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AN ARMY ENGINEER INTELLIGENCE BUREAU.

By 'G.'

Two previous contributions to these columns—Major A. T. Moore's in the number for December, 1905, and Capt. G. Walker's in that for March of this year—both contained a suggestion that merits further discussion, namely the proposal for an Engineer Intelligence Bureau.

We must all fully realize the necessity for such an institution. The Intelligence service of the Army is organized in geographical sections; its primary duty is to collate information on the organization, equipment, and training of foreign armies; and its officers are selected irrespective of the various branches of our Service. Consequently its sphere is largely confined to purely military subjects, and comparatively little notice is taken of scientific details which may have a military application. No doubt a certain amount of engineering and other technical matters are dealt with, but the collection of information on such matters does not appear to be definitely arranged for. Moreover, the sources from which such information is obtained are not always trustworthy, and it requires technical knowledge to test its reliability and judge of its importance. Furthermore, there is no medium for the circulation of the really useful residuum amongst those for whose benefit it is presumably collected.

The reasons for all this may be sought in the fact that under the existing system the majority of those employed in collecting intelligence are necessarily lacking in technical knowledge. The Army as a whole is not fully appreciative of the importance of contemporary engineering science in relation to warlike operations, though we have progressed considerably in this respect of recent years. As a nation, moreover, we are too insular in our ideas, too much given to rely on the old hammer-and-tongs methods, too little inclined to profit from technical advances in the sphere of civil life.

We as a Corps, with our multitudinous interests and most varied

duties, in which improvements are constantly taking place, suffer more than can be described in a short paper by the absence of a Central Intelligence Office. As individuals we find it almost impossible to keep abreast of the times as regards the changes and progress of engineer-technical matters, not only in foreign armies but also within our own organization. Employed as we are in all parts of the world on all sorts of work, often carried out without its very existence being known to more than a few on the spot, there must be an appreciable waste of time and mental effort through officers working out designs *de novo* instead of being able to start at a later stage with the knowledge and experience previously gained by others in similar concerns.

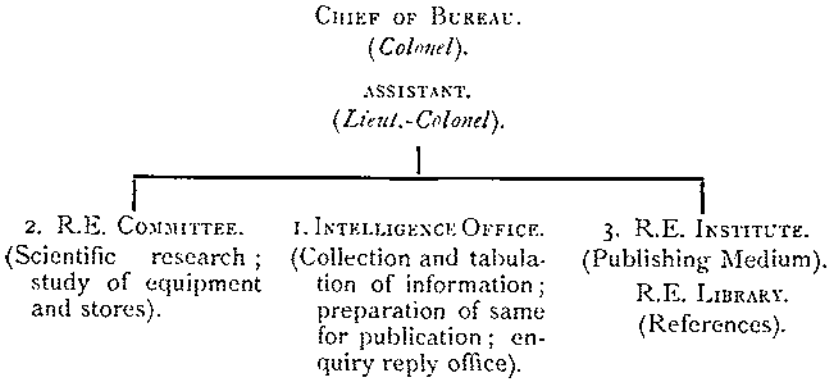
So much for the necessity for an Engineer Intelligence Bureau as a means of economizing time and labour, and therefore probably money also, and of keeping the Corps in a high state of education and therefore of efficiency.

As to the scope of the proposed Bureau, this is a more difficult question. If the organization is to be complete, the sphere of its operations must indeed be large; and it must comprise all branches of science, not only military ones (such as artillery, small arms, permanent and field fortification) but also the more purely civil branches (such as metallurgy, steel and iron manufactures, railway work, bridge construction, electricity, telegraphy and telephony, aeronautics, etc., etc.). In short the Bureau must be the central organization, whereby the Military Engineers of this country first of all, and also their colleagues in the other branches of the Service, may be put in possession of any sort of scientific knowledge bearing upon their work.

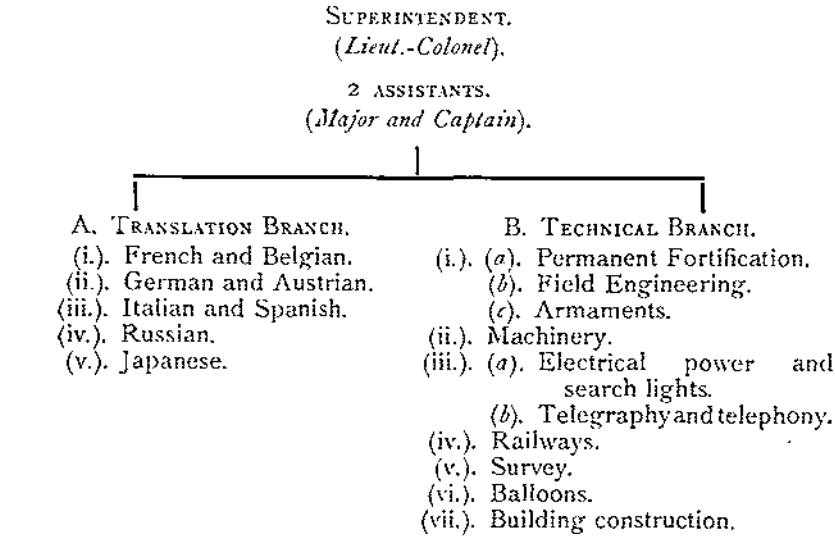
In initiating such a Bureau it would possibly be wise at first to confine its investigations as to civil methods to English-speaking countries. Military information pure and simple, however, would have to be sought throughout the world. It may be as well to point out here a malady which we Englishmen are very liable to suffer from: We are too apt to look on at the work of other nations with a sort of benevolent condescension and say to ourselves "that has no application to us, we are an island power, we have a navy" and so on *ad infinitum*. We suffer from a sort of sloth in this respect. If we do not see any direct application to ourselves in any foreign method, we cast it aside as unworthy of investigation; quite forgetting that, although we may never have to use the method in question, we may possibly have to counteract it, and that in this sense the more knowledge we have of it the better.

This is a digression; we must now consider a definite proposal for action. It has been said that an appreciation of any military situation without a definite proposal for action would be like Macaulay's bee without a sting or a horse without legs.

We therefore submit the following diagram as a definite suggestion for the organization of the proposed Bureau.



The Intelligence Office might be organized as follows:—



The duty of the Translation Branch would be to search for information and pass lists of the same to the Technical Branch; the latter, after personal communication with the former, would sift the information, obtaining translations when necessary, and forward the useful residue to the Superintendent. The Superintendent would pass this on to the Chief with a view to publication. One of the Assistant Superintendents would act as the medium between the two branches. The other might act as recording officer; he would thus be in a position to reply to any technical enquiry from any officer in the Corps, and to give at once either the actual information sought after or else a reference as to where it could be obtained; it would

probably be convenient for the R.E. Headquarter Library to be in his charge.

Each of the sections enumerated under A and B Branches should have an officer in charge, and it would be desirable to have two for B (i.). The officers selected for B Branch should be experts in their own line, and should not be below the rank of captain. They should be appointed for not less than five years, for continuity of policy is necessary; changes must be carefully weighed by men of experience, and frequent changes in personnel usually mean kaleidoscopic and therefore often harmful changes in policy. The B Branch officers would also carry out collating work in their own subjects so far as concerns all English-speaking countries. In addition their duties would include the acquiring of information from officers employed on any special work in their own line and the preparation of communications to the Corps at large.

The officers in A Branch might be of any rank, and might even be retired officers. The linguistic staff may appear large, but it is essential to the success of the scheme that the Bureau should be in *constant* touch with foreign progress and ideas.

The R.E. Committee already exists, and might remain as now constituted. It has been suggested that certain of the officers in B Branch might form this committee, but such a course seems undesirable. The Committee is an advisory committee to the War Office for the adoption of inventions and equipment in the British service; its deliberations and recommendations are often of a confidential nature; but we should avoid anything secretive in the Intelligence Office, which is intended to be mainly educational.

The R.E. Institute also already exists as a publishing medium; and could take its place in the proposed scheme with but little change.

The Chief of the Bureau might be *ex-officio* President of the R.E. Committee and Chairman of the Institute Committee. It would be necessary for him to be a senior officer of scientific attainments, as he would have to decide questions of considerable technical intricacy; he should also possess in addition a good all-round knowledge of the varied duties of the Corps. In order that his decisions and advice might have a solid foundation he should be empowered to send his officers on tours of inspection to visit works of all descriptions. Like the President of the Ordnance Committee he might be a retired officer.

There remains the question of cost. But a detailed consideration of this would be premature until a settlement of the most efficient organization of the proposed Bureau. Several of the officers could be retired officers so that their cost would not be heavy. The establishment of clerks and draftsmen would be very small; this also might consist mostly of reservists or pensioners, but in B Branch they

would have to be selected men of high technical knowledge. The only large item of expense would be the printing of communications to the Corps; but a subsidy for this purpose as in some of the European armies would surely be justifiable.

Whatever the cost—in reason—, if the proposed Bureau tended to the increased efficiency of the Corps, as it undoubtedly would, it would be money well spent; and it might even result in economy in the engineer portion of our military expenditure.

Finally, it is not suggested that this Intelligence Bureau should supersede any existing institution. Its object is to work hand in hand with those already established and to amplify their work. To do this it must be in constant communication with them and must be prepared to help them with scientific advice, and so bring about that millenium when the British Army shall be the first of all armies and the British Empire the most surely founded of all.

SQUARING THE CIRCLE, AND OTHER PROBLEMS.

By Col. Sir Charles M. Watson, K.C.M.G., C.B., late R.E.

The problem of squaring the circle, that is, of finding by geometrical construction a square of which the perimeter is equal to the circumference of a given circle, or a square of which the area is equal to that of the given circle, is a very ancient one. So far as is known a perfectly correct solution is impossible, but there are various geometrical solutions which give results very near the true one.

When recently investigating another question, I found a solution which seems worth placing on record in case it has not already been published, as it is a very simple one and gives a result approximating closely to the real values. It depends upon the propositions of the fourth book of Euclid which enable us to divide the circumference of a circle into certain fractional parts. We can find geometrically the fourth, fifth, and sixth parts of a circle, and, as it is possible to bisect an angle, we can obtain the same fractions of a semi-circle.

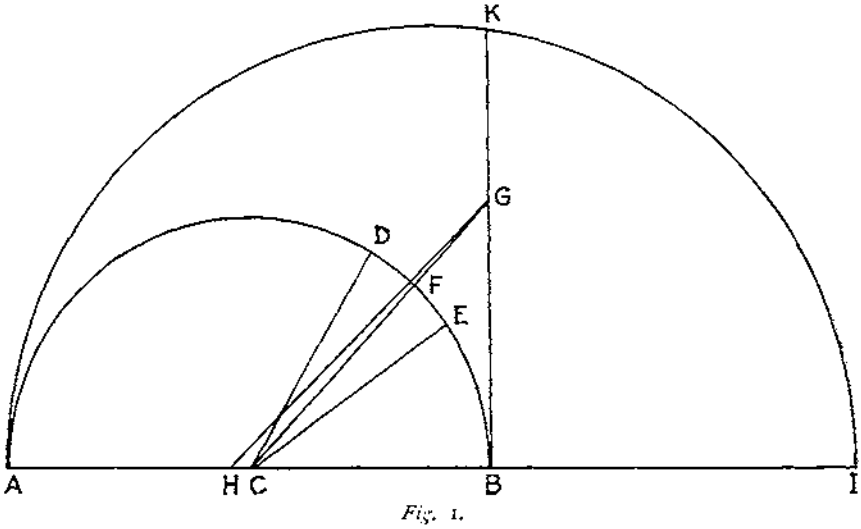


Fig. 1.

Let AB be the diameter of the given circle. Then the side of a square of which the perimeter is equal to the circumference $=AB \times 0{\cdot}78539$, and the side of the square equal in area to the circle $=AB \times 0{\cdot}88622$. On AB, the diameter of the given circle, describe a semi-circle. Make BD$=\frac{1}{6}$ and BE$=\frac{1}{5}$ of the semi-circle. Bisect the angle DCE at F and produce CF to meet at G a tangent at B. Make BH=BG, and prolong AB to I so that BI=GH. Describe a semi-circle on AI, meeting the tangent BG at K.

Then BI is very nearly equal to the side of a square of which the perimeter is equal to the circumference of the circle AB, and BK is very nearly equal to the side of a square of which the area is equal to the area of the circle.

The proof is as follows:—

The angle $$BCG=\frac{BCD+BCE}{2}=\frac{60^\circ+36^\circ}{2}=48^\circ.$$

$$BI^2=GH^2=2BG^2=2CB^2\tan^2 BCG=\frac{AB^2}{2}\tan^2 48^\circ.$$

$$\therefore\quad BI=AB\times\frac{\tan 48^\circ}{\sqrt{2}}=AB\times 0{\cdot}78532$$

and $$BK^2=AB\times BI=AB^2\frac{\tan 48^\circ}{\sqrt{2}}.$$

$$\therefore\quad BK=AB\times\sqrt{\frac{\tan 48^\circ}{\sqrt{2}}}=AB\times 0{\cdot}88619.$$

The value of BI as found by construction is 0·00007 less than the true value, and the value of BK is 0·00003 less than the true value.

There are two other problems of a cognate character, which can be solved approximately by construction in a somewhat similar way. These are:—

1. To find the side of a cube of which the volume shall be double that of a given cube.
2. To find the side of a cube of which the volume is equal to that of a given sphere.

If AB is the side of the given cube, then the side of a cube of double volume=AB × 1·25992; and the side of a cube equal to the volume of a sphere of diameter AB=AB × 0·80599.

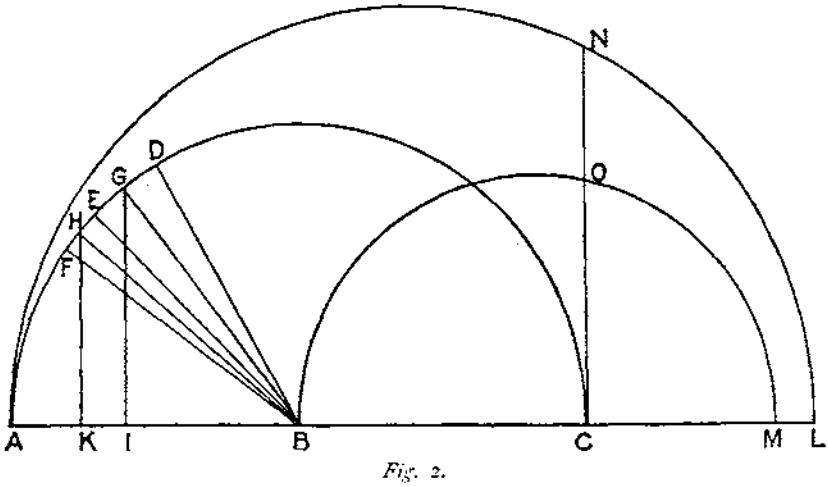


Fig. 2.

Let AB be the side of the given cube, or diameter of the given sphere. Prolong AB to C, making BC=AB, and on AC describe

a semi-circle. Draw a tangent at C. Make AD=$\frac{1}{3}$ the semi-circle, AE=$\frac{1}{4}$, and AF=$\frac{1}{5}$. Bisect the angles DBE and EBF at G and H. Draw GI and HK perpendicular to AB. Prolong AC to L, making CL=GI and CM=HK. On AL and BM describe semi-circles cutting the tangent at N and O.

Then CN is very nearly equal to the side of a cube of which the volume is double that of the cube on AB; and CO is very nearly equal to the side of a cube of which the volume is equal to the sphere of diameter AB.

For $CN^2=AC\times CL=2AB\times GI=2AB^2\sin ABG.$

But by construction

$$ABG=\frac{ABD+ABE}{2}=\frac{60^\circ+45^\circ}{2}=52^\circ\ 30'.$$

$$\therefore\quad CN=AB\times\sqrt{2\sin 52^\circ\ 30'}=AB\times 1{\cdot}25965.$$

Similarly $CO^2=AB^2\sin ABH,$

and, by construction,

$$ABH=\frac{ABE+ABF}{2}=\frac{45^\circ+36^\circ}{2}=40^\circ\ 30'.$$

$$\therefore\quad CO=AB\times\sqrt{\sin 40^\circ\ 30'}=AB\times 0{\cdot}80589.$$

The value of CN as found by construction is 0·00027 less than the true value, and CO is 0·0001 less than the true value.

TEMPERED DUCTILE METALS.

By Capt. C. H. Versturme-Bunbury, R.E.

A Mr. Z. F. Vaughn of Los Angeles in Southern California claims to have made a discovery that may have very far-reaching effects on the arts and sciences.

It appears that he has spent many years in experiments to solve the problem of tempering gold, silver, and copper; and that he has finally succeeded so far as to be able to produce instruments from these metals with a temper equal to, and with an edge more enduring than, steel.

At present the use of this discovery is confined chiefly to the manufacture of gold surgical instruments; but there is a large development probable in the production of tempered copper for journal bearings, springs, and electric supplies.

Samples of these tempered gold and copper instruments have been submitted to tests by experts in Los Angeles and are certified by these experts to be genuine gold and copper.

The following remarks are taken from the "Los Angeles Mining Review" of 17th February, 1906:—

"Mr. Vaughn began his investigations in 1888 and has been steadily at it ever since. He does not claim to have discovered a lost art, but to have invented means whereby gold, silver, and copper, either separately or in alloy, can be taken through the various degrees of crystallization which correspond to the several tempers known in the arts.

"By the process used these ductile metals are not only hardened, but their density and homogeneity are brought to such practical perfection that a cutting edge is effective because of its absolute and microscopic fineness and smoothness. It does not tear—it divides; and for surgical purposes instruments of tempered gold are said to be superior to those of steel because of this keener edge and because no microscopic speck of rust can harbour dangerous germs.

"Interesting and important as the tempering of gold is from metallurgical and surgical points of view, the great commercial value of the discovery lies in its application to copper and in the widely extended use of that metal which is thereby promised.

"It is stated by Mr. Vaughn that tempered copper is not subject to that crystallization through vibration which limits the life of steel; that springs of tempered copper have not only as great elasticity

and strength as steel springs, but that, owing to the extreme slowness of the process of crystallization, they will retain the spring temper for a practically indefinite period; furthermore, that, owing to this quality of tempered copper and its great tensile strength, all metal parts of machinery which are subject to vibration may be more profitably and (as in the case of propeller shafts) more safely made of copper than of steel.

"It is thought that the most immediate, and possibly the most extensive, use of tempered copper will be for journal bearings. It is stated that, owing to the great density of the metal, it takes a perfect polish with use and makes an almost frictionless bearing, free from danger of overheating, and long outlasting either babbit metal or brass for the purpose.

"It is also thought by scientific men that tempered copper, owing to its hardness and density, will solve several important problems of electrical engineering with the result that usefulness of electrical machinery will be materially extended, with corresponding increase in the use of copper."

I happened to be in Los Angeles at the time when this discovery was made public and have seen some of the gold surgical instruments. They certainly appear to have all the qualities claimed for them as regards elasticity and keenness of edge. But I have not seen any of them tested as to their being in fact gold. Nor have I ascertained what would be the effect upon their temper of raising them to a high temperature; it is stated that their temper would not be affected by such treatment.

This discovery appears to be worthy of investigation and scientific testing, as, if its claims can be substantiated, it should have an important bearing on many problems connected with science and art.

THE INFLUENCE OF RATE ON ACCURACY OF FIRE.

By CAPT. D. BRADY, R.E.

THE following is an account of some private experiments made at Esquimalt, B.C.

It will save repetition if the meanings assigned to certain words are defined :—

Rate is the reciprocal of the whole time taken for a single shot, taking a minute as the unit of time.

Accuracy is the reciprocal of the probable error of a shot.

Probable Error is the error—measured in minutes of arc—that in a long series of shots half the shots would fall short of and half would exceed.

Intensity is the number of shots that fall on a unit area in a unit time.

Density is the number of shots on a unit area; it is intensity multiplied by time.

Weight is the number of shots on an area; it is the *average* density multiplied by the area, or the *average* intensity multiplied by both the area and the time.

The object of the trials was to find out how *Rate* affects *Accuracy*. Strictly, rate depends on many things that cannot directly affect accuracy; for instance, on the time it takes to open the breech, to close it, and to bring the rifle back to its position for aiming. It would be difficult, and not very useful, to determine how much of the time taken for each shot was spent on such operations. Nothing but the time it takes to fill the magazine was excluded in the trials.

They are very incomplete, as I had to pay for them. Only three men fired, and all were good shots. Three were taken, because if only two had fired and one had some peculiarity I might have found it hard to say who it was; good shots, because had I begun with bad or medium shots I might have ended with good ones, without knowing how to make due allowance for their improvement.

No notice was taken of *lateral* accuracy; and to make sure that no time was wasted in trying for it, the target gave nothing to aim at but a horizontal line. On such a target correct elevation should secure a hit.

If a long line of men of equal skill fire at such a target, each man at the part opposite him, the shots will be spread uniformly *along* the line, however they may be spread vertically. In effect, it is the

same as if each man's shots were spread along a length corresponding to the interval between firers, and none of his shots went outside.

Imagine a great number of shots fired. Some will go above, some below, and a few will hit the line. If a vertical screen were put behind the line, and every shot were arrested by it or by an already arrested shot, a sort of mountain of lead would be built up, of a section like that shown in *Fig.* 1.

Level with O, which represents an end view of the line, the section would be thickest; above and below it would thin off, at first slowly, then more quickly, then again slowly. The thickness at every level exactly represents the probability of a shot there.

If at equal distances above and below O lines P*p* P*p* are drawn so as to enclose just half the area of the section, it is obvious that it is an even chance whether a shot will go between P and P or not. OP is the "probable error" of a shot.

The length OP cannot be determined with positive certainty; how it is determined approximately will be seen later on.

Now imagine the firing repeated, for the same length of time, but at a different rate, say twice as fast. All that can be foretold with certainty is that the new section will have double the area. Whether O*o* will be thicker or not depends on the new length OP. If the new OP is double the old, the new O*o* will be the same as before; if the new OP is the same as before, the new O*o* will be double the old. O*o* is in fact proportional to the *Rate* divided by the *probable Error*. As long as the quotient does not decrease, the intensity of fire at O will not decrease.

But even if O*o* is smaller for a higher rate, the *Weight*, and therefore the *Average Intensity*, will be greater for a height DD, if D and D are only far enough above and below O (*Fig.* 2). It is not easy to directly compare the areas of the sections between D and D; but if, instead of probability-sections, curves whose ordinates are proportional to the areas of sections for given distances from O are plotted, the difficulty disappears. These curves are shown in the lower half of *Fig.* 2.

Fig. 3 gives particulars of the probability and the probability-integral curves. In both cases r·o must be plotted equal to the adopted probable error. In the probability curve the ordinates must be plotted to a scale proportional to *rate* divided by *probable error*. In the probability-integral curve the ordinates are to be plotted to a scale proportional to *rate*. All curves of a class can then be read by one scale.

In the trials the level of O was assumed to be the average level of the shots, to avoid *constant* errors of rifle, sights, and holding. But as the average level changes with every shot fired it is itself subject to error. The probable error of a shot was found as follows:—The difference of level of each shot from the average was squared;

the sum of the squares was taken and divided by one less than the number of shots; ·6745 times the square-root of the quotient is the probable error. Of course, had the real level of O been known, the sum of the squares would have been divided by the number of shots, not by one less than that number.

Knowing the rates and their probable errors, probability and probability-integral curves could be drawn. But the probable errors were known for isolated rates only. So the rates and their probable errors were plotted as co-ordinates in *Figs.* 4*a*, 4*b*, 4*c*, and 4*d*, and smooth curves were drawn to show their continuous relation. The points given by the trials are too few and too inconsistent to let one draw these curves with any confidence; I may have drawn them wrong.

The curves show some well-known things, and for the men that fired something I did not know. They show that the probable error is never zero for any rate, however low; and that in quick firing, when nearly all the time is spent in mechanical work and little is given to aiming, the probable error grows fast. The tangents shown touch the curves at points corresponding to the rates of greatest intensity of fire at a mere line, and these rates are rather higher than I expected.

In *Figs.* 5*a*, 5*b*, and 5*c* the figured curves give the number of shots a minute, at various rates, that may be expected on targets of various vertical heights. The more curves come within the limits of a target the more shots a minute will that target get. The dotted line marked "index of best rate" indicates the closest grouping of the curves, and incidentally the rate that will give the greatest *average* intensity of fire for a given target.

These curves are constructed from *Figs.* 4 by plotting or calculating probability-integral curves for the different rates and probable errors—a simple but rather tedious business.

I hope the diagrams will in other respects explain themselves, as this account is already too long.

So far it has been assumed that accurate aiming means accurate hitting. It does, but only if the sights are properly set for the range. Otherwise the intensity is all in the wrong place. The clumsy remedy for uncertainty of range is to maintain accurate and therefore slow fire and to vary the backsight elevation. The better way is to let the fire spread itself so as to include any likely error in range-finding. In more precise words, the size of the target—measured in minutes of arc—to which the rate should be adapted is not the small vertical angle the enemy's line subtends; it is that angle *plus* twice the difference of backsight elevation due to the likely error in range.

