d.
To Government	3	5	7	By Bank	4	5	0
„ Co. C.F.....	3	15	0	„ Cash and stamps ...	2	15	7
	£7	0	7		£7	0	7

These are the correct balances for the new accounts.

It is not sufficient merely to correct faulty balances; the accounts will be useless unless the method of the correction is shown.

Each account should be kept on a separate page of the Ledger.

It will be observed that the Government Account is the Pay List statement of Receipts and Expenditure *reversed*.

The Bank and Cash Accounts are separated. There is no good reason for keeping them mixed up. Separate, each has a spare money column to use for details; nothing but the totals need go into the main column, and they will be found much easier to check and add up.

The Company (Consolidated Stoppage) Fund is kept as everyone keeps it at present.

The Balance Sheet will be found to correspond exactly to the statement in the Pay List that goes by the extraordinary name of "Cash Reconciliation Statement."

Accounts kept in the manner explained will be found very easy to keep. Double entries are necessary under the existing system between Bank, Cash, and the Company Fund; but they are made without method. The only new account proposed is the Government one; this *must* be worked out for the Pay List, and it is better to do it in the ledger than on loose scraps of paper.

If the Captain of a Company keeps his accounts by double entry he *cannot* pay or receive anything without knowing the proper person to debit or credit.

This is common commercial book-keeping, the result of the business experience of many centuries. There is nothing new or experimental about it.

If anyone should care to read it up, he could not get a clearer or a better book than Hamilton & Ball's *Book-keeping*, 2s.

LEDGER.

Folio 1.

CASH.

Dr. *Cr.*

		£	s.	d.			£	s.	d.	£	s.	d.
2	To Bank	60	0	0	3	By Govt. (paid to Co.) 1st week	60	0	0			
,,	,, ,,	70	0	0	,,	,, ,, ,, ,, 2nd ,,	70	0	0			
,,	,, ,,	70	0	0	,,	,, ,, ,, ,, 3rd ,,	70	0	0			
,,	,, ,,	75	0	0	,,	,, ,, ,, ,, 4th ,,	75	0	0	275	0	0
5	,, ,,	1	5	0	6	,, ,, (detail here)				1	5	0
10	,, Co. C.F.	3	0	0	8	,, ,, (shoemaker)				1	5	5
						Closing Balance				2	14	$6\frac{1}{2}$
						(Cash, £2 10s. 4d.; Stamps, 4s. $2\frac{1}{2}$d.)						
		279	5	0						279	5	0
	To Opening Balance	2	14	$6\frac{1}{2}$								
X	,, Govt. (Obsn.)		1	0								
Z	,, ,, ,,			$0\frac{1}{2}$		By Closing Balance				2	15	7
		2	15	7						2	15	7
	To Opening Balance	2	15	7								

Folio 17.

BANK.

Dr. *Cr.*

		£	s.	d.			£	s.	d.
1	To Govt. (per Chief Cashier)	300	0	0	2	By Cash	60	0	0
					„	„ „	70	0	0
					„	„ „	70	0	0
					„	„ „	75	0	0
					5	„ „	1	5	0
					9	„ Co. C.F. (details here)	19	10	0
						Closing Balance	4	5	0
		300	0	0			300	0	0
	To Opening Balance	4	5	0					

Folio 33.

GOVERNMENT.

Dr. *Cr.*

		£	s.	d.				£	s.	d.
3	To Cash (payments to Co.)	275	0	0	1	By Bank		300	0	0
4	„ Co. C.F.	21	0	0	7	„ Co. C.F.			15	6
6	„ Cash (part 3 payments)	1	5	0						
8	„ „ („ 2 „)		5	5½						
	Closing Balance	3	5	0½						
		300	15	6				300	15	6
Y	To Co. C.F. (Obsn.)			6		By Opening Balance		3	5	0½
					X	„ Cash (Obsn.)			1	0
	Closing Balance	3	5	7	Z	„ „ „				0½
		3	6	1				3	6	1
						By Opening Balance		3	5	7

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COMPANY CONSOLIDATED FUND.

Dr. *Cr.*

		£	s.	d.			£	s.	d.
7	To Govt. (Barrack Damages)		5	6	4	By Govt. (from Pay List)	21	0	0
9	„ Bank (particulars)	19	10	0	10	„ Cash (particulars)	3	0	0
	Closing Balance	3	14	6					
		24	0	0			24	0	0
						By Opening Balance	3	14	6
	To Closing Balance	3	15	0	Y	„ Govt. (Obsn.)			6
		3	15	0			3	15	0
						By Opening Balance	3	15	0

DEFENSIVE POSITIONS ON OPEN GROUND.

Solutions by MAJOR J. C. MATHESON, R.E., *of Problems in October*, 1906 *number; with Note by* MAJOR A. T. MOORE, R.E.

THE following are considered to be the best of the solutions received of the two Problems published in this *Journal* of October last.

The map was a reduction of the 6″ Ordnance Survey, with details omitted, and with place-names altered so as to put all competitors on the same footing. The ground represented is actually that immediately east of Lewes, Kingston on the map being Lewes and North Hill the site of the Lewes Golf Links. An enthusiastic golfer in that neighbourhood might usefully combine a little instruction with his pleasure by studying these Problems on the spot.

It may be well to recapitulate the topographical conditions governing the Problems.

Below the 50′ contour the country is practically dead level, consisting of marshy fields intersected by numerous small ditches. Between the 50′ and 200′ contours are cultivated fields, with low hedges about 250 yds. apart. Above the 200′ contour is open grass land, with chalk soil.

South-east of the Position is a ridge running due east and west, its summits varying from 600′ to 800′ in height. The western-most height of this ridge is Asham Hill, 625′ high, 3,500 yds. south-east of the old "Camp" on South Hill. Asham Hill is thus within distant to long field artillery range of the whole of the position, except the northern spur of North Hill, and within effective field artillery range of the southern end. The extreme range of the 5″ (Field) Howitzer is practically the same as that of the 18-pr. Q.F. Field Gun.

Except for this ridge the country north and east of the Position is practically dead level for several miles.

In Problem A the R. Arun is unfordable everywhere; the R. Stone is unfordable up to a point 1 mile due east of Wakelands. In Problem B these rivers are non-existent.

PROBLEM A.

A RED *Force has been defeated by a* BLUE *Force at AYLESFORD (east of the map) and is retiring to GRINSTEAD (west of the map).*

You are in command of the RED *Rear Guard, consisting of*

2 Companies M.I.,
1 Battery R.F.A.,
2 Battalions Infantry,

with orders to cover the passage of the Baggage and Supply Columns of the Main Body over the River ARUN and through the steep narrow streets of KINGSTON.

On arriving at 12 noon on 4th July at the NORTH HILL—SOUTH HILL position, you receive information that (a) *the Baggage and Supply Columns will not be clear of KINGSTON until 6 p.m. the same day, and* (b) *the Enemy's Advanced Guard (strength unknown) reached LAUGHTON (12 miles east of WAKELANDS) at 12 noon the same day.*

As Commander of the RED *Rear Guard*

(a) *Explain how you would dispose your troops,*
and (b) *Describe the entrenchments you would make.*

SOLUTION

by MAJOR J. C. MATHESON, R.E.

The governing conditions seem to be as follows :—

(1). The enemy cannot make his presence felt until about 3.30 p.m. and you cannot retire until say 6.30 p.m. So that, roughly, you have 3 hours to prepare the position and 3 hours to hold it before retirement.

(2). In the time available you cannot both execute and conceal efficient fire-trenches, your head cover will necessarily be very weak, and over-head cover will be non-existent.

(3). The strength of the enemy is unknown, but a superiority of artillery positions seems indicated. It is not at all certain that his artillery will go at once to ASHAM HILL; if it does, guns on SOUTH HILL, otherwise well placed, will have a bad time. Still, time is of the utmost importance; I should therefore put a section of the battery there, and thus try to lead the enemy to think that you are occupying it. To assist this idea, the soil of the old "Camp" might be turned up a little, and a dummy trench dug near the guns, should time permit. The two guns would be of great use at first; and, if outclassed, could easily retire.

(4). The RIVER ARUN is unfordable everywhere. So an attempted turning of your right flank is practically impossible in the

time, unless the bridges over the RIVER STONE are captured. There are at least five of these. It seems very doubtful if they could be destroyed in the time available, as explosives are not carried; so they must be well watched.

(*a*). *Disposition of Troops.*

Under the above conditions I should place the troops as follows:—

Artillery.—One section on SOUTH HILL about 200 yards north of the old "Camp." If obliged to fall back, they must retire by ROMAN BOTTOM to ASHTON COL, where they are completely sheltered from ASHAM HILL.

Two sections on the northern slopes of NORTH HILL, where they are 6,500 yards from ASHAM HILL.

Mounted Infantry.—They must leave their tools for some of the infantry to prepare trenches on the north and east sides of ASHTON PARK; retirement to be by ASHTON COL. Meanwhile they would keep in touch with the enemy, and would only occupy their trenches when driven in.

Infantry.—No. 1 Battalion: 4 companies about contour 180 on the north-east slopes of NORTH HILL, to watch the road through MIDDLEHAM, retirement to be by left flank. 3 companies between the first four and the commencement of the WINDMILL HILL spur, retirement to be by ASHTON COL. 1 company on the extreme northern end of NORTH HILL, to watch the left flank. 2 machine guns in BRIGDEN'S SHAW, to watch the three bridges in front of them.

No. 2 Battalion: 4 companies in STONEHAM PARK and STONEHAM, retirement to be by ASHTON COL. These companies must watch the two bridges in front of them with two machine guns. 2 companies in the horns of COURT WOOD about the 200′ contour. 2 companies in reserve in ROMAN BOTTOM, as the right flank may want strengthening.

The Dispositions are shown approximately on the Map.

(*b*). *Entrenchments.*

To carry out the entrenchments, it has been assumed, since no tools are mentioned, that those carried by the troops are available, of which the principal are:—

	Picks.	Shovels.		
Battery R.F.A.	18	36	and some cutting tools	and crowbars.
2 Battalions	296	444		
2 Cos. M.I.	27	55		

The tools of the 2 battalions must be pooled for the time. If any tools from the headquarter wagon of the brigade are present, these will be used by the 2 companies in reserve in ROMAN BOTTOM, to make the dummy trench on SOUTH HILL and turn the earth on the old "Camp" parapet.

The guns must entrench themselves as well as they can with the tools available in the battery. If there is time, alternative emplacements should be prepared; the 2 guns on SOUTH HILL must certainly have other emplacements ready at ASHTON COL. Considering the ground the entrenchments for the guns should be gunpits; these are more easily concealed than epaulments. The parapets must be carefully sodded.

As regards the infantry, the only cover that can be got in the time will approximate to the 3′ by 3′ trench with 1′ 6″ command, and this command should be ample on this site. To excavate his portion of this trench each man must have a shovel and the occasional use of a pick, and he would require the whole of the three hours available to do 6 feet run.

The amount of entrenching possible is very limited, and only 100 yards of front have been taken up for one company. As each man is to do 6 feet run of trench, for a company trench 50 men with 50 shovels and 25 picks are necessary. The trenches should be traversed every 10 yards; this can be done in the time without any extra labour. It is hardly likely that any time will be available for the construction of head-cover or for the concealment of the parapets, but these two points must be borne in mind.

PROBLEM B.

NORTH HILL—SOUTH HILL forms the N.E. Section of a continuous line of defence, which has been taken up to protect at all costs a large Supply Depôt at rail-head.

You are in command of this Section and a force consisting of

1 Battery R.F.A.,
2 5″ Howitzers.
2 Sections, Field Company R.E.,
1 Brigade Infantry,

and have a week to make your preparations. Civilian labour and tools are procurable.

As Commander of the Section

(a) *Explain how you would dispose your troops,*
(b) *Describe the entrenchments you would make,*
and (c) *Give a rough working table for labour and materials.*

Note.—As the map is limited the effect of the adjoining Sections of defence must be ignored. It will simplify matters to assume that the strength of the enemy is equal in artillery and double in infantry, and that the Rivers Arun and Stone are non-existent; but Asham Hill remains as a thorn in the side of the defenders.

SOLUTION

by MAJOR J. C. MATHESON, R.E.

The governing conditions appear to be as follows :—

(1). There is sufficient time and labour to make good entrenchments, which can be provided with head and over-head cover, and the parapets can be assimilated to the background and surroundings.

(2). The action will be a deliberate one and the defending troops will want relief and reinforcement. This can be effected much more easily in the case of trenches near the crest than in the case of those far down the forward slope. The cover afforded and the field of fire will also be better from the higher position.

(3). In deliberate actions it is a mistake to expend time and labour on several positions. It is much better (unless there is an unlimited amount of labour available, and very strong garrisons) to make certain that one line, the one which you mean to hold, is strong. Therefore, in this position there are no advanced posts and ASHTON and STONEHAM PARKS are not occupied.

(4). ASHAM HILL practically commands the whole defensive position within distant range, except the extreme north-west end of NORTH HILL. The trenches should be constructed with over-head cover, which permits the garrison to man them and use their

rifles even under artillery fire. The howitzer fire must be risked; it will be a long time before it will have any appreciable effect on a line of well-traversed trenches.

(*a*). *Disposition of Troops.*

For their actual fighting positions I should place the troops as follows:—

Artillery.—2 howitzers in ROMAN BOTTOM. 4 field guns on the north end of NORTH HILL, and 2 on ASHTON COL.

Infantry.—No. 1 Battalion:—2 cos. in trench '*a*.' 4 cos. in trench '*b*.' 2 cos. in reserve in redoubt 'Z'; this is 6,700 yards from ASHAM HILL, the only commanding hostile artillery position, and so is practically out of distant range; it will be only just visible, and can be made very inconspicuous.

No. 2 Battalion:—2 cos. in trench '*c*.' 2 cos. in trench '*d*.' 2 cos. in trench '*e*.' 2 cos. in reserve in SAXON BOTTOM.

No. 3 Battalion:—2 cos. in reserve in redoubt 'X.' 2 cos. in reserve in redoubt 'W.' 4 cos. in COURT WOOD.

No. 4 Battalion:—4 cos. in old 'Camp' trenches. 2 cos. in trench '*f*.' 2 cos. in reserve in ROMAN BOTTOM.

2 *Sections Field Company R.E.* in reserve in KINGSTON BOTTOM.

Ordinarily, when an attack was not in progress, the troops in the front trenches would naturally be very much reduced.

The Map shows the approximate positions of the trenches and redoubts.

(*b*). *Entrenchments.*

Civilian labour and tools are available, but one can hardly assume these to be unlimited. I have requisitioned 1,700 men per diem in 2 reliefs of 6 hours each, together with as many carts as possible. These latter are to remove the surplus earth from the cover trenches, which earth should be heaped at some distance from the real trenches to form dummy ones; dummies may do no good, but, if at some distance, will do no harm. The cover trenches give alternative cover to the fire-trenches.

All the fire-trenches have over-head cover to allow men to use their rifles under fire. Each man is between traverses (*i.e.* in a recess in the parapet). This should reduce loss to a minimum.

The old "Camp" end of SOUTH HILL is important and very exposed. Here fairly long trenches are proposed in order to allow reserves to remain at the front if necessary.

Three redoubts have been made to support the trenches, and should prove valuable *points d'appui* in the event of the fall of the line of trenches being threatened. Redoubts 'W' and 'X' are unseen from any part of the enemy's line, even from ASHAM HILL. Redoubt 'Z' is just visible from ASHAM HILL only, and is 6,700 yards away

from it, and so is practically out of distant range of field guns and field howitzers.

On these open downs trenches completely sunk should give ample field of fire. (N.B.—In Problem A these low trenches could not be made owing to lack of time).

(*c*). *Labour and Materials.*

Without a knowledge of the ground itself, it has been impossible to put the execution of the works in any order of precedence, one can only give the men, tools, and total time required to carry them out; these are shown in the attached rough Table.

ROUGH WORKING TABLE.

