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CHATHAM:

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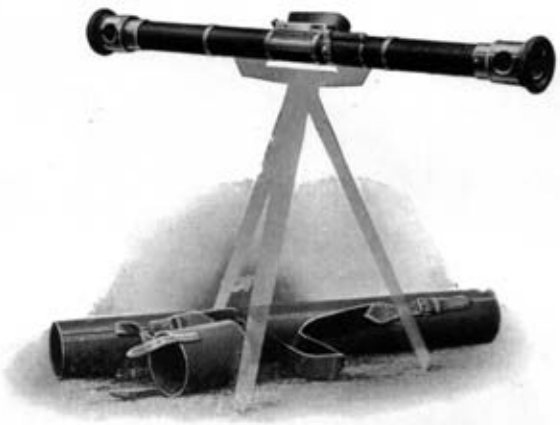


BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 1 METRE BASE.
FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

Approximate uncertainty of observation:—

5 yards at 1,000 yards.
40 yards at 3,000 yards.
170 yards at 6,000 yards.

Barr & Stroud Rangefinder

1. Flying Bridge made with Native Canoes.

3. Timber Trestle Bridge, length 140 ft., centre span 20 ft.

2. Arched Foot-Bridge made with Bamboos.

4. Suspension Foot-Bridge made with Bamboos and Creepers, 60 ft. span.

LIGHT BRIDGING IN BURMA

LIGHT BRIDGING IN BURMA.

By CAPT. D. FORSTER, R.E.

DURING the cold weather of 1905 No. 15 (Burma) Company of the 2nd (Queen's Own) Sappers and Miners proceeded to the village of Shwezayan on the Myitngè river, about 20 miles from Mandalay (the headquarters of the Company), for three weeks' bridging practice.

The British Officers were Lieuts. D. Forster, R.E., and (the late) C. W. Bushell, R.E.; and Lieut.-Colonel F. J. Anderson, R.E., the Commandant of the "Q.O." Sappers and Miners, who had come over from Bangalore to inspect the Company, was present during the first few days of the practice.

A suitable and pleasant site for the camp was found close to the village in a mango grove on the banks of the river.

The following stores were brought from Mandalay in addition to ordinary tools:—

1 small boat (a 15-ft. gig).
84 ft. of light pontoon bridge, carried by 13 mules.
100 fathoms 3-in. steel rope.
200 do. 1-in. do.
1 traveller for 3-in. rope.

The R. Myitngè, which drains a large portion of the Northern Shan States, emerges from the Shan Hills a few miles above Shwezayan, where it has an average breadth of 180 yds., and joins the Irrawaddy 7 miles south of Mandalay.

The country round Shwezayan is flat. It is covered with dense jungle, mostly low bamboo, interspersed with patches of cultivation and, near the village, with lime and mango orchards.

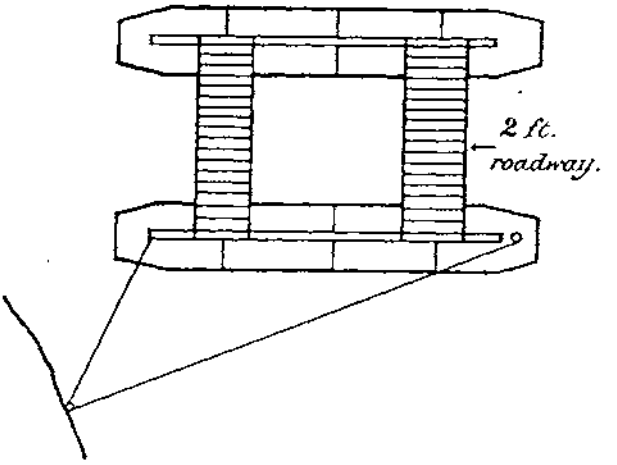
The work carried out consisted of

(i.). Flying Bridges over the R. Myitngè.
(ii.). Bamboo Bridge over a creek of the Myitngè.
(iii.). Timber Trestle Bridge over the Nadaungchachaung (a tributary of the Myitngè, which flows into it a little below the site of our camp).
(iv.). Overhead Cable-Way over the Nadaungchachaung.
(v.). Pontoon Bridge over the Nadaungchachaung.
(vi.). Rowing practice.

FLYING BRIDGES.

The Flying Bridges consisted of an overhead cable of 1-in. steel rope, carrying a small single block, to which the raft was attached. The ends of the cable were secured on either bank at a height of about 35 ft. above the water, the span being about 800 ft. There was an island on the south side, separated from the bank by a creek 60 ft. wide.