For example, the enemy's line subtends 2 feet and the range estimate is 1,250 yards with a likely error of 50 yards either way. At 1,250 yards, about 10 feet difference of backsight elevation gives 50 yards difference in range. The *virtual* target is therefore 2′ + twice 10′ = 22′, not 2 ft. as it would have been had the exact range been known.

Take a less simple case of spreading fire. Orders are received to search a belt *200* yards deep, of which the edges are 1,400 and 1,600 yards away. If the firer is above the plane of the belt he can measure the vertical angle it subtends; let it be 14 feet. If he is in its plane the angle is nothing. If he is below its plane the angle is negative, but he may have some indirect means of learning its amount; let it be 16 feet. These angles are the angles subtended by the target in the three cases. But the fact that the target is not all at one range has to be met. It is as if the estimated range were 1,500 yards with a likely error of *100* yards either way. For *100* yards at 1,500 yards the difference of backsight elevation is about $22\frac{1}{2}$ feet. The virtual targets are therefore $+14'+45'=59'$, $0'+45'=45'$, and $-16'+45'=29'$ for the three cases assumed.

To go a step further. Suppose the mark for aim is not the centre of the belt but something else. The proper backsight elevation is that for 1,500 *plus* or *minus* the vertical angle between the centre of the belt and the mark, *plus* if the mark is below, *minus* if the mark is above the centre of the belt. Let the mark be the near edge of the belt, *i.e.* 7 feet below, in line with, or 8 feet above the centre of the belt, according to the case considered. The elevations to be used are 1,531, 1,500, 1,464, though the mark for aim is 1,400 yards off.

Officers are not likely to have either time or facilities for such calculations on ordinary service. But they might find them worth while in special cases; for instance in sieges, or in fights round positions of very great importance, wherever indeed economy of ammunition is a secondary matter and economy of men and time is the first.

Of course if there is no cover, if firers must remain exposed to fire whether they are firing themselves or not, there would be no sense in using the rather high rates the diagrams indicate. The shooting of a man exhausted by over-exertion is not likely to be very useful. When there *is* cover to use for loading and for resting the best rates, the rates of fire that expose the firers for the shortest time and do most damage to the enemy can and should be used.

It is hardly polite to give my facts and then presume to draw conclusions which readers would prefer to draw unassisted; but my facts may be rather obscurely told, so it may clear up things if I say what my conclusions are.

1. Neither accuracy alone, nor speed alone, is enough.
2. Room must be made in the transport train for enough ammunition, even if fighting men are left behind to make it. Better make the fullest use of a smaller number by giving them enough ammunition, than make unnecessary targets of the rest. It is the weight of fire in the right place that counts, not the number of men.

3. It would be better in peace field practices to limit the *times* of fire at targets, not the ammunition; so that companies might learn the best use of their rifles, not the best use of a limited allowance of ammunition.

The most effective use of other things than rifles or bigger guns might be found in a somewhat similar way.

When the time is limited and the value of something has to be found by repeated measures, the most accurate result will be got when

> The *Rate* of repetition divided by the *square* of the *Probable Error* of a measure is a maximum.

It does not pay, then, to delay over each measure in the hope that it will be very accurate; the result of the series of measures may suffer.

CONDUCT OF TRIALS.

The targets were made of white paper, about 27 in. × 21 in. The mark for aim was the top edge of a broad wooden strip, red-brown in colour, along the bottom of the target. Targets.

The range was 71 ft. 8 in. from eye to target, so that an inch on the target subtended four minutes of arc very nearly. Range.

Kneeling position, no dead rests of any sort. Position.

The 700-yard sight was used, to avoid damage to the aiming mark and to avoid the use of leaf-down sights. Sights.

Eleven shots were fired at each trial, the first just off the target, the other *ten* at it. Shots.

Each man started himself. His first shot was his starting signal. Starting.

The time was taken by stop-watch from the sound of the first shot to the sound of the eleventh. It was assumed to be ten times the time of each shot on the target. Timing.

At each trial the man settled his own rate. If he repeated the same rate he was asked to avoid it in future if possible. Rate.

The rifles used were service rifles, long, all with somewhat worn barrels. The ·22 Winchester automatic used is only a toy, but it gives some idea of what the rifle of the future can do. Rifles.

I hope complete experiments will be made by someone more competent than myself; but no one could find three men more willing to make them a success than Co.-Sergt.-Major R. Orchard, Sergt. D. Godfrey, and Sergt. A. Sergeant, of the 48th Company. They must have found the firing very dull work, but they never showed it and it never spoiled their keenness.

NIGHT OPERATIONS AT CHATHAM.

THE night operations described in the July, 1905, number of this Journal were repeated on a somewhat extended scale on the 22nd and 23rd of January last.

The 'General Idea' was that a Blue Force of 3 army corps had landed at Sheerness, the North Foreland, and Lydd; its object, after concentration being the capture of Chatham for use as a base.

The 'Special Ideas' were as follows:—*Blue.* "Sheerness has been captured and Chatham and Rochester are invested on the south and south-east. On the 6th instant the north-west edge of the wood in front of Fort X was captured by our troops; but their further advance was checked by a redoubt (about 1,200 yards from the fort) against which it was decided to commence mining operations. On the 22nd instant the galleries were completed; and arrangements were made to fire the mine at 3.30 p.m. on this date and to effect a lodgment, from which advance trenches could be pushed against the fort."

Red. "Chatham and Rochester have been invested on the south and south-east. Sheerness has been captured by the enemy, and the movable armament has fallen into his hands. In front of Fort X a semi-permanent redoubt has been constructed, and from reports of spies it is believed that an assault of this redoubt is contemplated as a preliminary step to the capture of the fort. The fort must be held to the last."

The Blue Force attacked the advanced redoubt about 3.30 p.m. on the 22nd; and it was actually blown up. During the night the attackers advanced and entrenched themselves on a line running parallel to and from 200 to 300 yards from the front of the fort. On the morning of the 23rd, the defenders were driven in from their outlying trenches, the demolition parties cut ways through the wire entanglements, and under cover of fire from guns, howitzers, machine guns, and rifles the ladder parties scaled the ditch and the fort was captured.

DEFENCE MEASURES.

The defending force was under the command of Brevet Lieut.-Colonel A. W. Roper, R.E.; and consisted of the Training Battalion, R.E., an improvised Search Light party, R.E., 1 battery of 4·7″ guns, and 1 battery of 5″ howitzers. (The guns and howitzers were represented by R.A. officers).

Fort X is situated on a plateau; in front and on the left flank the ground slopes slightly; and on the right flank, commencing at about 150 yards from the ditch, there is a steep descent. The country in the neighbourhood is generally open and free from natural obstacles. The ditch is about 30 ft. wide and 20 ft. deep, with masonry escarp and counterscarp.

The troops defending the fort were divided into three sections—left flank, the fort itself and the outworks in front and on the left; right flank, the outworks on the right; reserve, in rear of the fort. The guns were assumed to be near the next fort on the right of Fort X, about 2,000 yards distant; and the howitzers about 1,500 yards behind the left rear of Fort X. The fire of the latter was supposed to be directed by telephone from a high building in rear of the fort.

As regards the actual defences, the parapet of the fort itself was recessed and overhead cover was provided for every rifle. Outworks, in the shape of covered or traversed trenches, were constructed on the front and flanks of the fort, the loopholes being made so that no work could fire into another. Between these trenches was erected a girdle of wire entanglement, so aligned that each length was enfiladed by one or more of the works. As much of the foreground as time permitted was covered with fougasses and mines, represented by flares, which were fired either automatically by trip wires, or by exploders, or by wires from the works. Three electric search lights were installed, one in the fort itself, one at the end of the battery site at the edge of the steep slope on the right flank, and one some distance down this slope. Along the hedge below the bottom of the slope flares were erected in trees, in order to light up the ground not covered by the electric lights; these flares were fired by friction tubes operated from an outwork (see sketch on accompanying *Plate*). Acetylene lights were also tried.

The amount of wire entanglement erected was limited by the amount of wire available; in reality a much greater extent of ground would have been covered by this and other obstacles, and barbed instead of plain wire would have been employed. Had time allowed covered communications would have been provided between the detached trenches and the fort; and more flares provided.

ATTACK MEASURES.

The attacking force was under the command of Brevet Lieut.-Colonel G. M. Heath, D.S.O., R.E.; and consisted of detachments of three Infantry battalions, of the Marine Light Infantry, and of the Depôt and District Battalions, R.E. (totalling about 1,300 all ranks), part of a Search Light Section, R.E., 1 brigade of field artillery, and 1 battery of 6″ howitzers. (The artillery were represented by R.A. officers). Capt. C. O. Place, D.S.O., R.E., acted as C.R.E.

The advance after the capture of the semi-permanent redoubt was made in the dark. O.C.s battalions were ordered to detail working parties for trench work under the orders of the C.R.E., who was made responsible for the reconnaissance of the enemy's position, the clearance of obstacles, and the distribution of tools and shields. Two of the battalions (less their working parties) acted as covering parties, guides being provided by the C.R.E.; and another battalion was in reserve. The C.R.E. was further instructed to facilitate operations by screens and smoke and by the use of the search lights; and to supply working parties for the C.R.A. as required. Lights, smoking and all noise were forbidden; and officers and men were ordered to lie down whenever the enemy's search light played on them, whether advancing or digging.

The actual assault on Fort X was carried out by daylight on the morning of the 23rd, the south-east face being selected as the point of attack. One battalion was detailed to assault this face, as soon as their left flank had been covered by the capture by another battalion of the outworks on the south face; a third battalion was ordered to occupy the trenches on the right, in order to enfilade the above faces of the fort and protect the right flank of the attack; the fourth battalion was held in reserve behind the left flank. Machine guns were brigaded and placed near the right flank. The C.R.A. was directed to keep down the fire of the adjacent forts during the advance, to bring as far as possible oblique fire on the faces of Fort X selected for the assault, and to co-operate in the assault by keeping up fire until the last possible moment. The howitzers were assumed to be in rear of the right flank, about 2,300 yds. from Fort X, using indirect laying; the field artillery far on the left flank, firing at a range of about 2,500 yds. on the fort to the right flank of Fort X.

The O.C. attack, who was with the reserve, was in telephonic communication with the trench from which the assault was to be delivered. The assaulting columns were organized as follows:—

First Line.	Covering party.	1 company.	At close distances.
	Demolition party.	R.E. (to remove obstacles).	
	Ladder party.	1 company with 6 ladders.	
Second Line.	Covering party.	1 company.	
	Ladder party.	1 do. with 6 ladders.	
Third Line. Fourth Line.	Remainder of battalion in successive lines.		

O.C.s units were shown a plan of the ground and given all information obtainable as to details of ground, nature of obstacles likely to be met with, etc. The position from which the assault was to be delivered and the right and left of the attacking parties were also indicated as far as possible. O.C.s storming columns were informed that, in face of the nature of the ground, want of cover, etc.,

success could only be obtained by successive waves of men at close intervals advancing with the greatest resolution and regardless of losses; to ensure the arrival of ladders for crossing the ditch, several spare officers and men must be detailed to each ladder, any ladders dropped by the first lines being picked up by lines in rear; once in the ditch the storming parties would be under cover. Covering parties were instructed to bring as large a volume of fire as possible on the face selected for assault, and to keep up this fire until the last possible moment.

GENERAL REMARKS.

The defenders of the fort would have benefited by the possession of light Q.F. guns, pom-poms, and machine guns, as no final assault could have been attempted before the destruction of such small calibre armament.

When the attack lights were thrown on the fort parapet its defenders were dazzled and could not direct aimed fire at less than an angle of about 60° with the enemy's beam. Otherwise the attack lights appeared to be of more assistance to the defenders than to the attackers, as the attack beams showed up the advance of the attackers very plainly.

The attackers employed a smoke screen to cover their working parties. The smoke was made by lighting sandbags filled with straw. When blown upwards by the wind it was ineffective, but it proved a good screen when dense enough.

The attackers also used shields on wheels to protect men detailed to destroy wire entanglements. One shield was in the shape of a clockwork mouse, being propelled by an officer lying flat inside it; the other was a wheelbarrow with plates fixed round the front and sides; both forms had slits to allow of the man protruding his arms to cut wire. Both shields were sent out on the night of the 22nd; but, being unsupported by rifle fire, they were easily captured. The mouse was again sent forward next day, and the umpire ruled that the operator was successful. It is doubtful whether such shields could be of general use; in this case the ground was smooth, and Q.F. and machine guns were absent from the defence.

O.C. Attack brought to notice that the artillery with heavy guns had no means of entrenching themselves, rendering it necessary to employ other troops for this purpose.

He was kept in excellent communication with his force by telephones erected by the R.E. and by the regimental signallers. The regulation oil reading lamp was not so good as a pocket electric-light lamp which was used by the officer in charge of the telephones. The barrows used for running out the telephone were very unhandy.

The mist during the morning of the 23rd interfered appreciably with the fire of the guns on both sides.

There was considerable confusion amongst the attacker's working parties when the covering parties were discovered by the defenders and fire opened on them.

The ladder parties did not advance on as broad a front as intended. Scaling ladders should be as light as possible, preferably of bamboo.

ELECTRIC SEARCH LIGHTS.

The following are extracts from the reports of the officers in charge of the search lights, Lieut. A. E. Davidson in the defence and Capt. R. Walker in the attack.

DEFENCE LIGHTS.

"*Position of Lights.*—Three lights were employed. Two, with 24-inch projectors were placed, one inside the fort on its left flank, and one at the end of the battery site on the edge of the escarpment beyond the right flank. The third light had an 18-inch projector, and was located below the crest of the escarpment. All these lamps had 15° diverging lenses.

The engines and dynamos were placed outside the gorge of the fort.

Control of Lights.—The two larger lights were in telephonic communication with the O.C. Defence. In the daytime certain directions for the beam were fixed and to each a letter was allotted. At night, on any letter being given, the light was traversed to the corresponding position.

The third light was out of the view of the O.C. Defence and was controlled by verbal instructions from the O.C. right flank.

Cover.—Owing to the wide arc through which the beams had to be traversed, it was not possible to provide satisfactory head cover for the men at the lamps, nor for the lamps themselves. It is suggested that for use in similar positions it would be worth while considering the question of designing a light steel bullet-proof shield, revolving round the same pivot as the lamp itself and with a narrow port or opening such as is used with the parabola ellipse projectors in coast defence.

Effect of Lights.—On account of the short time available for getting the projectors, engines, and necessary fittings into position, it was not found possible to have a trial run of the lamps before the attack commenced. Owing to this the beam from the lamp on the battery site was not particularly effective till towards the end of the attack.

One successful use of the defence lights was to shine up the beam of an attacking light and neutralize the dazzling effect of the latter.

One effect of the attack beams, which was of value to the defence, was that just sufficient light from these beams was reflected from clouds or mist on to the ground in and behind the fort to enable the defenders to find their way about.

As the attack was made over a wide front, and as there were not

sufficient lights to illuminate the whole of the ground, the lights had to be traversed frequently from one place to another. To ensure full use being taken of opportunities thus offered of firing at targets revealed, and to allow of a sufficient number of aimed rounds being fired at a target shown up by the beam, it is necessary to have close co-operation between commanders of fire units and the operator traversing the lamp. Owing to the supply of ammunition on this occasion being limited, it was not possible to make the conditions in this respect realistic.

When the lights were first started, as darkness came on, the attacking force was comparatively close to the position, and during the rest of the attack the light was only thrown on objects at short ranges. As a result no information was gained as to the value of the lights for long range work.

No serious attack was make on the outlying works on the extreme right flank; and the light in this section, although effective in illuminating the ground, was not called upon to light up bodies of the attacking troops."

ATTACK LIGHTS.

"The surroundings of the fort were not well adapted for attack search lights; but were favourable for the defence lights, as they always would be, the foreground having been previously prepared. The necessity for having portable projector towers as part of the equipment was proved.

No. 1 Light, concentrated fixed beam from 60 c.m. projector.—A wooden staging, giving 17 ft. command was erected for No. 1 Light at a point distant 1,000 yds. from the right front of the fort. The intervening ground was slightly convex; and at one point, about 300 yds. from the fort, it was noticed that (assuming the defence lights had been put out of action) trenches could have been constructed without detection with the aid of the diffused light from the beam overhead.

Disadvantages.—It is almost an impossibility, unless there is high or steep ground in the vicinity, to employ attack search lights without, at some time or other, showing up the attacking forces. This is a distinct disadvantage when the defence has no lights; but does not matter so much when it has, or when the attack trenches are sufficiently deep to protect the men in them. The disadvantage may be overcome by constructing first those trenches that are outside the attack beam—this being kept in a fixed position—or by creating a smoke screen and digging behind it.

Illuminating Effect.—There is no doubt this light showed up the fort parapet very well and was very effective in dazzling the defenders. It is considered that with a 16° diverging lens the dazzling effect would have been just as good, while 200 yards ($\frac{1}{5}$ of range) of the fort would have been taken in and no traversing of the light necessary.

Vulnerability.—Taking into account that the siege had been going on many days and that the defence had no guns fit for action, this light could have lived for a very long time, if not all the night through, at this range of 1,000 yds.

Use for the Assault.—Had it been decided to carry out the assault by night, this light would have been very useful in showing up the point selected for the assault and the ways cleared through the obstacles.

No. 2 Light, same as No. 1.—The other attack light was placed 600 yards to the left flank of the fort, so as to act as a screen to the entrenching parties, being directed in between them and the fort's two beams.

Owing to intervening buildings and want of command, this was practically the only position available where the attempt at screening could be made; and it was afterwards discovered that this position was within about 200 yds. from the supposed line of defence!

This light was not of very much use, however, as a screen, the defending lights being at too close a range, and the defender's view was not at all impeded.

The smoke screen, while it lasted, was much more effective; but special smoke boxes (as used in drain testing) which burn without a flame would probably be better than wet straw.

No doubt really close entrenching work could not have been executed until the defending lights had been put out of action. In such case this attack light would have been of great use, if kept in a fixed position to aid the entrenching by its diffused light and to act as a sentry beam guarding against the surprise of counter-attacks from the fort.

The Defence Lights (from Attackers' Point of View).—These lights were most useful in showing up the entrenching parties, but more lights and smaller would have been better. 12-inch projectors are effective as 16° beams within 700 yards and as 30° beams probably within 500 yds. As the last siege parallel is usually not more than 300 yds. off, small 25-ampère lights would be quite powerful enough, if so placed as to light up a given area of ground without any traversing being necessary. Moreover small lights afford smaller targets.

Uses in Siege Warfare.—Briefly the uses of search lights in siege warfare appear to be:—

A. In the Attack.

(i.). To dazzle the defence and prevent accurately aimed fire.

(ii.). To detect counter-attacks and attempts at repairing obstacles.

(iii.). To light up the points of assault and cleared ways through the obstacles.

(iv.). To assist in the destruction of obstacles and in the construction of trenches.

(v.). To assist artillery fire by night.

B. In the Defence.

(i.). To assist rifle fire from the parapet.
(ii.). To detect all attempts at trench digging within close range.
(iii.). To assist in the defence of the obstacles.
(iv.). To guard against a surprise assault in force."

As regards the range of search lights it has been found elsewhere that, with a 60 c.m. projector and a concentrated beam, observers slightly to one side of the light could detect masses of men at 1,400 yds., skirmishers in khaki at 1,000 yds., light coloured buildings at 2,000 yds., and any large objects at 1,700 yds. Observers 2,000 yds. in front of such a light would probably see 1,000 yds. beyond the limits just mentioned. As regards width of ground illuminated, with a concentrated beam it would be 50 yds. at 1,000 yds. from the light; with a dispersed beam from a 16° lens the width is approximately $\frac{1}{3}$ the range.

Both in attack and in defence the beams should normally remain fixed; concentrated beams are the most suitable for the attack, and dispersed beams for the defence. With defence lights properly used an assault by night is rendered very difficult; and in such a case the best time for an assault would appear to be early dawn. Attack lights intelligently used act as guides for the advance and are also useful for examining obstacles or particular areas of ground; but absolute concord is essential between the O.C. Attack and the officer in charge of the search lights.

ENTRENCHING UNDER SEARCH LIGHTS.

Capt. C. O. Place remarks:—

"The methods of extending working parties as laid down in the Drill Book could hardly have been adopted under the full glare of the search light without very heavy casualties and consequent confusion. In all probability the R.E. detailed to trace the trenches would have been put out of action, in which case the trenches would probably have been dug in the wrong places and without any system.

The plan adopted was as follows:—

(*a*). The tools were issued to the various working parties under R.E. arrangements, the places of issue for different units being quite distinct so as to avoid confusion.

(*b*). Each party was under the guidance of an R.E. officer, who had already received detailed instructions concerning the work to be executed.

(*c*). On the advance being ordered the parties moved forward independently, in extended order, to the most advanced sheltered position. There they lay down, utilising all existing cover.

The R.E. officer and a sapper crept forward to choose the position where the trench was to be, the officer using his own judgment as to

exact site. They took with them a tracing tape, divided with pieces of bunting into task lengths. This was picketed out along the required position, and then everything was ready for the working party to come up.

(*d*). The working party were sent up one by one in short rushes over the exposed ground, and on arrival each man's task was pointed out by the R.E. officer.

The men had to dig in a prone position. The large tools were very unsuited to this sort of work; and the amount of digging accomplished in this way was hardly enough to justify the hope that any one would survive long enough to produce any efficient cover.

Some men of the digging parties were provided with steel shields, 3 ft. by 1 ft. 6 in., weighing 40 lbs.; but these were heavy to carry, and not large enough to give much cover.

The working parties would have suffered great losses in real warfare unless the fire of the defence had been previously much subdued; and probably the only possible method of securing an advanced position in the face of an efficient defence is by sap."

FLARE LIGHTS.

The following are extracts from a report by Capt. F. S. Garwood, R.E., of the defending force.

"Lights may be divided into three classes.

1. *Long Range Lights.*—The only efficient ones are electric search lights. These are naturally few in number, but are unapproachable for general efficiency.

Flares set by trips can also be used, but they are uncertain and liable to be fired by the scouts of the attackers.

2. *Medium Range Lights.*

(*a*). Under control from parapet:—Flare lights fired by electricity; flare lights fired by wires to pull or cut.

(*b*). Flare lights, mechanical trip; flare lights, electrical with tread contacts.

All have the disadvantage that they can only be used once, and that they can be tampered with by the enemy's scouts. However, several mechanical flares may be arranged in series to be pulled off by a single long wire.

3. *Short Range Lights.*—Only useful up to what our ancestors called 'pistol shot.'

(*a*). Wells' Lights (oil); Acetylene Lights.

(*b*). Flare lights, fired by lengths of instantaneous fuze.

These are all certain in their action, but have a limited range.

The flares used in these operations were nearly all fired by the

sandbag and friction tube method of ignition. All of them were protected from rain by small pieces of canvas.

The following were the results. (1) Lights worked by mechanical trip wires: one missed fire owing to tube slipping out; one wire broke on account of its being thin through rust; the remainder worked successfully, except one jack-in-the-box, which failed when wanted owing to its being improperly set, though successful before and afterwards. (2) Lights with buried firing battery and contact tread; worked successfully. (3) Lights connected up electrically with an exploder: were marked by the enemy during daylight, and wires cut before they were fired. (4) Lights fired by instantaneous fuze: worked successfully. Many of the flares were fired by spectators and umpires.

Light composition was put in all the flares, but no attempt was made to differentiate between flares proper and those representing land mines and fougasses. The means of ignition would be the same, but the two latter were out of the question in manœuvres.

The results of the flares were disappointing considering the labour expended on them. They suffered from the following disadvantages:—

(1). They were put in hand too late, when the other working parties had used up every bit of wire for entanglements and only short scraps were left.

(2). The friction tubes for ignition could only be obtained at 1 p.m. on January 22nd.

(3). Only one N.C.O. and myself knew how to set them properly, and this had to be done hurriedly in a bitterly cold wind.

(4). No flares are obtainable from the Ordnance Department, and all the composition had to be manufactured from a receipt out of Spon's *Workshop Receipts*.

(5). Crowds of spectators were wandering over the ground pulling off the trip wires.

(6). The enemy's officers and N.C.O.s reconnoitred all the arrangements at their leisure, and were able to cut all the leads of the electric circuits.

(7). The defence search lights cast the flares in the shade and gave the enemy light to cut wires.

Umpires' Criticisms.—The chief umpire with the attack said the flares were too low. They were placed as high as possible. The flare light placed up the tree had an excellent effect; the wire controlling it was 250 yards long, hung on telegraph poles and quite out of reach of the enemy's interference.

The chief umpire with the defence said the flares did not burn long enough, but there I venture to differ. In manœuvres men crowd round a flare; in war time in two minutes there would not be a man in its neighbourhood. Short-lived and frequent flares are what is required.