Place.	Work.	No. of Men at One Time (6-hour relief).	Time Required to Execute.	Tools and Materials.						
				Picks.	Shovels.	3" Poles.	Roofing Material.	Saws.	Wire or Rope.	Sundries.
						ft. run	sq. ft.			
NORTH HILL	Trench 'a,' 200 yds.	160	18 hours	120	120	—	720	—	—	
	Cover trench 'a,' 50 yds.	40	18 ,,	30	30	830	1350	3	wire or rope	One or two carts to remove surplus earth.
	Commn. trench to 'a' and 'Z,' 200 yds.	100	6 ,,	100	100	—	—	—	—	
	Trench 'b,' 400 yds.	320	18 ,,	240	240	—	1440	—	—	
	Cover trench 'b,' 100 yds.	75	18 ,,	60	60	1660	2700	6	ditto	ditto.
	Commn. trench to 'b,' 550 yds.	275	6 ,,	275	275	—	—	—	—	
	Trench 'c,' 250 yds.	200	18 ,,	150	150	—	900	—	—	
	Cover trench 'c,' 75 yds.	55	18 ,,	45	45	1245	2030	5	ditto	ditto.
	Commn. trench to 'c,' 750 yds.	375	6 ,,	375	375	—	—	—	—	
	Trench 'd,' 250 yds.	200	18 ,,	150	150	—	900	—	—	
	Cover trench 'd,' 75 yds.	55	18 ,,	45	45	1245	2030	5	ditto	ditto.
	Commn. trench to 'd,' 450 yds.	225	6 ,,	225	225	—	—	—	—	
ASHTON COL.	Trench 'e,' 250 yds.	200	18 ,,	150	150	—	900	—	—	
	Cover trench 'e,' 75 yds.	55	18 ,,	45	45	1245	2030	5	ditto	
	Commn. trench 'e,' 300 yds.	150	6 ,,	150	150	—	—	—	—	
COURT WOOD	Trenches, 300 yds.	240	18 ,,	180	180	—	1080	—	—	
	Commn. trench from 'X,' 200 yds.	100	6 ,,	100	100	—	—	—	—	
SOUTH HILL	Old "Camp" trenches, 550 yds.	440	18 ,,	330	330	—	2000	—	—	
	Commn. trenches, old "Camp," 350 yds.	175	6 ,,	175	175	—	—	—	—	
	Trench 'f,' 250 yds.	200	18 ,,	150	150	—	900	—	—	
	Cover trench 'f,' 75 yds.	55	18 ,,	45	45	1245	2030	5	ditto	ditto.
	Commn. trench to 'f,' 150 yds.	75	6 ,,	75	75	—	—	—	—	
NORTH HILL	Redoubt 'Z'	170	12 ,,	140	140	some revetting material wanted, labour is allowed for.				
SOUTH HILL	Redoubts 'X' and 'W'	360	12 ,,	300	300					
Whole position	Gun entrenchments	Made by R.A. : guns on NORTH HILL want special protection on right flank.								
	Clearance of hedges, etc.	As may be necessary.								
	Obstacles	Impossible to detail, depends on wire, etc., available.								
	Collecting and carting roofing material	400	12 hours	—	—	—	—	—	—	A number of carts.

Allowing for making clearances and obstacles, the above works out at about 1,700 men per day in 2 reliefs (850 each), for 7 days. Entrenching tools required are about 600 picks and 600 shovels. For roofing materials, brushwood, corrugated iron, etc., etc., can be used.

REMARKS.

The above cases of positions on open ground are good examples for illustrating the different factors which must be taken into account in all fortification, and especially in field works.

It is impossible here to consider all these factors; but there is one beyond all others that the two problems bring into relief, and that is the extreme importance of *time* in preparing a position for defence. With the word time is also included labour, by which time is turned to good account.

Perhaps the most difficult problem in the art of fortification is the preparation of a position in a few hours. Let anyone try to imagine the conditions. A force arrives on a position in an unknown country, and an officer receives orders to prepare the position for defence against an attack expected in a few hours. Of course some data are known,—the strength of the force for fighting and labour, and possibly the approximate numbers of the enemy. But the chief point is that the ground is new, the nature of the soil may be unknown (a very important matter), and the longer the time taken up in studying the position the shorter the time available for preparation. And there are many points that have to be weighed,—the nature of the action to be fought, the necessity for good field of fire, cover, invisibility, power of reinforcement, power of retirement, etc. Many of these requirements must be omitted or compromised through lack of time. Then is the moment for the genius with an "eye for country"; he will be worth several companies.

What an Utopian training would be the chance for an R.E. or any officer to have the actual preparation of such a position under these conditions, with due criticism and discussion afterwards. But it would be Utopia and not England or any other known country.

Turn to the Problem B and see what a change the factor of time has wrought. Is the field of fire obstructed? Time will surely improve it. Trenches can now be made of any desired type, superfluous earth can be removed, and the "slim" art of deception is possible. In fact, in almost every way time will allow the defects of nature, as regards the particular position, to be made good.

To come back to Problem A, the more difficult one, the design of the trench is a very secondary matter compared to its *site*, which is the crucial point. Everyone now knows how a trench should be made; for the siting no definite rules can be laid down. But it is evident that, since time is so limited and a certain amount of excavation is essential (namely the irreducible minimum to give effective cover), there will be very little time to spare for concealing the parapet, for making head-cover, or for digging communications up to the trenches; and so the site must be looked to to provide as far as possible for the requirements in these respects.

In this particular case it is evidently necessary to get below the chalk line, unless the trenches are to present an excellent target to the enemy. Retirement from these forward positions will be attended with danger; but this must be risked, and those lines of retreat chosen which are most concealed by nature. One small point here is in favour of the defenders,—owing to the orientation of the position, the forward slope should be in shadow when the retirement is to take place.

NOTE BY MAJOR A. T. MOORE, R.E.

It must always be a matter of difficulty to evolve a satisfactory solution of a tactical problem by means only of a map. In the cases here under discussion the difficulty is by no means diminished by an investigation of the actual ground; and to arrive at the best solutions would entail a detailed yard-by-yard examination of the position and a considerable expenditure of time (not permissible under the conditions of Problem A).

Having visited the ground and discussed the features with other officers who have been there, I may be justified in making some remarks on the considerations which led me to think that Problem A was of peculiar interest.

(1). *The Topography of the Defensive Position.*—Though Asham Hill is of serious import in Problem B, it is of less significance in Problem A, since the duration of the operations is limited and it will be some little time before the enemy learns the value of this hill and gets his artillery there; his guns will have to come into action in daylight against guns already in position; and it is only the extreme south end of the position that is within effective range of field artillery on this hill.

Roughly speaking, the whole of the position above the 400′ contour, except the north side of North Hill and the reverse slope of South Hill, is within full view of Asham Hill; and it must be remembered that this hill is not an isolated one, but portion of a ridge which rises some 200′ higher at points further to the east. On the other hand, practically the whole area of the three Bottoms is out of view by the Enemy, and the whole of the northern flank of North Hill and the greater part of its north-eastern side are also defiladed. The probability is that from Asham Hill the existence of the Bottoms would not be discovered, as from this distance North and South Hills, being open grass land, would appear one plateau. (It is assumed that the Enemy would have maps of the country, but small scale maps on which the configuration of the ground would not be shown in detail).

The only crossings over the R. Arun (concerned in the problem) are the railway bridge south of Kingston and the road bridge in this town. The former is probably unsuitable for vehicles and horses, it is

commanded by the whole position, and there is a considerable extent of open dyke-covered ground on the right bank of the river here. The road bridge is defiladed by the ground, as well as by houses, from the whole of South Hill ; this crossing is therefore the most important for both sides.

North Hill forms a most efficient natural bridge-head for the road bridge ; this hill could be held after South Hill had been captured, but it is doubtful whether the converse would be true. Hence North Hill is the key of the position.

As the country north and east of the position is practically dead level and open for several miles, the line of the Enemy's advance would, in July weather, be discovered at an early period ; so there would be no question of a surprise.

(2). *The Probable Action of the Enemy.*—The Enemy would soon discover, if he did not know it already, that Red's baggage and supply columns were in difficulties. The possibility of capturing them would induce him to push on ; and his attack would probably be developed by 3.30 p.m.

He would endeavour to prevent all, or at any rate a portion of, the columns from crossing the R. Arun. Hence, for reasons deduced from the above topographical considerations, his principal physical objective would be North Hill.

He would be headed off from an attack on South Hill from a southerly direction by the unfordable R. Stone with its few crossings all under close fire from the position, and would eventually arrive in the neighbourhood of Wakelands. Here there would be two alternatives for him :—(1) To make an attack from the north-east over open ground direct on his main objective, viz., North Hill ; or (2) to take advantage of the cover afforded by Ashton and Stoneham Parks and Court Wood in order to first occupy South Hill, and thence proceed to attack North Hill. Though the latter course might occupy more time, which is of importance to him, he would probably adopt this alternative. In any case his attack would probably be supported by artillery fire from Asham Hill.

The fight would then resolve itself into two distinct phases from Red's point of view, namely a rear-guard action on South Hill and a protracted resistance on North Hill.

(3). *The Occupation of the Defensive Position.*—Allowing only ½ an hour for examining the position, Red commander would have a maximum of 3 hours to make his preparations ; and he must hold North Hill at any rate for a minimum of 2½ hours.

In occupying a rear-guard position, one axiom is to ensure a good line of retreat ; in this case there are the two bridges immediately in rear.

Since the pursuing force would endeavour to work round the flanks, another axiom is to have strong flanks ; in this case, the flanks are

naturally strong, whether we consider the whole position or only North Hill.

A third axiom is to ignore the immediate foreground of the main infantry firing line, for the rear-guard would retreat before the Enemy arrived at anything like close quarters. But in this particular case, since the baggage and supply columns may be delayed beyond 6 p.m., it may be necessary to make a stubborn resistance. Owing to the peculiar convex formation of the terrain, any line along the top of the hill has the disadvantage of so great a depth of dead ground in front that the attacking infantry would be under cover long before they arrived within decisive rifle range; also, the top of the hill is too narrow to provide an effective field of fire for a line placed on the rear crest; lastly, since the soil above the 200′ contour is chalk, any trenches made above that level would give the position away at once, as there would be no time to disguise and conceal them. Hence, at any rate on the north-eastern side of North Hill, the main infantry firing line must be well down the forward slope.

As regards the Disposition of the Troops, the following are the conclusions arrived at with some knowledge of the locality :—

Red's force is too small for any portion to be sent up to Asham Hill in order to delay the occupation of this commanding position by the Enemy; and any troops sent there for such purpose would be liable to have their retreat cut off.

The force is also too small to permit of Windmill Hill being occupied effectively, and without danger, as part of the main line of defence; but some portion of the mounted infantry might have occasion to hold its northern face temporarily.

The mounted infantry, after getting early information of the main line of the Enemy's advance and delaying him as long as possible, would retire by the flanks, and would eventually cover the retirement of the infantry by occupying the trenches vacated by them; they might have to occupy first the position on South Hill and then that on North Hill, or the latter only.

The best position for the artillery is on the northern spur of North Hill, which is beyond distant field artillery range from Asham Hill and from which there is an excellent field of fire to the north and north-east. It would be advisable to place 1 section "in observation" just behind the crest on Ashton Col, whence they could operate against an attack on South Hill from the east or bring a flanking fire on an attack on North Hill, eventually retiring on to the latter.

The main strength of the infantry should be on North Hill. No. 1 Battalion could be entrenched at suitable points about the 200′ contour on the north and north-east slopes; there would be little possibility of reinforcement, and the only route for retirement would be a somewhat hazardous one by the left flank. If trenches on the upper edges of

the quarries on the north slope could be assimilated with these edges, the companies on this flank might be disposed just above the quarries instead of on the 200′ contour.

2 companies of No. 2 Battalion might be placed as a reserve in the hollow on the west side of North Hill; and should construct entrenchments along the south-west spur of this hill, from whence they could cover the retirement of the troops on South Hill and also oppose an attack from that direction. If the forward slope permitted of these trenches being on the crest, the surplus soil could be removed out of sight down the reverse slope.

The remaining 6 companies of the second battalion would be disposed behind the crest of South Hill, 4 between Ashton Col and the southern extremity of Court Wood, and 2 on and to the north of the old "Camp." These companies would not entrench, and would only come into action along South Hill in order to repel an attack on that part of the position; they would be available for reinforcing or supporting the troops on North Hill.

So far as time permitted, dummy trenches would be constructed on conspicuous sites on the unoccupied portions of the various crests and slopes, in order to mislead the enemy and draw his fire.

The infantry could retire partly by one bridge and partly by the other or by the road bridge only, the mounted troops and guns by the road bridge. The artillery and mounted infantry would retire last, and it might be necessary to sacrifice them in order to gain time for an orderly retreat of the baggage and supply columns and the infantry.

OUR REQUIREMENTS IN RIFLE RANGES.

By Capt. A. B. Carey, R.E.

The provision of suitable and sufficient rifle range accommodation for the efficient musketry training of our forces is a problem of great difficulty. This question is one far more difficult of solution in Great Britain itself than in Colonial or Foreign countries which are less densely populated and where large open areas of land are comparatively easily obtained. It is, moreover, a question of which the difficulties are accentuated by two factors :—

(*a*). The increasing ranging power of modern weapons.
(*b*). The increased amount of musketry training which is recognised as necessary for both the Regular Army and the Auxiliary Forces, whether those auxiliary forces consist of volunteers and militia or are obtained under some form of universal training.

The subject should be considered from its origin, as it is evident that under present conditions the practices laid down in the Musketry Regulations necessarily conform to the type of rifle range available on which to execute them ; whereas, when the construction of a new range is about to be undertaken, the chief consideration is usually how it can be made most suitable for the practices laid down in the Musketry Regulations. Unless, therefore, a periodical consideration of the question is taken up *ab ovo*, it will follow that, in spite of strenuous endeavours on the part of the officials responsible for this portion of the training of our army, musketry instruction will fall largely into a groove bounded on both sides by the narrow limits of existing range accommodation. As an instance of this may be quoted the snap-shooting practices introduced into the Musketry Regulations after the Boer War, and the fact that on a large number of ranges these practices have to be deleted as the danger areas have been found insufficient.

It is therefore necessary to consider first—What is the object of musketry instruction, both as regards the individual soldier and his fire commander ? and afterwards—What means have we available for providing this instruction, and what form should the provision of new accommodation take in order to meet modern requirements and developments in the near future ?

OBJECTS OF MUSKETRY INSTRUCTION.

The objects of musketry instruction may be divided into three sub-heads :—

(*a*). To enable the soldier to use his rifle to the best advantage on service under conditions where it is possible for the individual to select his own target and to have a reasonable chance of hitting it.

(*b*). To enable the fire leader to direct the fire of his party to the best advantage under conditions which prohibit the use of purely individual fire as above.

(*c*). To inculcate such fire discipline into the individual soldier as to ensure that he will obey the commands of his fire leader even under the stress of modern battle conditions.

(*a*). Now the soldier may be called upon to use his rifle under widely varying conditions. At one time he may be firing under the command of his fire leader, who will have pointed out the object to be aimed at, and will give the range to be used and will adjust it as he may consider necessary from his observation of the results of the fire. Or he may be called upon to fire, upon his own initiative and with no time for reflection, at short range, at single figures, possibly showing only their heads and shoulders, and these indistinctly and for short intervals of time as they move from cover to cover or appear for an instant to fire.

Between these two extreme types of condition lie many intermediate stages. But it is the latter set of conditions that calls for the highest skill and therefore the highest degree of instruction for the individual soldier, in that he must be able firstly to see the enemy, possibly a few indistinct objects against a dull background, secondly to select his target, estimate the range, and align and fire his rifle with an almost automatic rapidity. This high degree of skill is more likely to be called for on small expeditions than during a war with a great power where larger numbers are in question and battle conditions with controlled fire would more frequently prevail. But even under these latter circumstances individual skill would find many opportunities both in the skirmishing preceding the battle and even during the battle itself; and although the fight may be won eventually by superior direction of the fire of masses of men, yet it would appear equally certain that a high degree of skill on the part of the individual firers will count largely in the conditions leading up to the battle, and will, other things being equal, give increased power of reconnaissance and greater facility for seizing and holding important points at a distance from the main body.

It is evident therefore that our Regular Forces, which are frequently called upon to take part in small expeditions, should be trained to as

high a degree of skill as possible in firing, at decisive ranges, at figure targets appearing at unknown distances and in unexpected directions so as to simulate as far as possible actual service conditions; whereas our Auxiliary Forces should have at least some instruction in firing of this description.

(*b*). For the fire leader to be able to direct the fire of his party satisfactorily in war, it is necessary that he shall have had some practice in time of peace in observation and direction of fire at targets made to resemble service conditions as far as possible and appearing at unknown ranges and unexpected times and directions.

(*c*). As regards this point, a reasonable amount of training under sub-heads (*a*) and (*b*), carrying with it necessarily the increased confidence of the individual in himself and his weapon, without which fire discipline is scarcely attainable, should provide all that is necessary. It should also be noted that, whereas it will not be practicable (and is indeed scarcely necessary) to train the Auxiliary Forces to the same high degree of individual skill in the use of the rifle as is necessary for the Regulars, yet their training for what may be described as battle firing should not fall far short of the standard laid down for the Regulars; and the selection and training of their fire leaders should be performed with the greatest care, in order that the fire discipline and control should attain the highest practicable degree of efficiency.

To analyse then the requirements of musketry instruction for the individual soldier, these consist of:—

(1). *Mechanical Motions.*—Handling of the rifle quickly and correctly, and aligning sights, including knowledge of the peculiarities of his own rifle, pressing trigger, quick loading.

(2). *Intelligent Motions.*—Spotting enemy, selecting target, judging distance up to short ranges (say 500 yards) at the same time as he is choosing his own firing position and commencing the mechanical motions of firing.

The fire leader, in addition to the attributes enumerated above, should have some knowledge of the effect of wind and other climatic conditions, should be trained to use glasses to assist in spotting and selecting his target, and should also be trained to judge distance up to medium ranges or be supplied with a range-finder* which is portable and convenient to use and accurate up to 1,500 yards.

* Of course if a range-finder can be obtained, which will combine accuracy at long ranges with convenience and portability for short range work, this would be most desirable, but convenience and portability are not such essential conditions for use at the longer ranges. Larger bodies of men are necessarily employed under better control, rapidity of range-finding and invisibility of the range-taker are not of such essential importance, and it might perhaps be sound policy, while supplying numerous small range-finders to fire leaders of low rank, to supply also range-finders of a longer base, and consequently of greater accuracy at long ranges, for the use of fire-leaders of higher rank.

DESCRIPTION AND EXTENT OF TRAINING OBTAINABLE UNDER PRESENT CONDITIONS.