Two kinds of rafts were used. The first was made with the light pontoon equipment as shown in figure; this carried about 20 men.



The other kind was made with two native 'dug-out' canoes, about 25 ft. long, placed 12 ft. apart and connected with a bamboo deck (see *Photo* 1). This took 50 men, and crossed the river in 3 minutes.

Bamboo landing stages were erected, projecting 25 feet into the stream.

BAMBOO ARCH BRIDGE.

To complete the crossing a Bamboo Bridge was constructed over the creek on the south side (see *Photo* 2).

The bamboo in the neighbouring jungle was too small to be of any use, so 1,000 bamboos, about 15 ft. long and $1\frac{1}{2}$ in. diameter, were purchased from a raft going downstream.

It was originally intended to make the crossing with one 'fascine arch,' with a clear span of 70 ft.; but the bamboo was too small and green, and trestles had to be used as well. The bridge sloped up to the south bank at about $\frac{1}{12}$.

TIMBER TRESTLE BRIDGE.

There is a village named Kyauk-o, half a mile from Shwezayan and just across a ford on the Nadaungchachaung. At this ford the east and west banks of the river are 20 ft. and 30 ft. high respectively, and the width of the stream 40 ft.

A timber trestle bridge was constructed, with the roadway on a level with the east bank (see *Photo* 3). The total length was 140 ft., the centre span being 20 ft. and the remainder 12 ft.

There were two tiers of trestles. The first consisted of piles, 5 to each trestle, driven with a Norton's Tube Well monkey. The second tier was built up with trestles made on shore and placed with the help of the traveller on the overhead cable.

All the timber was cut in the jungle, some at a considerable distance, except that for part of the roadway; for this some old teak posts, which had belonged to a Burmese bridge further downstream, were used.

The 3-in. overhead cable was taken over the forks of trees on either bank, and was of great use.

PONTOON BRIDGE.

A Pontoon Bridge was made just below the trestle bridge, for use during the construction of the latter.

The pontoons, which were made in the Company's workshops at Mandalay, are very similar to those shown at the end of the old Vol. III. of *Instruction in Military Engineering*, except as follows.

The superstructure consists of a 2-ft. roadway supported by 3 folding roadbearers of teak, 12 ft. long, with two hinges, the centre portion being 2 in. × 4 in. and the end thirds tapering to 1 in. × 4 in.

The roadway consists of teak battens, 2 in. × 1 in., fastened together with 1-in. rope, leaving 1 in. space between battens so that the whole will roll up. Successive lengths of 12 ft. are fastened together with small iron hooks and eyes. No ribands are required; a 1-in. rope handrail along one side is provided.

BAMBOO SUSPENSION BRIDGE.

In January, 1905, the Company proceeded to the Shan Hills for manœuvres, etc.

The Left Half Company, under Jemadar Maungaungbaw, made two bridges from verbal instructions.

(1). A Suspension Bridge of 60 ft. span, which was made with creepers and bamboos growing in the vicinity (see *Photo* 4). This would take infantry at about 3 paces interval.

(2). A 'Fascine Arch' Bridge with 30 ft. clear span, similar to that mentioned above, but without the aid of trestles.

BAMBOO OBSERVATORY.

They also made a Field Observatory in rear of an entrenched position near Maymyo. The uprights were single bamboos 50 ft. long. The whole of the bamboos were bought in a neighbouring village, and cost only Rs. 3/8 (4s. 8d.).

THE CAMPAIGN OF THE FUTURE.

A Possible Development.

By Capt. C. E. P. Sankey, R.E.

"Generally speaking an engagement between two hostile forces, be they large or small, begins either by one side in motion attacking the other while stationary or by the collision of both sides when in movement.

The exceptional case of troops meeting when both hostile forces are stationary is, I regret to say, omitted in the Drill Book" (Major-General George D'Ordel in *Tactics and Military Training*).

The last para. is an example of a true word spoken in jest. It has been noticed by the more modern writers on the attack and defence of permanent works of fortification that the formerly sharp line of demarkation between these operations and those connected with the collision of two armies in the field has become considerably less distinct, but it is doubtful if strategical and tactical writers have given this point the attention it deserves. In olden days there was a very great difference between the etiquette and science appertaining to the investment and capture of a citadel on the one hand, and on the other to the conflict between two manœuvring hosts.