General Remarks.—Setting trip wires properly is an art in itself, requiring plenty of practice. A good supply of small hooks and eyes for changing direction of trip wires is necessary.

For most cases instantaneous fuze should be painted any colour but bright orange (I had to have a pot of paint handy to paint it green). The box it is packed in could be painted red, if it is not to be stored in magazines, the fuze itself being of a similar colour to service dress.

The acetylene gas light is useless as a flare when opposed to electric lights. When the latter are not available it is useful in bridge repairs or issuing stores, or any work where a good light is required by night.

Hastily improvised flares, where only an hour or two is available for preparation, are bound to be unsatisfactory. There are always so many men and animals in the neighbourhood of camps that trip wires are more dangerous to friends than to the enemy and should be prohibited. In savage warfare, where the enemy are known to be addicted to sniping and firing into camp, the flare light arrangements should be in the hands of a special detachment. Trip wires should be fitted with a hook-and-eye connection so that they may be rolled up out of the way and quickly set when wanted.

When several days are available for the defence of a position the wires for flares and land mines should either be buried in piping, or carried as aerial lines on trees and telegraph poles. If electrical apparatus is not available, the sandbag and friction tube method will be found just as effective, but should not be used for land mines. The sandbag can be suspended from a safety line, the cutting of which sets off the light. The friction tube must be firmly secured to the wood by at least four 2″ nails. The sandbag should be connected to the eye of the tube by a strong piece of wire. There should be a gap of about an inch between the mouth of the tube and the strands of quickmatch which ignite the instantaneous fuze. Flare light composition can easily be made by mixing four parts nitre, one part sulphur, and one part mealed powder."

*NOTES ON ENGINEER DUTIES IN GARRISON.**

By Capt. A. M. Henniker, R.E.

Many officers look upon Division Work as uninteresting. When a man tells you that Bridge is uninteresting you may be sure that he is not a first-class player, and you will probably find that he has not played enough to appreciate its problems or learnt how to solve them. It is the same with Division work. No other branch of R.E. work is really so varied or brings one in touch with so many different professions, trades, arts, and sciences.

It is hoped that the following pages may be of some assistance to officers taking up Division work for the first time, and perhaps suggest some new ideas to those already employed thereon.

If you take any garrison and add up all the people who live in barracks—including in the total not only men who figure in a Church Parade state, but all the women and children, all the civilian subordinates, barrack labourers, canteen attendants, and so on—the population will rarely amount to less than that of a respectable village, and will sometimes equal that of a small country town. In many cases the barracks form a thickly populated ward or district of a town. A large proportion of the subjects which engage the attention of Municipal Authorities—the laying out and maintenance of new roads, street improvements, street lighting, water supply, sewerage and storm-water drainage, fire prevention, what in municipal affairs is known as the "housing of the working classes," and many others—require just as much care and forethought in barracks. And the man whose business it is to look after these things, planning out new works, extending, altering and improving existing things, is the Division Officer. Repairs and maintenance are no doubt important parts of his work, but in a well-ordered Division they are more or less matters of routine. He is the man to consider whether altered circumstances have necessitated a new road; whether his barrack roads are lit as well as those of the town; whether his married quarters are up to the standard of modern requirements; whether the barracks are adequately protected from fire, and all such questions.

An actual example will perhaps show best the sort of work referred to. Fifty years ago a single block of married quarters was planted

* Lecture delivered at the Royal Engineers Institute on 11th January, 1906.

on a piece of waste ground. It has since grown into a compact village of over 400 inhabitants, housed in 7 blocks, with a large laundry and numerous outhouses, forming 100 separate quarters. Until recently 40 of the quarters consisted of a single room with no water laid on. In some cases the nearest place for the disposal of waste water was 50 yards away down a flight of stairs, and the nearest closet 90 yards away across a muddy green. The soil is clay; a little gravel had been put down here and there, but practically the blocks stood like islands in a sea of mud. At night the only lighting of the streets was by two or three stray gas brackets fitted with the same small burners that are used for indoor lighting. The drainage however is modern and good. The following are some of the works already executed or proposed :—

(1). Abolition of all single-room quarters. Owing to the construction this necessitated a re-appropriation scheme involving 60 quarters.

(2). Provision of annexes with scullery and W.C. to every quarter. Although funds have not yet been obtained for this scheme it had to be worked out before the previous item could be proceeded with, because otherwise much of the work done in grouping the single rooms to form two-room quarters would probably have been wasted when the annexes came to be built. Now that this scheme is worked out any alterations made from time to time are arranged to fit in with it.

(3). Making up of roads and provision of footpaths between blocks. All day there is constant traffic, both wheeled and foot. Good roads and paved footpaths are considered essential and taken as a matter of course in the town outside the War Department enclosure. The density of the population inside the boundary fence of these married quarters is greater than that of the civilian population of the same social scale in the adjoining area of the town ; still more therefore are the conveniences of good roads and paths required.

(4). External lighting. This is equivalent to the street lighting of the town and the same remarks apply.

(5). Fire precautions. Owing to the blocks having grown up by degrees it was found that hydrants were deficient in some places and badly situated in others. In considering how lines of hose could be brought to bear on some of the blocks it was discovered that the only route was over a wall with a coping of broken glass which would have cut the hose. Some of the buildings were 3-storied ; a fire at the foot of the staircase would have cut off the escape of the occupants of the top story, this indicating the necessity of keeping long fire ladders on the spot with a shed to protect them from the weather.

(6). Other services carried out, arranged for, or under consideration are the planting of trees and hedges to relieve the dreariness of the

rows, provision of window blinds, incandescent gas, improved kitchen ranges with automatic water supply to the boilers, larger gas mains, etc. The original gas mains were laid to supply 94 lights; extensions had been made until 247 burners were supplied off the same mains, with the result that no quarter was well lighted and some got practically no gas at all.

Enough has been said to show the class of question a Division Officer has to take up. It is a mistake to suppose that money is never available for such work. The sole secret of getting improvements lies in asking for them at the right time; viz. in the "Annual Statement of Services." We know very closely how much Part II. money will be available each year. We shall not get it all—some will be wanted for services specially chosen by the C.R.E. or the G.O.C.—but a Division Officer can count on getting a good many of his proposed services approved.

The first thing, then, to do is to form a comprehensive idea of what is wanted, and then to select the services which form the most important steps towards carrying out our schemes. It is a great help in one's choice (and a blessing to one's successor) to keep a book in which is entered every useful service, whether asked for by Units or noted by the Division Officer and his Foremen of Works. Such a book will often suggest some general scheme which will meet several independent proposals brought forward by various people at different times. Without such a record of requirements, something important is sure to be forgotten when the "Annual Statement" is compiled. Having a list of everything that has been suggested, a Division Officer can choose according to his probable funds, weighing one service against another, and making sure that no urgent one is overlooked.

Whether such a list is kept or not, there are certain stock services both Part II. and Part III., some of which are wanted in almost every Division. It is of course impossible to make a list that will include every desirable service and be applicable to every station. The following list, however, includes none that are not required somewhere. A Division Officer can add to it *ad libitum* or strike out any not required in his Division. He will then be in a position to select the schemes he decides to work on.

PART II. SERVICES.

Improvements to Barracks as a town:—

Planting trees; setting hedges to take the place of wooden fences.

Making up, kerbing, and channelling roads. Laying paved footpaths.

Systematic lighting of roads and paths by lamp posts at regular intervals.

Means of recreation;—provision or improvement of cricket grounds, racquet courts, swimming baths, skittle alleys, stages in recreation-rooms.

Provision of clocks in barrack squares, letter boxes, street "orderly bins," sign posts.

Fire precautions;—fire engine houses, hose drying gantries, fixed fire escapes, new or larger mains, more hydrants, hydrants on upper floors of large buildings.

Improved lighting; *e.g.* incandescent in place of ordinary gas, electric light in place of oil.

Sub-soil drainage of parades, drill grounds, manèges, etc.

Improvements to cemeteries, waste spaces, grass plots.

Provision of modern conveniences:—

Telephone system in place of orderlies.

Speaking tubes in offices.

Light in offices.*

Improvements to accommodation:—

Abolition of one-room married quarters.

Provision of annexes to married quarters, or the addition of sinks with water laid on.

Provision of minor buildings; *e.g.* pioneer stores, coal stores, mineral oil stores, etc.

Provision, by building or re-appropriation, of dining rooms, squadron and company stores, R.E. stores, drying rooms.

Provision of authorised fittings:—

Hot water to all baths. Baths in officers' quarters.

Window blinds.

Beer engines in canteens and sergeants' messes (in place of brewer's fittings).

Gas meters (in place of meters hired from Gas Companies).

Cupboards in offices, picture rails in messes, shelves in sculleries, etc., etc.

Galleries for gas globes.

Lights to urine tub stands.

* No light is allowed by *Barrack Synopsis*, 1905, but see Table of authorized burners and footnote to Appendix VI. of *Regulations for Supply, Transport, and Barrack Services.*

Replacement of old fittings by improved patterns:—

Abolition of trough and pipe latrines.
Replacement of slate baths by iron ones.
Modern fire grates in place of old-fashioned patterns.
Replacement of old pattern ranges by modern ones with constant water supply to boilers.

Alterations needed owing to changed circumstances:—

Larger mains and meters for gas and water.
Provision of relief mains, stop valves, cross connections, etc.
Additional ashbins.
Extension of fire mains, and additional hydrants near new buildings.

Miscellaneous:—

Provision of gas governors.
Provision of universal pattern heads to stopcocks and fire hydrants. (See I.G.F. Circular 725).
Provision of dry areas to damp buildings.
„ of covers to all tanks and cisterns.
„ of concrete seal under all wood floors on ground level.
Removal of disused tanks and cisterns.
Provision of safety valves to all closed hot water boilers.
„ of wire guards to exposed windows.

Some of the above items deserve a few remarks.

Hedges have two or three advantages over wooden fences. They are inexpensive, lasting, and comparatively impassable. The cost of maintenance is generally less than that of a wooden fence, and in many cases does not fall upon the War Department, because if it is in connection with a mess or quarter it is the business of the occupants to keep it in good order. In appearance the advantage is generally on the same side. The large use of hedges by railway companies is strong evidence in their favour.

A regimental officer recently remarked that 10% of the minor offences in his regiment arose from men being late for parade. The suggestion that a clock visible from the barrack rooms would reduce the prevalence of such offences and that he should ask for one in his Statement of Services was a new idea to him. At one station letters were collected from the officers' and sergeants' messes by an orderly, but the men had to walk three-quarters of a mile to post theirs. In this case the Post Office agreed to fix three letter boxes in the barracks.

As regards fire precautions, it should be remembered that the R.E. are responsible for the supply of water at convenient places. It is

wise to make sure before any fire occurs that the hydrants are sufficiently numerous and conveniently situated, the mains ample in size, and that there is no unsuspected obstruction to the flow of water in them; and to put in your Statement of Services items for any alterations found to be required. However satisfactory the fire system may appear in the Barrack Atlas Plans, it is essential to occasionally watch the troops at practice before you can be certain that you have not overlooked some point that will cause your system to break down at the critical moment.

A parade ground that is hard and dry all the year round is very expensive. The cost of the necessary hard bottom is so great that it is often omitted, with the result that in winter some parades are often unusable. The only cure is to supply the hard bottom; the cost may have to be spread over two or three years.

The number of "employed men" is a constant source of complaint among regimental officers. No civil firm employing a thousand hands would take men away from their proper work to carry messages and run errands. Much army business is transacted by correspondence which could be done better and quicker by word of mouth. It is surprising that telephone systems connecting the administrative offices and the offices of units are not asked for oftener.

It is hardly necessary to point out the grave objections to single-room married quarters. At almost every station it is desirable to get out a complete and classified list of all the married quarters, showing against each quarter what is wanted to bring it up to modern standards; but as a rule the most urgent requirement is the abolition by re-appropriation, building, or otherwise, of such single-room quarters as still exist.

In some cases the storage room for the Division stores is inadequate or is such that safe custody or due supervision is impossible. The insertion in the Statement of an item for the provision of proper storage accommodation then becomes of importance.

It is a standing complaint in barracks that the allowance of coal is insufficient. You can help the troops by a systematic weeding out of antique and wasteful patterns of grates. Since this was written the point has been drawn attention to in D.F.W. Circular No. 897.

PART III. SERVICES.

All buildings and fittings have a certain life. If your barracks are new or have been well kept it may be possible to pay for renewals out of your incidental item. Otherwise you are likely to require items for some of the following. In many cases you can average your requirements and have the same standing items year after year; *e.g.* assuming that a married soldier's range will last 15 years, if you

have 150 married quarters you will have to renew 10 ranges every year.

Renewing barrack room floors.
" doors and frames.
" sashes and frames.
" slate roofs and slate boarding.
" wooden fences.
" soldier's cooking apparatus.
" married soldier's ranges.
" large ranges in messes and married officers' quarters.
" fire grates.
" hot water boilers.
" wooden floors elsewhere than in barrack rooms.
" stable paving.
" gas and water mains.
" large areas of tar or other paving.
" particular fittings, such as accoutrement shelves, school desks, stable mangers, etc.
Pointing walls.
Rebuilding or topping chimneys.

Every brick or masonry building requires pointing from time to time. Units rarely requisition for such work. To do it is expensive, and brings no particular credit to a Division Officer, so it is often neglected. Places out of sight—such as the outer side of boundary walls where they abut on private grounds—sometimes escape inspection for many years. Then some day it is discovered that several thousand pounds worth of pointing is required. The systematic way to deal with such cases is to have a minor maintenance item every year, "Point brickwork," so many hundred pounds. Rebuilding or topping chimneys is a similar class of work.

In old barracks it is desirable to plan out minor maintenance work some time ahead and not live hand to mouth. Three good principles to go on are :—(1). Concentrate your funds on one barrack or one block and finish it off; do not fritter money away on patching in many places. (2). Deal with inhabited buildings first, then storehouses and stables; leave outhouses, garden walls, boundary walls, and so on till last. (3). Start at the top and work downwards. Make the chimneys sound first because a certain number of slates are sure to be broken in the process of repairing chimneys; then put the roof in order; next replace any decayed woodwork in the sash and door frames; and then do the pointing. To complete a building may of course take two or three years.

Besides regular quarterly inspections and periodical services like painting, there are in every Division various things which have to be seen to from time to time if the Division is to be well looked after.

Some are specifically laid down, but, from being scattered about in unexpected places in Regulations, they are often overlooked, until a report is called for as to why para. so-and-so has not been complied with. The following list may be useful; it does not profess to be exhaustive; duties as to the performance of which a periodical return is required are not included—if the office list of returns is kept up to date no other reminder is required.

Clearing eaves gutters (*R.E.S.** 694).
Trimming hedges, lopping trees, clipping creepers.

Unless hedges are *properly* trimmed and the roots dug over they soon become thin at the bottom and cease to be an obstacle. The work must be done by an agricultural labourer; a town-bred man often does irreparable damage. A few years' neglect or ill-treatment of a hedge may necessitate a large expenditure on railings to replace it.

Overhaul of boilers for supply of hot water (removal of scale, test of safety valves, etc.).
Cleaning out water part of Warren's cooking apparatus (the makers recommend once in 6 months).
Testing all drainage bit by bit.
Flushing of certain drains every 6 months (*R.E.S.* App. VI.).
Testing of ventilating pipes for leakage (by smoke test).
Testing of ventilating pipes for blockage (by wooden ball lowered by a string).
Testing of automatic flushing apparatus. This is a weekly duty of the troops (*R.E.S.* App. VI.); but the apparatus is often so constructed that the troops cannot comply, and in any case constant supervision is needed.
Washing of window blinds (*R.E.S.* 737).
Cleaning of tanks (*R.E.S.* 895).
Painting of manhole covers (*R.E.S.* 855).
Testing of gas mains and services (*R.E.S.* 844).

It saves trouble in the long run always to send a representative with the Army Service Corps when they make the quarterly test laid down in *Regulations for Supply, Transport, and Barrack Services.*

Testing of water mains and fittings. (Similar to test of gas mains; see *K.R.* 400 and *R.E.S.* 888).
Verification of inventories and lettering of buildings, including fuel units.
Inspection of skittle alleys (*R.E.S.* 732).
Sweeping of ventilating flues and shafts.

In the path of a Division Officer trying to effect all the repairs and provide all the conveniences asked for by other branches of the

* *Regulations for Engineer Services.*

service are many pitfalls. They are of course matters which every Division Officer should know; but unless they are all constantly borne in mind, at some time or another one is sure to fall into a trap and trouble and correspondence result. Some of the commoner ones are as follows:—

(1). Distinction between "Barrack Annual Estimate," "Fortification Annual Estimate," and "Army Ordnance Buildings Estimate." Money in one estimate is not available to help out another, and no local transfer is possible (*R.E.S.* 783).

(2). Distinction between Part II. and Part III. Funds (*R.E.S.* 407). Part III. money (*e.g.* incidental items) is available for repairs and maintenance *only*; it is *not* available for anything new (*R.E.S.* 788). Similarly Part II. money is not available for repairs or renewals; no local transfer is possible (*R.E.S.* 783).

(3). New Services. G.O.C.'s authority (at home that of the Major-General i/c Administration) is needed for *any* new service; he alone can authorize a Part II. item (*R.E.S.* 783).

(4). Proposals for new accommodation or fittings. These should be tested by the *Barrack Synopsis*, and should not be entertained unless they are in accordance with it or there are exceptional reasons for departing from it; *e.g.* there should be exceptional circumstances before you recommend the addition at Government expense of a gas hot-plate in a mess already fully equipped according to *Synopsis*.

(5). Alterations to buildings and fittings should be tested by the "Construction Return." If you are asked to put racks in a company store make sure that it is a company store and not really a barrack room misappropriated as a store.

(6). Fittings should be verified by the inventory before they are repaired or altered; *e.g.* when you are asked to repair the beer engine of a sergeants' mess make sure that the engine is a War Department one and does not belong to a brewer.

(7). Supply of Fittings. Make sure that fittings asked for are an R.E. and not an Army Service Corps supply; *e.g.* foot gratings to sergeants' mess sculleries are an R.E. supply (*Synopsis*), but those in ablution rooms are an Army Service Corps supply (*R.E.S.* 723).

(8). Duties of the troops. A Division Officer is asked to do many things which, by regulation, are the duty of the troops or of some other Department; he must be constantly on the watch to see that the Vote for Works is not saddled with the cost of such services. The following are either not Engineer services at all, or only to a limited extent and under the conditions laid down in the paragraphs of *R.E.S.* quoted:—

Artificers' tools, repair of (601).
Artillery matériel, repair and painting of (738).
Beer engines, repair and maintenance of (720–721).
Billiard-room fitments, repairs to (797).

Boats, repair of (740).
Cisterns, cleaning of (895).
Cricket grounds, maintenance of (729, but see also *K.R.* 322).
Disinfection of rooms (712).
Drainage, routine work in connection with (App. VI.).
Drawing instruments, repairs to (960).
Floor margins, staining of (696).
Fitments, supply of (722–3).
Furniture, supply of (722–3).
Gardens, upkeep of (796).
Glass in canteens, repair of (718).
Glass generally, repair of (714–9, but see also 743, 757, 765).
Greenhouses, upkeep of (714).
Jumps for mounted corps, maintenance of (734–6).
Lime for disinfecting, supply of (712–3).
Lime whiting (701 and 704–9).
Machinery, repairs to certain (688).
Parades, rolling, sweeping, weeding, etc., of (728).
Rifle ranges, upkeep of (724).
Roads, scraping, rolling, sweeping, etc. (728).
Skittle alleys, repairs to platforms and buffers of (732).
Snow, removal of (692–3).
Surveying instruments, repairs to (960).
Transport (425).
Water supply, routine work in connection with (App. VI.).

One is constantly getting requisitions to clear stable gullies, scrape roads, repair paths, etc. If once you start doing such work for the troops you will have employment for three or four permanent men, whose wages will absorb a large percentage of your incidental item without anything to show for the money spent.

(9). Limewashing. The troops are always asking the R.E. to limewash buildings for them. Without the sanction of the G.O.C. civil labour can only be employed in a few special cases (703–4, 712); all ordinary limewashing has to be done by the troops themselves (705).

(10). Distempering. Certain buildings of better class are allowed by *Synopsis* to be distempered instead of limewashed. They may be distempered by civil labour, but only once in two years (697) except in certain cases (709, 712).

(11). Papering and painting. Requests to have officers' quarters and messes papered and painted are very common; but it may only be done at fixed periods (695), unless the G.O.C. has previously approved of its being done at other than the proper time, or after a case of infectious disease (712).

(12). Repairs of glass. Practically all broken glass has to be made good at the expense of the occupants (714—719). There are certain

modifications in the case of lunatics (743), recruits (757), and prisoners (765), and in certain cases by a particular procedure a Division Officer can charge the repair to the public (716); but the troops, perhaps naturally, try to avoid the instructions plainly laid down. A common method is to send in a requisition with a certificate that the damage has been caused by persons unknown. The answer to this is exactly the same as the answer that the tenant of a private house would receive if he asked the landlord to repair glass under similar circumstances, viz., it is your business to discover the unknown persons and if you cannot recover the cost from them you must bear the loss yourself.

(13). Damages generally. A Division Officer is the man to say if a breakage or deficiency is a damage or not, and there is an appeal to the C.R.E. (742). But the R.E. are not the arbiters as to who should pay; that is a matter of discipline for the local commandant. For instance, if a door in an unoccupied building is left to blow about with the wind and gets broken, it is for the Division Officer to say whether the breakage is due to neglect or not, and there is an appeal through the C.R.E. to the G.O.C. But if the final decision is that the cost of repair is not chargeable to the public, then, in the event of any dispute as to responsibility, it is for the local commandant, not the R.E., to say who should pay. Nor are the R.E. called upon to distinguish between individuals. When damages are found in a quarter which has been continuously on charge of some unit, the unit is responsible although the individual who caused the damage may have left the station. The collection from the particular individual at fault of the sum due is a regimental matter (*K.R.* 320).

(14). Use of buildings. A Division Officer has nothing to do with the allotment of buildings. When a new saddle room is added to a stable, it is on completion handed over to the Army Service Corps. It is for them to decide between rival claimants to the use of it. Nor is it an R.E. question what use the occupants actually put it to (provided they make no alterations, see *K.R.* 330); that also is a matter for the Army Service Corps (*Regs. for S.T. and B. Services*); but it may be desirable to bring it to the notice of the C.R.E. with a view to reappropriation under para. 359, *K.R.*

(15). Requisitions must be examined for items which are not due to fair wear and tear (*R.E.S.* 749 and 795). Items such as "accoutrement shelf deficient," "clear stopped drain," "lavatory basin cracked," are *prima facie* damages until a satisfactory explanation is forthcoming. Items which are the duty of the troops (see above) must also be excepted.

(16). Articles included in the *Vocabulary of Stores* must not be obtained from the Triennial Contractor, even when there is an item in the schedule (*R.E.S.* 936). This applies to articles like rope, nails, paint, etc., but not to special building stores (930).

(17). Purchase of stores locally. Vocabulary stores must be purchased through the Army Ordnance Department (936). The purchase of other stores is governed by D.F.W. Circular 900; but this is interpreted in various ways in different Districts, and the local routine must be adhered to if delay and correspondence are to be avoided.

Specifications for stores to be purchased locally almost invariably require a clause somewhat as follows:—"To be delivered free of all charges for packing, carriage, and delivery, addressed in oil to the Division Officer at the R.E. Stores ___within_____weeks (or days) of receipt of order."

GENERAL REMARKS.

A Contractor whose profit depends on the amount of work he can get out of his men can almost always do work at a cheaper rate than it can be done by labour directly enployed by the War Department. At stations where there is a triennial contract it is desirable therefore to reduce to the lowest possible extent the number of men directly employed. In every Division there are odd jobs to be done, not covered by any requisition; but it is distinctly more economical to put as many of such jobs as possible on requisition, and, where day-work is unavoidable, to obtain men temporarily from the Contractor than to keep several permanent men for whom work has to be found at all times.

An analysis of the Barrack Incidental Item will often show the direction in which economies are possible. The following Table, giving particulars of two years expenditure in a Division, shows that nearly 40% of the work of the directly employed men is taken up in odd jobs, and suggests enquiry as to what those jobs are and whether they are worth the cost.

EXPENDITURE ON BARRACK INCIDENTAL ITEM.

	Percentages.		
	1st year.	2nd year.	Average.
Wages of men directly employed, not accounted for on any requisition	5·3	5·4	5·35
Ditto, accounted for	7·9	8·6	8·25
Stores obtained for use of men directly employed.	2·6	1·3	1·95
Work on requisition done by T.C.	78·2	81·7	79·95
Stores obtained under D.F.W. Contracts	1·8	3·0	2·40
One lot of Stores obtained under special circumstances	4·2		2·10
	100·00	100·00	100·00

Proportion of wages of directly employed men unaccounted for, 5·35 out of a total of 13·60, or 39·63 per cent.