Preliminary instruction in handling rifle, setting sights, aiming, and trigger pressing is given on the drill ground, and possibly on Morris Tube ranges; also judging distance, and some practices for improving the eyesight, but each subject by itself.

For further and practical instruction there are three types of range available:—

(*a*). The Classification Range.
(*b*). 30 Yards Range.
(*c*). Field Practice Range.

(*a*). *The Classification Range* is the best known and exists in the largest numbers; for this reason it is being dealt with before the 30 Yards and Field Practice Ranges. It allows for the completion of the instruction of the individual in the mechanical motions; that is, the soldier is enabled to detect errors and correct himself in aiming, trigger pulling, flinching from recoil, etc.; and is on some ranges able to practice rapid fire and snap shooting at simple moving or vanishing targets at known distances, though this cannot be carried out on all classification ranges. He is also able to learn the peculiarities of his own rifle and get some knowledge of weather conditions.

The disadvantages of this type of range are that for the individual soldier it is impossible to carry out practices resembling service conditions when range, direction, and time are unknown. For the fire leader the ordinary classification range is practically useless; he may be able to obtain some knowledge of weather conditions, but this type of range affords no instruction in fire observation, direction, control, or discipline.

The chief feature of a classification range is that it provides an opportunity for practice at medium ranges in the effects of wind and light. Setting aside the fact that the value of these lessons would be largely discounted on service in another country with a different climate, there remains the fact that accurate individual shooting at these ranges is entirely dependent upon accurate marking. On service there will be no marking, and accuracy can only be looked for by good range-finding followed by skilled observation of controlled fire; corrections for individual shots for slight alterations in the strength of the wind or the quality of the light will be impossible. It therefore follows that, while the fire commander should have some general knowledge of the effects of wind and weather conditions, the degree of skill in this subject required to win prizes at Bisley is quite unnecessary and his time would be far better employed in studying observation and control of fire.

(*b*). *30 Yards Ranges.*—These ranges allow the individual to perfect himself in all the mechanical portion of firing, including rapid fire, to obtain by means of double targets some knowledge of the peculiarities of his rifle, and to perfect himself in the use of the dial sights. Like the classification range, however, they provide no training in the subjects which require the use of the firer's intelligence, nor do they provide any training for the fire leader.

(*c*). *Field Practice Ranges* should theoretically supply all the deficiencies of the two types of range described above. In reality, however, they are at present too small and not suitably laid out, with the result that, although some opportunity is given to fire leaders to observe the effects of fire at moving and vanishing targets and some training in fire discipline and control is afforded, yet this instruction is insufficient even for the fire leaders; and little or no opportunity is afforded of practising the individual firer in those exercises which oblige him to use simultaneously both his intelligence and his mechanical skill and are the only means by which a reasonable degree of skill in shooting under service conditions can be attained.

ADVANTAGES AND DISADVANTAGES OF PRACTICE AMMUNITION.

There are three possible types of ammunition for practice purposes, viz. :—

(*a*). Miniature Ammunition.
(*b*). Reduced Charges.
(*c*). Break-up Bullet.

(*a*). *Miniature Ammunition* is cheap. It has little penetration, and consequently the stop butt and other construction is not costly. It is, however, useful only as a preliminary step between aiming drill and firing service ammunition.

(*b*). The same remarks apply to *Reduced Charges.* It must never be forgotten that, after aiming drill, the first and chief requirement of musketry instruction is to teach the firer to become accustomed to the shock of recoil and to load and fire equally correctly whether he has a service charge or an empty chamber. Teaching rifle firing must not be confused with big gun firing, which is absolutely dissimilar for the reason that in the first case the firer holds the weapon and receives the shock of discharge, whereas in the latter case these functions are performed mechanically.

Firing reduced charges practically amounts to doing a better class aiming drill. For rifle shooting it does not give the main desideratum, viz. :—practice in becoming accustomed to noise and shock of recoil.

Further it must be remembered that any ammunition, either miniature or reduced charges, which will shoot accurately at 200 yards,

will require a danger area of many hundred yards. For instance, the Bisley pattern Morris Tube ammunition has a maximum range of about 1,300 yards and a ricochet range of about 500 yards. Kynoch's B reduced charge is rather more dangerous as regards ricochets. Moreover, the use of these forms of ammunition in field practices up to 500 or 600 yards is greatly to be deprecated, because, even if they shot straight enough, owing to greater elevation being required the firer would become habituated to holding his rifle at too great an angle of elevation, and consequently on service he would be liable to repeat this error, especially under battle conditions when accurate sighting is scarcely probable. Another drawback to the use of these types of ammunition is that, owing to invisibility of strike of bullet, the fire leaders would get little or no instruction in observation and control of fire, a point of considerable importance.

It may be urged that possibly a special practice ammunition might be devised which, being more powerful than existing types of reduced charge ammunition, would give with a very light bullet a high muzzle velocity and considerable recoil and noise with the advantage of a flat trajectory at short ranges; but, owing to the unfavourable sectional density, the bullet would rapidly lose velocity and would have considerably less ranging power than the service bullet. This may or may not be possible; the difficulty would be to ensure accuracy with such a light bullet. Even if this were obtainable, however, it is very doubtful whether a sufficient saving in depth of danger area could be effected to counterbalance the expense of making a special ammunition and the disadvantages of it from a training and ordnance point of view. For instance, the main disadvantage from a musketry point of view of such a type of ammunition would be that the errors in sighting of each individual rifle would differ when used with service ammunition to what they were when this special practice ammunition was used; *e.g.* a man may learn that his rifle with practice ammunition at 500 yards throws 2 feet left and is 50 yards undersighted, whereas at the same distance with service ammunition it throws perhaps 1 foot right and is somewhat oversighted. The confusion arising in a soldier's mind from having two sets of corrections to remember would be a grave disadvantage.

(*c*). *Break-up Bullet.*—As regards the use of a bullet which would break up on impact, this would, if practicable, be very desirable, and would tend to reduce the range of ricochets by at least one-half; but I am not hopeful of this solution of the question being attainable. The shocks received by the bullet while in and on leaving the barrel are very much more severe than the shock received on lightly grazing a smooth and possibly soft soil. Consequently it must not be expected that a bullet which will stand the shocks of propulsion in the barrel and discharge from the muzzle of the rifle, although it is

to some extent supported by the sides of the barrel during these, will be so fragile as to break up on grazing a soft and yielding substance. Of course, if it could be guaranteed that the bullet would strike the earth nose first, the case would be different, and comparatively certain results might be looked for; but this is not attainable, and it must be accepted that large numbers of ricochets would have grazed the earth on their undersides only. I am therefore forced to the unwelcome conclusion that a segmental or fragile bullet will not form a solution to this difficulty.

SUITABLE TYPES OF RIFLE RANGES.

Long *Protected Ranges* have been abandoned. But in view of the fact that some misunderstanding possibly exists as to the value and degree of safety of these ranges, it seems desirable to append the results of considerable experiment at Hythe and of experience gathered from ranges of this type both on the Continent and in Great Britain.

1. A well-designed and economically constructed protected range of 200 yards costs about £200 per target.

2. Absolute safety is not attainable unless the range is practically converted into a tunnel, when its training value decreases and its cost increases.

3. As regards training value a 30 yards range is the superior of the 200 yards protected range, in that it permits of rapid fire, use of long range sights, etc., and especially of quicker instruction.

4. As regards constructional cost the 30 yards range in most unfavourable circumstances would be less than half the cost of the most favourably situated 200 yards range.

5. As regards area of land and accessibility required the 30 yards range again has an immense advantage. The deduction is therefore that, for a densely populated country such as Great Britain, having a comparatively long service army and being dependent for its reserves on auxiliaries who, under any organisation, will spend far less time in their training than obtains in the reserves of continental armies, the three main points to consider are safety, rapidity of instruction, and accessibility. On all these points the 30 yards range is far in advance of the 200 yards protected range.

For instruction in the mechanical portion of musketry the 30 yards range, or the classification range if sufficiently close at hand, are suitable. For the instruction in weather conditions of fire leaders or men likely to become fire leaders the classification range is suitable, though it is a very expensive item to provide for this one item in musketry instruction and is often inconveniently situated. For the further instruction of the individual in firing under what may be called snap-shooting conditions, and for the instruction of the fire

leader in his duties, the 30 yards and classification range are useless and the present type of field practice range is unsuited.

It will be seen, therefore, that both the types of existing ranges and also their numbers and accessibility are not up to requirements. The *Classification Range*, which type alone exists in any numbers, is quite inadequate for musketry training to meet modern conditions. It provides limited opportunities for our men to become good mechanical shots and to learn the sighting of their rifles; and it does this in a very wasteful and extravagant manner, owing to (*a*) the value of the land and size of danger area required, (*b*) the distance of ranges from the men who use them and consequent expense and loss of time entailed in going to and fro. Moreover, classification ranges, although considerably in excess of the 30 yards and field practice ranges, are still quite inadequate in number for the needs of either our Regular or Auxiliary Forces; and they are particularly unsuited for the elementary training of these latter, owing to the distance from populated localities at which these ranges are usually sited and the limited time which the Auxiliary Forces are able to spare for musketry training.

30 Yards Ranges form a much more economical and convenient means of supplying elementary training in rifle shooting to both the Regular and Auxiliary Forces. But as yet there are very few of these ranges in existence, a defect which it is to be hoped will be gradually remedied since they provide for the cheapest and quickest form of elementary instruction.

That these arguments will be considered as heresies by the Bisley marksman and his following is probable. But the solid fact remains that in war time casualties are not caused by riflemen who slowly and deliberately adjust their elevation and wind between each shot accordingly as a complaisant enemy signals the amount of error to which he still owes his life. No, conditions are very different. Casualties in real war depend much more largely on the probability of one of a number of fairly well-aimed shots reaching its mark; and, after a reasonable degree of mechanical accuracy of firing has been attained, the chief factors in increasing the probability of hitting are:—

1. Well-trained eyesight.
2. Accurate judging distance.
3. Rapid fire.
4. Good fire leading.

The ordinary type of bull's-eye target shooting as carried on at present gives no training whatever under the first two and the fourth sub-heads and very little under the third. I might go further and say that not only does it not help in training the eyesight but it even does harm in accustoming the mind and eye to abnormally easy and slow conditions.

It is evident therefore that a new type of range is necessary which will provide for training the individual in each of the subjects enumerated above—not each subject separately, but all in combination.

Small Field Practice Ranges.—The first requirement, therefore, is the provision of a sufficient number of separate ranges, on each of which a small party of men can be exercised in offence or defence under the control of its fire leader; the size of the party to be so small that it is practicable for each man to receive individual instruction, for each man to have his own target to shoot at, appearing at unknown times, distances, and directions, but falling when hit.

The targets should be sufficiently far apart for each man to be able to observe the results of his own shots, or for his right or left-hand man to do so for him, and correct his aim accordingly. Practices of this description compel the individual to use both his intelligence and his mechanical skill in combination, and it is ranges of this type that are specially necessary.

The second requirement is that these separate and independent ranges shall be so sited on one area that, when not required for individual instruction, they can be used in combination for the instruction of the fire leaders in direction, observation, and control of fire, and also in covering fire and mutual support. But these practices will only be the secondary purpose of the area, the first necessity being the training of the individual firer, which, besides being of importance in producing good shots, is also of considerable value to the fire leader who will improve himself from watching or firing with his small party of 8 to 12 men.*

For the individual practices, ranges permitting of firing up to 600 yards will suffice, as this distance may be considered well outside the limit at which any individual man can fire with a reasonable prospect of hitting in a few rounds an individual target. For the elementary fire leaders' practices rather longer ranges should be provided. It should be possible also to carry out occasionally firing by large bodies at long ranges, say up to 2,000 yards, and also demonstrative practices at medium and short ranges, such as for instance to show the effect of fire on a small body of cavalry charging.

Although at first sight it would seem that individual practice in firing at moving targets was a very necessary item of instruction,

* This is not intended to imply that practice in direction and control of collective fire is of less importance than individual fire; but that, since ammunition is limited and because the individual practices necessarily occupy a much greater amount of time than collective practices, therefore, in laying out an area, the first consideration must be to so lay it out as to provide the greatest possible amount of accommodation for the individual field practices. This being done it may be taken for granted that sufficient accommodation for collective practices will be easily obtained.

yet it will be seen on consideration that it is not of great importance and would be wasteful. It would lead to considerable expense in the provision of numerous moving targets; greater risk would be incurred of widely divergent shots; and instruction would be delayed owing to mechanical difficulties. These arguments however are secondary; the main reason for not providing individual practice at moving targets on field practice ranges is that firing such as is practised at Bisley at the running deer does not occur on service. On service the moving target will usually be advancing more or less directly towards, or retiring more or less directly away from, the firer, especially at ranges where purely individual fire is effective. Under these circumstances firing is but little more difficult than if the target is stationary. The more difficult case for the individual is the crossing shot; but here again the Bisley running deer type of shot would nine times out of ten be useless, as the man target would not go at a steady pace along nicely inclined slopes, but would usually appear and disappear with folds or irregularities in the ground, and would vary its pace accordingly, the result being that the firer, if he attempted to follow Bisley practice, would get badly left. The only practical method of dealing with a crossing target on uneven ground is to aim and fire rapidly at the spot which you judge the target will have reached by the time the bullet can get there. A good shot at surprise targets will be able to do this sufficiently well. As regards collective fire at crossing targets on service, these will usually be comparatively large bodies, and steady shooting at the head of the body will do all that is necessary. It is for these reasons that firing at moving targets, such as at a small party of charging cavalry, is classed as a demonstrative practice and is not included in individual instruction.

The provision at each locality of a sufficient number of easily accessible field practice ranges is practically an impossibility; as a range suitable for only one section of 8 or 16 men at a time to carry out individual field practices entails the provision of a danger area of some 800 acres, the cost of which would be very unlikely to be less than £100 an acre if the range was at all conveniently situated. The reason of this large danger area being necessary is that, in order to provide a sufficient variety of direction of fire, an angle of divergence of at least 10 or 11 degrees to either flank must be allowed for; to this must be added the 20 degrees necessary for deviation of ricochets; and it will thus be seen that for field practices of any value to be carried out a danger area far wider than that required for an ordinary classification range is absolutely necessary.

It may therefore be accepted that the provision of single individual field practice ranges in easily accessible situations for each locality is an economic impossibility; and that the only rational means for providing for field practices is by taking up a few large areas of

ground on which such numbers of individual field practice ranges can be constructed as to reduce the area of ground required per range from 800 to about 200 acres or less, and then to supply these ranges with such a complete outfit of both personnel and target apparatus and appliances as will ensure the possibility of imparting the greatest amount of instruction in the least possible time and will consequently reduce the total number of areas required. A massed number of individual field practice ranges, provided with hutting accommodation so that men can be sent for a course of field practices lasting perhaps a few days for the Auxiliary Forces and a few weeks for Regulars, will have the advantage over the single local individual field practice range that greater variety will be obtainable ; so that, even were the advantage of massing individual field practice ranges not so great from a pecuniary aspect, there would still be this considerable advantage of variety from a training point of view.

Since, however, it would be very wasteful practice to take a man to a field firing practice area to fire ball ammunition until his eyesight and intelligence had been sufficiently developed for him to be able to spot and select his target reasonably quickly, it is most necessary, in order to obtain the full value of these field firing areas, that provision should be made near every station of aiming grounds, not less than 600 yards in length by 200 yards wide, on which practices by small parties (up to say 1 company) can be carried out with or without blank ammunition but otherwise simulating service conditions—in order, (1) to train the individual in rapidly spotting, selecting, judging distance, and aiming at surprise figure targets and in fire discipline, and (2) to give the fire leader elementary instruction in fire direction and control as well as improving his eyesight and rapidity of decision. Such a dummy range as this should be provided with a sufficiency of figure targets and apparatus by means of which the appearance and disappearance of the targets can be regulated at the will of the instructor, so that practices either in attack or defence can be carried out. Cover of various forms should be provided both for the figure targets to appear from and for the men under instruction to be taught to take advantage of ground.

If ever we are engaged in war with a first-class power we shall have to rely on the good average training of large numbers of Auxiliaries rather than the high degree of skill of a small Regular Army. This good average of training is impossible for really large numbers of the Auxiliary Forces under present conditions since rifle range accommodation is not sufficiently accessible. It can only be obtained at a reasonable price by the provision of easily accessible 30 yards ranges and no less easily accessible aiming grounds as described above, the final training being given when possible by a few days' practice with ball ammunition on a field-firing area.

The Auxiliary Forces would, as a whole, be a far more valuable

asset to the nation, if they were enabled to become good mechanical shots on conveniently situated 30 yards ranges; and if judging distance, rapid aiming, and eyesight were improved by training on carefully prepared aiming grounds. In both these cases however accessibility is of the first importance. A man who is working for his living may be able to spare pretty frequently one or two hours in the evening without detriment to his business; but the giving up of a whole day, or even of an afternoon, is a far more serious matter, and may entail considerable pecuniary loss to the business man or loss of his situation to the labourer.

It may therefore be deduced that the following types of range are necessary:—

(*a*). The *30 Yards Range*, in sufficient numbers and so sited as to be easily accessible for every man, whether of the Regular or Auxiliary Forces, to attain mechanical perfection of firing.

(*b*). *Aiming Grounds*, to be both numerous and easily accessible, and which might possibly be sited in conjunction with the 30 yards ranges.