As mentioned above, this distinction has gradually become less and less defined, and now some of our recent experts on fortresses (for instance, Capt. Thuillier, R.E., in *The Principles of Land Defence*) state that the types of entrenchments and parapets suitable for even first-class permanent works are little, if at all, heavier or more complicated than those employed by a field army on the defensive.

The point to be noticed, however, is that this modification is also operating at the other end of the scale, and that the types of trenches suitable for field armies are gradually becoming more and more like those employed in permanent works.

The logical outcome of this continued approach from two extremes is a common mean, where it will be difficult to say whether a force acting on the offensive is attacking an entrenched and defensive field army or an enemy holding a fortress, improvised in some haste, perhaps, but still a fortress.

The experiences of the recent Russo-Japanese war will to a very great extent bear out this theory. Whereas formerly the operation of reducing a fortress possibly occupied years and a battle was an affair

of hours, the sieges of this campaign have been measured by months and the battles by days. Moreover the Japanese, even on the offensive, have almost invariably entrenched themselves at the completion of each phase of the attack. May we not expect that in conflicts between two powers, not more individually civilised than these combatants but operating in a more civilised theatre of campaign and employing considerably larger forces, sieges and battles will both be reckoned in weeks and will be in fact indistinguishable?

Take a case of two of the larger European continental nations, having a common frontier of say 1,000 miles, being at war. The number of men that each can put into the field would probably be between 2 and 4 millions, that is 2,000 to 4,000 men per mile of common frontier, which number does not differ very largely from the most recent estimate of that required for a modern fortress.

Moreover this common frontier will be secured, probably on each side, by a chain of fortresses, which, being constructed and maintained in peace, may be called permanent. With modern specialised arrangements for mobilisation, there will probably be no time for one side or the other to reduce any of these strongholds before their opponents are prepared; and there is no need to point to the danger of advancing past these hostile fortresses, situated, as they would surely be, upon the main arteries of traffic that would form the lines of communication.

What then will be the result? The cavalry forces of both sides will be hurriedly mobilised, and pushed forward as far as prudence allows; contact will therefore be probably obtained along some line, which will be between the hostile chains of fortresses and only limited in extent by the length of common frontier. The infantry, mobilised perhaps as quickly but moving more slowly, will arrive on either side of this line and will take up entrenched positions, the flanks of which will be secured by political rather than by natural obstacles. The heavy artillery will be slower still, but will also be of a more formidable nature than what has hitherto been considered the maximum possible for a field army.

If, during these preliminary stages, neither side has blundered badly, allowing a keen-witted and daring enemy to strike a quick blow, the situation will be that each force will have taken up an entrenched position within striking distance of the other, a compromise being effected between (*a*) choosing the best topographical line of defence, (*b*) being within reach of the enemy, and (*c*) conforming to the general line of the permanent fortifications. Each army will then practically become the garrison of an enormously extended fortress, the original permanent works becoming the pivots of the line.

From this situation whichever side assumes the offensive will also assume the *rôle* of a force besieging one of these fortresses, with the consequence that all the artifices peculiar to this species of warfare will

be employed, such as sapping and mining, the use of heavy siege guns, howitzers, and mortars, etc., etc. Moreover the attack, considered as a whole, will be frontal, although of course flanking movements will still be possible on a small and local scale.

As experience has shown, these operations are not affairs of a few hours or days only ; and with the highly civilised condition of to-day a state of war between two countries cannot be allowed to extend for an indefinite period, interfering as it does with the trade of the whole world. Also, with the concentration of events in modern warfare, due principally to quicker modes of transport, it is doubtful whether the people of the combatant nations themselves will stand the moral strain for periods as protracted as of old ; and, further, the financial strain of maintaining these huge forces will be enormous. The newspaper correspondents will be another powerful factor in this direction.

Hence the side that first penetrates the opposing defences, thus winning a victory—it may be a local one only—will probably be considered by the surrounding nations to be the victor ; and the other side also will be compelled by them to acknowledge this fact, and to pay an indemnity or cede territory as the case may be.

It has always been held that the life and growth of nations may be compared to that of man individually, though on a larger and more protracted scale. May we not here trace the same analogy ? Formerly, and not so very many centuries ago, when two individuals became foes, their enmity entailed conflict on every occasion, the quarrel only ceasing on the death of one or other of the adversaries. Latterly, in the period of the duel, honour has been satisfied by the drawing of first blood (often in microscopical quantities). More recently again there is reason to hope that even this speedily-determined species of combat may become obsolete. To draw the parallel—in other ages the cost of defeat in a campaign was extinction as a nation ; nowadays an indemnity or the loss of outlying possessions is thought sufficient, though a lengthy war is still deemed necessary to discover the victor. May we not consider that in the future one battle will be the test, that side obtaining the victory which first penetrates the enemy's fortress ?