If the War Department is to have the benefit of a large percentage off schedule rates the Triennial Contractor's bills must be regularly passed for payment without delay. The total profit a Triennial Contractor makes is dependent on the amount of money paid to him by a Division, irrespective of how often he turns over his money. But the number of times he can turn it over in the year greatly affects the liquid capital he requires and the percentage of profit he makes on that capital. Suppose he is paid £5,000 a year, and that out of this he is making the usual builder's profit of 10%; then he will pay away £4,545 in labour and materials, and make a profit of £455. If he has to wait four months for his money, he will need ⅓ of £4,545 or £1,515 ready money to carry on the work until payment begins; if he is paid every 5½ weeks, he will only require $\frac{1}{10}$ of £4,545 or £455. Disregarding capital sunk in plant, at the end of a year in the one case he will have made £455 on £1,515, *i.e.* 30%, and in the other £455 on £455, *i.e.* 100%. The difference between the sums required is £1,060. He may employ this elsewhere; and if he turns it over 3 times in the year, he will make £288 more. Quicker payment will in that case enable him to earn £288 more on the same capital. If, instead of receiving £5,000, he only receives (£5,000 − £288 =) £4,712, but more promptly, he will be in exactly the same position as before. If net rates produce £5,000, a deduction of 5¾% will produce £4,712; and next time the contract is open for competition, he can tender at a deduction of that amount. In a Division where £5,000 a year is paid to the Triennial Contractor a deduction of 5% off schedule rates means a saving to the War Department of £250 a year, or £250 a year more to be spent in the Division.

In siting new buildings, the future often deserves more consideration than it gets. When there is vacant space available—and at the time the exact position of some new building does not much matter—the future state of affairs, when all the vacant area is built over, is apt to be overlooked. Before any permanent building however small is put up, the roads in the vicinity that will be required 20 years hence should be decided on. This will give a "building line" to which all new buildings should conform. Such a line makes all the difference between a row of buildings forming a street and the same buildings scattered about irregularly, close together where the traffic needs wide roads and widely separated where convenience requires them to be side by side. Having planned out the development of a vacant space, reserve the best sites for important buildings; do not waste corner plots on some small outhouse which can go equally well in some less prominent position. Many instances can be pointed out where want of foresight in such matters in the past is the cause of inconvenience at the present time.

War Department buildings are exempt from most of the provisions of the Public Health Acts and from the building bye-laws made under those Acts. They should, however, be at least up to the standard

required in civil buildings. A Division Officer is often required to give an opinion as to the habitability of some building, especially in old barracks, such as huts, basement rooms, or old and out-of-the-way married quarters. Of course in time of emergency bye-laws cannot be regarded, but they give a standard for buildings meant for permanent occupation in peace time. A room in the basement of a mess, which does not come up to the standard required by the Public Health Act of 1875 in a "cellar dwelling," can hardly be considered fit for a messman's quarter or for a mess waiter's bedroom. On the other hand do not condemn a building offhand merely because it is dingy; that may be your own fault because you have not kept it in repair and painted it when due, or it may be the fault of the troops in not keeping it clean.

From time to time epidemics of some disease, such as typhoid or diphtheria, occur in barracks. Although such matters are primarily questions for the Medical Officers yet there is a good deal a Division Officer can do to help them. A "spot map" is a plan on which is marked by a dot the position occupied by the bed of each case at the time of seizure, or at least at the time of admission to hospital. A spot map has its limitations; but it may, and often does, point plainly to something in the buildings occupied, if not the actual cause of the epidemic at least a predisposing one, which might otherwise have escaped notice.

One of the chief difficulties in Division work is to find out what the occupants of War Department buildings really want. They seldom suggest any comprehensive scheme of improvements; in minor matters the improvements asked for are sporadic and often conflicting. For example, you are asked to put a boiler in a cookhouse, when what is really required is hot water laid on to the baths in a neighbouring bath house; and even this may be only a part of what is really required; it may be that there is no hot water in any of the bath houses, and, instead of a £5 estimate for a boiler in a cookhouse, in the end you get out a £150 scheme for hot water in half-a-dozen different places.

Schemes for the benefit of more than one unit must generally originate in the R.E. office. There are innumerable alterations and improvements, some small in themselves and of little cost, others large and expensive, by which the labour of the troops can be lessened and their comfort increased. Useful suggestions can be obtained from the Quartermasters, the Medical Officers, the Chaplain, and others. But it is the Division Officer who has to work out their ideas and put them in a practicable form. The work is by no means a dull round of petty repairs and routine maintenance. An Officer who has never done any Division work is hardly in a position to express any opinion about it. One who has been a Division Officer and has not found any points of interest in it must either have shut his eyes or else must be a man of very narrow interests.

TRANSCRIPT.

SOME FORTIFICATION DEDUCTIONS FROM THE STRUGGLE FOR PORT ARTHUR.*

By A. B. von Swartz, *dated Port Arthur, October—November*, 1904.

The struggle for the possession of the Kwangtung peninsular, which began with the series of battles of May, June, and July, 1904, and culminated in the 5 months' siege of Port Arthur, frequently verified the force of the old maxim "more earth dug—less blood shed," and bore testimony to the fact that in modern warfare engineering tools are of no less importance than magazine rifles and quick-firing guns. As the development of artillery progresses and as the rifle becomes more deadly at long ranges, so much the more important becomes the *rôle* of fortification in opposing them. The greater the number of bullets in shrapnel and of splinters in howitzer shells, and the steeper the fall of their trajectories, the deeper must be the entrenchments and the more perfect the cover afforded by them.

In artillery the present campaign has produced an entire change. Formerly guns were placed on hills and fired at visible targets; now they are hidden behind hills and the targets are not visible from the firing points. In fortification the substance remains as of old—ditch and bank—only in dimensions and some fortification developments have changes occurred. In relation to these changes the struggle for Port Arthur has produced many interesting features, and in the following notes, which were jotted down as time permitted during the fighting, will be found everything which attracted my notice as being of especial interest to our work.

Organisation of Port Arthur Fortress Generally and of the Forts Particularly.

The fortress of Port Arthur consists of a girdle of forts (six in number, of which one was not completed) and of a central enclosure covering the old town.

The distance of the forts from the centre of the town (where lies the port) is from 2 to 2½ miles; and the distance of the line of the central enclosure (which encircles the town) from its centre is from 1 to 1½ miles.

* Translated by permission from articles in the September and October, 1905, numbers of the *Eenzhenernee Zhoornal*. The original was accompanied by an excellent map of the northern defences of Port Arthur, on a scale of 700 ft. = 1 inch.

The enemy posted his guns at a distance of from $1\frac{2}{3}$ to $3\frac{1}{3}$ miles beyond our forts, and from the very beginning of the siege succeeded in bombarding the town with 6-inch guns, and in September with 11-inch guns, while as he drew nearer he shelled it with field and 57-millimètre guns. In October, having advanced as far as the forts, he was even able to fire into the town with rifles. The most distant battery from which he threw shell, which daily took effect upon the town, was nearly 6 miles away, and the distance of this battery from our nearest fort (Erlungshan) was $3\frac{1}{4}$ miles. The nearest of the batteries of the enemy's first artillery position was $1\frac{2}{3}$ miles from the line of forts. Consequently, to have preserved from bombardment not only the centre but also that portion of the central bulk of the town which is nearest to the central enclosure, it would have been indispensable to have moved forward the forts to a distance of not less than 6 miles from the centre.

The shortest interval between the forts laterally was $1\frac{2}{3}$ miles (between forts Erlungshan* and North Keekwan) and the greatest $2\frac{1}{3}$ miles. However, owing to the broken nature of the country even the gap of $1\frac{2}{3}$ miles seemed too wide.

Conditions Governing Distance Apart of Forts.

Consequently, in deciding how near to one another forts should be placed, the following indispensable conditions must be taken into consideration :–

1. If the country is level, the forts must be near enough to bring a powerful cross fire of rifles as well as of guns over the whole of the intervening ground. In this case the size of the gaps depends partly on the existence of sites suitable for the forts, but it must not be greater than double the range of effective rifle fire (*i.e.*, 3,000 yards). The ground must be thoroughly cleared so that there may not exist between the forts a single inch of ground which is not swept by their fire.

If a gap has additional importance owing to the existence of any important objects in rear of it, it would be extremely useful to connect the gorges of the forts by a rampart and ditch. It was only due to the existence of a rampart of this kind (the Chinese wall) between forts Erlungshan and North Keekwan that we were able to drive back the enemy's assaults on this interval during the month of August.

2. When the country is deeply indented and consists of a series of hills and deep ravines, the forts should be brought nearer together. In this case they must be sited so as to see one another ; and if it is not possible for them to command with their fire all the intervening ground, there should be placed between them one, two, or even more, permanent works, of the same or some different type, with this one important object—not to leave one single piece of dead ground between them.

Unfortunately this was not the case at Port Arthur, especially in the gap between the two forts above-mentioned, and the Japanese were not slow to appreciate the defect and to take full advantage of it. These forts

* Erlungshan was the north salient and North Keekwan east by south of it.—F.E.G.S.

were placed on heights standing somewhat forward from the main line of the Dragon Range. Between them were four hills, all exceeding in elevation the site of fort Erlungshan and two of them almost equal to that of North Keekwan; the hills were separated from one another and from the forts by five deep ravines. The forts could not see one another and the ravines were not commanded by their fire. When the defences of Port Arthur were taken in hand in the spring of 1904, works were designed for these hills, redoubts for the two centre ones and light field works (called open caponiers) for the two outer ones. But these works were only partially made; and, as they were only of a temporary nature and had no exterior ditches, they did not offer very serious obstacles and were enveloped during the first assault.

This and other experiences have shown that it is useless to put works of a temporary nature in the intervals between forts, for the power of modern siege artillery fire is so terrific that nothing but concrete of considerable thickness can serve as safe cover.

The defences in the gaps between forts must be taken in hand in good time and they must possess all the important features of permanent fortifications, differing only from the latter in point of size. (The 'subsidiary works' at Port Arthur are examples of this).

It is important also to arrange for mutual aid between works by means of rear caponiers. Thus the caponier in rear of fort Erlungshan gave great assistance to 'subsidiary work' No. 3,* and the "open caponier" No. 3, in the gap between forts Erlungshan and North Keekwan, gave much help to the former fort.

DESIDERATA IN DESIGN OF FORTS.

The following are some of the most indispensable requirements of all forts and subsidiary works:—

1. A fort must have a good field of fire for rifles up to 2,000 paces from all its faces. (We did not have this).

2. Neither in front nor on the flanks of forts must there be any dead ground. Sometimes, owing to the nature of the ground, this can only be attained by a suitable arrangement of the neighbouring subsidiary works.

3. Heavy artillery placed in forts and similar works draws upon them such a heavy fire from the enemy's guns that it leads to premature damage to the forts and to a consequent saving of ammunition on the part of the enemy. Therefore heavy artillery must not be put inside forts (as was done in the case of some of the forts at Port Arthur).

4. Each fort must be equipped with a large number of light guns for opposing storming parties. These guns should be quick-firing. (We had only old field guns, and in fort Erlungshan even less useful weapons and only three of them).

5. At every angle and in the middle of the sides there must be platforms, each for two of these guns, and in the intervals between them places for machine guns. (In fort Erlungshan there were only two machine guns;

* Sungshushan, about ½ mile west by south of Erlungshan.—F.E.G.S.

these proved insufficient, and there were added afterwards two automatic quick-firers).

6. Concrete shelters must be provided close by for these guns.

7. The guns should be mounted either in armoured turrets of the rising and disappearing type, or should be completely under cover, firing through embrasures in the shelters.

8. As regards infantry fire this siege has shown the immense importance of providing some new arrangement for rifle fire. I can say with full assurance that *the designs of the days of infantry parapets without head cover for the riflemen must now be put away among the curiosities of ancient history.*

Furthermore, the experiences of this war bear witness that it is useless to build up light parapets, blinded and traversed with sandbags as in field defences, for these are rapidly and easily destroyed by the shells of heavy guns. This is a question which calls for the serious consideration of Engineers. I myself think that it could be successfully solved by constructing along the parapets concrete galleries with loopholes for the riflemen.*

9. It is extremely important during fighting or bombardment to have uninterrupted communication between the parapets and the casemated barracks in the gorge. This can only be arranged by means of underground galleries, because the force of modern artillery fire is so great that it makes all partially covered communications useless. (In fort Erlungshan men were killed daily while crossing from the banquettes on the faces to the barracks in the gorge). Covered banquettes constructed as suggested in the previous para. might usefully be made to serve also for communications.

10. In addition to an open sally-port there should also be a tunnelled entrance, leading from some place not exposed to the fire of the fort, so that fire can be brought at all times to bear on all the rear approaches. (In fort Erlungshan there was only one open sally-port).

11. At all times during a siege a fort must be in uninterrupted communication with the fortress staff. The arrangements made by us, which consisted of aërial telephones and cables laid on the ground, did not answer their purpose well, as they were often cut by shells during the crises of the fighting. For this reason special arrangements should be made in good time for burying the cables in pipes of small diameter specially laid for that purpose.

12. In order to maintain the necessary observation of the enemy from the forts during both fighting and bombardments, it is evident that sentries cannot be posted without suitable protection, and there should be provided for their use in each fort two armoured rotating turrets or concrete emplacements. Telephones and electric signals should communicate from these conning towers with the casemated barracks by lines not liable to interruption.

13. Search lights should not be fixed within forts; they should be outside and to the flanks. But the concrete casemates for the boilers and dynamos must be inside the forts.

* When I visited in June, 1905, the works of Colonel A. P. SHOSHENA, I saw that he had arrived at the same conclusion as myself and had built a portion of a similar gallery.

14. The casemated barracks for the garrison should as heretofore be in the gorge. But there must also be casemates for the guards told off daily for manning the parapets, and these should be in direct communication with the galleries leading from the parapets to the casemated barracks.

15. The barracks for the garrison must have sufficient space, light, and air. We have never turned our attention sufficiently to ventilation and prevention of damp in casemated barracks, and consequently in the forts many of our men get ill.*

The following are indispensable:—separate quarters for officers, a cookhouse, two storerooms, a small arm ammunition magazine, and a latrine. There should be two completely covered entrances on the flanks; also another about the centre, giving into the inner court in the ditch, open to the air but beneath the level of the bottom of the ditch. Sufficient and good lighting must also be provided.

16. In every fort there should be a well or some other reliable water supply. (With us in the forts the water is stored in casks, but this supply is soon wasted and it is not always possible to replenish it).

17. As a precaution against fire (such as occurred on the 21st August in fort Erlungshan) no wooden structure should be allowed within a fort.

18. There can remain no doubt as to the value of concrete for buildings in time of war; but a thickness even of 4 feet for concrete walls without a covering of earth proved insufficient.

19. The great value of a covering of earth over concrete structures was proved in fort Erlungshan. A covering of 4 to 5 feet of earth effectually preserved a casemate with a concrete vaulted roof from damage. On one occasion 11-inch shells fell on it, in one place, one after another, and after them 6-inch shells, but the arch was not broken.

20. The deep ditches with vertical sides of fort Erlungshan proved an insurmountable obstacle to the enemy.

21. The ease with which the Japanese obtained possession of the caponiers beyond the counterscarps in forts Erlungshan and North Keekwan shows clearly the danger of such structures. The question of the best means of flanking ditches deserves careful consideration. Experience shows that the arrangements for the defence of ditches must be guided by the following considerations:—

(*a*). They must be well under cover.

(*b*). Both flanking and frontal defences must be provided, so that if one is lost the other may still remain available.

(*c*). Flanking defence is preferable; it is impossible to trust to frontal only.

(*d*). Machine guns and automatic quick-firers must be available for the defence of the ditch.

* In fort Erlungshan the casemated barrack provided for one company is like a tunnel, 9 feet wide. There are at present living in it two companies with their officers, besides gunners and sappers. Here also the cooking is done, and here are stores of water, food, and warlike materials. The ditch of the gorge serves as a latrine.

22. At the time of constructing the fort a system of counter-mines should be arranged; and these should be extended 100 to 140 feet from the counterscarp.

23. In all concrete buildings care should be taken to leave no sharp angles; all angles should be rounded off, or they will be knocked away by shells even of small calibre.

24. The question of masking the fort should not be overlooked at the time of its construction.

25. Works covering the entrances are useful, but they should be defiladed from the dropping fire of large shells. (Fort North Keekwan suffered from the neglect of this precaution).

26. Doors and window shutters should be of one-inch steel, to be proof against the splinters of small and medium-sized shells.

27. The garrison of a fort should not be less than 400 men, to enable it to be independent of outside assistance and to supply the necessary working parties for repairing the defences.

Batteries in the Intervals between Forts.

The greater number of the batteries between the forts were placed at Port Arthur on the tops of hills for firing at visible targets; most of the long-range guns were in these batteries, while the rest were mounted within the forts and subsidiary works. All our guns were well sited for long-range fire and badly sited for short. Some batteries posted on hills were plainly visible from a distance, as for example the Great Eagle's Nest Battery* (two 6-inch Canet), the subsidiary work at Sungshushan (same armament), and the Zaleeternaya battery† (two 15-c.m.). The guns in all these works were disabled in the course of the first two months.

Among the well-sited batteries may be mentioned the howitzer battery on the Obelisk Hill, the Great Howitzer Battery,‡ Zaredutnaya Battery§ (four 6-inch of 4,330 lbs.), the Tumulus Battery,‖ and the batteries of the second line of defence.

The following are some features necessary in batteries:—

1. Guns of large calibre, intended to engage the siege artillery of the enemy, must not be placed in forts but in the intervals between and slightly (200 to 350 yards) in rear of them. (In fort Erlungshan there was a battery of four 6-inch guns of 4,330 lbs. and in forts Nos. 1 and 4 the same number of 6-inch guns of 6,859 lbs.).

2. Small separate batteries are more difficult to hit than large ones, and therefore it is best to build a large number of batteries, each for a small number of guns. Thus it is better to have two guns than four in a battery.¶

3. A battery should not be placed on the crest of a hill unless it is only for flanking purposes.

* On the Dragon Range west of North Keekwan Fort.—F.E.G.S.
† South of North Keekwan.—F.E.G.S.
‡ On the Dragon Range midway between Erlungshan and North Keekwan.
§ Just east of the Great Howitzer.—F.E.G.S.
‖ South of Sungshushan work.—F.E.G.S.
¶ This refers only to temporary batteries; the permanent ones should be constructed for four guns each, and they should have near them small concrete casemated barracks for the garrison.

4. In the interval between two adjacent forts there must be four permanent concrete batteries, armed in good time, secure against assault, and provided with accommodation for the necessary infantry garrisons.

It would be useful to have in each battery some machine guns which can be brought into action at the moment of an assault. Battery B° was assaulted six times and each assault resulted in hand-to-hand fighting.

5. In the intervals between the permanent batteries there should be prepared two or three batteries of a temporary type, some to be armed with heavy guns at the time of mobilisation and others to be held in reserve. Any other batteries which may be necessary can be constructed during mobilisation.

6. This siege fully bears out the vast importance of howitzers in defence. I personally think that the proportion of howitzers in a fortress should not be less than 50 per cent. In destructiveness and in moral effect they far exceed other siege guns. The Japanese prisoners spoke of them with as much horror as we ourselves experienced when the Japanese howitzers began to fire.

7. Howitzers should be placed in pairs. (The Japanese even posted theirs singly).

8. Batteries for howitzers must be sited behind hills to fire at invisible targets. To disable a howitzer is very difficult and this fact largely increases the value of this weapon.

9. The Japanese did not fire salvos with howitzers, but our side sometimes did so with two or even four at moving targets.

10. In concrete batteries the guns should be mounted on disappearing carriages if the battery is not behind cover.

11. Traverses between guns should have a covering of earth, or otherwise should consist of very thick arches.

12. The corners of traverses must be rounded off. In fort Erlungshan the destruction of the traverses began by their corners being knocked away and once begun was steadily increased.

13. During the whole siege the number of fortress guns with us was hardly less than with the Japanese, and yet no sooner had the artillery dual commenced than the preponderance of the Japanese fire became evident. This is explained by the following peculiarities:—

(*a*). All the Japanese guns were quick-firing and ours were the reverse.

(*b*). The Japanese had the power of removing their guns and concentrating them wherever they were required. But with us, when once our guns were in position, we could not move them; no new batteries were armed; and only to replace disabled guns were any moved from the western face to the eastern.

It appears therefore that the armament of a modern fortress must consist of:—

(i.). Long range and quick-firing guns of medium calibres (120 m.m. or 6-inch Canet).

* South-east of North Keekwan and just east of Zaleeternaya Battery.—F.E.G.S.

(ii.). A certain number of long-range guns of large calibre, such as 10-inch, posted behind cover.

(iii.). 50 per cent. howitzers (from 6-inch to 11-inch).

(iv.). Besides these it is necessary to have a certain percentage of guns of medium calibres in store and with the reserve.

(v.). It is also important to have in a fortress two or three divisions of quick-firing field guns and also some 37 m.m. and 47 m.m guns for use at the shortest ranges against storming parties. Our field artillery was of great assistance in repulsing assaults.

(14). It is extremely important to take measures for masking batteries. To effect this, care should be taken to keep them as near as possible to the colour and general level of the surrounding country. Earth parapets should be avoided, the parapet being the natural surface of the ground and the battery itself excavated.

(15). In addition to the real batteries it was found very useful to make some false ones in which dummy guns were stood and flashes occasionally fired in them. The enemy expended much ammunition on such batteries before he recognised their object. But it does not follow that it is sound to place dummies in real batteries.

16. As soon as the direction of the attack has been clearly shown, the following should be done in the intervals between the forts of the threatened front:—

(i.). Construct some batteries for quick-firing guns to oppose assaults.

(ii.). Arm the reserve batteries (see para. 5 above).

(iii.). Reinforce the artillery in the threatened front with guns from the reserve.

(iv.). Construct some batteries for special action against the enemy's siege works.

In Port Arthur the batteries for opposing assaults were constructed so that the guns could usually be kept under shelters and brought up into the firing positions at the moment of the assault by means of ramps. Near the batteries were also casemates for the men serving the guns. Between each two firing platforms was a traverse with two recesses in it for ammunition. On the outer sides of the firing platforms were small trenches for the gunners, with light cover from shrapnel.

When the fortress is armed there should be provided a large number of 18-pr. and 36-pr. howitzers for use against the enemy's siege works. Our field grenades were not suitable for this purpose, and the 6-inch howitzers and guns could not throw shell so short a distance. Not having these light howitzers we could not actively oppose the enemy's saps.

COMMUNICATIONS WITHIN THE FORTRESS.

As the enemy drew nearer to the forts our communications with the centre of the fortress and between ourselves became more difficult. It was soon evident that the field roads constructed within the fortress, however well aligned for peace time, were quite unsuitable for use during

a siege. They were consequently abandoned, and communication was established by the ravines between the hills; and in those places where it became necessary to cross a rise, a road of communication was excavated through it.

A great part of the roads were so constructed that they were visible to the enemy from a distance, and therefore it is not surprising that the Japanese on occasions fired shrapnel even at individuals travelling along them. Thus in daylight not only was it impossible to use the roads for driving on or for transporting ammunition or war materials within the position, but even communicating with us was very difficult. By night the enemy kept up fire on the roads with rifles.

This matter is extremely important. When constructing a fortress in peace time the roads should be so aligned that they shall not be visible to the enemy or raked by his fire.

In places where there are hills and ravines the road should be carried behind the hills, no attention being paid to the necessary increase in length. In exposed places the road must be carried through in tunnels, for in no case should it pass over an exposed piece of country. In the case of the roads between forts the same rules apply, with this exception that on the side towards the enemy there must be an earthern parapet sufficiently high to cover the whole road from shrapnel.

As regards fortress railways with steam traction, in Port Arthur there were none and we did not experience any special need of them. But the use of such during a siege would be attended by much difficulty. The enemy would always know the direction of the line. He would certainly learn this in peace time from spies, and during the siege he would place batteries to command parts of the line and would destroy passing trains. By night he would command it as thoroughly as by day, being warned by the noise of the approach of trains. I am convinced that a permanent railway would not prove as useful as it might be expected to be.

It would be quite another matter to arrange under cover of a parapet a tram line connecting the forts, for transporting guns to the various works. The idea was long ago proposed by French engineers, and the present siege has fully proved its usefulness. If we had had such a line at Port Arthur it would have been immensely useful in helping the rapid concentration in a given place of a sufficient number of guns for opposing assaults.