(*c*). *Field-Firing Areas*, as described above, with hut accommodation, on which the Regulars can be efficiently trained in firing under service conditions and on which the Auxiliary Forces can have a modified training.

Classification Ranges are desirable as an intermediate step between the 30 yards range and the field practice range; but, provided that conveniently situated 30 yards ranges and aiming grounds are available, they are not absolutely essential. Since, however, a few of these ranges can as a rule be sited on a large field-firing area without detriment to its use for field practices, and at no expense other than for construction, they should when possible be supplied, in order that the individual may be able to test the sighting of his rifle within the limits of decisive ranges and that the good shots and N.C.O.s may obtain some knowledge of weather conditions.

CONCLUSION.

It is therefore evident that the provision of small classification ranges, having the minimum danger area allowed by regulations, is not in the true interests of either economy or efficiency having regard to:—

(*a*). Their cost as compared with the 30 yards range.

(*b*). Their inaccessibility as compared with the 30 yards range.

(*c*). The fact that they provide no training whatever in fire observation and control, a subject which in war between first-class powers is of the first importance. It is a matter of common knowledge that a well-drilled number of medium shots under a capable fire leader will produce far better results in collective fire than an equal number of skilled shots under an inexperienced or incompetent fire leader.

(*d*). The fact that they provide no training for the individual soldier in shooting under service conditions. This is a subject which in war between first-class powers is second only in importance to the training of the fire leader, and which in our smaller expeditions is of perhaps greater importance.

(*e*). The fact that the training of the fire leader in fire observation and control under service conditions is of far greater importance than a knowledge of wind and weather conditions obtained on a classification range, which knowledge, though it may help to win prizes at Bisley, will be of little value on service.

Also it cannot be denied that, if the United Kingdom were at war with a first-class power, there would not be time available for training fire leaders. All that could be done when war had been declared would be to partially train the masses of auxiliaries who would be required in the purely mechanical processes of shooting.

Now field-firing areas cannot be provided in a few days, nor in a few months; on the other hand 30 yards ranges and aiming grounds can be provided comparatively quickly. Therefore any comprehensive scheme for the provision of rifle range accommodation should deal with the requirements of the nation in the following order:—firstly as regards field-firing areas, secondly as regards 30 yards ranges and aiming grounds, and lastly as regards classification ranges and these only where they can be provided at a reasonable cost.

TRANSCRIPT.

SAPPING AND MINING WORK BY THE 1ST COMPANY, 17th SAPPER BATTALION, AT MUKDEN.*

Position of the 3rd Infantry Division.

THE 3rd Infantry Division, to which Captain Ter-Akopov's Company was attached, took up, at the beginning of November, 1904, the portion of the Shaho position which extended from the railway embankment (inclusive) on the east to the village of Sifontai on the west. To the east (or left) was the 35th Infantry Division and on the west (or right) the 5th Army Corps.

The main line of defence lay along the line of the villages Ingoa and Sifontai, about a mile north of the river. But there was in addition an advanced line, extending from a point on the river bank about 200 to 250 paces west of the railway bridge, through the northern outskirts of Linshinpu (where there was a *point d'appui* called Fort Resurrection) and thence westwards in approximately the same direction. The only support to the left flank of this line was the so-called Bolkhov redoubt, which consisted of two lines of rifle trench meeting at right angles, the one facing the river at a distance of 180 paces, and the other facing the railway embankment, which at this point varied in height from 21′ to 35′, at a distance of 90 paces.

The Japanese Position (3).

On the eastern side of the railway the Japanese occupied the north bank of the river. They had seized the Fir Copse, and had constructed there a lunette surrounded by obstacles which approached within 100 paces of the embankment at a point 70 to 80 paces north of the bridge-head.

(11) and (12).

At the bridge itself they had excavated in the embankment a gallery with loopholes enfilading the Russian trenches, and somewhat further to the north they had built on the embankment a casemate of rails. They were able each night to extend their hold on the embankment northwards by excavating in its eastern slope recesses for riflemen, which commanded all the ground lying between the main and advanced positions of the 3rd Division.

To the west of the railway they held the left bank of the river, and from the bridge to Linshinpu the distance between the hostile lines increased gradually from 135 to 400 paces, which latter distance separated the Japanese in the Temple from Fort Resurrection. Beyond this the Japanese line was drawn back gradually to 1,200 paces from the Russians, the country here becoming completely open and level.

* From an article by Capt. V. Ter-Akopov in the June and July, 1906, numbers of the *Eenzhenernee Zhoornal.*

The numerals and letters in the margin refer to the map.

Russian Arrangements for Retiring from Front Position.

For defence the Russian advanced position was entrusted to one complete regiment. It was decided that, in case this position had to be evacuated, the regiment should retire through the obstacles of the main position and rally as a reserve in rear of the remaining troops of the Division who were occupying the works on this line; but the task of arranging such a retirement and deciding on the exact moment for opening fire from the main position in night time proved exceedingly difficult.

The "Intermediate" Trench (1).

With a view to facilitating such a retirement, the Sappers, on the night of 10th—11th November, made a trench for one company on both sides of the railway half-way between the bridge and Ingoa, a connection through the embankment, and a communication trench from Ingoa leading along a ditch on the west side of the railway.

When the working parties were extended on this line the Japanese discovered them, and, anticipating an attack on the bridge, they lit beacon lights and brought up guns which opened a heavy fire on the Russians. But in spite of some casualties the latter stuck to their work and finished it successfully in the single night.

Reorganisation of the Positions.

About the middle of November General Orlov took over command of the 3rd Infantry Division, and forthwith turned his attention to the difficult problem of retirement. It was decided that the advanced position should for the future become the main position, and that in case of attack it should be reinforced by the troops of the original main position, which should henceforth be considered only a rear one.

In support of this arrangement the line of the 35th Infantry Division on the left flank was pushed forward until it became roughly a continuation of the "intermediate" trench; but it still remained about 1,000 paces in rear of the left of the newly appointed main position of the 3rd Infantry Division, and the condition of this flank was felt to be very precarious. If the Japanese should concentrate by night a large force in their Fir Copse lunette, rush over the embankment, and fall on the rear of this flank, the 35th Division at that distance, and defiladed as they were from view by the high embankment, could do nothing to stop them. Consequently it became evident that the power of retaining the advanced position during the winter depended entirely upon whether this flank could be made strong enough of itself to resist attack.

The "Rear" Trench (2).

With a view to enfilading any attacks made by the Japanese on the rear of the threatened flank, another one-company trench was made on the night of the 5th—6th December. This trench was sited entirely on the west side of the embankment, half-way between the "intermediate" trench and the bridge. The work was carried out under incessant fire from the Japanese casemate on the embankment.

The First "One-Day" Trench (3).

But as it was clearly evident that for the effective defence of this flank some arrangement must be made to command the eastern side of the embankment, a party was sent out, on the night of the 14th—15th December, from the north end of the Bolkhov redoubt to commence tunnelling through the embankment at that point. During this and the three succeeding nights they completed the passage, and with the help of flying sapwork of sandbags they made a trench like a tambour for 20 riflemen on the east side of the railway. This trench was subsequently

(4). connected with the Bolkhov redoubt, but at first its garrison could only be relieved by night, and for this reason it received its name of the "one-day" trench. It was situated 100 paces north of the nearest Japanese rifle recess, 200 paces from their rail casemate, and 360 paces from the head of the bridge, these distances being accurately estimated from the telegraph poles which were 70 paces apart.

Attack on the Casemate. On the night of the 19th—20th December, under cover of the fire from the "one-day" trench, a party of volunteers succeeded in rushing the rail casemate, which the Sappers forthwith demolished to its foundations.

The Sap on the Embankment (5). But the "one-day" trench, although very effectively situated, was considered too small, and in case of attack a very high standard of courage and devotion would be required from its 20 defenders. It was consequently decided to bring the eastern face of the Bolkhov redoubt up to the top of the embankment by driving a sap from the "one-day" trench southwards along the embankment. This was begun on the night of the 23rd—24th December, the trench being given in plan a special zigzag form to enable it to bring both the head of the bridge and the eastern side of the embankment under heavy fire.

The work was carried on day and night in spite of great difficulties caused by the rails and sleepers, the frozen state of the ground, and the incessant opposition of the enemy, who, in addition to their magazine fire, were able to bombard the work with shimoze shells from guns mounted in caponiers on the southern bank of the river. In spite of heavy casualties the sap proceeded uninterruptedly, and as each section was finished it was manned with riflemen. Damage done to the works by day was repaired by night. By the 24th January the trench had advanced 80 paces along the embankment, its length along the zigzags being not less than 150 paces, so that by this date a whole company was accommodated in the sap and "one-day" trench.

Flying Sap in Line with South Face of Bolkhov Redoubt (6). It had meanwhile become evident that the space of ground, measuring about 200 paces, between the head of the bridge and the left flank of the main position was insufficiently protected by fire, as the south face of the Bolkhov redoubt was partially masked by the trench in front of it. It was consequently decided to extend this face eastwards to the embankment by means of flying sapwork. After three days' preparation, during which 10,000 sacks were filled with earth, the Sappers, on the night of the 17th—18th January, began building up in the open the parapet of the sap under magazine fire from the enemy who were not more than 100 to 150 paces distant. Under such conditions the sap on the third night reached the embankment, considerable damage being done each day by shimoze shells to the sandbag parapet, which had to be repaired during the night.

The Second "One-Day" Trench (7). On the night of the 21st—22nd January this sap was prepared for infantry, and a mine gallery was begun running eastwards under the embankment, at the eastern exit of which a second "one-day" trench for 40 riflemen was completed by the 28th January. The difficulties of this work can be estimated when it is understood that the Japanese Fir Copse Lunette was only 70 to 100 paces distant from it, and nearer still

the Japanese had posted concealed sharp-shooters who kept up a continual fire on the working parties and caused serious losses.

The Third "One-Day" Trench (8).

On the 29th January was commenced an exit leading from the gallery under the railway up to the surface of the embankment slightly to the north of it, and here was built another so-called "one-day" trench. From this trench fire could be brought to west, south, and east, and in the last-named direction it provided another tier of fire to assist the second "one-day" trench against the Japanese lunette; it was also found to be a good place for observing the effect of artillery fire. It is needless to say that the construction of this trench was carried out under very heavy fire from the enemy.

Offensive Saps (9).

With the construction of the above-mentioned works the defence of the left flank was considered complete, and the Sappers were set to work to prepare for an attack on the bridge itself. On the nights of the 27th—28th and 28th—29th January, moving out from the left flank of the front trench on the river bank, they constructed a trench by flying sapwork which reached a point about 100 paces west of the bridge-head; and on the night of the 6th—7th February, by the help of two sap-roller mantlets, they built a parapet of sandbags close to the west side of the embankment in front of the south face of the Bolkhov redoubt and only 90 paces from the bridge.

(10).

During the construction of this last some Japanese, skirmishing up by ones and twos to a neighbouring fold in the ground, were preparing to rush the work, when they were discovered and exterminated by magazine fire. On the following night an attempt was made by the Sappers to dig a trench behind this parapet; but the ground being frozen hard and the enemy on the alert, they were driven back with heavy loss and obliged to discontinue the work.

The Mine under the Embankment (a).

As further progress by sapping was impracticable, a mine was started from the gallery of the second "one-day" trench, and was driven southwards day and night with the intention of blowing up the Japanese gallery at the head of the bridge. As soon as the mine reached the neighbourhood of the sandbag parapet just mentioned, a branch was started towards this parapet; by the 28th February this communication was finished and the mine itself had approached within 60 paces of the Japanese gallery.

Attack on the Bridge.

On the following night the attack on the bridge was carried out, but as the Sappers were busily employed elsewhere only 14 men of the volunteer section took part. The assaulting columns, having assembled in the saps and having received written and verbal orders, at 8.0 p.m. rushed the head of the bridge.

(b).

The Sappers burst into the Japanese gallery and made an exhaustive reconnaissance of all their works in the vicinity. They discovered that the Japanese had driven two mines northwards under the embankment, and that these were waiting ready charged until the Russian approaches should arrive within their sphere of action. Another mine, unfinished, was also found, running westwards from a ravine on the west side of the bridge-head; this one was intended to work under the left flank of the Russian trench. Having cut the leads of the charged mines the Sappers

set to work to turn the captured works against the enemy, but the attack was not fated to be successful and the Russians were forced to retire after losing many of their number. The Sappers brought away as trophies some drills, a long pyroxiline cartridge, and some samples of the Japanese leads.

Mining Warfare at Linshinpu (16) and (17).

For the remaining few days during which the 3rd Infantry Division continued to occupy their positions on the Shaho, the Sapper work was confined to mining warfare; but before detailing this some account may be given of the mining in the neighbourhood of Fort Resurrection.

Japanese Mine to Fort Resurrection (*a*).

About the middle of January the outposts noticed that the Japanese were removing large quantities of earth from their post in the Temple at Linshinpu, and at times, when the weather was calm and there was little firing, underground knockings were distinctly heard. It became evident that the Japanese were driving a mine against the Fort, which was occupied by 1,000 men of the 9th Ingermanland Infantry. The Japanese mine ran almost due north, passing to the east of the fort, from whence a branch was driven which ran under its left flank.

Russian Counter-Mine (*c*).

On the 14th January the Russians commenced a counter-mine from the left end of the front face of the fort, running south-eastwards almost straight for the centre of the Temple. After proceeding about 180 paces, branch galleries were thrown out to the right and left and it was in the latter (or easterly) branch that the systems met.

On the night of the 27th—28th February the Japanese, evidently sounding for information, drove a drill, probably 14 to 20 feet in length, into the head of the Russian branch gallery. The Russian Sappers tried to break off the end of the drill, but failing in this they reported the occurrence and orders were given to charge the branch gallery as quickly as possible. From sounds heard in two casemates in the Fort it appeared that the Japanese were also charging their mine. The whole of the following day a very heavy bombardment continued, the Russians having commenced this as a preparation for their attack on the railway bridge. But the Sappers succeeded in bringing up 18 barrels, each containing about 92 lbs. of powder, and, working in a suffocating atmosphere from which many fainted, they succeeded in charging and tamping the mine. Everything was ready by 10.0 p.m.; permission having already been received, the mine was fired forthwith by a Siemens machine; and the Japanese mine was destroyed, to the very great relief of the garrison of Fort Resurrection.

(*c*).

On the 1st March, as a result of the information received during the assault on the bridge, a shaft was sunk from the eastern end of the front trench, and branch galleries were begun, running north, east, and south, to counteract the enemy's action in those directions. The mines at Fort Resurrection and on the railway were also pushed forward.

But on the 3rd March orders were received to charge all the mines as enormous fougasses; and on the night of the 5th—6th March, after all the remaining troops had retired, they were fired by the Sappers, who thereupon abandoned the position, which, at the cost of 27 per cent. of their numbers, they had done so much to render impregnable.

F. E. G. SKEY.

REVIEWS.

APPROXIMATE ESTIMATES: A POCKET BOOK FOR ESTIMATING. *By* T. E. COLEMAN.—(E. & F. N. Spon. Price, 5s. 3d., post free).

THIS is the third edition, revised, greatly enlarged, and with an altered title, of Mr. Coleman's *Architect's and Engineer's Price-Book.*

It starts with general remarks on the preparation of estimates, including notes on the proportional value of labour and materials in each trade and the cost of an ordinary house by trades and by parts. A list of the various external services, such as approaches, paving, water supply, etc., which have to be thought of in making an approximate estimate, might have been added with advantage.

Next come remarks on the execution of works, with tables of the average current rates of wages per hour of tradesmen in London and the country, working hours, payment for overtime, and average prices of building materials.

The bulk of the book (400 pages) consists of an alphabetical list of average prices for all sorts of building and engineering works, by unit, cube, square, foot-run, and otherwise. In many cases the actual costs of works recently executed are given. Comparing the rates given for various Barrack buildings with the average costs of those erected between 1897 and 1905 under the Military Works Loan, we find the majority of the figures are decidedly low, but this may be due to Mr. Coleman's cube rates being calculated from the bottom of the foundations instead of from half way up them. For most military buildings it would be better to take cube rates from the *Synopsis of Cost and Construction of War Department Buildings*, which is to be found in all R.E. Offices.

But it frequently happens that approximate estimates are demanded at short notice of works for which few or no data are to hand and of which the estimator has had no experience. In such cases a book like this is of great assistance. Like all price books it must be used with discretion, but so used it will be found of considerable value.

The last 40 pages are taken up with miscellaneous building notes and memoranda. Equipped with Hurst's *Pocket Book*, Mr. Rea's *How to Estimate*, and Mr. Coleman's *Approximate Estimates*—all three written by gentlemen of the civil Staff for Engineer Services—Division Officers and Foremen of Works should have little difficulty in furnishing any estimates required.

A. M. HENNIKER.

LES CHASSEURS DES VOSGES, ET LE PONT DE FONTENOY.

By LT.-COL. SAINT ETIENNE.—(Toul: Imprimerie Lemaire. Price, 3 frs.).

This is a very interesting description of the blowing up of the bridge at Fontenoy by franc-tireurs on 22nd January, 1872.

At the date of the Franco-German War there were three railway approaches to Paris:—

1. *Via* Mulhouse. This was defended by Belfort and Langres, and was never any use to the Germans.

2. *Via* the Ardennes. Defended by Montmedy and Mezières, and not cleared till just at the end of the war.