It would be beyond the scope of this present essay to continue the analogy to that peaceful and possibly distant future when the wolf shall dwell with the lamb and the leopard lie down with the kid.

BREEZE CONCRETE IN ROOF COVERINGS.

By LIEUT.-COL. W. H. SYKES, LATE R.E.

I HAVE recently had the opportunity of observing the erection (under the superintendence of Mr. Ralph Nevill, F.S.A.) of a house and stables, wherein the employment of breeze concrete under tiles has been adopted. Although this system is not a novelty, it having been used by Mr. Nevill for over 25 years, it appears to be rarely employed in War Department works, and perhaps it deserves to be better known.

The best description that I can give is by reference to Mr. Nevill's specification, which he has kindly placed at my disposal: this reference is partial and brief, but further details can be readily obtained.

The plaster laths are first put on the inside of the rafters.

The outside of the rafters is then laid with single fir laths.

Rose nails, 2½-inch, are then driven into the back of each rafter, 4 inches apart, and left projecting 1 inch to form a key or holding for the concrete.

The concrete is made of 1 part Selenitic lime and Portland cement (mixed in proportion of 3 to 1) to 3 of ashes and 1 of sharp sand. Portland cement without the lime may be used if more convenient; the ashes may be coke-breeze or clean siftings from engine ashes, etc. The mortar thus made is laid on the laths, above the eaves lath, in long strips 1¼ inches thick, and carefully trowelled.

In 6 to 12 hours the concrete is sufficiently set to hold the tile pins, which may at this stage be pressed in by the thumb, or at a later stage a hammer may be used; the latter method is perhaps preferable, if there is any fear of the soft concrete dragging with the weight of the tiling.

It is necessary to sling a cradle over the ridge to support the workmen, the cradle resting of course on well-stuffed bags.

The ridge must be fixed as the work proceeds, and the tiling should be carried up from both sides of the ridge simultaneously, or nearly so.

The thickness of the concrete against chimneys, barge boards, etc., should be slightly increased to give the necessary tilt.

The process above described refers to tiling, but the system is equally applicable to a slated or an iron covered roof, and, with slight variations, to lead, copper, zinc, etc.

As regards weight there is little difference between the concrete and felted boards, the breeze being, as we all know, very light.

The cost is of course an initial extra over plain tiling on laths, and in the case of slating the difference between concrete and rough boarding can readily be estimated. Mr. Nevill states that 15 shillings per square is a full approximate price for the concreting, and no additional strength is necessary either in the walls or roof timbers.

The advantages of the system are apparent almost without enumeration. The presence of an impervious sheet of concrete, which is bound to keep out snow, rain, and wind, and to ensure extra warmth in winter and coolness in summer, must be a great gain to the householder; and Mr. Nevill further remarks that it would be a great protection against the rapid spread of fire in a roof.

It is probable also that under this system there would be a considerable diminution in those small breakages which the slater produces when nailing, and which he usually conceals, much to the future trouble and expense of the property owner.

One great advantage must surely be in durability and cleanliness as compared with the results following the employment of felt and of various other materials, which in course of years become inoperative and, after becoming rotten themselves, communicate their rot to the boards and leave the slates loose and leaky.

NOTES ON LOOPHOLES.

By Capt. H. O. Mance, d.s.o., R.E.

It is easy to dismiss the subject of loopholes with the remark that any fool can make them, provided he remembers that they must give a good view of the enemy, sufficient field of fire, a maximum of cover, ample scope for the necessary elevation and depression of the rifle, and be as invisible as possible. This is all very well, but a few attempts to make out of various materials the best possible loophole for a sited fire-trench will probably disclose the desirability of enquiring rather more fully into the application of the above principles.

It is not intended to imply that victory will invariably lie with the side employing the most efficient types of loopholes. Cases may arise where the kind of head cover or the entire absence of it are of comparatively small importance. But on the other hand, in situations where, for example, both sides are entrenched at close quarters (as was the case at Mafeking) an enormous advantage might (and did) accrue to that side which designed the most effective pattern of head cover. Besides, generally speaking, the more effective the defences are, the greater the number of men available for the counter-attack or striking force.