But it is also clearly evident that the artillery in a fortress should not be fixed but should be capable of being moved. That is why it is so important in peace time to construct such a large number of batteries in the intervals between the forts. Those which are standing unarmed are ready to be armed, as soon as the direction of the attack has finally declared itself, with guns either from the reserve or withdrawn from the unthreatened fronts. Besides this some of the batteries can be held in reserve, either for use against other objectives or especially, when the enemy is bombarding one particular battery, its guns can be rapidly removed into one of the reserve batteries, which the enemy will have to discover and bombard in its turn, thereby expending much time and ammunition. The Japanese often did this. Silence on the part of any

of their batteries brought perplexity into the minds of our gunners; and then suddenly new batteries would open fire and the old ones appear unarmed. The Japanese arranged their batteries for over-bank fire, but a few had embrasures. Every possible contrivance was resorted to for masking these: for example, they gave the battery the same elevation as the trench; they made false embrasures and veiled the real ones with cloths; they also stuck plants of kowliang into the parapet, but this was not very successful as the colour of dry kowliang differed from that of the growing plants.

As I frequently witnessed the artillery duels I always noticed that the enemy concentrated the fire of two or three of his batteries on one of ours. He destroyed the works with various kinds of shells and the gunners who were endeavouring to reply with shrapnel. The rapid fire of the Japanese guns and their superiority in numbers soon crushed our batteries. They ceased fire and the men, driven into the blindages, awaited an opportunity of replying. On such occasions our fire was feeble and that of the enemy uninterrupted.

When the fortification or battery at which they were firing was sufficiently destroyed, the enemy brought up his troops for assault under cover of shrapnel. *I therefore maintain that the number of batteries in the intervals between forts should be increased and the number of guns in each diminished. It would then be more difficult for the enemy to concentrate the fire of two or three batteries on each one of ours. He would be obliged to disperse his fire among all our batteries; his fire would thus be weaker and consequently the combat would be less unequal.*

SEARCH LIGHTS.

In the defence of Port Arthur two novelties were tried for the first time:—

(1). The lighting up of the ground in front of localities by search lights, and

(2). An electric fence as an obstacle against assault.

Neither of these novelties had particular success. The electric fence was surmounted by the Japanese by throwing on it special metallic hooks, the ends of which led away the electric fluid into the ground; and by cutting down the posts with pyroxyline.

As to the search lights during the first weeks of the siege, the lighting up of the ground by them did not produce any advantage; it revealed neither the transporting of the enemy's guns, nor his new works, nor the movements of his troops. It is possible that in places perfectly level search lights might be useful; but in intersected ground, with masses of various ravines and gullies, they were no good. Later on, when the enemy had captured East and West Panlung redoubts,* we tried to prevent him from putting them in a state of defence by lighting them up at night. This was found to be much more effective than even artillery fire.

* On the two centre of the four hills between Erlungshan and North Keekwan.—F.E.G.S.

The following points generally hold good :—

(1). Search lights are useful for lighting up the very near approaches to forts and other works, up to a distance of 600 to 800 paces.

(2). They must be so placed that they can light up the ground in the intervals between the forts as well as the approaches to the forts themselves.

(3). The number required must be determined as follows :—Three to each fort (one in front for the threatened face and two for the flanks) and two or three for the intervals between forts (not necessarily in the forts but near them).

(4). Lights which are fixtures must be placed in armoured or concrete emplacements ; but it is far better that the lights should be movable.

The arrangements for the search lights in fort Erlungshan were as follows :—Each light was kept in a trench at the foot of the glacis ; it was fixed to a truck and by day was placed under a special blindage ; when required for use it was run up a light rail about 35 feet to the front, into an emplacement where it was protected by a parapet up to the level of the mirror. With this arrangement the enemy's fire of shell and shrapnel, even in salvos, proved ineffectual ; but most of the lights were destroyed by rifle bullets when the enemy came to closer quarters. At the period of close attack search lights would prove a most important factor in the final struggle.

ASSAULTS AND MEASURES FOR OPPOSING THEM.

The enemy generally prepared for his assaults by bombardments. According to the requirements of the object in hand the bombardment was sometimes prolonged, sometimes of short duration.

The general assault on Port Arthur on the 21st August was preceded by an almost uninterrupted bombardment ; it commenced on the 18th August at 4 o'clock and continued till 7 o'clock at night ; on the 19th the bombardment continued the whole day ; on the night between the 19th and 20th there was occasional firing ; on the 20th it again continued from morning till evening ; that night there was very occasional firing, and on the 21st again there was a continual bombardment from morning until the beginning of the night assault. Thus the bombardment leading up to this assault lasted for more than two periods of 24 hours and the assault resulted in the capture of the two Panlung redoubts.

In the bombardment which preceded the assault on the Aqueduct redoubt, firing was continued for a complete period of 24 hours on the 19th, and on the 20th the assault commenced which was repulsed. In September, before the assault and capture of the Aqueduct redoubt, the bombardment lasted only 12 hours. There were many other instances of the duration of bombardments.

In all the frequent assaults on the various smaller works and trenches the bombardments were less severe, lasting generally for about two hours. In these the enemy directed his fire not only on the point on which the assault was to be directed but also on the neighbouring works, on all the batteries, over the roads leading to the attacked front, over the

places where it was supposed that our reserves were hidden, and even on all ravines lying in rear of the threatened neighbourhood. Guns of all calibres, whichever the enemy could bring to bear in the required direction, took part in the bombardment; and while some guns were firing common and high-explosive shells others were firing shrapnel.

In spite of the generally-accepted opinion that an attacking enemy must stop firing when his columns arrive within 200 paces of their objective, the Japanese did not cease firing at that time but kept it up until there remained between the columns and the fortification not more than 30 to 50 paces, and then concentrated their fire on the interior of the work. At Fort Erlungshan the Japanese continued their fire even later than this, until they had even crowned the glacis and constructed on it a number of their own trenches; but it was actually observed that occasionally, though only rarely, they hit their own men. The combined action of the artillery with the storming columns was most important, because, by the time the enemy ceased firing at the parapets, only an inconsiderable distance remained between them and ourselves, and because, *by the time we had succeeded in hauling the guns for opposing assaults from their shelters up to their emplacements by means of the ramps, the enemy were already protected by defensible epaulements.*

It is evident that the method of providing for the guns specially intended for opposing assaults has been imperfectly considered. To leave them unprotected would be impossible, as in that case they would be very soon disabled; and to bring them up during the continuance of the artillery fire is also impossible as it would prove fatal to the gun detachments.*

I think that guns for opposing assaults must either be immovably fixed in permanent concrete casemates or armoured turrets, or else mounted on disappearing turrets with very thin armour.

The effect of modern quick-firing artillery is so great that, if it can be made possible to keep in a fort or other work guns suitable for opposing assaults and to have them ready for action when the attack arrives within 500 to 600 paces from it, then it is certain that the enemy, no matter how persistent he is, will not be able to face their fire and must fall back. But to preserve the guns from destruction and to give them the power to act when required can only be done by one of the arrangements mentioned above or by modifying the construction of the existing shelters.

Thus in the attack which has been described the enemy, under cover of his artillery, brought up his columns so close to the attacked works that the infantry of the garrison had barely time to give him two or three volleys before his troops rushed in with the bayonet, and the result depended on the quantity and quality of the troops.

During the siege of Port Arthur both sides used hand grenades in large quantities. These grenades created a great impression on both sides, but everything points to the fact that this measure was only a makeshift and that the proper means of opposing an assault is the provision of guns and machine guns kept for that special purpose.

F. E. G. SKEY.

* This difficulty of bringing up the guns was met in the end by our refusing to put them in the shelters, and they were left in the open at the risk of being prematurely disabled.

REVIEW.

REPORT OF THE INDIAN SURVEY COMMITTEE, 1904–05.

(Folio. Simla.)

This Committee was appointed by the Government of India to report on certain points, the most important being:—

(1). The state of the maps in each Province, and the measures required to bring them up to date.
(2). Methods and expense of survey.
(3). Methods of reproduction.
(4). The organization of the Survey Department.

The Committee consisted of:—

President.—Mr. J. O. Miller, C.S.I., I.C.S., Secretary to the Government of India (Revenue and Agriculture).

Members.—Colonel Sir John Farquharson, K.C.B., R.E. (retired), late Director General, Ordnance Survey.
Lieut.-Colonel F. B. Longe, R.E., Surveyor General of India.
Colonel F. H. Kelly, R.E., A.A.G., General Staff, India.

The time at the disposal of the Committee was short; but they managed to collect evidence and to produce a report which is full of interest, not only to officers employed in the Department concerned, but to the Corps at large, seeing that one of the recommendations made was for the employment of 70 imperial officers instead of 40 as herefore.

The following appears as a Summary of the Recommendations made. I have added some comments in italics.

"(1). The preparation of a modern 1-inch map of India should at once be undertaken. [*For considerable areas* ½*-inch or* ¼*-inch would suffice, and save expense.*]

(2). This work should be regarded as the most important now before the Department.

(3). The direction of operations should be strictly Imperial, and local authorities should not be allowed to intervene.

(4). The Surveyor-General himself should directly control the operations with the staff proposed in the report.

(5). The operations should be conducted on the lines laid down in Sir John Farquharson's scheme printed as Appendix B to the report.

(6). The whole of India should be divided into tracts, each of which should be allotted to a Survey party, for which a definite programme should be laid down, that should not be departed from without grave

reason, and then only under the orders of the Government of India. The number of topographical parties should be fifteen. [*These should be grouped under circles for decentralisation, as recommended by Surveyor General.*]

(7). The departmental programme should extend to the whole of India and 25 years should be allowed for its completion.

(8). Special arrangements should be made for the completion of the work required near the North West Frontier within a period of 4 to 6 years.

(9). In the course of the 25 years' programme all topographical maps should be brought up to date. There should be no further correction (except for the addition of new railways and canals) until the next systematic revision of the maps of India is undertaken.

(10). Cadastral and other large scale surveys should be left entirely under the control of Provincial Governments and Local Authorities, and should be conducted at their expense, but should be based on a scientific skeleton or traverse. [*This arrangement very expensive, and unsatisfactory for uniform quality.*]

(11). Special forest surveys should cease as a general rule, and, where required on scales larger than the regular topographical ones, their cost should be debited to the Forest Department. [*Forest surveys directly remunerative, and necessary.*]

(12). For mapping purposes the most important classes of work in the Trigonometrical Branch are triangulation and levelling, and to these the more purely scientific work of this Branch should give way, if there is any difficulty about sufficiently increasing the staff. [*Scientific work always pays well eventually.*]

(13). The question of handing over tidal work to the Local Authorities concerned should be considered.

(14). The Government of India should prescribe the general and special maps which it is to be the duty of the Survey of India to produce.

(15). The form of the topographical maps should be permanent.

(16). The standard sheets of the 1-inch map should be reduced to half their present size.

(17). The scale of survey should, as a general rule, be at least double the scale of publication, and the latter should ordinarily be not less than 1 inch = 1 mile.

(18). The symbols used on the maps should be uniform throughout, and the modern spelling of names should be adopted.

(19). The number of trigonometrical and clinometrical heights and levels shown on the maps should be largely increased; but first all the main lines of levels should be equated.

(20). The vertical interval between contours is a matter requiring attention.

(21). The 1-inch map should be printed in four colours, black for the detail, brown for the hills, blue for water, and burnt sienna (or lake) for the roads.

(22). The topographical maps issued by the Survey of India should contain only information verified by its staff.

(23). Village boundaries should not be shown on the ordinary topographical map.

(24). An edition of the 1-inch map may be prepared showing village boundaries under certain conditions.

(25). For the production of the 1-inch map an improved process of helio-zincography should be employed, a few selected standard sheets being engraved on copper.

(26). The Atlas of India sheets should now be superseded by "Degree" sheets on the $\frac{1}{2}$" scale, which should be engraved on copper. [*Engraving too expensive and slow?*]

(27). In the place of the $\frac{1}{1\frac{1}{6}}$-inch Provincial maps a general map of India on the scale of 1:1,000,000 should be prepared and engraved.

(28). To leave the Surveyor General free for the supervision and control of the operations, the Deputy Surveyor General should deal in the first instance with the business of all kinds of the Survey Office, and should dispose of all matters of routine. He should be allowed an Assistant, and the post of Assistant Surveyor General in charge of the office will then be unnecessary.

(29). To assist him in inspecting the field parties the Surveyor General should be allowed an inspecting officer.

(30). Surveys towards or beyond the frontier should be treated specially, and be placed directly under a Superintendent of Frontier Surveys occupying a position similar to that of the Superintendent of Trigonometrical Surveys.

(31). Owing to the abolition of special forest surveys, the post of Superintendent of Forest Surveys should lapse.

(32). The Trigonometrical Branch should be strengthened by two officers to assist in triangulation and levelling.

(33). The strength of the field parties should be increased by 50 per cent.

(34). There should be two officers, one in charge, the other his assistant, with each ordinary topographical party.

(35). With the frontier parties there should be three officers, one in charge, and two assistants to allow for special calls.

(36). To meet these proposals the staff of the Imperial Service for topographical and trigonometrical work should be increased from 40 to 70 officers.

(37). First appointments of officers of the Army to the Imperial Service should be for a term of five years only and a language test should be imposed.

(38). The Provincial Service should be divided into two Services, a Provincial or Indian Service, and a Junior Service; the pay of the former to range from Rs.250 to Rs.800, and that of the latter from Rs.80 to Rs.400; and some modifications in the system of recruiting should be introduced.

(39). Natives of India should continue to be employed in the Provincial and Junior Services in the proportions stated.

(40). Officers in charge of parties should have a free hand to enlist surveyors, and parties should recess in the neighbourhood of their charges.

(41). Imperial and Provincial officers employed on cadastral or similar work should be treated as temporarily outside the regular cadre, and the

Surveyor General should be authorised to employ other officers in place of those so deputed.

(42). The supervision in the Photographic and Lithographic Office should be strengthened by the appointment of an additional officer as assistant to the officer in charge. The superintendence of the Mathematical Instrument Office should be placed under these two officers.

(43). The first duty of the reproducing offices should be the production of the maps of the Survey of India.

(44). No drawing of extra-departmental work should be permitted to be thrown on the Survey of India office. [*Is this feasible, or desirable if proper regulations and financial rules are made to control such work?*]

(45). Local Governments should reproduce their own cadastral maps.

(46). As the reproduction of the revised topographical maps throws more work on the headquarters office, arrangements should be made to gradually transfer extra-departmental work to other Government mapping offices.

(47). Certain improvements should be introduced in the methods, working, establishment, and plant of the reproduction offices.

(48). Seeing that the general revision of the topographical map of India is being commenced, the publication of maps compiled from obsolete material should cease. [*Temporary maps better than nothing.*]

(49). To facilitate the supply of maps to the public and to officials, up-to-date catalogues and index maps should be freely issued.

(50). The form of the Survey budget should be simplified, and better financial control instituted within the Department.

(51). An attempt should be made to devise more definite standards of work in order to check out-turn and cost.

(52). The annual programme should be discussed with the Surveyor General by a Board or Committee representing the different departments of the Government of India.

(53). The proposed removal of the headquarters from Calcutta should be postponed for the present.

(54). Greater attention should be paid to the preservation of all permanently marked survey points." [*Is this possible under the centralised organisation proposed?*]

The meaning of these proposals cannot well be understood without a study of the Report as a whole, more especially as the member of the Committee best acquainted with Indian conditions, the Surveyor General, dissented from them in vital particulars.

It is necessary to mention that the Committee found the state of the topographical maps to be in an unsatisfactory condition and the methods of reproduction not all that could be desired.

The maps themselves showed a lack of some definite standard as regards quality, and important districts appeared to have been neglected for work of less urgent nature elsewhere. This result is ascribed to the want of a definite central policy in dealing with all classes of survey for the country as a whole; consequently local interference was able to exercise a deleterious effect, and fitful reductions of establishments were made by the Imperial Government.

The Committee was, therefore, faced with a vast problem, comparable in kind to that of Army Reform. The same radical questions required an answer, and the decision which the Government of India is now called upon to give is one of much gravity.

These questions are:—

(1). What should be the functions of the Survey of India?
(2). What should be its organisation to carry them out?

It will be seen that they involve a wider scope than was included in the term of reference to the Committee, and may be said to arise out of the result of its labours which demonstrated that such questions required an answer. For this reason the recommendations of the Committee become automatically out of date; although their labours retain their full value in information collected in the Report.

An endeavour will now be made in the short space at disposal to indicate the chief considerations of main policy which appear to suggest themselves from the new standpoint. These will naturally differ from the recommendations of the Committee.

The possible functions of a Survey Department comprehend a very wide range; viz., from such highly scientific activities as geodetic work or magnetic surveys to the actual letting of government lands to settlers (New Zealand Survey) with the appraisement of agricultural and mining values, legal titles, and other matters merging into the functions of a Department of Agriculture. The whole forms an edifice the value of which as such depends on the quality of its parts, but more particularly upon its foundations. The scientific part of survey comprises the foundations. As with buildings, these are apt to be scamped by the jerry builder; because they are unseen, or because their uses are not understood by the ignorant, whose knowledge only extends to the uses of the rooms above. Or, we may regard it as a good example of the metaphysical idea, the incarnation of wisdom, the scientific idea descending through various stages, becoming more and more visible in material uses from primes to ultimates. Thus, the practical uses of highly scientific work are not apparent to the man in the street; then comes triangulation, with the small scale or topographical maps recognised as useful for military and general purposes by a considerable number; whilst the ultimate stage of large scale cadastral maps, to be used for administration, land transfer, building, etc., has uses patent to all.

Whilst the history of survey in various countries furnishes examples of the fatal policy of jerry building, of trying to provide the "rooms" of cadastral maps without any but the skimpiest "foundations" of triangulation; so there is a danger amongst scientific surveyors of underestimating the real urgency for cadastral maps to meet the practical, political, and commercial needs of a community. It is the *rôle* of the statesman to control extremists, and to see that a Survey Department is charged with, and organised to provide, both the scientific foundation and the cadastral plans in addition to topographical maps. The provision of good topographical maps for military use and general purposes is, doubtless, the most important requirement. The Committee's desire

that the 1-inch and smaller scales should be pushed on with energy will be generally endorsed; whilst an outside suggestion for a larger scale map for military use may be ruled out, because the distribution and storage to the extent required is impracticable in the case of large scale maps.

It would be a most questionable policy for the Government of India to adopt the recommendations of the Committee in so far as they advise that the Survey of India should practically throw over cadastral work, and concentrate all attention on the completion in 20 years of the topographical survey. This is recommended because the small scale maps are so backward, and because the attempt to deal with them and odd portions of cadastral work together has had such unequal results. But, the reason plainly discernible in the evidence is not, as assumed, due to one department doing both classes of work, but to the fact that the organisation of the Department was unfitted to deal adequately not only with both together but with either singly.

The broad fact remains that when once the triangulation is done, it can be used as the basis either for a topographical survey or for cadastral survey. There is no reason whatever why a Survey Department should not then be organised so as to be capable of dealing concurrently with the most urgent demands in each branch. No other organisation can be based on principles of continuity and economy; for as soon as the original topographical maps are completed, and only periodical revision remains, the activities of the survey personnel must largely be transferred by degrees to cadastral work. The concurrent working in each district of both kinds of work enables the staff to be gradually trained in cadastral duties as the proportion of this class of work expands and topographical work diminishes. This is the natural progress of a Survey Department from youth to old age. To confine it to topographical work is to ensure its extinction in middle life.

Another cogent reason for furnishing the Department with a complete constitution and functions is that forest and cadastral work carried out properly, as they then would be, can be utilised to assist topographical work.

The Government of India is peculiarly *in loco parentis* to the people; and it is inconceivable that such an essential requirement as good cadastral maps, urgently needed by localities, should be thrown to the winds as something to be obtained anyhow and of no concern to the Imperial authorities. Indeed, political expediency would appear to add its claims to paternal duty in support of a policy of providing local survey establishments, in moderation, to cope not only with local government and municipal needs but also with private work on repayment.

It is a mistake to suppose that such a policy involves a greater imperial expenditure or less progress in the imperial work of topographical survey. There is, indeed, no reason, given a suitable organisation and financial system, why the inclusion of cadastral work should not cause a saving of imperial funds. Cadastral work is essentially work for which those who want it should pay. They are always willing to pay a government department, owing to the great cheapness and excellence of its survey compared with what can be obtained outside. Hence, with a Department organised suitably, decentralised into local centres with power to enlarge staff and

plant, like any business concern, up to outside demand and payment for goods, the expenses of both staff and plant can be adjusted to the orders normally given. The topographical work can go on independently in each district up to the limit of imperial funds. Such a conjunction of the two in each centre, not too remote to be in touch with its area, is beneficial to both through the give and take in staff that can be made to meet fluctuations in demand, the loss arising from such fluctuations being practically wiped out by this arrangement. With a centralised organisation, such as now exists and is proposed to be retained by the Committee, it would be impossible to work on such business lines.

Much may be said, therefore, in support of the suggestion of the Surveyor General to institute a decentralised organisation of local centres. Reasons have been given why cadastral work should be efficiently provided for in such a scheme, a consideration which must raise the number of local establishments to 8 or 9 in the first place, eventually to more. The cost of providing such will be considerable; but as they will chiefly be required for non-imperial work, this cost should eventually be recovered from the payments for cadastral work. It appears only necessary to include a charge sufficient for a sinking fund to meet capital advanced and interest. Each District could be debited with a debt to pay off, a system which would make the local survey officer chary in his demands for capital expenditure beyond the scale of local business. It would also furnish a continual check to the Imperial Government on the principle of keeping all cadastral work self-supporting. This is most necessary; for, if it would furnish the above check on undue expenditure in some localities, it would also show clearly others where such demands should not be refused because obviously justified.

The Survey of India has always deservedly held a great reputation by reason of the high excellence of the scientific work of its officers, and the resource and energy shown under difficulties in frontier surveys and other operations assigned to its staff. Such a distinguished personnel should have its energies directed by an organising and business capacity of a corresponding order. It should not suffer, even by a misunderstanding of the circumstances, from the imputation of partial failure to reach satisfactory results. The very best staff of experts cannot make a business successful unless their energies are co-ordinated and directed to a definite end by a competent system of management.

The decision of the Government of India in this important matter of the future of the Survey of India will be awaited with much interest; for this department as constituted at present, does not offer, as the Surveyor General himself remarks, an attractive prospect to ambition. Still less will it do so, if, in future, its operations are to be confined to topographical work entirely and under a centralised system of administration. Apart from the consideration of efficiency and economy, to which undue centralisation is opposed in practice, such an organisation offers little field of activity to the higher ranks; and the supply of suitable officers of the large numbers required, all experienced, but of junior rank in extreme proportions, is not likely to be obtained without great difficulty.

E. P. BROOKER.

NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

March, 1906.

Armoured Concrete in Railway Work in Russia.—The Russians would appear to have been by no means behindhand in availing themselves of this system of construction; and in this article there are some useful descriptions of works carried out on the various railway systems, detailing also their mode of construction, methods of casing and centering and leading dimensions, together with numerous illustrations, such as might be useful for reference. Among the works described are :—Locomotive shed roofs, water reservoirs and tanks, buildings of various kinds, culverts, foundations, and viaducts.

Certain ice-houses and vaults for paraffin strike one as particularly interesting, as these structures, covered over as they are with earth, are much of the nature of small magazines, and a similar method of construction for stores to contain explosives might on occasion be both suitable and economical.

In this connection one may mention that a large terminal station has recently been erected at Atlanta, Georgia, for the Southern Railway, U.S.A., constructed throughout in reinforced concrete, and including among other features some retaining walls of rather interesting design.

C. E. Vickers.

Engineering News.

April 5th, 1906.

Construction Work on the Canadian Northern Railway.—This line has now a considerable system, some 2,500 miles, extending from Lake Superior to the North West, where settlement is now taking place very rapidly. Between March and November, 1905, some 400 miles of line were laid up to Edmonton, and work has since been continued westward

as weather permitted. The soil being easy, a soft black loam underlaid by clay or gravel, it was possible to make the formation mainly with drag-scrapers, use of steam shovels being only occasionally necessary The culverts are of timber, squared for the sides, top of cross logs notched to fit.

Track laying was worked by a train consisting of a "pioneer" car leading, then flat cars of rails, then the engine followed by cars of sleepers and bridging material. The rails were run forward along roller ways at the sides of the cars and the sleepers carted (about 50 teams being employed, averaging about 25 sleepers to a load). Spiking and fishing were completed close behind the train. The leading "pioneer" car was provided with a high platform from which signals could be given to the engine.

A tracklaying gang, to do 3½ miles per diem, 7 a.m. to 6 p.m., was made up as follows :—

In front of engine.	*In rear of engine.*
1 foreman.	1 foreman.
8 rail pullers.	24 spikers.
2 line men.	12 bolters.
14 sleeper men.	6 nippers.
4 spikers.	3 spike distributors.
2 nippers.	1 putting in bolts.
18 steel men (handling rails on both sides of car).	1 water boy.
	6 liners.
1 liner.	6 sleeper men.
1 gauge man.	80 men handling sleepers, including teamsters.
1 sleeper marker.	
4 bolters.	1 blacksmith.
4 loading rails on trollies.	2 cooks.
	4 helpers.
	1 time and storekeeper.

Total 208.

Sidings for material trains were put in about every seven miles.

C. E. VICKERS.

MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

March, 1905.