3. *Via* Strasbourg and Toul. This was the shortest and best route; and after the fall of Toul on 23rd September it was clear for the Germans as far as Nanteuil tunnel, which was blown up. Later, when this tunnel difficulty had been surmounted, the line was available right up to the lines of investment round Paris.

The three possible places for demolitions near Toul were the bridge at Fontenoy, a 7-arch masonry structure across the Moselle, and the tunnels of Foug and Pagny.

Pagny was never prepared for demolition. Foug was prepared at the last minute, but the workmen were interrupted by the Germans on 17th August before completing.

The bridge at Fontenoy had been prepared, when it was built, with a chamber for demolition in the first pier on the Strasbourg side; but the plans had been lost, and no one knew where the galleries were. They were discovered again in August by means of one of the masons who had helped to build the bridge 20 years before, and the arrangements were put in order.

The preparations were completed on 7th August, but the Commandant at Toul received orders that the bridge was not to be destroyed without direct orders from the Emperor. Such orders were never received; and though urged to do so, he refused to carry out the destruction.

On 2nd September the Commandant at Langres, 120 kilos. away, sent an expedition to destroy it. Too many men were sent, and they were slow in getting there, and on the news of Sedan they were recalled with nothing done.

On 23rd September a civilian expedition with powder started from Langres, but was stopped by the fall of Toul. The powder was buried in a wood.

Several plans were made after the taking of Toul, but they came to nothing.

On 9th November a Military Committee was formed, to act against the German lines of communication. They made their headquarters at Lamarche, a secluded village in the mountains. A very interesting account is given of the formation of a company of franc-tireurs, and the difficulties that had to be overcome in equipping them. A fortified camp of instruction was formed in the Forest of Boëne.

By the end of December there were 300 men. They applied to the Commandant of Langres for powder, and, though refused for some time, obtained it by the middle of January.

The expedition started for Fontenoy on 19th January, and was completely successful, breaking down two arches of the viaduct. The previously prepared demolition chamber was discovered after some trouble; and the powder, 250 kilos. of which had been brought on 3 horses, was inserted down the shaft, which was large enough for two men to enter. The actual amount of powder used is not stated. There is an interesting account of the march to Fontenoy and the return by another route.

The Germans began to mend the bridge on 24th January, by filling in the broken arches with an embankment. Traffic was resumed on 4th February.

E. G. GODFREY-FAUSSETT.

OUR BIRTHRIGHT: AN ESSAY ON THE VITALITY AND RESOURCES OF THE NATION IN RELATION TO NATIONAL DEFENCE.

By 'OPTIMIST.'—(1s. Constable).

This essay was written before the publication of the recent proposals for the reorganization of our Auxiliary Forces. Its objects are, firstly, "to set before the country positive proof of the immense amount of material trained on a sound social as well as military basis which it possesses"; and secondly "to bring home to every one the possibility that this material can be so developed, by the existing great voluntary organizations which have created it, as to supply a present and effective substitute for universal compulsory military training."

The author considers that the entire future solution of the problem of sound National Defence on Voluntary lines lies in the extended support of the existing organizations. "This alone is the real and only safeguard against that militarism which may rightly be characterised as Defiance not Defence, and as carrying with it that hateful thing 'Conscription.'"

Unfortunately, he purposely does not attempt to deal with the question of the compulsory or voluntary military training of the adult manhood of the nation. And as to 'Conscription,' so far as we are aware, no responsible person has advocated for this country the adoption of conscription in its proper sense, that is of compulsory manhood military service which is by no means universal and which entails hardships on many classes; what has been urged is compulsory universal military training on the threshold of manhood.

In his introduction 'Optimist' makes a statement which covers the solution of the whole question of National Defence—

"It is no longer a debatable matter, it is a recognised fact, that the *outer* guardians of our islands are our sailors and our ships of war; but it

is strongly taking hold of the public mind that the *inner* defenders of our homes ought to be found not in our Regular Army but in our citizens, properly trained, organised, armed and equipped. Our soldiers are required for the defence of the Empire, our citizens for the defence of our homes."

He shows how at various epochs in the past the right, as well as the liability, of every citizen to serve in defence of his country has not only been acknowledged but put into practice; and he gives a most interesting summary of the origin, history, organization, methods, and achievements of various Voluntary Official Bodies and Voluntary Civil Bodies.

Amongst the Official Bodies he includes the Yeomanry and Volunteers, uniformed Cadet Battalions and School Cadet Corps, the Duke of York's Military Schools, un-uniformed Cadet Corps, and Rifle Clubs. Amongst Civil Bodies he includes the Telegraph Messenger Lads, the Boy Messenger Company, Church Lads' and Boys' Brigades, the Polytechnic Society, the Y.M.C.A., Dr. Barnardo's Homes, the Salvation Army, the Church Army, Industrial and Reformatory Schools, and Working Boys' Clubs and Homes. He shows that during the last 45 years some 2,000,000 men have passed through the Volunteers and over 2,000,000 boys through the other institutions, and that therefore over 4,000,000 have "voluntarily received instruction in military drill, physical training, and shooting of a regular or modified description." He therefore succeeds in carrying out his first object; but, since it has been acknowledged that the present training of the Volunteers is insufficient to enable them to contend with the trained forces of the Continental Powers, 'modified' is a somewhat generous term to apply to the training of the members of some of the other Bodies mentioned, and in these latter it is doubtful whether the training has not been undergone as a result of 'peaceful persuasion' rather than as a strictly voluntary act.

To effect his second object 'Optimist' divides a boy's life into three phases;—(1) from birth to 5 years; (2) from 5 to 13; and (3) from 13 to 19, the ages given for the upper and middle classes in the two last phases being somewhat greater.

The care and development of the child in the first phase can, he thinks, be left to the National Health Society and the National League for Physical Education and Development.

The moral, mental, and physical training of the working-class boy from the time he enters an elementary school till he leaves it as a wage earner, and of the higher class boy from the time he enters a preparatory school until he leaves it for a secondary one, can be carried out under the instructions of the Board of Education. It is said, no doubt with truth, that military training under 12 years of age is more likely to do harm than good.

The physical and modified military training from 13 or 14 years until manhood may be effected through the various uniformed and un-uniformed Cadet Corps, Clubs, etc., already mentioned. The difficulty in the matter is in connection with the working-class boy, and the author thinks the solution lies with an extension of Working Boys' Clubs in towns and the formation of Cadet Branches in rural districts. He suggests that it

should all be done on voluntary lines under a Central Committee in London, without State supervision, and without State aid other than capitation grants for efficiency, the free issue or loan of arms, ammunition, and camp equipage, and permission for officers to attend military schools of instruction; but all this means money. The crux of the problem is the officering of the boys; and in this connection the author remarks that "the man of the well-to-do classes, between the ages of 20 and 40, as a rule will not give up his leisure to performing any work which smacks of duty and in the carrying out of which he is brought under any form of discipline."

To our understanding 'Optimist' does not succeed in effecting his second object. He indeed shows that the various organizations directly or indirectly provide a considerable number of recruits for the Regular Army; and "afford such elementary military training as will fit their members to become more useful and efficient citizens," and to be more easily convertible into soldiers, than they otherwise would be. But he perpetuates the existing anomalous system under which the defence of the country is undertaken by a small number of patriots at considerable expense and inconvenience, whilst the great majority of citizens wilfully and even ostentatiously neglect their first duty. He does not show that much of the monetary support voluntarily given to the above-mentioned organizations would not be better spent, as a matter of personal and national insurance, in the form of an additional tax for the purpose of covering the cost of really universal training. And he does not prove that these voluntary organizations would be less costly than or an *effective* substitute for compulsory military training.

Since the experience of other countries has conclusively shown that compulsory military service improves the nation both in individual physique and in collective industrial efficiency, and since the majority of our military experts are convinced that compulsory universal military training is the only means by which the Regular Forces of the Crown can obtain that power of expansion which is essential if they are to wage war successfully with any of our rivals, it seems almost a pity that the institution of such training should be delayed by a few patriots volunteering for modified military service and by 'Optimists,' even with the best intentions and with justice, applauding them for doing so and attempting to prove that this patriotism by proxy renders such training unnecessary.

A. T. MOORE.

NOTICES OF MAGAZINES.

BULLETIN OF THE INTERNATIONAL RAILWAY CONGRESS.

February, 1907.

LOCK-NUTS.—The simplest and most extensively used contrivances for preventing the working loose of nuts are the ordinary lock-nut, the split pin, and the Grover washer. All of these are more or less unsatisfactory because they do not attack the real cause of working loose of the nut, which, a little paradoxically, lies in its inertia and the couples set up by vibration.

The lock-nut acts by forcing its lower thread against the upper thread of the nut proper; but the usual shape of the lock-nut only enables it to utilise a very small portion of its possible useful effect.

After considering the various other systems, we come back to the lock-nut, and enquire whether its design cannot be improved so as to eliminate its faulty features.

The type advocated embodies:—

(1) reduction of the faces in contact so that only those parts bounded by the diameter of the thread are in contact,

(2) reduction of the total diameter to minimum, so that less energy is imparted by the vibration to the lock-nut than to the nut proper, and consequently any working tends to tighten the contact between the faces.

The design proposed is in fact bevelled off on both faces, and the working face is cut at a slope to the axis (not at right angles), so that one side of the working face only is screwed up into contact with the nut proper.

C. E. VICKERS.

ENGINEERING NEWS.

February 7th, 1907.

DESIGN OF RAILWAY FREIGHT TERMINALS.—While this paper considers mainly the design of large yards calculated to handle a great volume of traffic, it is worth reading as enunciating clearly several important principles in design. It must not be forgotten that both the cost of and time occupied in shunting depend on how the yard is laid out.

The bulk of the work in a goods yard is the separating or classifying of trucks ("sorting"), second to which comes the arrangement of trains in station order ("marshalling"); and besides this independent sidings have to be provided for wagons held for orders (*i.e.* to be reconsigned) as is commonly the case with coal traffic, for empties, for damaged vehicles, etc. Any one yard is generally best used to handle traffic in one direction only, up or down; and if traffic for more than one district is to be handled, the first stage of separation would be to send to the appropriate yard.

Again, there are at least two or three different ways of shunting, by "kicking off," by "poling," or by gravity—either "hump" arrangement or by running down from a natural inclination.

The receiving yard should be of sufficient length to accommodate the maximum length train plus a certain amount of leeway for double-headed trains and for pulling up; but too long sidings mean difficulty in handling by the shunting engine.

It is advisable that the "sorting" of a train should be accomplished in one operation as it is brought into the sorting yard; the "poling" method has many advantages for doing this, but requires that the ladder tracks should branch off a straight. On the flat the marshalling must be done by push and pull, but in a gravity yard the wagons can be lowered out so as to assemble into the departure tracks in station order.

The exact position of the weighbridge is a matter needing careful consideration. On the whole it seems best not to put the weighbridge on a line by which trains regularly enter, but to site it on an independent line, into which "weigh" cars can be shunted until a convenient number are got together, and then they can be pushed successively over the bridge and subsequently taken back to the sorting sidings. In the same way the transhipment shed had better be located alongside an independent line.

It is important that yards should be well lighted, particularly at the head of the sorting sidings; and there should be sufficient light to allow of cars standing on any line being seen sufficiently clearly to ensure the cars entering being braked down in time. Reflectors to electric lights, so as to cast the rays in the proper direction without dazzling, are suggested.

C. E. VICKERS.

ENGINEERING RECORD.

February 2nd, 1907.

TREATMENT OF CONCRETE SURFACES.—A paper read by Mr. L. White, Engineer of the South Park Commissioners, Chicago, discussing methods of obtaining a suitable surface finish to concrete work. Concrete is now being used extensively for the fronts of buildings and for architectural mouldings as well as for pavements, balustrades, drinking fountains, and so on.

The author remarks that surface defects are due mainly to (1) imperfectly made casings, (2) badly mixed concrete, (3) carelessly placed concrete, (4) efflorescence and discolouration of surface. Lining the casing with sheet metal or oilcloth has not been found much use. Two methods suggest themselves:—treating the surface to correct the defects, or using for surface finish a mixture which will not take the imprint of the casing and will minimise rather than exaggerate surface defects and will not effloresce.

Besides these, various methods of treatment by tooling, scrubbing, etc., have been proposed, all having the object of removing the outer skin of mortar in which the surface defects exist. The author has tried what he calls the Acid Treatment. Dilute acid (presumably hydrochloric) is used as a wash to remove the cement and expose the stone and sand, then an alkaline solution is applied, and finally a wash of water. Obviously the treatment is inapplicable where a limestone aggregate is used. It is not stated how the removal of the cement skin is expected to affect the subsequent weathering of the finished surface.

C. E. VICKERS.

MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

February, 1907.

THE RUSSIAN ENGINEERS.

1. *Organisation and Training.*

The present organisation dates from 1894. The duties comprise:—fortification of positions; co-operation with other arms during the attack of a position; construction and demolition of roads, bridges, etc.; and the attack and defence of permanent fortresses.

In peace time the Sapper Battalions, consisting of 3 Sapper Companies and 1 Telegraph Company, are massed in brigades to facilitate training.

In war one battalion is posted to every Army Corps. One Sapper Company belongs to each of the two Infantry Divisions, and the third is at the disposal of the Corps Commander.

The war strength of a Sapper Company, which appears to correspond with our Field Company, is 4 officers, 20 N.C.O.s, and 200 sappers, with 2 trumpeters; and in addition 16 men belong to the Company Train.

The Train consists of 16 wagons divided into a technical train and a baggage train. The technical train (9 wagons) is composed of 1 four-horse team, 2 three-horse teams, and in the Divisional Companies 6 six-horse teams for the bridging material. The baggage train consists of 1 portable field kitchen, 1 two-horse ammunition cart, 1 officer's cart, and 4 more pair-horse carts.

The following tools are carried with the company:—100 shovels, 70 large pickaxes, 8 saws.

The technical train takes the reserve tools, sandbags, wire, instruments,

320 kilograms of explosives, telephones, and a light bridge train for a bridge about 65 feet long (2 trestles, 4 half-pontoons, 20 baulks, 105 chesses).

The baggage train carries two days' rations (biscuits, corn, salt, tea, sugar, and preserved vegetables); also 30 rounds for every rifle, and the officers' baggage.

The company is organised in 2 half-companies.

The technical training is mostly accomplished during the winter, and the following annual courses are arranged:—

(1). A Field Engineering Course for young N.C.O.s.
(2). An Advanced N.C.O.s' Class.
(3). A Course of Demolitions.
(4). A Railway and Mining Course.

The practical training in summer is as follows:—

(1). *Company Training*, when field fortification, placing obstacles, and making camps are practised.

(2). *Battalion Training*, when bridging is carried out, and also mining and railway work by the special units detailed for this work.

(3). *Brigade Training*, when the attack and defence of positions are practised.

(4). *Manœuvres*.—During the manœuvres the companies are attached to their respective Divisions and carry out any work that may be ordered.

The recent war showed that the previous organisation was not altogether satisfactory, and that it was desirable to hand over the battalions to their various Corps during peace.

2. *Tactical Employment.*

The most important works with which the Russian sappers are concerned are the construction and restoration of roads and bridges, the demolition of the same, the fortification of positions, and co-operation in attacks on fortified positions.

(*a*). *Roads and Bridges*.—The restoration of roads and bridges destroyed by the enemy is particularly important in order that the troops may not be delayed in their advance.

During the last war, there were many occasions on which the Sappers had to carry out this work during halts or by night, and then had to continue their march the next day without any rest.

In order to save time as much as possible, the Sappers should be sent on in front as far as circumstances permit. The greater part should be detailed to the advanced guard, so that this part can be pushed forward with the mounted troops during a halt in order to carry out any work that may be necessary, the remainder staying with the main body or transport train.

Thus a company is usually divided as under:—

½ company with advanced guard.
1 section at the head of main body.
1 section at the head of the transport column.

As regards bridging a Russian Sapper Company makes pontoon, temporary, or permanent bridges. With their bridging train they can bridge a gap 16 to 20 yards wide with 4 N.C.O.s and 24 men in 20 minutes to ½ an hour. Their field bridges are made from material obtainable in the vicinity. Permanent bridges are only constructed when the bridge is required for a long time and has to take every sort of traffic

(*b*). *Destruction of Roads and Bridges.*—Complete destruction of roads or bridges is only undertaken on the express order of the Commander-in-Chief.

Such work is generally done by the railway and demolition detachments, which form part of every company. The Field Troops attached to the Cavalry and Cossack regiments of the Warsaw and Wilna Districts are of great value for these services.

(*c*). *Fortification of Positions.*—Colonel Anisimof, the author of this article, lays down the following principles for the fortification of positions:

"Every position in defence, and every position captured during the attack, must be at once strengthened by artificial means.

The troops must invariably be capable of carrying out without assistance from the Sappers any work in connection with temporary field defences."

He further lays down that the only way to obtain success with the minimum loss is by the closest co-operation of rifle, spade, and bayonet.

In hasty defences, when the maximum time available seldom exceeds 24 hours, every minute is of importance.

He states, as the general experience of the Russian Staff during the last war, that the Sappers were not generally at hand during the advance against a position, and that the troops must not expect that help from them will be available.

On such occasions only the simplest type of trench for infantry and artillery will be attempted, and where it is a case of defence improvised obstacles and very simple defence works must suffice.

The knowledge and experience necessary for these works must be acquired by the troops in peace.

Colonel Anisimof declares that the foundation of this peace training for officers and men must be a firm conviction of the supreme importance of artificial cover.