Reverting to the opening description of a loophole one is first struck with the fact that all the conditions except that of invisibility are very much influenced by the thickness of the material used necessary to keep out a bullet. The less this is, the easier it is to make the loophole conform to the conditions. In the case of a steel plate it is obvious that a very perfect type of loophole can be attained. Conversely a sandbag loophole with clayey soil, necessitating a thickness of about 5 feet to be bullet-proof, would be almost impracticable.

Yet earth will always be the principal and frequently the only material for head cover, and it behoves us to consider in what way its inherent disadvantages can be minimised. The following notes deal almost exclusively with sandbag loopholes, and no reference has been made to many better types of loopholes which can be made with other materials than earth.

Earth head-cover in its simplest form may be regarded as an increased height of parapet perforated at intervals by revetted

apertures. Considering these apertures in plan the three well-known types A, B, and C in *Fig.* 1 suggest themselves.

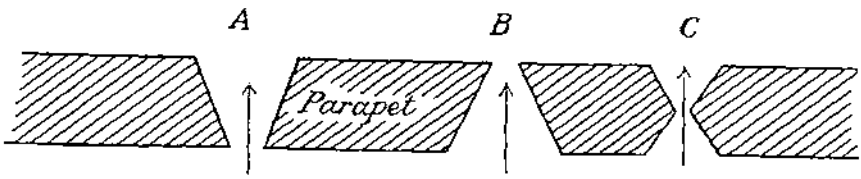


Fig. 1.—*Plan.*

Type A affords a better view of the enemy and requires less movement to fire from, but is more visible to the enemy. Type B is less visible to the enemy, but more trouble to see and fire through. Type C is a compromise between A and B; this pattern can be more easily adapted for a large field of fire.

Looking at these types from the point of view of protection from fire, it will be seen (*Figs.* 2, 3 and 4) in all the above cases that with the usual thickness of parapet, just enough to comfortably keep out bullets, shots coming from all directions P, Q, R, and S, except those indicated by P, are likely to penetrate the parapet and do damage beyond.

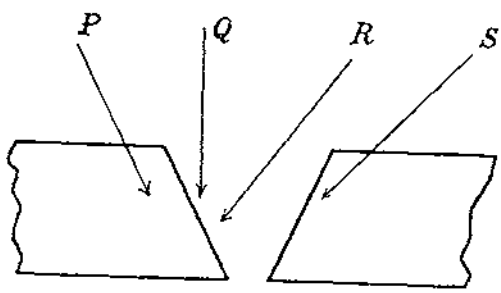


Fig. 2.—*Plan. Type A.*

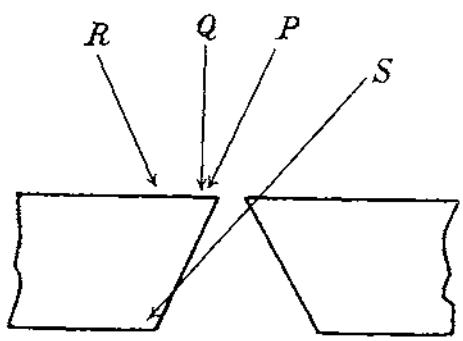


Fig. 3.—*Plan. Type B.*

It can also be seen that nothing is gained by thickening the parapet in the case of a single loophole of A or B type ; but a great deal is gained in type C, as bullets from R and S can then be kept out. The width of the danger zone for bullets coming in the direction Q is least in type C for the same field of fire.

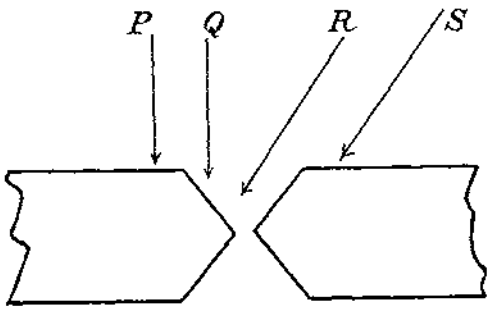


Fig. 4.—Plan. Type C.

From the above, the best type of earth loophole appears to be **X** shape in plan, the parapet being $\sqrt{2}$ times the proof thickness, assuming for example that a field of fire of 90° is desired.

It may here be pointed out that, in order to take full advantage of the increased range of modern rifles, either loopholes must be constructed with a wide field of fire or else alternative loopholes must be constructed. The former is worth trying for as being more convenient and also necessitating less labour in digging trenches. Here we are reminded that we must not confine ourselves to single loopholes, for loopholes will, as a rule, be made at minimum intervals along the parapet (*Figs.* 5, 6 and 7).