A MINIATURE RANGE.—A short account of a range erected on the exercising ground of the Railway and Telegraph Regiment may prove interesting to R.E. officers, who often have to supervise the erection of such ranges at home.

It will be seen that the Austrians spend considerably more on their

ranges than is usual in England; and they are provided with every form of target.

The range described has an extreme length of about 37 mètres measured from the centre of the firing point, and is 14½ mètres wide.

Accommodation is found for 12 men to shoot simultaneously; and the firing point, instead of being merely a platform, consists of a shelter trench with covered loopholes 90 centimètres apart. For half its length, that is for six loopholes, the trench is for fire kneeling, and for the other half for fire lying down. The sides and bottom of the trench and the interior slope of the parapet are lined with boarding in order to increase their stability and also to save the uniforms of the men firing. To enable shooting to be carried on irrespective of the weather, the whole firing point, with the machinery for working the targets, is roofed in, forming a shed some 14½ mètres long and 7 mètres wide.

The range itself consists of four small butts at different distances from the firing point, as shown in the longitudinal section. On each of these butts are fixed two targets.

On the first three butts the targets are simply vanishing targets that can be lowered or raised from the shed over the firing point by means of connecting wires. The targets also fall when struck by a bullet. On the fourth butt are two moving and vanishing targets which have a lateral motion along the edge of this butt.

In rear are two advancing targets. Thus in one range every variety of target is provided.

All the targets can be worked from the firing point by one man; but if several are to move simultaneously a second man is required.

From each target wires run to posts on the left side of the range and from these posts they run over pulleys to the firing point, where there is a separate wheel and handle for each target. There is a notice above each wheel showing to which target it is connected. When the targets are lowered they are concealed from view by the butts.

The working wires, when they leave the posts on the left side of the range, are taken well below the top of the butt so that they cannot be injured by bullets. Each wire is provided with a 'tightener,' so that any slackness in the wires caused by change of temperature can be promptly remedied.

An idea of the mechanism of the first five targets can be obtained from the accompanying section and elevations.

The wooden lining of the reverse side of each butt is supported by strong posts, 10 c.m. × 10 c.m., and to these are screwed iron brackets (*z*) which are connected by an iron bar (*w*).

The position of this bar is secured by an iron filling piece inserted between the bracket and the bar. This also serves the purpose of regulating the height of the bar so that the targets when laid back are the proper height. On the brackets (*z*) are the bearings (*m*), carrying the roller (*r*), to which the figures (*x*) are fastened by means of hinges (*s*).

The figures are made of strong iron plate, 5 millimètres thick, as anything thinner is found to break very quickly. To keep them in their

proper positions a flat spring (*f*) is used, screwed at one end to the hinge, and pressing at the other end on the roller which is filed flat to receive it; in this manner a certain resistance is offered to the falling of the target.

The roller is turned out of a bar of iron 22 millimètres square. At its centre point it is squared to receive a two-armed lever (*b*). The arms of the lever are connected by rings and spring clips at (*f*) and (*g*) with the wires which work the target.

The movement of targets 1 to 6 is accomplished as follows:—

The wire *f* is tightened by turning the proper wheel at the firing point, and one arm of the lever (*b*) is drawn downwards; the roller is turned through an angle of 90°, and the figures are thus raised into position.

If the handle of the wheel is turned in the opposite direction, the other end of the lever is pulled by the second wire *g*; in this way the roller is brought to its former position again and the figures are lowered.

The figures knocked over by bullets are restored to their natural position by the force of impact, as the spring presses on the flat place in the roller and so brings the figures back into their proper position.

Removable wooden covers are fixed to all the targets in order to protect the mechanism from the weather. These covers are made large enough to allow of the targets being raised while they are on. It is found that with these covers the range may be exposed to bad weather, the whole winter without suffering any material damage.

The moving targets 7 to 10 are rather more complicated, and would require too much space to describe in detail as they combine a vanishing target with a moving target.

The provision of spring clips to connect the wires with the levers of the targets is claimed as a great advantage, because the targets can be so easily connected and disconnected whenever it is necessary to supply a new wire.

In the maintenance of this contrivance it is principally necessary to thoroughly grease all parts exposed to friction, and when there has been heavy rain to clean any rusty parts and then grease them.

In dry weather the ramps of the butts should be well watered, to prevent the dust thrown up by the bullets getting into the mechanism of the targets.

As regards the time and material expended on the construction of this range the author gives the following information. The mechanical parts were executed by 5 smiths (including fitters) and 1 joiner in 21 working days of 8 hours each, but this did not include putting the parts together on the site. The earthwork, including the erection of the four butt walls and the main stop-butt was carried out by a working party of 30 men in 4 working days of 8 hours. The erection of the hut at the firing point was carried out by 1 N.C.O. and 10 pioneers, mostly carpenters; its entire construction, with the provision of tables, benches, and arm-racks took 10 working days of 8 hours. The fixing up of the different parts was carried out by the 5 smiths and the joiner in 8 days.

The total cost, using old material as far as possible, was 2,500 kronen.

C. OTTLEY PLACE.

NATURE.

April, 1906.

"MAST AND SAIL IN EUROPE AND ASIA" (*p.* 536).—Mr. Warington Smyth describes this volume as an attempt to record the peculiarity of the principal types of sailing craft in Europe and Asia, and to consider the causes which have been at work in the development of boats, and the results attained under the conditions with which they have had to contend. For many classes of sailing vessels he gives the lines and the sail plans. Half the book is devoted to European types, beginning with the Baltic and Scandinavian countries, and passing to Holland, Scotland, the east coast of England and the Thames Estuary, the south and west coast of England, and then to France and the Mediterranean. Dealing with Eastern vessels, including those of the Indian Ocean, the Malay Peninsula, the Gulf of Siam, and China, Mr. Smyth finds special types of great antiquity differing widely from Western vessels, but well adapted for their special services and surroundings.

The degree of civilisation of any race is remarkably reflected in its boat architecture, and in maritime races this has always been marked by activity in boat building and by variety of design and rig. In no case has this been more notable than in the history of China and of Holland, and in the Adriatic in the fifteenth century, in Europe during the last two centuries, and in the United States since 1780. The Negro, the American Indian, and the Slav, on the other hand, have never designed a seagoing boat or cut a sail. It has not been for want of waterways or of opportunity; it has been simply owing to a lower class of intelligence and to want of originality and enterprise. This book should find a hearty welcome from all who love to sail the seas and manage their own craft.

HOAR-FROST IN THE MOON (*p.* 569).—A series of measurements of the bright spot around the lunar crater Linné were made at Harvard Observatory during the total eclipse of the moon on 8th February. These results show that the diameter of the spot began to increase as Linné passed into the earth's shadow, and to decrease rapidly on a return of sunlight to that portion of the moon's surface. Professor Pickering considers that this phenomenon is due to the formation and melting of hoar-frost.

"ROWING AND TRACK ATHLETICS" (*p.* 605).—From the British sportsman's point of view this book will be read with pleasure, for it shows how eagerly the Americans have strived, and not in vain, to equal the prowess of the athletes on this side of the Atlantic. From the scientific point of view it is also of value, for it shows the evolution of ideas which have culminated in the present methods. The successful oarsman is he who is able best to combine a number of variables. These include personal fitness, easiness of style, length of oar and width of blade to suit his particular capability, length and weight of boat, and alertness of brain to take advantage of prevailing conditions and unforeseen eventualities. In

many national characteristics climate plays an important part. The British style of rowing has been evolved under British weather conditions.

In track athletics the same principle holds, and this is borne out by the fact that, on the average, the American is the fastest sprinter, while the Britisher is the best at long distances.

THE SAN FRANCISCO EARTHQUAKE (*p.* 609).—The first series of preliminary tremors reached the Birmingham seismograph at 1h. 25m. 3s. p.m. 18th April; they were small in amplitude and had an average period of 6·4 seconds. At 1h. 35m. 7s. a second series much larger in amplitude and with a period of 11·4 seconds were registered. These tremors traverse the body of the earth with varying velocities of from 10 to 4 k.m. per second. The end portion of the disturbance began at 2h. 1m. 4s. and consisted of a long series of unusually clear and regular waves with an average period of 15 seconds. Another series of long low undulations from 4h. 58m. 32s. to 5h. 6m. 34s. represent the return of the first series of surface undulations, after they had completed the tour of the globe and travelled once more as far as Birmingham. They did the journey in 3h. 10m. 19s. with a mean velocity of 3·36 k.m. per second. The mere fact that the earth waves should disturb a seismograph after thus travelling 30,000 miles shows that this earthquake belongs to the very front rank, inferior, perhaps, to the Lisbon earthquake of 1755 and the Indian earthquake of 1897, but in the same rank as the Japanese earthquake of 1891 and the Indian earthquake of 1905.

W. E. WARRAND.

OESTERREICHISCHE MILITÄRISCHE ZEITSCHRIFT.

March, 1906.

PRACTICAL EXPERIENCES OF SPADEWORK IN THE ATTACK.—The experiences of the recent war in the Far East have shown that under certain circumstances the provision of artificial cover may be as valuable to the attack as to the defence.

The Austrian military authorities appear to have thoroughly recognised the truth of this; and in April, 1905, the General Commanding the 11th Corps issued to all the troops in his command certain provisional instructions which may be summarised as follows:—

Spadework in the attack has, as its most important object, the construction of covered positions on open and exposed ground, where it is a question of definitely securing the possession of ground already won, and of enabling the firing line, once installed in these positions, to hold them with comparatively slight loss against the fire of their adversaries until a renewal of the attack is practicable.

The soldier must therefore be well schooled in entrenching himself during a fight as rapidly as possible, keeping in a prone position.

As a rule only half the personnel should be provided with shovels, so that every alternate man may entrench himself whilst the remainder continue firing as circumstances may require. These latter entrench themselves as soon as the others have commenced firing from their completed cover.

In this way a number of independent shelter trenches are provided within the beaten zone, that give at least protection against rifle fire. It is of course obvious that every advantage must be taken of the contour and natural cover of the ground when making these trenches.

The type of such trenches cannot be laid down by any hard and fast rule, and the illustrated examples given in the text are only to be regarded as types suggested as likely to be suitable.

The cover must, however, offer real protection; and therefore in ordinary soil the thickness of the parapet at the top should not be less than 1 mètre.

The trench must be adapted for comfortable shooting, and the oblique position of the body when shooting from a prone position must be allowed for.

"The first spadefuls are taken as shown in *Fig.* 1, the digger taking the earth from both sides and in front of him, and making a parapet of it; the earth on the surface, which is generally the firmest, being used to form a revetment for the interior slope.

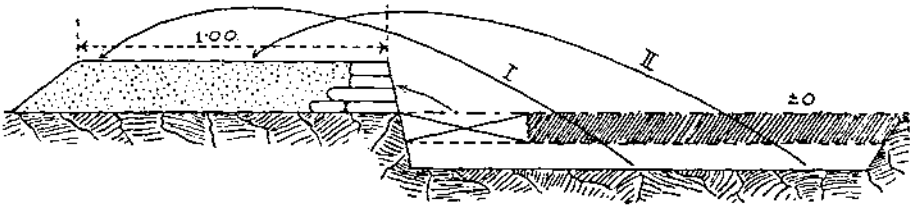


Fig. 1. 1/25

The first piece which is excavated at the commencement of the task and which is used to form the interior slope of the parapet; it also serves as a screen for the continuation of the work.

The first task of the trench; taken out from front to rear, so that the earth from the rear portion is thrown to the inner side of the parapet (II) and that from the front portion to the outer or far side of the parapet (I).

Completion of the trench, working from rear to front.

"The earth taken from in front should be thrown to the far side of the parapet, and that taken from the rear to the near or inner side.

"These exercises should be executed for the most part during company training.

"The first object aimed at should be the instruction of the individual; later on they should be practised in sections; and if the size of the ground available for the purpose permits, in still larger parties."

The above instructions were issued when only the fact that the Japanese had successfully used entrenching tools in the attack was known; but the more complete knowledge obtained later in the same year served to substantiate the value of their teaching.

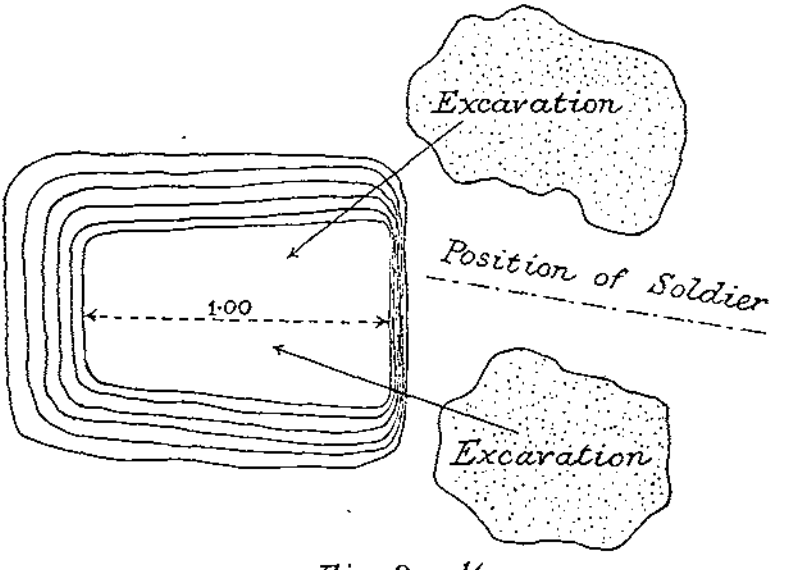


Fig. 2. ½5

The following is a summary of the chief points of information and practical experience gained in carrying out these exercises with entrenching tools:—

DESCRIPTION OF TRENCH, ETC.

Of the four types given as examples, Types I. and IV. had each their peculiar characteristics, while Types II. and III. were simply variations of Type I.

In Type I., the man entrenching himself takes the earth for the parapet from in front and from underneath him, corresponding to the position of his body as he lies to shoot, and throws it straight in front of him. The trench thus formed serves him at once as a sunken position to fire from. His cover is obtained from the trench and parapet combined. The process of the work is explained in *Fig.* 1.

In Type IV. the man remains lying on the natural surface of the ground and obtains earth by scooping holes on one or both sides. This earth he throws obliquely to his front to form a parapet (*vide Fig.* 2).

His cover thus consists only of a heap of loose earth, as the holes give no protection but only supply material.

Very slight movement, besides turning from one side to the other, is necessary to get out the earth.

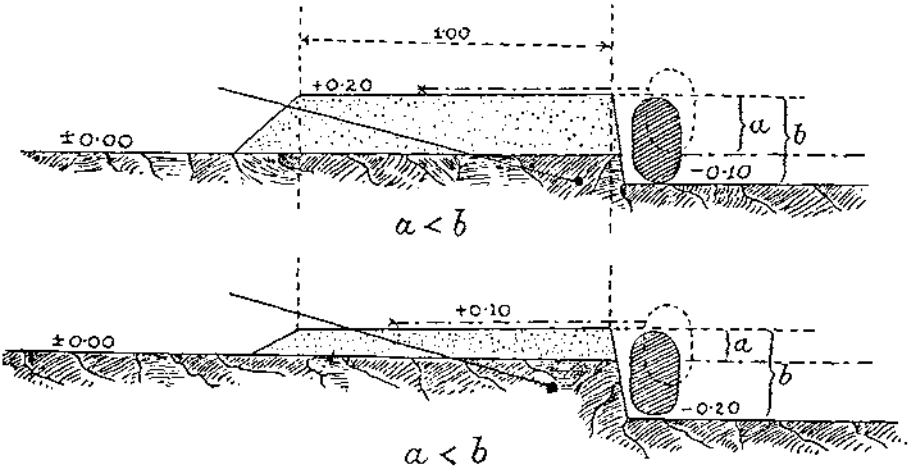


Fig. 3. 1/25

Type I.

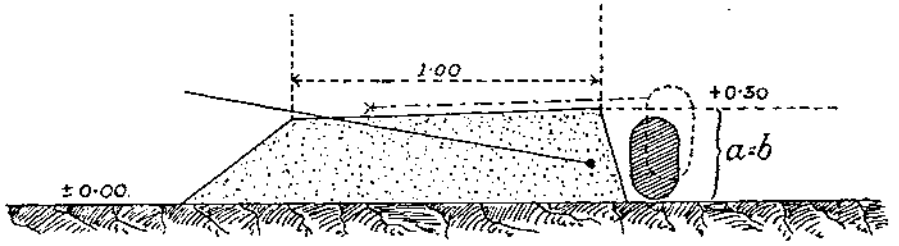


Fig. 4. 1/25

Type IV

Height of Parapet *a.*

Depth of Cover *b.*

Type I.—Advantages.—It complies best with the chief requirement of a trench, that is it enables the man to cover himself from the sight and fire of the enemy as quickly as possible.

As the cover provided is a combination of excavation and heaped-up earth, it follows that the parapet rises very little above ground level and so forms a very small mark for the enemy's fire.

Less earth is required than in Type IV. and it is therefore more quickly completed. The resistance of the parapet is greater as the lower portion is solid earth.

Disadvantages.—The trench to be dug is very long from front to rear, requiring considerable movement in the position of the body; and the excavated earth has to be thrown further than in Type IV.

Type IV.—Advantages.—Requires less bodily movement than Type I.; and the holes from which the earth is taken may be utilized at a later stage in the construction of cover for other men.

Disadvantages.—It is some time before cover is obtained, as the man remains on the surface of the ground.

The parapet for the same amount of cover as Type I. has to be taken much higher, and offers a better target for the enemy's fire.

The earth to be dug out is nearly twice as much as in Type I.; and the parapet, consisting entirely of loose earth, has less resistance.

A comparison of the two types is therefore all in favour of Type I.

It is very difficult to decide whether it is more practicable to obtain earth for the parapet from holes dug on each side as in Type IV. or from trough-like trenches dug to suit the position of the body. It must depend for the most part on the capability of the man and the nature of the ground.

With a view to solving this question, some interesting experiments were made in a Militia Regiment.

A party of men were formed into a firing line, and were told that they were under very heavy fire and that they had to entrench themselves whilst lying down. Nothing was said as to the type of cover, and everything was left as much as possible to their own instinct.

It was found that they all corresponded in the main to Types I. or IV. It was noticed also that many of those who began by taking earth from holes on each side soon of their own accord gave up this method and copied those who were digging the earth from underneath them. In point of fact this Regiment (XI.) took more than twice as long over Type IV. as over Type I.

It is obvious that the left-handed hole in Type IV. is very awkward for a right-handed man; and his efforts to get earth as near his parapet as possible, and without too much movement and turning, generally result in his working only on his right side and getting out a deep and narrow hole, which has no value either for his neighbour in the firing line or for the supports in rear when they come up.

This objection would be abolished by the following method of construction (*Fig.* 5). The man entrenching himself takes the earth for his parapet from a long shallow ditch on his right side (if he is right handed); this he can do by extending his arms when working, and by a sliding motion of his body. The first portion excavated is used to make a steep interior slope for his parapet, and this serves at once as a screen. On completion he gives his shovel to the man on his right, who has hitherto

been firing, and opens fire himself. The right-hand man crawls to his left into the shallow trench (1), and enlarges it into a trench for firing from a prone position (2), similar to Type I.

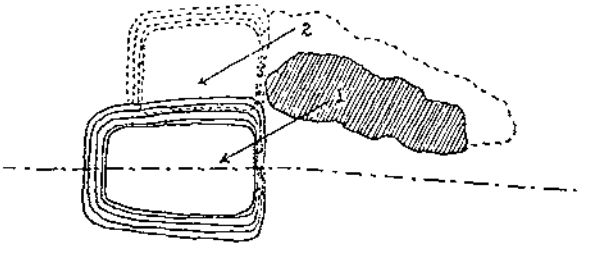


Fig. 5. 1/50.

In cases where the right-hand man has made his cover independently, these flat trenches could be utilised by officers or by the supports, and completed accordingly.

In some cases it appears to have been reported that Type IV. was undoubtedly superior to Type I. because in wet weather it was drier. But as any flat ground will be thoroughly wet after heavy rain, this objection is not sufficient to condemn Type I.

The author suggests some form of judicious drainage; but admits that time and opportunity would generally be lacking.

HEAD COVER.

A variety of views appear to be held on the subjects of head cover and concealment.

While fully admitting the value of head cover for trenches in the attack, it is argued that the construction of loopholes takes considerable time, and unless well and carefully formed they cramp the field of fire. Moreover the necessarily increased height of the parapet makes it a much more conspicuous target for the enemy's fire.

On the whole it seems to be the author's opinion that loopholes should not be provided, because in the attack the trenches should be as simple as possible in order that the cessation of fire on the part of each individual while he entrenches himself should be as brief as possible.

CONCEALMENT.

The necessity of taking every advantage of all natural and existing cover, when entrenching during the attack, is thoroughly recognised; but the provision of artificial concealment must be judged from a different standpoint.

The best results as regards artificial concealment can only be obtained by a force acting on the defensive with plenty of time and a variety of material at their disposal. Screens of grass and straw and the artistic use of colouring material will often make the various defence works harmonise so completely and naturally with their surroundings that they are impossible to detect even at decisive ranges.

The occasions on which the attacking side could employ artificial concealment to similar advantage would however be extremely rare; and even if the best results were obtainable, the fact that the work would have to be carried out under the eyes and fire of the defence would render them useless. Concealment being therefore almost impossible, the attacking force must content itself with offering as small a target as possible to the enemy's fire.

On level ground where men can fire with their rifles at ground level (*i.e.* without any command) a parapet may sometimes be advantageously dispensed with. In this case the earth taken from the trench may be made into a false parapet (*Fig.* 6) to attract the attentions of the defence.

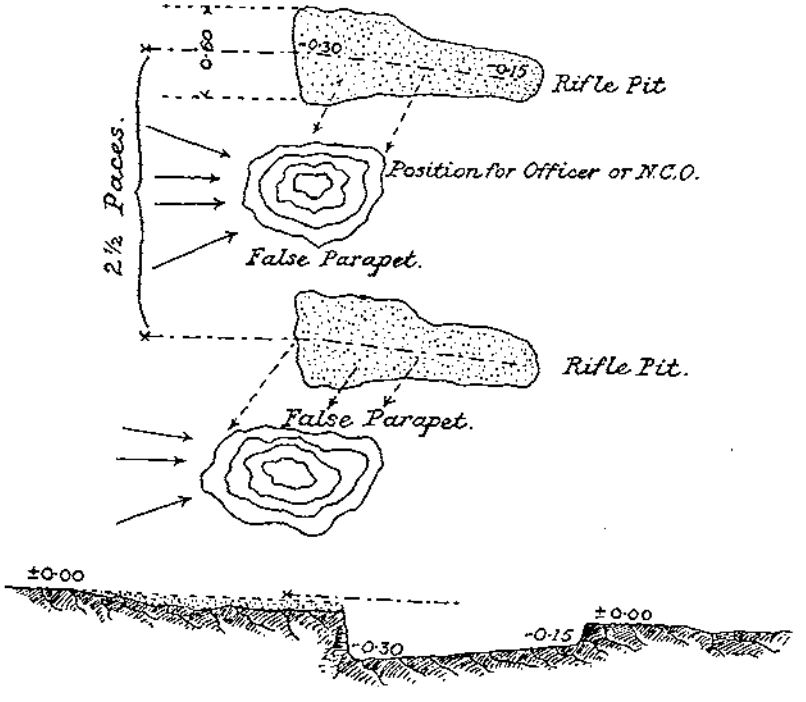


Fig. 6. 1/50.

It would be interesting to test by practical experiment the extent to which hasty trenches thus executed by the attacking force could be

improved and completed during the fight as opportunity offered. Such an opportunity would occur when an indecisive battle was temporarily suspended during the night. Under cover of darkness the little individual trenches could be amalgamated into one strongly protected work and the attacking force would be much more favourably situated to continue the fight the next day.

METHOD OF CARRYING TOOLS.

Experiments were carried out by two Infantry Regiments with a view to deciding whether the present method of carrying the entrenching tools permitted of their being quickly unbuckled and taken into use and also tended to prevent their being lost.

According to the Austrian official instructions these tools are strapped to the man's valise or knapsack; but it appears that it requires the help of a second man to unbuckle them, and they also impede the man when marching.

Various suggestions are made for improving this; but they are of little interest to those who are not acquainted with the Austrian pattern of equipment.

CONCLUSION.

In order to clear up the differences of opinion which were noticeable in the reports of the units taking part in these experiments, and to form a correct estimate of the value of this kind of spadework, it is to be hoped that this problem will attract equal interest elsewhere.

Great as are the advantages of a proper use of entrenching tools in the attack, it must be borne in mind that corresponding precautions must be taken against the misuse of these strictly defensive weapons.

It must be remembered that the only road to superiority of fire, and at the same time the best protection against the fire of the enemy, is to be found in one's own fire; and therefore spadework must be the exception rather than the rule. But when the attacking force is at a disadvantage, and it is impossible to advance, whilst retreat means destruction, then it would be folly not to make use of such means of restoring strength and confidence as have stood the test of practical experience in the recent war in the East.