The Russian *Manual of Field Fortification* lays down the following as the duties of individual officers.

The Commanding Officer of a Regiment inspects the position, and issues his orders as to the duties of the different battalions; he decides the general alignment of the trenches and the position for the batteries and reserves; he also determines the defensive measures to be adopted for isolated points and the arrangements for communications.

He inspects the ground itself and not the map only. He should be careful not to issue his orders from the map and then ride over the ground, as by this method a great deal of work already accomplished will be rendered useless by subsequent alterations.

He must avoid going into detail, as this prevents his subordinates from learning to adapt themselves to time and circumstance, and the training is then of doubtful value.

The Battalion Commander directs the work of his own command.

He carefully supervises the direction and position of the trenches, which he brings into the proper relative position with the trenches of the neighbouring section and with the battery positions in his own section.

The Company Commander, after having obtained from the Battalion Commander the general line of the trenches, must be able to select at once for any portion of those trenches the most advantageous position.

At present in Russia 1 officer and 4 men from every Infantry Brigade are attached yearly for two months to the Sapper Brigades, and they should then be able to organise and supervise the fieldworks of their own troops.

Their numbers and the duration of their training should however be considerably increased. Then and only then will the infantry be able to carry out thoroughly the hasty field defences which will fall to their lot.

If under exceptional circumstances there are any Sappers unemployed in a section, they will be sent to other sections and come under the commander of that section.

In any section of the defence, the Senior Sapper Officer acts as section engineer, and it is his duty to bring to the notice of the Commanding Officer of the Section any irregularities or mistakes in the works under construction. The Sappers will usually be employed on the more difficult work, such as erecting obstacles, etc., where their special training is of most value.

At the battle of the Yalu the Russians were in dire need of engineers. There was not a single Sapper in the whole detachment. The consequence was that, in spite of General Kuropatkin's express order that the whole of the time available (1 month) should be devoted to fortifying the position, the only works executed were trenches for kneeling and standing fire and some slight cover for the artillery.

When the troops, or civil labourers, are employed in putting a position into a state of defence, all the Sappers are absolutely necessary for purposes of supervision. Their actual manual labour should be confined to bridging, mining, making abatis, etc.

(*d*). *Attack on Fortified Positions.*—The Russian Sappers are used to give technical aid to the troops in overcoming obstacles.

The artillery fire begins the destruction of the obstacles, and facilitates its completion. The Sappers overcome obstacles by demolishing them with explosives, removing them by hand, or surmounting them by bridges; and combination of all three methods is advisable.

The Sapper detachment detailed for this work follows immediately behind the skirmishers, who take up a position in front of the obstacle and with the help of machine-guns try to keep down the fire of the defence.

As the issue of the entire attack often depends on the success of this very important and difficult work, it is necessary that the best men should be taken and placed under the command of a cool and determined officer; and they must devote all their intelligence, courage, and inventive powers to overcoming the obstacles that bar their way.

Having effected an entry into the work, the Sappers must at once search for the leads which may be in connection with a mine in the work itself; when found these leads are at once severed. Then they proceed to strengthen the work against counter-attack.

The execution of such tasks as these, under a deadly fire, without a moment's hesitation, can only be entrusted to a special corps, which is highly trained in peace time and is animated by the highest *esprit de corps* and by patriotic devotion.

IMPROVISED EXPLOSIVES AT PORT ARTHUR.—In the August, 1906, number of the Russian Engineer Journal, in an article entitled "Samson, an American Explosive Material," it is stated that a new explosive was manufactured in Port Arthur during the siege. It was used with great advantage for filling hand grenades, charging fougasses, and carrying out other demolitions.

This explosive was made of constituents the nature of which was first discovered by the Russians in September, 1906. The raw material consisted of a fine white powder, known as kali, and a dark brown gelatinous oil, known as "the fluid." The chemical composition of these two substances is a secret, but it is supposed that the powder called "kali" was a form of potash.

The description of the properties of the constituents and of the preparation of the explosive, as also the qualities of the latter, serve however to show that it probably consisted of potassium chlorate with some organic substance such as petroleum residue, and some added carbon; and that it was a compound similar to "rackarock," which consists of 79% potassium chlorate and 21% of nitrobenzol.

The preparation of the final material had to be carried out very circumstantially. The potassium compound had to be powdered and sifted; then the constituent parts were carefully weighed out in a special room, 3 or 4 parts of the potash salts to 1 of the "fluid"; and finally the constituent parts were mixed together by hand, gloves being worn for the purpose.

The resultant explosive, which cannot be recommended if exposed to damp, is liable to be fired by friction, spark, or flame; and its use is therefore attended with some danger.

It develops an explosive force somewhat greater than black powder. To obtain the best effects for blasting purposes it must be well rammed into the hole, but not much tamping is necessary.

Chinese shells filled with "Samson" explosive were burst into smaller fragments than when black powder was used.

Potassium chlorate, with the addition of some organic substance, has long been known as an explosive material, and its application to such purpose in war-time is always possible.

But of late years other compounds for the same purpose have been experimented with; and in view of the unpleasant and dangerous properties of compounds of potassium chlorate, it is not likely that extensive use will ever be made of "Samson" explosive.

C. OTLEY PLACE.

NATURE.

January, 1907.

"PETROLEUM AND ITS PRODUCTS" (*p.* 218).—This book deals with the history of the petroleum industry from the use of bitumen in building the Tower of Babel down to statistics as late as 1904. The methods adopted for winning the crude oil in America, Canada, and Russia are detailed. The shale oil industry, being of British origin, is described. There is an able section on the transport, storage, and distribution of petroleum. The testing of crude petroleum and its many products and the fixing of the flash point at its present value are especially interesting. A full account is given of the beautiful method of testing for petrol vapour and other inflammable vapours in air, which depends upon the fact that a hydrogen flame of fixed dimensions, burning in air containing a small portion of inflammable gas or vapour, is seen to be surmounted by a small cap or halo, the size of which indicates the amount of inflammable vapour in the air, long before the mixture itself becomes inflammable. In these days when petrol is so largely stored, and when so many steamers are engaged in the oil trade, tests, capable of revealing any dangerous leakage of vapour, are of the greatest importance, and the "flame cap" offers a certain mode of detection.

"JUJUTSU," by Mrs. Roger Watts (*p.* 250), gives concisely and clearly an idea of this fascinating art. It is written with the idea that anyone having had a few lessons may continue the exercises, or throws, without the constant help of a teacher, though to learn, from the description only, would be quite impossible. Sir Lauder Brunton, writing a preface to the book, says: "By it not only is every muscle strengthened, but the highest centres of the brain are developed—those whose functions are perception, discrimination, and decision." The book contains 141 excellent illustrations; the photographer has most patiently caught the different positions, enabling the reader to follow the text. English wrestling is more or less a trial of strength, but "jujutsu" is a question of quickness and brains.

MARINE BIOLOGY (*p.* 251).—The results of active investigation, under the auspices of the International Council for the Exploration of the Seas round North Europe, record and endeavour to explain the constantly changing physical conditions under which fishes pass their lives, as well as a detailed knowledge of the various smaller marine creatures which serve as their food. The whole story of the life of the common eel, as now made clear by these investigations, is one of the most fascinating which it has fallen to the lot of any naturalist to reveal. We can picture the great shoal of parent eels, the long journey from the inland waters ended, arriving at their proper spawning places in the deep Atlantic; the floating eggs gradually developing into transparent, deep-ribbon-shaped Leptocephali; the slow transformation to slender, active elvers; the vast

multitude of elvers, foodless, moving steadily in towards the coast, entering the rivers; and finally the feeding and growth of the eels all over the European continent in preparation for the return migration to the sea.

THE SOLAR RADIATION (*p.* 326) is determined by allowing a beam of sunlight of known cross-section to shine upon a known weight of water for a known length of time and measuring the rise of temperature. The observations at Warsaw showed that between December, 1902, and February, 1904, the radiation was abnormally low as compared with the mean for the years 1901–5. This phenomenon has been noticed by several observers and is supposed to be due to the large amount of volcanic dust in our atmosphere.

THE RECENT HIGH BAROMETER.—On January 23rd at Riga the reading was 31″·58, at some of the stations in the British Isles it stood at 31″·1, being higher than any previous record. At Irkutsk on 20th December, 1896, it reached 31·72 inches. The lowest reading in our Islands was 27·33 inches at Ochtertyre on 26th January, 1884.

February, 1907.

ASTRONOMICAL CLOCKS (*p.* 353).—The accuracy with which these are now regulated is very interesting. Bradley in 1758 used a fairly accurate clock for his star catalogue, but this has been much improved on by enclosing the clock in an air-tight glass case, mounted in a vault where the temperature is kept constant, the pendulum being of nickel-steel.

Mean Deviation of Daily Clock Rate.

Clock.	Date.	Mean Deviation in Seconds.
Bradley's clock in	1759	0·102
Greenwich Observatory	1850	0·149
Greenwich Observatory	1900	0·051
Berlin Observatory	1877	0·030
Leyden Observatory...	1900	0·028
U.S. Naval Observatory	1904	0·015

SCIENCE IN INDIA (*p.* 403).—Major Lenox-Conyngham's report on the pendulum observations in 1904 for determining the force of gravity is interesting. He used "half-second" pendulums, which are only one-quarter the length of those previously used in the department. A new method has also been introduced for registration of the coincidences of beat between the free pendulum and the clock pendulum, the pendulums being no longer swung in vacuo. A considerable increase in accuracy of observation has thus been assured. Corrections have been applied for the minute vibrations of the stand on which the instrument is fixed, due to the swing of the pendulum. Some of the results are curious; for instance, it was found that at Calcutta the perpetual tremor, set up by the traffic, due to the nature of the alluvial deposits on which the city

may be said to be floating, absolutely negatived the value of the observations, while, on the other hand, observations taken at Colaba in Bombay were not appreciably affected by the firing of the big guns of the fort in their vicinity.

Amongst the most interesting records of the season are the results obtained by a careful re-computation of Capt. Wood's observations for determining the position of Everest and other high peaks in Nepal. The difference, however, never amounts to half a second of arc, but the corrections in altitude of the peaks observed, due to the employment of a revised co-efficient for refraction, are more marked. The height of Mount Everest is reduced by about 300 feet, 28,700 instead of 29,002 feet. This, however, must not be accepted as a final determination, as there are other factors in the computation of altitudes, observed under extraordinary conditions, still to be determined with more vigorous exactness.

W. E. WARRAND.

RIVISTA DI ARTIGLIERIA E GENIO.

January, 1907.

NOTES ON IMPROVISED FORTIFICATIONS.—By Capt. Cardona of the General Staff.—Field fortification in the last century has seen an important evolution in military progress, whilst in the past centuries it had remained almost stationary. With regard to this we may note that Napoleon I. had affirmed "The principles of field fortification have need of improvement; this important branch of military art has not made any progress since ancient times; it is to-day lower than it was two thousand years ago; it is necessary to encourage the military engineers in this branch of their art, and to bring it to a level with others."

Until the adoption of arms of precision (about the middle of the last century) field fortification had made little progress; while in the latter half of the same century we find a continual adaptment of fortifications to resist the greater effects caused by the successive improvements in guns and rifles, characterised by the adoption of breech loaders, quick firers, especially weapons of small calibre, and smokeless powder.

In face of the old muskets and rifles of large calibre that were in use in the wars from '48 to '85 the value of entrenchments rested almost entirely on their obstacle ditches, because, the fire being of little effect, recourse to the bayonet became an absolute necessity.

The trenches were constructed with the idea of stopping the assailants, and throwing them into confusion by means of deep ditches, and the great quantity of earth taken from these found a natural use as a covering mass. This, while it served the purpose of stopping the projectiles of the enemy's artillery, had the defect that it was greater than was necessary to

resist the penetration of the bullets fired from the afore-mentioned weapons and also that it was very visible.

In these wars the construction of land defences involved a slow and laborious operation. It is true that since the war of the American Secession there has been introduced the use of relatively hasty entrenchments in order to repair rapidly the effects of the enemy's fire; yet, in some armies there was for many years a lack of light sapper tools, so that the type of hasty entrenchments was not largely brought into use.

With the adoption of smokeless powder, rifles of small calibre, and modern artillery the fire has become more rapid, exact, and destructive, so that it generally suffices to decide the victory; and now it is necessary both for the assailant and the defender to seek cover from the effects of the fire by means of natural and artificial defences. These last should be of an altered character, since it is sufficient to provide protection from the enemy's fire while in former times it was necessary also to protect against shock. The artillery now seem to be abandoning the practice of firing with shells against the parapets of the trenches, because these are slight and invisible and the fire of shells against them does not warrant the enormous consumption of ammunition.

It is evident that the construction of improvised fortification, although it may be as it were a monopoly of the engineers, will form part of the duties of every arm, though the more difficult work may be reserved for the engineers.

It is not credible that the rôle of the engineer should lessen in importance on the battle field—quite the contrary. It is now, even more than before, his duty to display his proper activity in the entrenching of special positions, in improving the communications, in the construction and destruction of bridges, etc., and for such works a company of Sappers to each division would not be too much.

These facts have proved the forecasts of the writers who approve of the new methods of fortification. In the recent Anglo-Boer and Russo-Japanese wars, in which improvised fortifications were greatly developed and were more rationally used than formerly, the Boers and the Russians accomplished wonders in the sphere of active defences; and the Japanese, again, obtained from fortifications a greater power for the offensive, finding that, whilst somewhat impeding the movement of troops, they in no way lessened their aggressive spirit.

The transition from the old to the new methods of fortification has proceeded slowly and with some uncertainty, as has always happened in similar cases. It is precisely like everything else which offers great advantages if properly adopted and presents great inconveniences if badly used, that fortification is highly prized by many and condemned by not a few. The period of uncertainty however still continues, because we have not entirely abandoned the old ideas and we have not yet determined on the new ones. In fact there are still many who abhor fortification as being a grave hindrance, especially in the matter of tactics, being antagonistic to the free employment of troops. Others, while recognising that fortifications are indispensable, have doubts as to the method of

employing them. However, notwithstanding the experience of the late wars, it has not yet penetrated into the minds of all that improvised fortifications are no longer a mere accessory but a principal element of tactics.

In most discussions and publications on the subject of fortification there are wanting abstract ideas on its essence and use. And it is precisely this want of unity which causes disagreement, as is especially shown in late years in which the old system of fortification has stumbled upon the new tactics. It is sufficient in fact to confront the ideas expressed by the Belgian Major Deguise in his work *La Fortification Passagère et la Fortification Mixte ou Semi-Permanente* with those of Colonel Rocchi in his *Traccia per lo Studio della Fortificazione Campale*, to recognise how widely different are the views of these two able writers, who have written on the subject within a period of only two years.

It now seems necessary that this uncertainty should cease, and we may be permitted to hope for the adoption of the issue of light sapper tools to the infantry.

The new phase of tactical evolution and new methods of fortification, as has been said, owes its origin to the introduction of smokeless powder and weapons of small calibre.

In 1891, in his treatise *La Fortificazione Improvisata*, the then Captain of Engineers Spaccamela, attached to the School of Parma, had abandoned the old scholastic methods formulated on the basis of geometry and grounded his instructions on the principle that improvised fortification should be recognised as a part of tactics. Spaccamela was one of the first in Italy to affirm that the construction of improvised fortifications should be the duty of infantry troops.

It was only after the Boer war that the military chiefs came to recognise the importance of improvised fortifications. The Russo-Japanese war gave to this importance an official sanction, and added the absolute necessity that tactics and improvised fortifications should be considered as parts of one and the same thing.

With regard to the evolution of field fortification, Deguise is of opinion that this owes its origin to the defensive organisation of lines of blockade, which followed the organisation of permanent fortification. It may be added that the latter system of fortification was renewed in the XVIth century owing to the influence of firearms. The above-mentioned author notes that the engineers of the XVIIIth century somewhat adapted their defensive dispositions to the times, believing it sufficient to modify the form of their works according to the improvements in weapons. It was only indeed from the adoption of arms of precision and of shrapnel that fortification could reasonably be associated with tactics, and in the war of the American Secession new forms of improvised fortification were introduced requiring little time in their construction and by their small dimensions not so much attracting the attention of the assailants.

A new phase in the evolution of fortification was developed towards the end of the last century, when ditches, placed in front of entrenchments to impede the assailants, became less necessary obstacles, because

of the effective fire of arms of small calibre and also because smokeless powder rendered less apparent the positions occupied.

Deguise moreover affirms very justly that in fortification we cannot apply absolute formulæ, but that we should endeavour to make the character of the works conform with the various and complex tactical circumstances; for if we lose sight of the tactical idea, fortifications, which are otherwise useful, may become hurtful.

With regard to the influence that the progress of firearms has on fortifications Deguise notes very opportunely that the more the weapons become efficacious so much the less should become the visibility of the position, and that the masking of the entrenchments is essential.

He considers that a greater relief than 1·30 m. is unnecessary, and that only when the ground in front is open; and he advises a thickness of parapet of 4 to 6 m. in ordinary ground and 6 to 9 m. in clayey soil to resist the fire of field and heavy artillery.

With regard to the relation between the ground and the fortification Deguise affirms that it is necessary to study *the influence of the accidental topography with respect to the fortification.* He indicates the provisions to be made in various cases and dilates on the proper steps for defilading the work, especially in mountainous countries. In discussing the relations between the entrenchments and tactics, he gives examples of various forms of trace, and of the methods of assuming the defence of a position with traces adapted and profiles corresponding to the various aspects of the combat.