To lay down rigid rules for this sort of trench work would do more harm than good. The main point is in every case to find out the type most suited to the circumstances, and to stimulate and keep alive the men's intelligence and interest in this sort of work. Each man must thoroughly understand his tools, and how to use them in any combination of circumstances. A good shot who can also ply a good pick and shovel will instinctively do the right thing at any moment during the fight.

But this knowledge of the proper use of entrenching tools can only be obtained by careful instruction in peace time, accompanied by frequent practical exercises on a variety of ground. In this way his entrenching tools will be to each man what they are meant to be, that is a welcome

and useful assistance, not only in defence but also under certain circumstances in attack; and they will never be regarded by him as so much useless extra weight.

Thus regarded, the construction of covered trenches in the attack can have no ill effect on the soldier's desire to get to closer quarters with the enemy; for he will willingly leave his cover to advance to the attack, if he knows that he possesses both the means and the skill to entrench himself equally well at the next halt. Thus relying on both rifle and spade, and energetically led by his officers, he will never forget that the reward of his work and his danger lies in the place which his foe occupies.

Working Time Table.

Regiment.	Time occupied in Minutes.					
	Type I. Soil.			Type IV. Soil.		
	Light.	Medium.	Heavy.	Light.	Medium.	Heavy.
I.	25—30	60—72[1]	—	—	—	—
II.	—	20—30	—	—	30—40[2]	—
III.	30	50—90	—	20	40—60	—
IV.	—	—	—	20	—	—
V.	9[3]	13[4]	18[5]	18[5]	27[4]	36[9]
VI.	13—20	—	—	13—20	—	—
VII.	10—20	30—45	—	10—20	30—45	—
VIII.	10	25	—	30	40	—
IX.	15—20	30—45	—	—	—	—
X.	12—15	18—22	—	—	35	—
XI.	10	15—20	—	25	35—40	—
XII.	15—20	—	—	—	—	—
XIII.	8[6]	—	—	10[6]	—	—
	16[7]	29—52[9]	90[10]	20[7]	45—60[9]	80[10]
	22—29[8]	—	—	15—20[8]	—	—
XIV.	5—6	10	18—20[11]	—	—	—
XV.	8—10	15—20	20—30	—	—	—

NOTE.—[1] Hard dry stubble field. [2] Pasture land with clay stratum and turf top soil. [3] Loam covered with 7 c.m. of turf. [4] Stiff clay. [5] Stiff soil, marl and chalk. [6] Sandy loam. [7] Sand and gravel. [8] Plough land. [9] Hard grassy ground. [10] Hard dry clay and stones. [11] Damp soil.

C. OTTLEY PLACE.

RAILWAY GAZETTE.

March 23rd—30th, April 6th, 1906.

TRAFFIC STATISTICS AND FREIGHT TRAIN WORKING.—By W. Marshall, North Eastern Railway.—This series of articles is extremely interesting, as they cast a good deal of light on the actual employment of statistics in railway management, apart from those summarised figures which, communicated to the shareholders, enable them and others to criticise the management of their property. In this connection a remark may be made as to the extraordinary apathy of railway companies regarding the use of statistics in combating increased taxation. It is well known that the companies are pretty severely bled by the rating authorities.

The principal units employed up to the present are:—Wagon-miles (sorted according to loaded and empty, and by direction), engine-hours, train-miles, and ton-miles. None of these figures, however, are absolute or always based on equivalent units, for capacities of wagons vary, engines are not all of the same class, and tonnage has to be taken out laboriously from invoices, with the added complexities introduced by through traffic. Combinations of the above-mentioned units, such as 'wagon-miles per engine-hour,' are also taken out, and are doubtless valuable.

What the writer says about application of statistics goes to show that the more the figures are aggregated to show results over the whole of the line the less use they are for practical purposes. The figures which are actually useful are those relating to particular operations, enabling comparisons to be made from day to day; and so that they should be both available promptly and got out in a convenient form it is an advantage to leave their compilation in the hands of the local man.

When, however, the figures apply to operations controlled from headquarters, *e.g.* loaded and empty wagon mileage, the abstracting of the figures into more general totals is advantageous, provided they are all obtained in the same way.

We are inclined to come to the conclusion that the simplest figures are the most useful, such for example as those showing the work done in handling and carting goods at stations, loading of trucks, and loading of particular trains. As regards ton-mileage, the figure which would be directly useful and readily applicable would perhaps be most easily obtained by recording the actual load contained by each truck on its outside. Where it is possible to load up trains to their maximum engine capacity, the existence of this figure handy for reference enables the actual load behind the tender to be calculated at once; and by this means a great improvement is effected on the rough-and-ready rule of 'load, so many wagons coal, so many merchandise, etc.'

C. E. VICKERS.

REVUE DU GÉNIE MILITAIRE.

January, February, and March, 1906.

THE SIEGE OF PORT ARTHUR.—An article compiled by Colonel du Génie de Grandprey from various accounts which have been published gives an interesting description of the dynamite hand grenades that were used by both sides. The Japanese grenades consisted of tin cylinders filled with 17 ounces of dynamite; they were exploded by a detonating cap and a short length of safety fuze. The Russians used old shells and the brass cartridge cases of the 47-m.m. guns. Both sides suffered very heavily from the dynamite grenades, the Japanese in particular.

Both sides also made use of wooden mortars for throwing dynamite shells. The mortars were made in two halves, bound together with bamboo strips. The Japanese pattern were about 3 feet long, and had a calibre of $4\frac{1}{2}$ inches. The projectile was a tin cylinder, full of dynamite, and was fitted with a wooden time fuze which could be set to five distances between 250 and 450 yards. The powder charge for the mortar was adjusted to the range required.

The Japanese protected their sap heads from dynamite grenades by means of wire screens, constructed like spring mattresses, from which the grenades rebounded harmlessly. They also used similar screens to prevent the Russians setting fire to their sandbags.

Many attempts were made to destroy the Russian wire entanglements. On one or two occasions the Japanese fastened ropes to the front row of pickets, and managed to drag the whole entanglement out by the roots. After this the Russians anchored them more securely. Finally the Japanese decided that the best method was to send out men protected by steel bullet-proof shields (weighing about 40 lbs.) to cut the wire.

In attacking the permanent forts the Japanese at first mined up to the counterscarp and blew it in, thus filling up the ditch; and then tried to construct saps across the *débris*. This method met with little success, and they finally found it necessary to run their mine galleries under the forts themselves. At North Keekwan Fort they gained access to the counterscarp galleries, where some very severe fighting took place for more than a month. The fort however was not finally captured till the escarp had been mined and destroyed. The capture of 203 Metre Hill was rendered possible by the fire of the 11-inch howitzers, which destroyed the Russian shelters and communications and made it impossible for them to bring up their reserves.

The writer, commenting on the Russian defence, suggests that the position on Wolf Hill should have been more resolutely held; it was much stronger than any position in rear, and completely covered the main defences. The Russian heavy guns were too much exposed as the Russian gunners did not understand indirect laying; they were thus quite unable to cope with the Japanese artillery, which was always concealed and used indirect laying only. The Russians made great use of their Maxim guns, and were always able to bring them into action at the right moment to repel an assault; never before has Maxim fire been

so effective. If the Russians had possessed any balloons, they might easily have located and destroyed the Japanese light railway and siege batteries.

The difference between the resistance offered by the semi-permanent and the permanent Russian works was most marked. The former were captured as soon as the attackers' trenches reached them; the latter held out for from 54 to 61 days after the enemy had gained the counterscarps. None of the permanent works succumbed until they had been mined. It is therefore as necessary as ever to instruct engineers in this form of attack. The Japanese trenches advanced at a rate of about 100 yards a day till they came within 300 yards of the Russian works, when the rate was reduced to 10 yards a day.

The writer considers that the Japanese made a great mistake in first attacking the northern section of the defence, as the western was far weaker.

March, 1906.

THE RUSSIAN MILITARY TELEGRAPHS IN THE WAR.—It was found that in connecting units smaller than a Division it was best to use telephones; but that for larger units telegraph instruments were most suitable. The telephone tempted the superior commanders to interfere too much with their subordinates. Under fire the telegraph operators were steadier and more reliable than the men working the telephones. Some of the Russian field cable was in constant use for over fourteen months. When it was too badly damaged for the telegraph lines it could still be used for telephones. They lost very little material in the retreats from Liao-yang and Mukden.

METAL GABIONS.—A description is given of a new type of gabion which is made of wire netting. The size of the mesh is ·3 inches; but even a larger mesh is said to contain the earth perfectly. The pickets consist of eight vertical iron rods, ·2 inches in diameter.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

March, 1906.

MANCHURIAN CAMPAIGN from the middle of May to the end of August, 1905.—Capt. Giannitrapani's account of the Russo-Japanese war is brought to a close.

From the middle of April to the end of August, the operations were limited to combats of advanced posts—without any great action taking place—followed by a general advance of the first Japanese lines. The Japanese occupied Tsintsiatun* at this time with the 2nd Cavalry Brigade, infantry, artillery, and mitrailleuses; at Tschiantu was the 1st Cavalry Brigade with reinforcements. On their right wing the Vth Army Corps.*

* Place names and titles are as in the original; they differ from those used in English accounts.

which extended far towards the east in the mountains, with some detachments, attempted to advance in the valleys of the Hun, Sintsintin, and Tungvasian towards Heiluntschieng, but these attempts were rendered futile by the troops of Rennenkampf's detachments.

During the second half of May operations took place of greater importance, that is to say a new raid of the cavalry corps under Mischtschenko against Fakumen to the east of Tieling, where were found the entire IIIrd Japanese Army Corps (Nogi). The complete surprise caused to the Japanese troops by this raid would seem to show that their vigilance was neglected at this period. The object of the undertaking entrusted to General Mischtschenko was to reconnoitre the disposition of the Japanese troops on the Russian right. His force included the Cossack division of the Caucasus newly arrived on the theatre of war, and the Cossack divisions of Ural and of Transbaikal, with two horse batteries, total 50 sotnia with 12 guns.

On the 17th May this cavalry corps had succeeded in approaching the left of the Japanese lines, and passed the Liao to the north of Kupinsian, and directed itself at once towards that part of the 7th Division which was entrenched behind a fortified position. On the 18th a movement was made against Fakumen, a Japanese depôt was burned and the personnel of a field hospital were made prisoners, and long sections of the telegraph line were destroyed. On the 19th the cavalry advanced to the east of the road joining Fakumen and Sinminting, and with the assistance of a horse battery succeeded in overcoming the resistance of a Japanese infantry regiment of the 7th Division, which was protecting the roads to Skifutsi and Mukden. Taking advantage of a gap in the enemy's lines another sotnia succeeded in penetrating into the zone of the cantonments, producing further destruction. On the 20th the Russian cavalry, returning towards the west, was at Siaofaoscin, a little distance from Sinminting, where they passed the night. Then discovering the presence of other Japanese troops at Sinminting and movements of the enemy on the Skifutsi-Fakumen road, General Mischtschenko decided to retire. Without further encounters the cavalry corps on the 23rd recrossed the Liao and returned to its position on the right of the Russian army, where it was able to furnish the Commander-in-Chief with a precise report on the situation of the IIIrd Army Corps. In this undertaking the Russians lost 185 men, but captured from the enemy 2 mitrailleuses, 20 waggons, and about 200 horses; 6 Japanese officers and 234 soldiers were made prisoners.

On the eastern wing, from the middle of May to the middle of June the Russians had succeeded in repelling the advanced Japanese detachments as far as Ufanlu, and had occupied Scimiaotsi; and moreover had descended for a time into the valley of Tsin-ho that leads to Kaignan.

On the 16th June, on the western wing, another important battle took place in which the cavalry corps of Mischtschenko was engaged. This corps had recently occupied Liaoiangvoping (to the east of Tsintsiatun) and was attacked at daybreak by a Japanese infantry brigade with cavalry and artillery. The Japanese succeeded in gaining possession of the villages, but the losses were heavy on both sides.

After the middle of June, the possibility of great tactical actions in Manchuria became more remote as the plenipotentiaries had commenced to treat for peace and the climatic conditions were unfavourable. At the beginning of July commenced the rainy season, which filled all the water courses and flooded the ground to such an extent that the communications were interrupted. Moreover the great heat in July was very unfavourable for the sanitary condition of the troops. Engagements, however, continued to take place between the advanced troops, especially on the eastern wing. The Russians continued to fortify their positions at Sipinkai, and further back to Cianciang, and more to the north near the railway bridge over the Sungari. Behind these positions the Russian army was known to have been reinforced with new corps stated to have been mobilised after the battle of Mukden.

Whilst awaiting the conclusion of the treaty of peace, engagements took place in August, some of which were of importance, between the troops of Rennenkampf and the Vth Army Corps.

On the 11th September the last battle took place in Manchuria; three Russian regiments broke through towards Ufanlu, and were repulsed by the Japanese, who, however, did not follow up their advantage.

On the 16th hostilities ceased completely owing to the conclusion of the armistice.

WATER GAS FOR HEATING AND ILLUMINATION.—It has been noted that water gas obtained by decomposing water with red hot coke costs little, and it is also observed that by mixing this gas with ordinary coal gas the heating power may be notably increased.

Several towns, profiting by this fact, have permission to use this mixture, thus causing a reduction in the price of gas for illumination, for motive power, and for heating. The mixture however is not devoid of dangers, owing to the presence of oxide of carbon, which is found in large quantities, even exceeding 20 %. Now, however, according to a report in the *Revue Scientifique* an English industry has discovered a method of liberating the water gas from the oxide of carbon.

E. T. THACKERAY.

RECENT PUBLICATIONS.

Instructions for Practice: Siege Artillery. Official. (8vo. 3d. Wyman).

The Solution of Tactical Problems. A logical and easy way of working out the Tactical Schemes set at Examinations, by Lieut.-Colonel J. Layland Needham, *p.s.c.* (8½ × 5½. 3s. 6d. Hugh Rees).

Essai sur l'Emploi Tactique de la Fortification de Campagne, par Lieut.-Colonel L. Piarron de Mondésir. (8vo. 3 fr. Berger-Levrault, Paris).

The Application of Military History to Modern Warfare, by Capt. J. W. E. Donaldson. (7½ × 5. 10s. 6d. Thacker).

A Dictionary of Russian Military and Naval Technical Terms, by Capt. V. Ferguson. (12mo. 3s. 6d. Wyman).

Fontenoy. Great Britain's Share in the War of the Austrian Succession, 1741–48, by F. H. Skrine. (9 × 6. 21s. Blackwood).

Cromwell: The Campaigns of Edge Hill, Marston Moor, Naseby, and of 1648 in the North of England, by Capt. P. A. Charrier, Royal Munster Fusiliers. (11 × 8. 6s. Relfe Bros.).

Wolfe and Montcalm, by the Abbé H. R. C. Casgrain. (21s. Jack).

The Enemy in our Midst. The Story of a German Raid on England, by Walter Wood. (7½ × 5. 6s. Long).

Specification (1906). (13 × 8½. 2s. 6d. Builders' Journal and Architectural Record).

Gothic Architecture in England, by Francis Bond. (31s. 6d. Batsford).

A History of Architectural Development, by F. M. Simpson, Professor of Architecture, University College, London. Vol. I. (two more to follow). (12s. 6d. Longmans).

Modern Tunnel Practice, by D. McNeely Stauffer. (10 × 6½. 21s. Constable).

Electrical Engineering in Theory and Practice, by G. D. A. Parr, Head of the Electrical Engineering Department, Leeds University. (9 × 6. 12s. Macmillan).

The Principles of Electric Wave Telegraphy, by J. A. Fleming, Professor of Electrical Engineering, University College, London. (9 × 6. 24s. Longmans).

Le Tachéomètre et ses applications aux levers des plans et aux tracés de chemins de fer, Autoréduction, Photo-grammétrie, par J. d'Angelo. (8vo. 10 fr. Beranger, Paris).

Notice sur l'installation du Camp d'Instruction de Mailly, par Capt. M. Menu. (8vo 3 fr. Berger-Levrault, Paris).

The Cambridge Modern History: Vol. IX. Napoleon. (9½ × 6½. 16s. Cambridge University Press).

British Citizenship, Its Rights and Duties. Our System of Government—Legislature, Executive Government, the Judiciary, Local Government, by Sir J. Lawson Walton. (7½ × 5. 2s. Ralph, Holland).

Western Culture in Eastern Lands. A Comparison of the Methods adopted by England and Russia in the Middle East, by Arminius Vambéry, C.V.O. (12s. Murray).

China and her People. Observations, Reminiscences, and Conclusions of an American Diplomat, by Charles Denby. 2 vols. (8vo. Boston).

Makers of Japan, by J. Morris. (9 × 5½. 12s. 6d. Methuen).

Golgotha and the Holy Sepulchre, by the late Major-General Sir Charles W. Wilson, K.C.B., K.C.M.G., late R.E., edited by Colonel Sir Charles M. Watson, K.C.M.G., C.B., late R.E. (8½ × 5½. 6s. Palestine Exploration Fund).

A History of Assam, by E. A. Gait, I.C.S. (9 × 6. 15s. Thacker).

A Vision of India, by Sidney Low, special correspondent during the tour of H.R.H. the Prince of Wales. (8½ × 5½. 10s. 6d. Smith, Elder).

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Australia's Aspirations, by Claude H. Hill, C.I.E. (7½ × 5. 1s. Spottiswoode).

Sport and Travel: Abyssinia and British East Africa, by Lord Hindlip. (9 × 6. 21s. Unwin).

SOME IDEAS ON FIELD ENGINEERING.

OVERHEAD COVER IN PERMANENT FIRE TRENCH

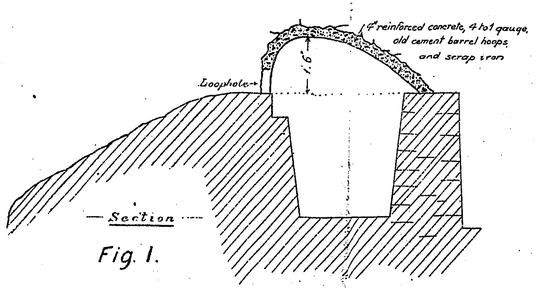


Fig. 1.

ELECTRIC MINE FOR RAILWAY LINES.

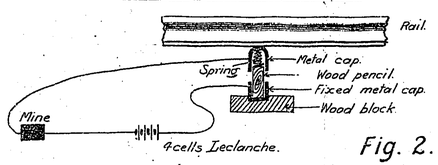


Fig. 2.

DETAIL OF STANDARD FOR HAND RAIL.

Scale 1" to 1'.

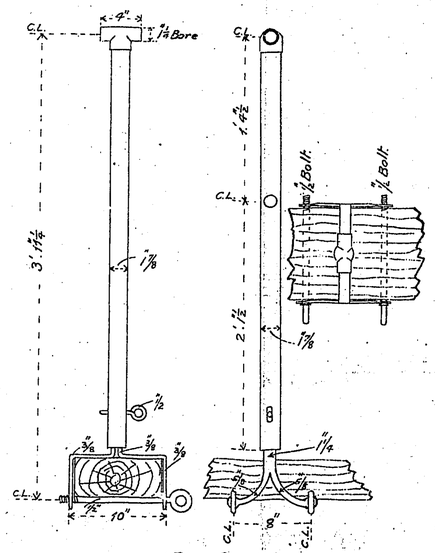
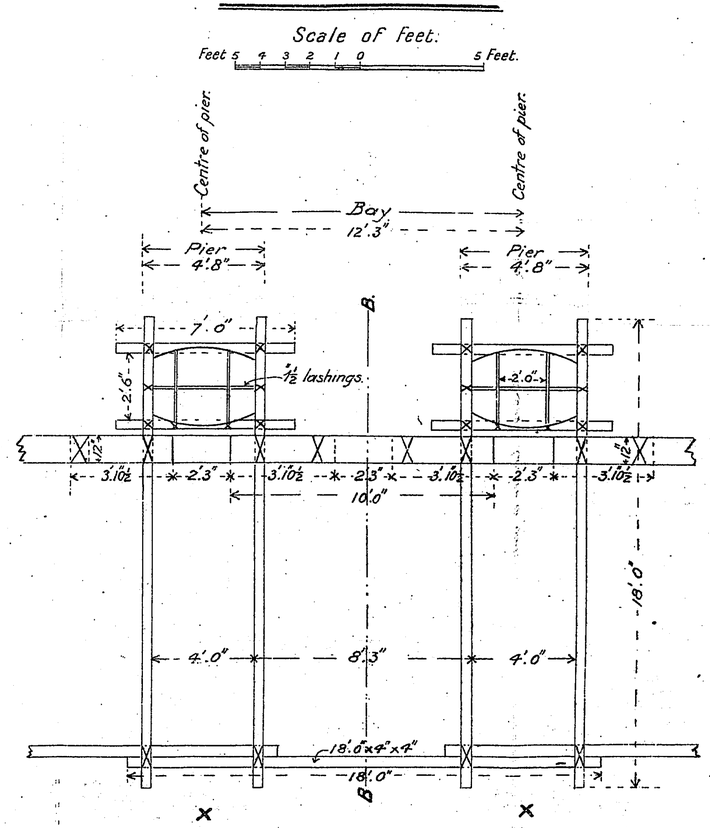
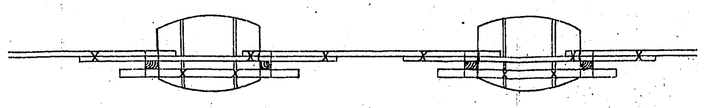


Fig. 3.

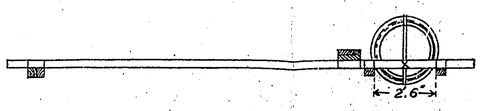
INFANTRY FOOTBRIDGE.



PLAN OF ONE BAY



ELEVATION. (looking from X X)



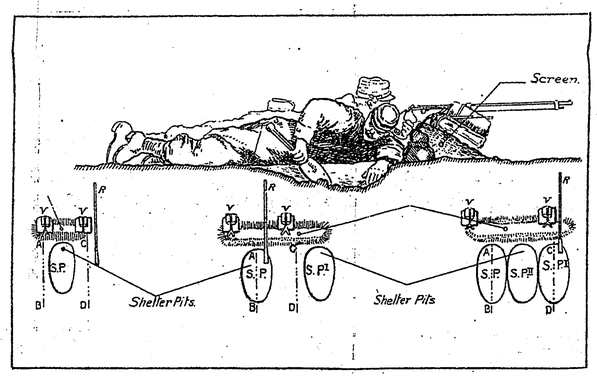
SECTION B.B.

Fig. 4.

PLATE SHOWING SHELTER PIT MADE BY TWO COMPANIONS.

Reference.

V = Valise.
R = Rifle in firing position of soldier not digging.
A.B.= Ground occupied by one of the soldiers.
C.D.= do: do: do: do: do:
S.P., S.P.I , S.P.II = Shelter Pits.



1st Period. Plan.

A B digs out S.P. throwing up screen between the two valises V. and V.

2nd Period. Plan.

A B is ready to fire out of S.P; C D digs out pit S.P.I, and throws up screen on right of his valise prolonging existing screen.

3rd Period. Plan.

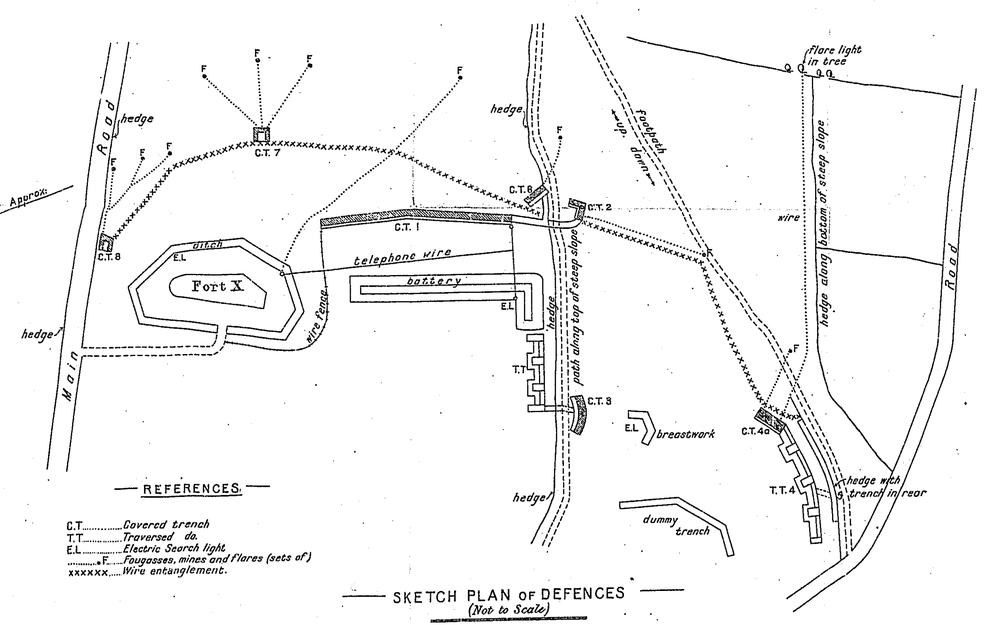
A B starts digging again and excavates pit S.P.II and increases thickness of screen. C D is ready to fire out of S.P.I and brings his valise close to his side.