With regard to the practical use of field fortification Deguise distinguishes three cases:—When there is considerable time available, when there are only a few hours, and when the work has to be executed in a great hurry during an action.

In the first case the engineer officer should receive from superior authority a disposition showing the scope of the organised defence required for a position and a general trace of the same position. In such case, says Deguise, the engineer officer should solve the tactical problem, and the chief should leave to him a very large initiative; and therefore the engineer, in carrying out the reconnaissance of the ground, should indicate on the map the distribution of the troops and the defensive organisation of the position.

In the second case Deguise recognises that the problem offers great difficulty, because works which would require several hours of labour have to be constructed in a short time. He recognises that the infantry should take part in the entrenchment of the position while the engineers are employed on special works; that these fortifications should be improvised according to the solution given to the tactical problem; and that the works ought to be constructed with light tools.

In the third case he provides for the necessity of using light tools, allotting the special works to the engineers reinforced by infantry; and he affirms that the first endeavour should be to develop the simpler and more important works, so as to be ready for an attack at any moment.

EDWARD T. THACKERAY.

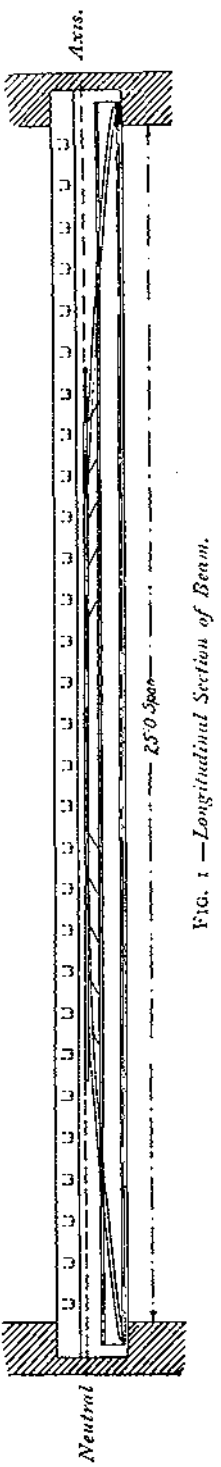


FIG. 1.—*Longitudinal Section of Beam.*

THE BUILDER.

16th February, 1907.

THE LESSON OF A CONCRETE-STEEL FLOOR FAILURE.—This is a most useful leading article on the collapse of a floor built for a small public institution in England. The failure was due to the disjointed character of the reinforcement, to the unsuitable section of two of the bars, and to other bars being placed where their strength could not be properly utilized.

The floor, 25 ft. × 36 ft., consisted of two main beams, with a clear span of 25 ft., and a floor slab; and was intended to support a uniformly distributed load of about 75 lbs. per sq. ft., some brick partitions extending to the ceiling, and its own weight.

Each beam was 17 in. wide and 12 in. deep, making with the 6-in. floor a total depth of 12 in. The reinforcement consisted of two 6″ × 3″ rolled steel joists; between them one 1½″ Indented bar, curved upwards to a height in the centre of 11 in. above the bottom of the beam; and above them, extending 7 ft. 6 in. on either side of the centre, and 1 in. below the upper surface of the beam, two 1½″ × ½″ Kahn bars with their wings downwards. The ends of the beam were built into the brick walls.

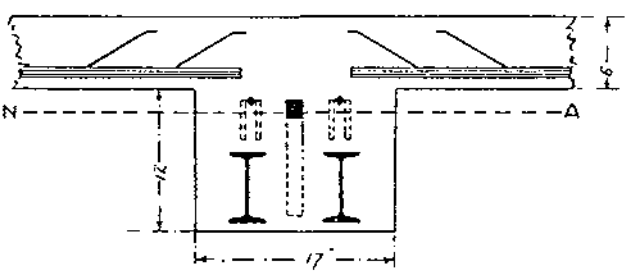


FIG. 2.—*Transverse Section of Beam and Floor.*

The reinforcement of the floor consisted of 1½″ × ½″ Kahn bars at 10-in. intervals, running in one direction only; instead of being laid continuous over the beams, these bars had gaps between their ends above the centres of the beams.

When the centring was removed, after what was supposed to be a sufficient lapse of time for the concrete to set, the floor failed under its own

weight and that of the brick partitions. The failure occurred near the end of one of the beams. The author assumes that the designer of the floor was unfamiliar with the principles of beams and of ferro-concrete construction, or that he possessed just enough knowledge to make his knowledge dangerous.

The arrangement of the reinforcement in the beams is at variance with the principle that between the ends of such a beam and the points of contrary flexure, the upper fibres are in tension and the lower in compression, whilst in the middle length of the beam the conditions are reversed. In the case under reference the concrete in tension got no reinforcement from the bars because they were placed where the concrete was in compression. Possibly the bars were so placed to comply with a misunderstood diagram of bending moments and the steel joists were inserted because they fitted conveniently into the space available.

The author suggests that the reinforcement used might have been better applied by running the Indented and Kahn bars of the beams continuously and horizontally near the upper surface of the floor, *i.e.* simply shifting their position upwards, and by making the transverse Kahn bars continuous over the beams, leaving the joists as they were. A still better reinforcement would have been to replace the joists by two rows of three round bars near the bottom surface of the beam, and the longitudinal Indented and Kahn bars by one row of three round bars near the upper surface of the floor, providing all these bars with stirrups to resist shear. But even then the floor would not have possessed a sufficient factor of safety. It should preferably have been divided into twelve, instead of three, panels, with two 8 in. × 13 in. main beams, three 4 in. × 7 in. secondary beams, and a 4-in. slab; sections showing suitable reinforcement for such a floor are given in the article and deserve study.

A concrete floor, properly designed, and constructed so as to ensure the monolithic connection of the concrete throughout, becomes one slab stiffened by ribs. The slab constitutes a compression flange for all the beams and the secondary beams act as stiffeners to the main ones. The design involves careful analysis of stresses, correct determination of the proportions of every part, and reliable calculations for the percentage and disposition of the reinforcement.

Unqualified persons should not dabble in construction on rule-of-thumb methods, but should obtain the assistance of an expert. Ferro-concrete beams and floors cannot be designed by the aid of catalogues; rolled steel joists are usually out of place in such work, and patented bars possess no magic qualities that can compensate for the lack of knowledge and experience.

A. T. MOORE.

CORRESPONDENCE.

THE BATTLE OF HASTINGS.

SIR,

Some further notes on this great decisive Battle of the world may be of interest to R.E. officers.

In studying simultaneously the documentary evidence relating to the general details of some comparatively ancient battles whilst engaged in following out the course of events on the actual battlefield, it is astonishing how difficult it is sometimes to reconcile many of the recorded facts with the traditional descriptions generally or locally given, although these latter may occasionally cast valuable sidelights helping us to clear up ambiguous or doubtful points under discussion.

In the case of the Battle of Hastings for instance, as revised by Major-General James, late R.E., in the January number of the *R.E. Journal*, dealing amongst other controversial questions with the correct site of the "Malfosse," it appears that there has been in the past some old tradition, on which the idea has been based that there were remains of ancient British earthworks at this spot. These might, if existing at the present time, help us in fixing this important site.

In Mr. C. W. Oman's work, *The Art of War in the Middle Ages*, published in 1898, a speculation is made that traces of ancient earthworks existed on the battleground, but other authorities (Freeman, Round, Hon. F. Baring, Sir James Ramsay, and Major-General James, late R.E.) have not judged that there was sufficient evidence in support of this idea. The extract from William of Jumièges "Nam crescentes herbae antiquum aggerem tegebant" may have originated the tradition as to these ancient earthworks; and this evidence, it is considered, must only be accepted for what it is considered to be worth. The 'Fosse Disaster' in reality appears to be rather too obscure a matter to be easily settled.

Major-General James regards the "Malfosse," in the position assigned to it in the plan accompanying his article, as a mere ravine hidden by brushwood, into which the pursuing cavalry stumbled in the darkness; but the Bayeux Stitchwork pictures an obstruction which appears to have a decided similitude, in the eyes of some authorities, to a mount Fort (with Fosse and Bailey).

To the minds of others, the Tapestry represents an artificial rampart with an unexpectedly-met-with herbage-covered Fosse on one side, such as in fact would be some prehistoric hill Fort, so nearly obliterated that its rampart, still visible to the Normans, did not suggest the existence of the ditch which proved to be their deathtrap.

The inscription on the Tapestry "Here fell together English and

French in battle" is supposed by Lancelot and Sharon Turner to indicate that particular event in the battle, when, deceived by a feigned retreat of the Normans, the Saxons were thrown into disorder, and the Normans themselves, coming suddenly upon a great ditch concealed by vegetation, and afterwards called "Malfosse," perished in great numbers, dragging the Saxons also into the said Fosse.

In the account of the actual battle written by William of Poitiers—which is considered by the authorities to be the best description of the fight—no mention is made of the "antiquum aggerem" referred to by William of Jumièges, nor of the palisade and fosse touched upon by Wace.

If an "antiquum aggerem" of somewhat similar character to that at Bigbury Camp near Canterbury—which is referred to by Cæsar as an old fortification said to have been used in former times in some civil tribal war—really existed in 1066 at Hastings, it should be sought for somewhere about the main battle ridge taken up by Harold.

The earthworks at Bigbury, corresponding to the traditional "antiquum aggerem" of Hastings, are mentioned in Cæsar as having formed in the year B.C. 55 a "point d'appuie" or rallying "place d'armes" for the main resistance of the Belgae-Cantianae defenders, soon however to be rushed by a Roman Phalanx issuing out from behind the cover of a traverse hastily thrown up by their Legionaries.

It seems unlikely that at Hastings Harold carefully selected his battle position relying on the existence of an "antiquum aggerem," which may have been visible in 1066, but that he chose rather to fight thereon because of the splendid defensive position ready to hand, and owing to the force of circumstances which led him to assume the defensive on William's unexpectedly sudden advance to meet him.

William of Normandy on the other hand, hoping, it is said, to pounce upon Harold in the open and defeat him by his superior tactically trained troops, is reported to have been unpleasantly surprised on finding Harold resorting to prepared position tactics. As the site of the "Malfosse" adjudged to be the true one by Major-General James, Hon. F. Baring, and Sir Augustus Webster had not been accepted by Sir James Ramsay (in the *Foundations of England*), who preferred a spot much nearer the Standard, it would, owing to the persistency of the tradition theory as to the "antiquum aggerem," appear to be well worth the while of an enthusiastic expert to endeavour to trace the foundation of the idea to its source, and to pursue the search on the ground itself.

But after the lapse of nearly 8½ centuries, and owing to the changes due to cultivation, houses, terraces, and trees, it is a little more than doubtful whether the topographical details on the old-time terrain of Senlac could now be recognised by any of those of the actual combatants who so bravely fought to a finish round the Saxon Standard.

The discrepancy between the numbers of the troops engaged on the Norman side as recorded by the documentary evidence and those calculated by computations based on the carrying capacity of the invaders' sea-transport is a striking one. 60,000 Normans are mentioned by William of Poitiers, but it would appear that about 11,000, as estimated by Major-General James, conveyed across the Channel in 700 ships and boats, is

likely to be nearer the mark; for it must be remembered that the accommodation provided by the largest of the ships is for 25 men only, being based on the information conveyed by the pictorial data of the Bayeux Tapestry and other corroborative evidence.

This conclusion is partially supported by the evidence of an ordinance of Henry III., dated 1229, prescribing the contribution in warships and crews to be provided by the Cinque Ports as a nucleus for a British Navy.

Dover had to send 21 ships, Winchelsea 10, Hastings 6, Sandwich 5, Hythe 5, Romney 5, Rye 5, thus making a total of 57; each vessel to carry 21 men and 1 boy. These warships were to be provided at the cost of the Cinque Ports for a training of 15 days yearly, many special privileges by way of compensation being granted to the several ports.

In this connection it is to be noted that at the Conquest one exceptionally large ship existed, the Dreadnought of the times,—that of Remigius—which was only of sufficient interior capacity to accommodate 20 knights, their bâtmen, and their horses.

Thus the 57 ships provided in 1229 by the Cinque Ports were equivalent nearly in carrying capacity to 57 Dreadnoughts at the time of the Conquest.

Again, as regards the Saxon numbers, one of the Norman writers has recorded a total of 100,000. The popularly accepted numbers figure up to 25,000. Wace states that the opposing forces were about numerically equal. Major-General James, R.E., makes out a strong case for some 11,000 strong.

As the old Constitutional Force at the time, including all those male adults of suitable age who were capable of bearing arms, is given by Hume as numbering 48,770; or one-twentieth of the total Anglo-Saxon population, their duties comprising the preservation of game, the repairs of roads and bridges, as well as Militia duties, the effectives of the only line available to fight the two successive battles of Fulford and Stamford Bridge on the 20th and 25th of September respectively would probably not exceed a maximum of 20,000.

When the losses suffered in the defeat at Fulford and the large defections reported as having taken place after Stamford Bridge are considered, and afterwards the rapid march concentration movements in order to arrive off Hastings by forced marches on the 13th of October, the total effectives in the striking force at Harold's disposal may, it is considered, be largely discounted.

This reduction is to a certain extent borne out by the narrative of the old chronicler Florence of Worcester, who states that at York on the 1st of October Harold was still deficient of half his troops who were not yet assembled, but nevertheless did not hesitate to meet the enemy in Sussex without loss of time.

Yours faithfully,

O. E. RUCK.

The Editor, "R.E. Journal."

RECENT PUBLICATIONS.

Ce qu'il faut retenir de la Guerre Russo-Japonaise, par Lieut.-Colonel Picard. (8vo. 3.50 frs. Chapelot, Paris).

Zehn Monate Kriegskorrespondent beim Heere Kuropatkins. Persönliche. Erlebnisse und kritische Betrachtungen aus dem Russisch-Japanischen Kriege, von Oskar V. Schwartz. (5 mks. Schröder, Berlin).

Meine Erlebnisse während des Feldzuges gegen die Hereros und Witbois nach meinem Tagebuch, von Oberleut. Helmuth Auer v. Herrenkirchen. (2 mks. Eisenschmidt, Berlin).

Artillery Fire: The Battery, by Major W. A. Nicholson, R.F.A. ($7\frac{1}{2} \times 5$. 5s. Stanford).

Wiederholungsbuch der Befestigungslehre und des Festungskrieges, von Haupt. v. Toepfer, Adjt. der 4 Ingenieur-inspektion. (3 mks. Eisenschmidt, Berlin).

Der Kampf um Sperrbefestigungen. Nachtrag zum Grundriss des Festungskrieges, von Haupt. W. Stavenhagen. (75 pfs. Gupel, Sondershausen).

Die Feldbefestigung. Nachtrag zur dritten Auflage vom Grundriss der Befestigungslehre, von Haupt. W. Stavenhagen. (90 pfs. Mittler, Berlin).

Der Festungskrieg, von Major v. Fritsch, Militärlehrer an der Kriegsakademie zu Berlin. (4.50 mks. Liebel, Berlin).

Approximate Estimates: A Pocket-Book for Estimating, by T. E. Coleman. 3rd edition revised and enlarged. ($3\frac{1}{2} \times 5$. 5s. Spon).

The Modern Plumber and Sanitary Engineer, by sixteen Specialist Contributors under the editorship of G. Lister Sutcliffe, A.R.I.B.A., M.R.S.I. Divisional Vol. I. (10×7. Gresham Publishing Company).

Experiments on Hot-Water Systems, by A. Sayers. (Sanitary Publishing Company).

Pocket-Book of Aeronautics, by Major Hermann W. L. Moedebeck, Badischen Fussartillerie Regiment, in collaboration with O. Chanute and others. Authorised translation by W. Mansergh Varley. ($5\frac{1}{2} \times 4$. 10s. 6d. Whittaker).

Houses and Gardens, by M. H. Baillie Scott. ($12 \times 8\frac{1}{2}$. 31s. 6d. Newnes).

Signs and Portents in the Far East, by Everard Cotes. ($9 \times 5\frac{1}{2}$. 7s. 6d. Methuen).