4th and subsequent Periods.

The two companions work and fire alternately, and gradually get into more convenient positions as screen and pit give greater shelter.

Fig. 5.

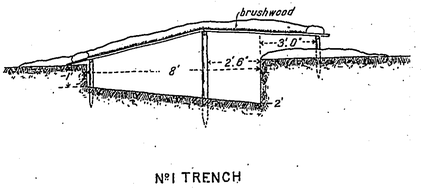
NIGHT OPERATIONS AT CHATHAM



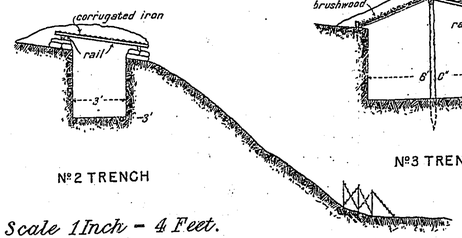
REFERENCES.

C.T. ..... Covered trench
T.T. ..... Traversed do.
E.L. ..... Electric Search light
..... F. ..... Fougasses, mines and Flares (sets of)
xxxxxx ..... Wire entanglement.

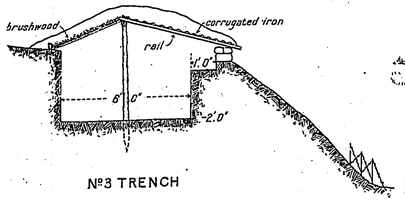
SKETCH PLAN OF DEFENCES
(Not to Scale)



Nº1 TRENCH

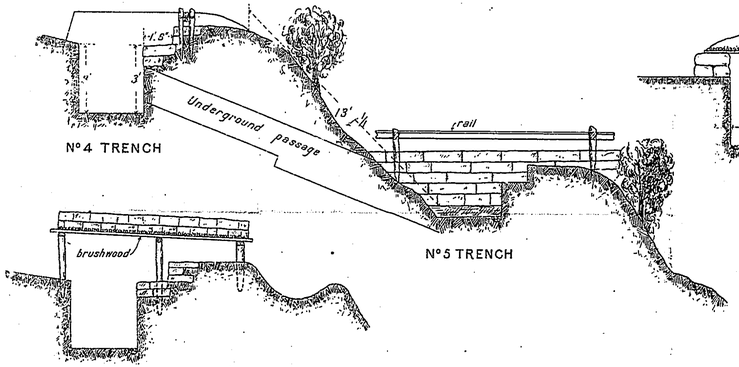


Nº2 TRENCH



Nº3 TRENCH

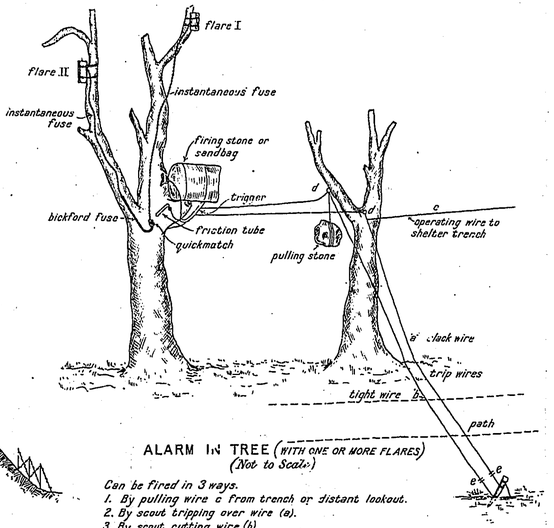
Scale 1 Inch - 4 Feet.



Nº4 TRENCH

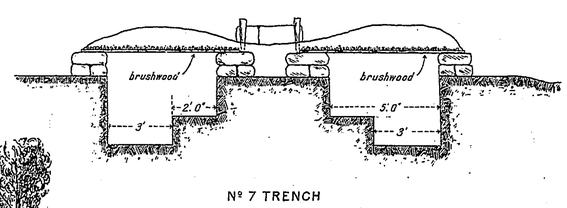
Nº5 TRENCH

Nº4a TRENCH

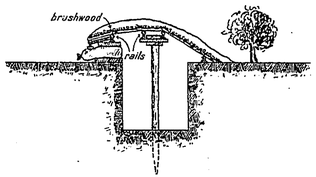


ALARM IN TREE (WITH ONE OR MORE FLARES)
(Not to Scale)

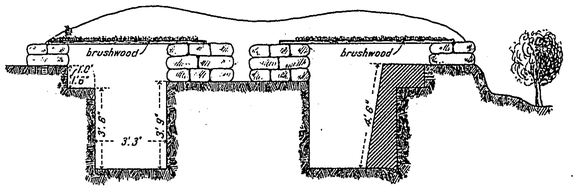
Can be fired in 3 ways.
1. By pulling wire c from trench or distant lookout.
2. By scout tripping over wire (a).
3. By scout cutting wire (b).
Flare II to light after a given interval, when Flare I has burnt out. Both sandbags and flares should be masked with foliage or grass.
d. Picture frame eyes; e. Hook and eye connection.



Nº 7 TRENCH

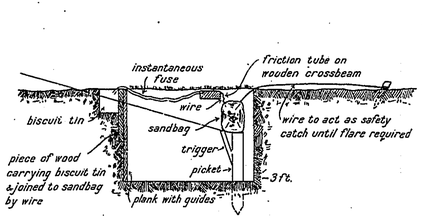


Nº6 TRENCH

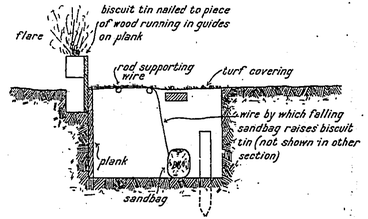


Nº8 TRENCH

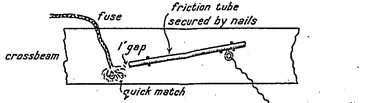
Scale 1 Inch - 4 Feet



DOWN



UP



METHOD OF FIXING FRICTION TUBE
(The whole covered with canvas)

JACK-IN-THE-BOX FLARE
(Not to Scale)

This flare had a double trip, one to cut and one to pull

INFLUENCE OF RATE ON ACCURACY OF FIRE

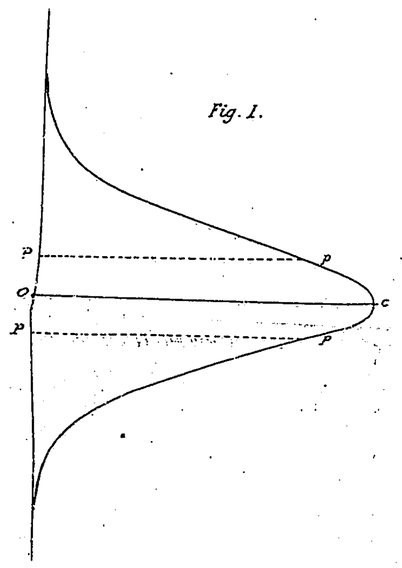


Fig. 1.

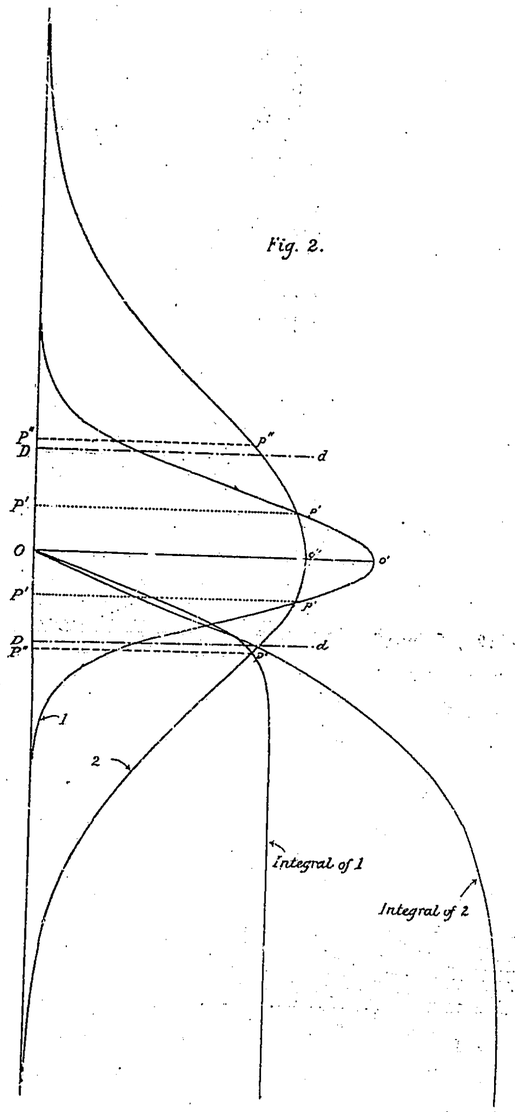


Fig. 2.

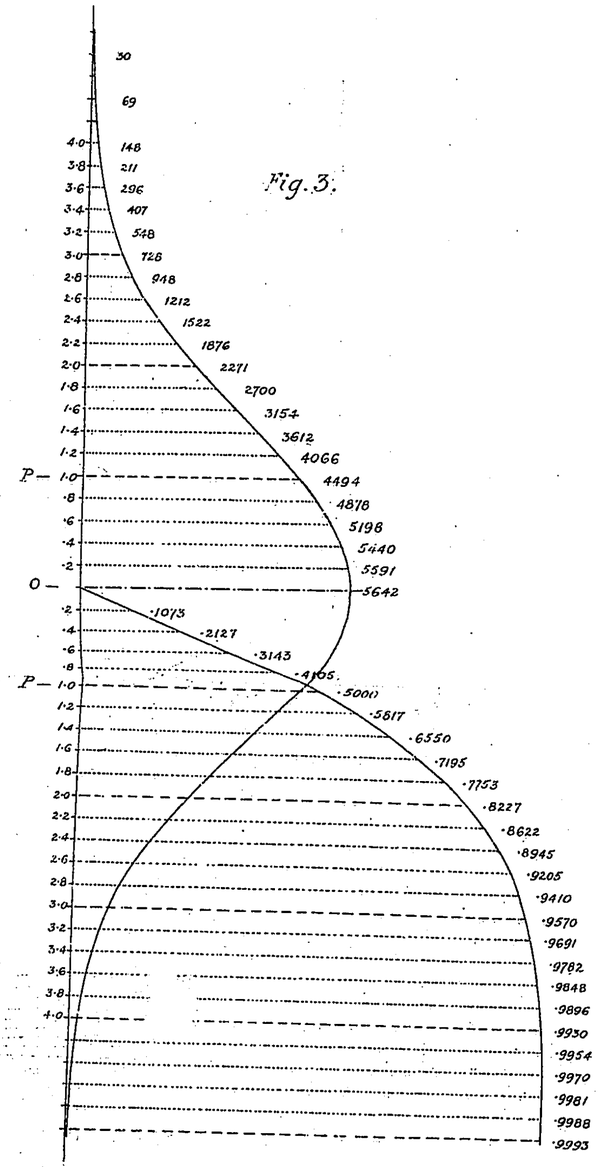


Fig. 3.

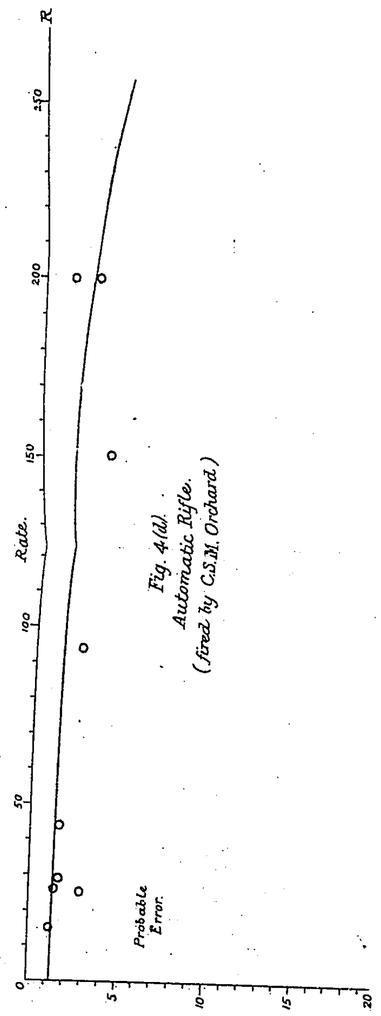


Fig. 4(d).
Automatic Rifle.
(fired by C.S.M. Orchard.)

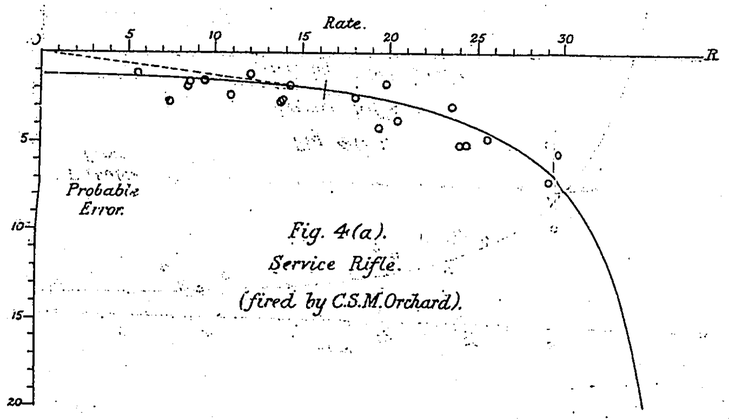


Fig. 4(a).
Service Rifle.
(fired by C.S.M. Orchard).

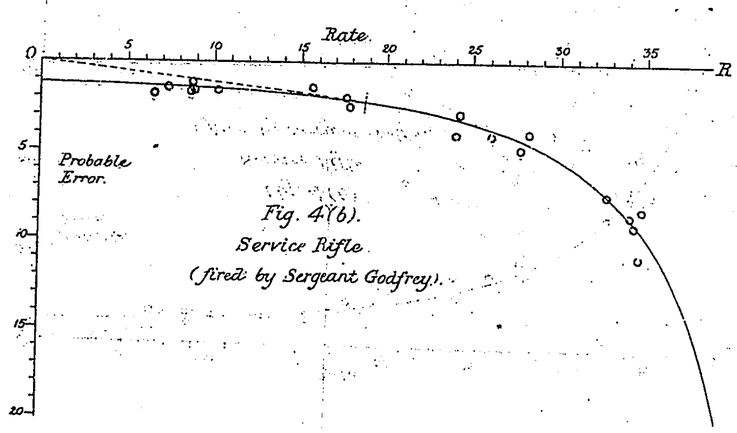


Fig. 4(b).
Service Rifle
(fired by Sergeant Godfrey).

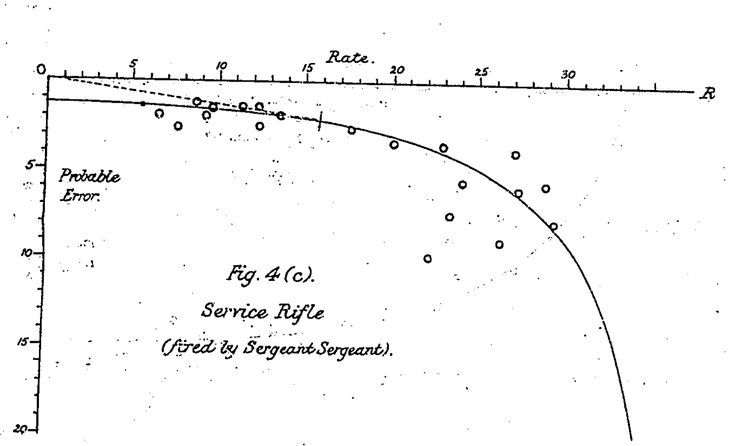


Fig. 4(c).
Service Rifle
(fired by Sergeant Sergeant).

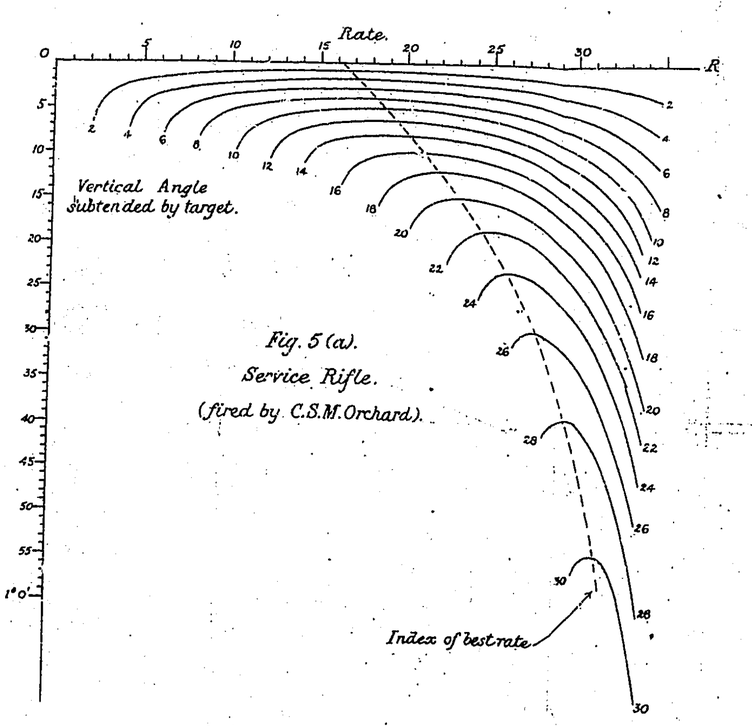


Fig. 5(a).
Service Rifle.
(fired by C.S.M. Orchard).

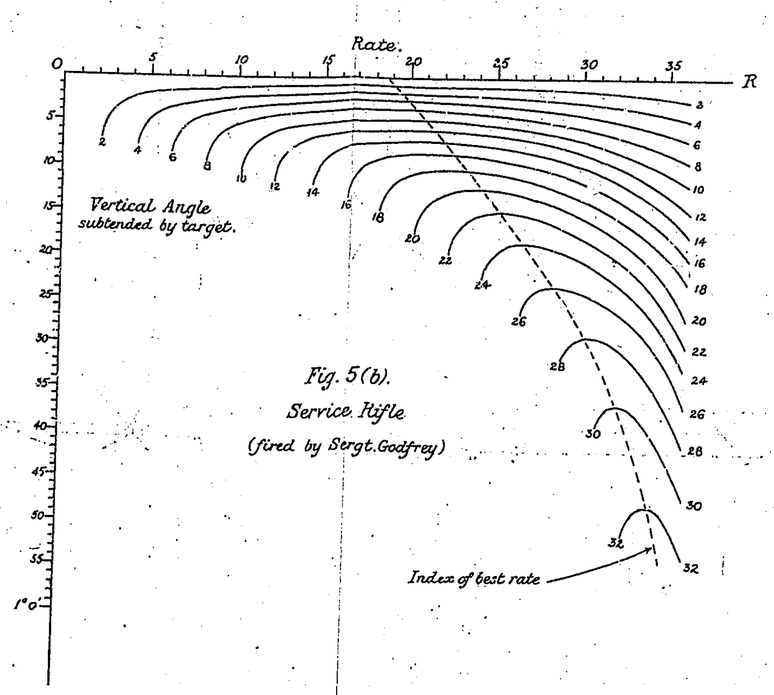


Fig. 5(b).
Service Rifle
(fired by Sergt. Godfrey)

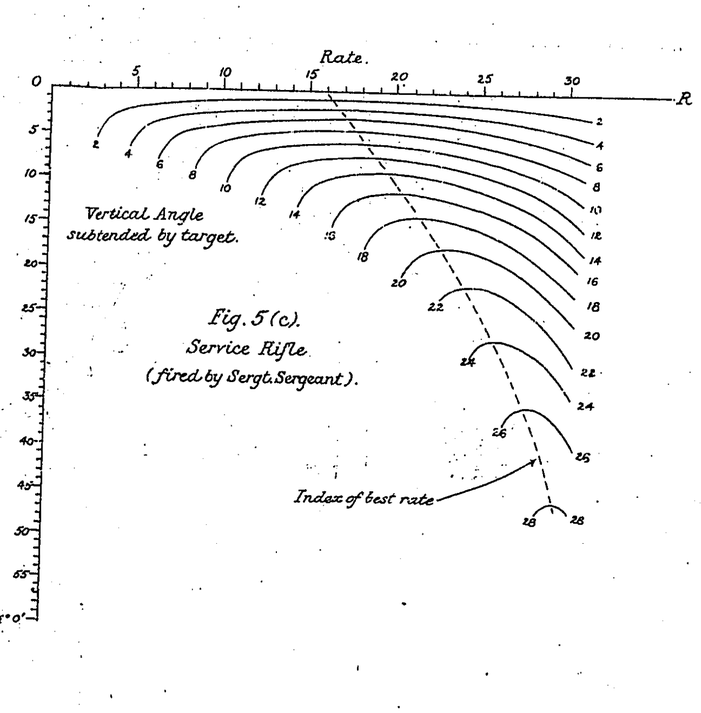


Fig. 5(c).
Service Rifle
(fired by Sergt. Sergeant).

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Recent Successes Include:—

STAFF COLLEGE, AUGUST, 1905.

ON THE COMPETITIVE LIST.

Capt. E. B. Ashmore.....Royal Horse Arty.
,, W. H. F. Weber*...Royal Horse Arty.
,, H. A. Boyce*.....Royal Field Arty.
,, A. A. Montgomery...Royal Field Arty.
,, F. W. Brunner.....Royal Engineers.
,, W. Robertson .....Royal Engineers.
Bt.-Major B. T. Buckley...Northumberland Fusiliers.
Capt. G. D. Jebb, D.S.O. Bedfordshire Regt.
,, J. W. O'Dowda... R. West Kent Regt.
,, J. H. Davidson, D.S.O. King's Royal Rifle Corps.
,, R. J. Drake.....North Staffordshire Regiment.
,, H. E. M. Hutchinson West India Regt.
,, E. F. Orton.....Indian Army.

THE FOLLOWING RECEIVED NOMINATIONS.

Bt.-Maj. T. A. Cubitt, D.S.O. Royal Field Arty.
Capt. M. G. E. Bowman-Manifold, D.S.O.....Royal Engineers.
,, W. E. M. Tyndall, D.S.O.....West Riding Regt.
Capt. G. J. Farmar.....Lancashire Fus.
,, R. F. Riley, D.S.O...Yorkshire Lt. Infy.
,, C. C. Newnham....Indian Army.

*Read partly at the Army College, Aldershot.

August, 1904.

SEVENTEEN passed on the Competitive List and THREE received Nominations.

August, 1903.

TWELVE passed in the Competitive List and FIVE received Nominations.

August, 1902.

ELEVEN passed in the Competitive List and FIVE received Nominations.

PROMOTION.

More than EIGHTY OFFICERS who Read with us PASSED (*d*) in May last.

WOOLWICH, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SECOND	H. G. MacGEORGE	7,196
FOURTH	G. WALTON	7,046
FIFTH	H. A. COX	6,967
16th	R. CROFTON	6,330
45th	D. STEPHENSON	5,899
54th	J. KENNEDY	5,711

SANDHURST, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SEVENTH	L. H. CRIPPS	5,144
46th	M. E. C. JOSEPH	4,336
58th	A. G. D. O'FLYNN	4,215
59th	P. J. R. WIGLEY	4,212
61st	G. C. I. HERVEY	4,187

ARMY QUALIFYING (SEPTEMBER), FOUR.

PROMOTION.

More than EIGHTY Officers who read with us PASSED (*d*) in MAY LAST.

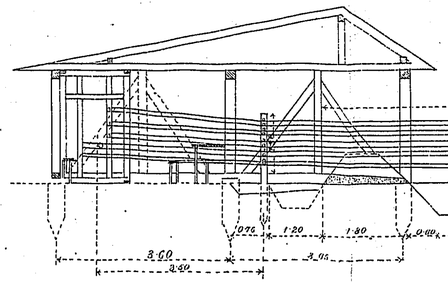
Work for both "C" and "D" is now going on.

Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.

MINATURE RIFLE RANGE IN AUSTRIA

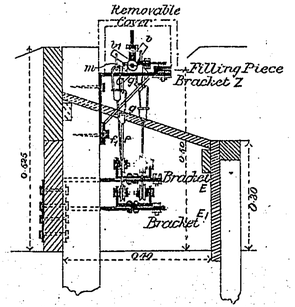
Cross Section of Firing Point



Longitudinal Section

Scale 1/75

End Elevation of Targets 1 & 3



Back Elevation of Targets 1 & 2

Scale 1/10

Targets 1 (& 3) ready for firing