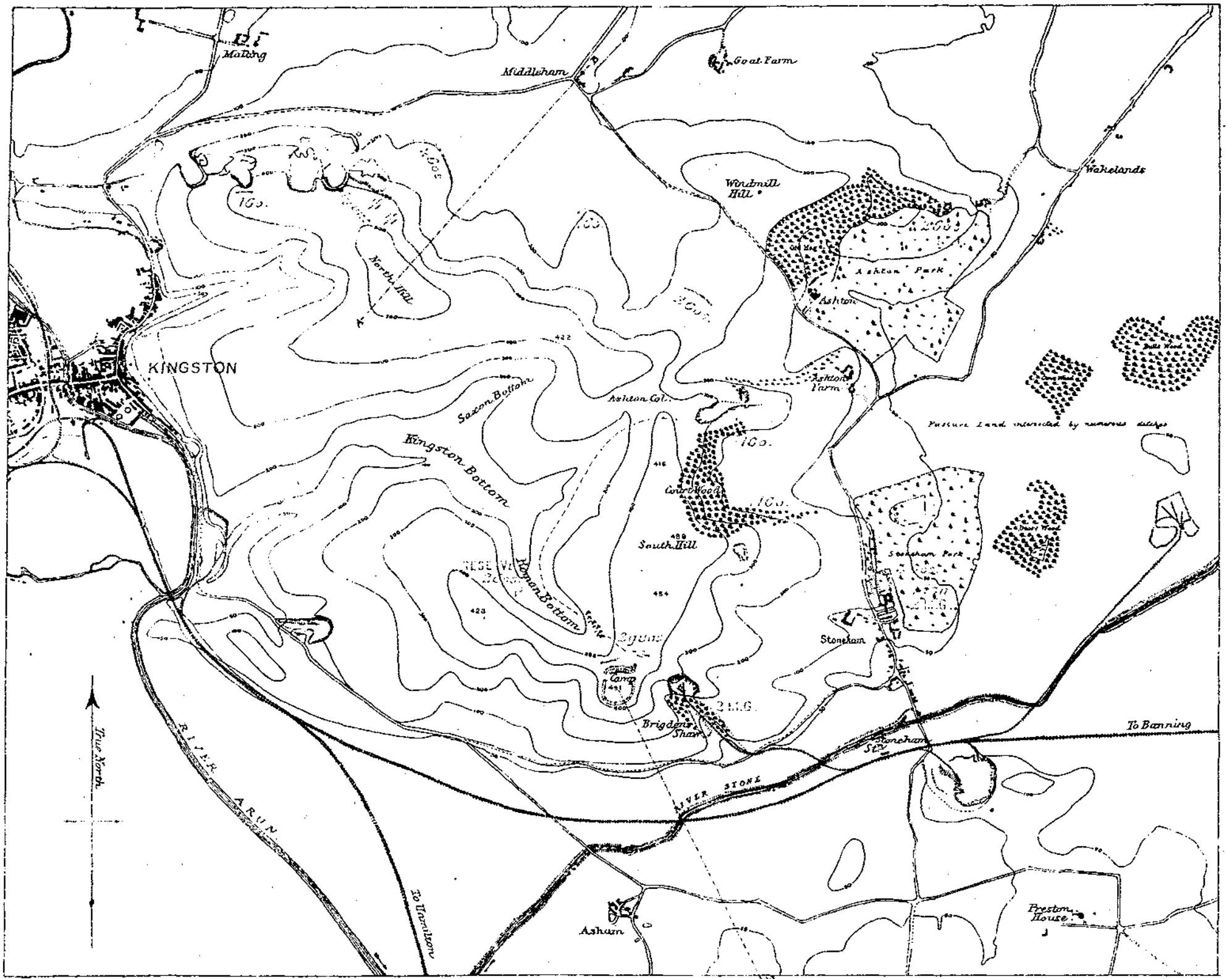
The Whirlpool of Europe. Austria-Hungary and the Habsburgs, by A.R. and Ethel Colquhoun. (9×6. 15s. Harper).

Sketches in Mafeking and East Africa, by Major-General R. S. S. Baden-Powell. ($8\frac{1}{2} \times 12\frac{1}{2}$. 21s. Smith, Elder).

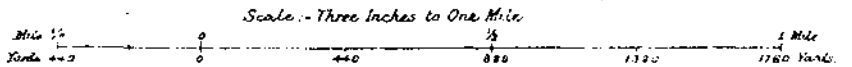
The Stable Handbook, by T. F. Dale. ($6\frac{1}{2} \times 4\frac{1}{2}$. 3s. Lane).

DEFENCE OF POSITION ON OPEN GROUND.

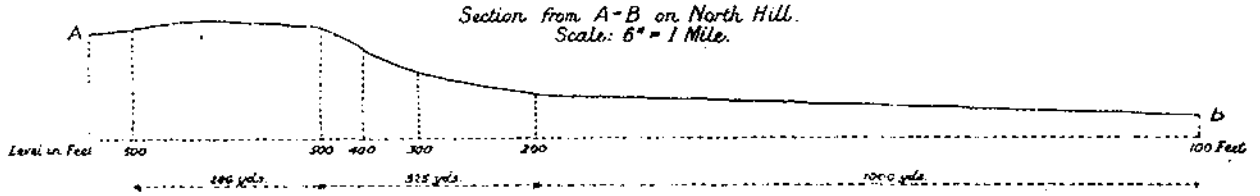
Problem 2.



Scale:- Three Inches to One Mile.



Section from A-B on North Hill.
Scale: 6" = 1 Mile.



NOTE.—To avoid confusing the contours, the fences have been omitted.

Below the 50' contour the country is practically dead level, consisting of marshy fields with numerous small ditches.

Between the 50' and 200' contours are cultivated fields, with low hedges about 250 yds. apart.

Above the 200' contour is open grass land.

South-east of the Position is a ridge running due east and west, its summits varying from 600' to 800' in height; the western-most height of this ridge is Asham Hill, 625' high, 3,500 yds. south-east of the "Camp" on Sonth Hill. Except for this ridge the country north and east of the Position is practically dead level for several miles.

The River Arun is unfordable everywhere; the River Stone is unfordable up to a point 1 mile due east of Wakelands.

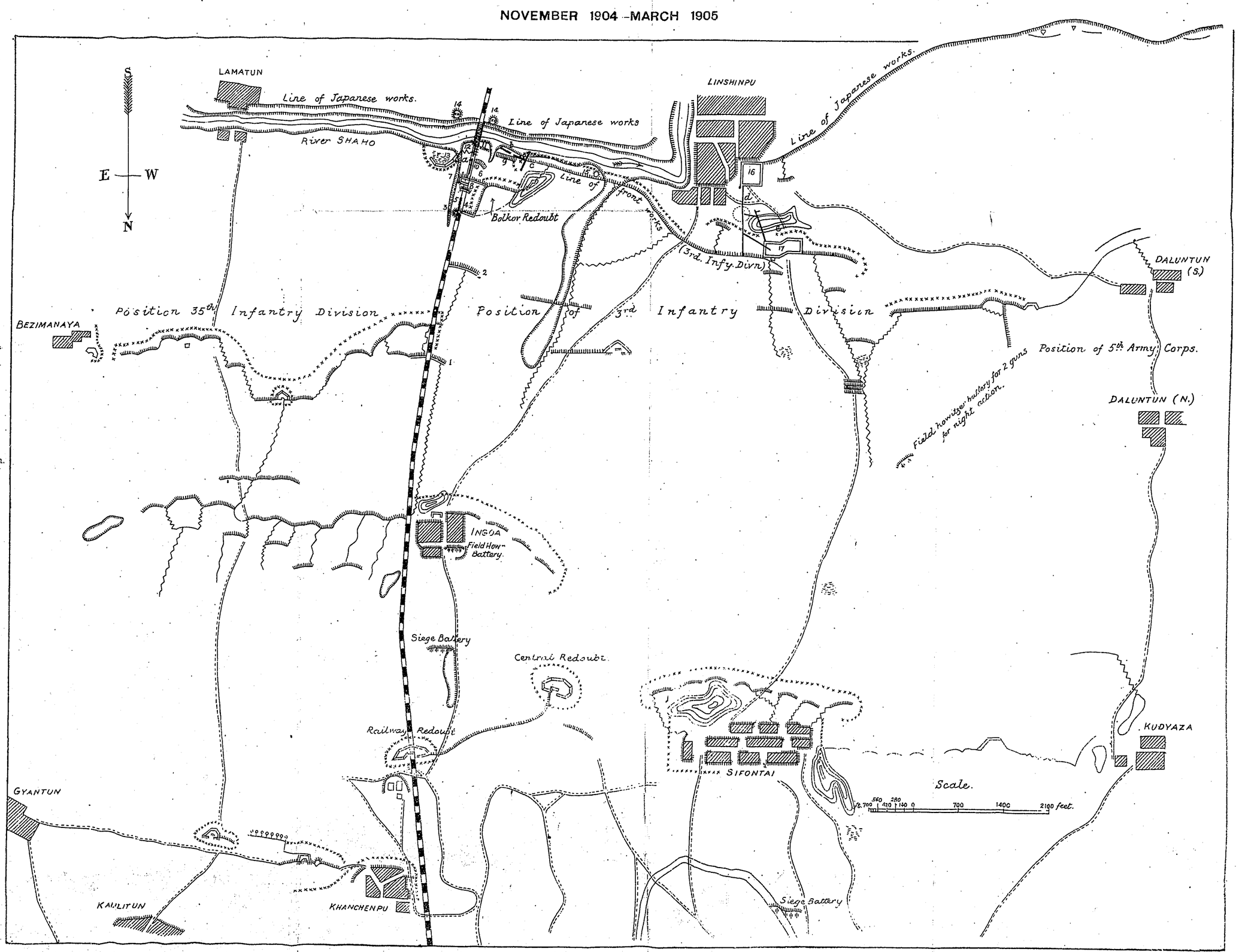
SAPPING AND MINING

ON THE POSITION OF THE RUSSIAN 3RD INFANTRY DIVISION ON THE R. SHAHO

NOVEMBER 1904 –MARCH 1905

REFERENCES.

- Defensive saps.
- Offensive saps.
- 1 Intermediate trench.
- 2 Rear trench.
- 3 1st "one-day" trench.
- 4 Approach made by Sapping.
- 5 Sap on embankment.
- 6 Sap trench made on night 17th—18th January.
- 7 2nd "one-day" trench with underground approach.
- 8 3rd "one-day" trench.
- 9 Flying sap made on night 27th—28th January.
- 10 ,, ,, ,, ,, 6th—7th February.
- 11 Trench occupied by Japanese.
- 12 Japanese mined gallery prepared for riflemen.
- 13 Japanese lunette at Fir Copse.
- 14 Japanese gun caponier.
- 15 Russian gun caponier (Ter-Akopov).
- 16 Japanese Temple.
- 17 Fort Resurrection.
- *a* Russian mining system under embankment.
- *b* Japanese mine galleries.
- *c* Russian counter-mine system.
- *d* Japanese mining gallery under the fort.
- *e* Russian counter-mine system near the fort.

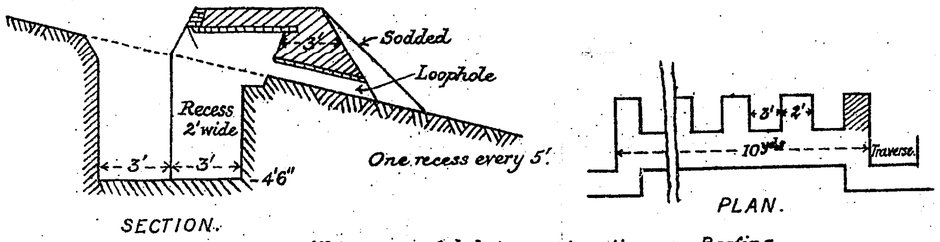


DEFENCE OF POSITION ON OPEN GROUND.

Problem. I.

SECTIONS OF WORKS.

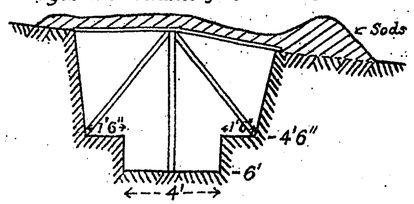
Trenches, a, b, c, d, e, f, old "Camp", and in "COURT WOOD."



All recesses roofed, but parapet continuous. Roofing should be managed easily, owing to short span.

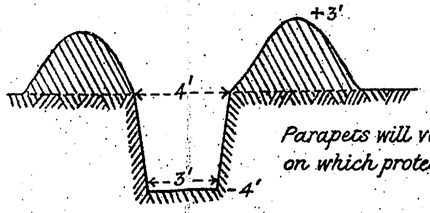
Cover Trench.

50 yds. or so behind fire trenches.



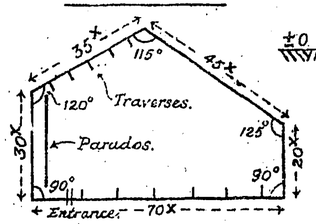
Partitions of brushwood & earth, halfway across, every 20', breaking joint.

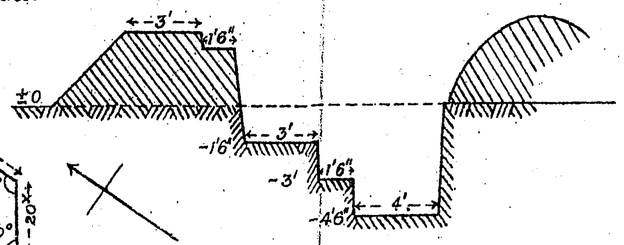
Communication Trench.



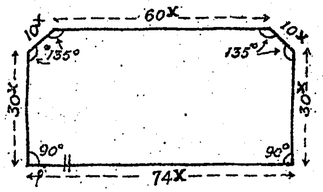
Parapets will vary with side on which protection is wanted.

Redoubt Z.





Section through face with parados; parados on other faces omitted.



Redoubts X and W.

Section same as Redoubt Z.

REFERENCES.

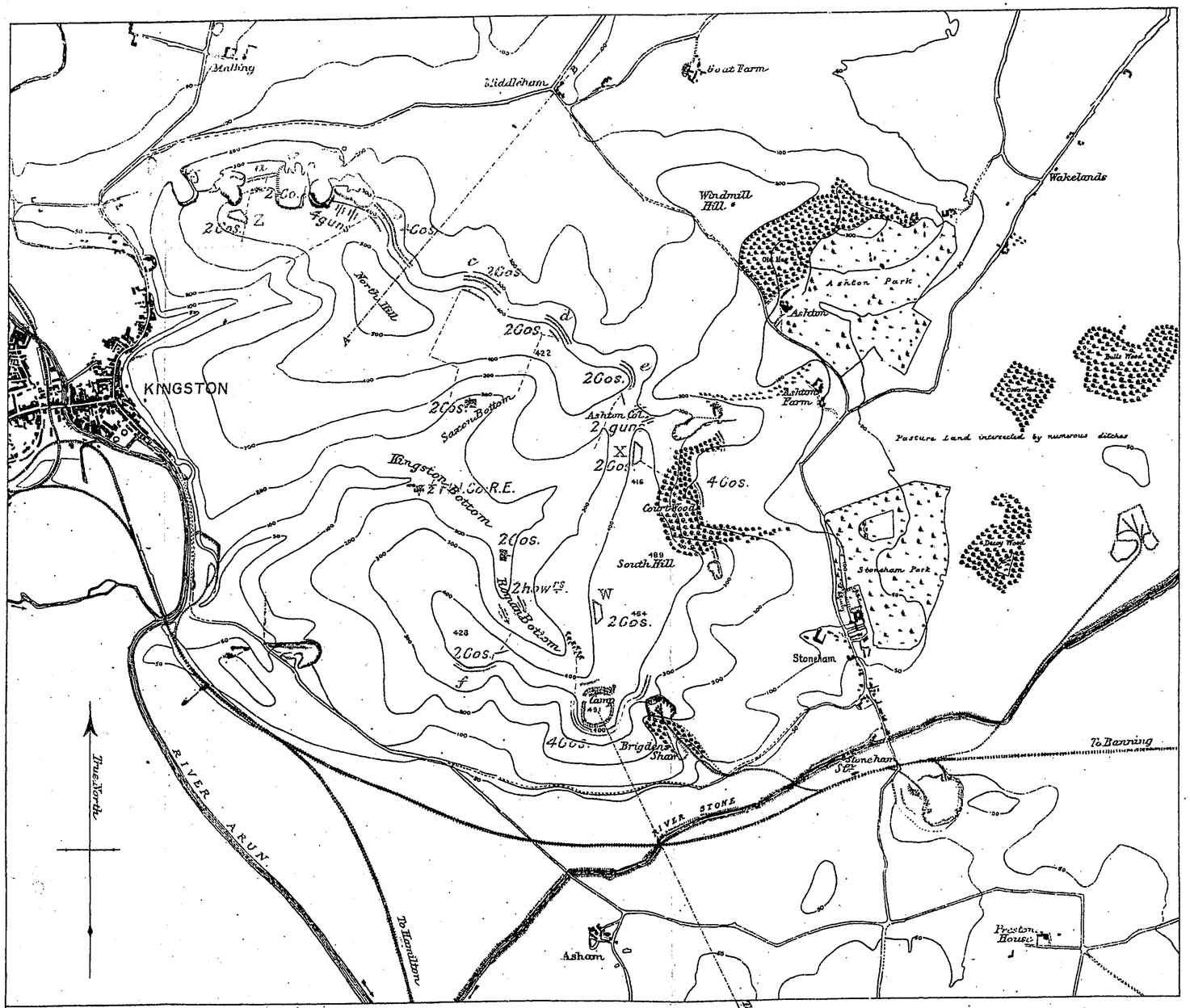
Fire Trenches

Cover do

Communication do

Redoubts (not to scale or shape)

Wire Entanglements & Abattis (as required, not shown)

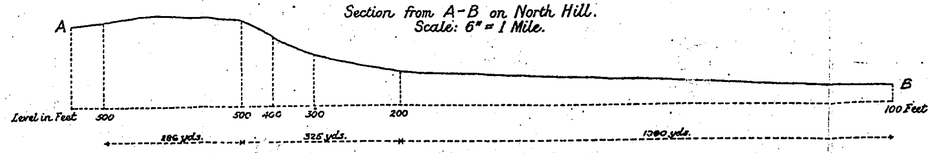


Scale:- Three Inches to One Mile.

Mile 1/4 — 0 — 1/2 — 1 Mile

Yards 440 — 0 — 440 — 880 — 1320 — 1760 Yards.

Section from A-B on North Hill.
Scale: 6" = 1 Mile.



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