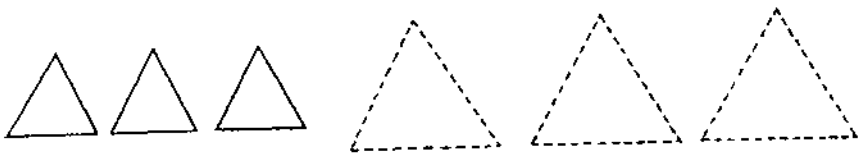


Fig. 5.—Plan. Type A.

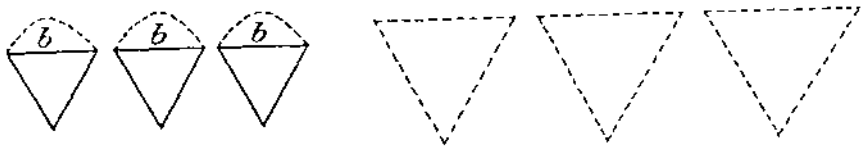


Fig. 6.—Plan. Type B.

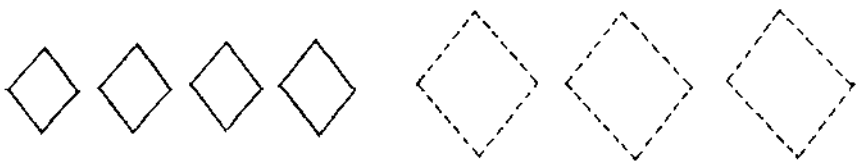


Fig. 7.—Plan. Type C.

Comparing types A, B, and C, it is evident that they are almost equally useless for keeping out bullets, unless the thickness of the parapet from front to rear is made a good deal greater than the minimum thickness proof against bullets. This thickening of the parapet results in the loopholes being spaced wider apart, and for any given field of fire the C type takes up less room besides affording more protection. The practice of putting earth between the front faces of loopholes of the B type (as at *bb*, *Fig.* 6) merely converts this loophole to one of the C type.

The head-cover need not be the full thickness of the loopholes, the proof thickness being all that is required. In the C type loophole the span of the head-cover supports is less than in either the A or B types, thus facilitating construction.

A splay of 90° has been mentioned above. This amount would be impracticable in a sandbag earth loophole except of the C type; in the latter it is not only practicable but easier to construct, as the sandbags can be laid square.

Fig. 8 shows the proposed type of loophole in ordinary soil. The corners AA can be done away with if preferred by tucking in that portion of the sandbags. Such a loophole requires careful construction if the centre opening is to be only 4″; with unskilled troops 6″ would perhaps be better. The theoretical minimum distance apart of these loopholes is 3′ 10″, but in practice it works out to about 4′ 8″.

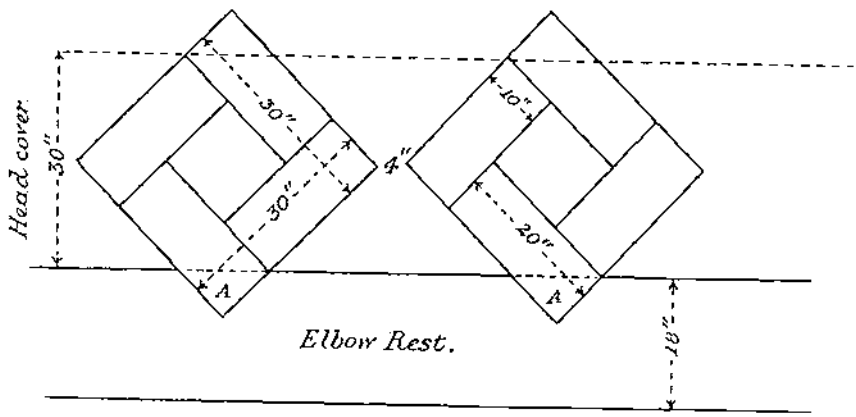


Fig 8.—*Plan. Sandbag Loophole.*

Before passing from the consideration of earth loopholes in plan, it may be mentioned that the protection obtained by an ordinary earth loophole can be much improved by placing a large movable stone, a piece of iron plate, or some other proof substance in that part of the loophole not in immediate use. A loophole as shown in *Fig.* 9 has been suggested if such substances are available.

This pattern gives a wide field of fire and a partially masked opening.

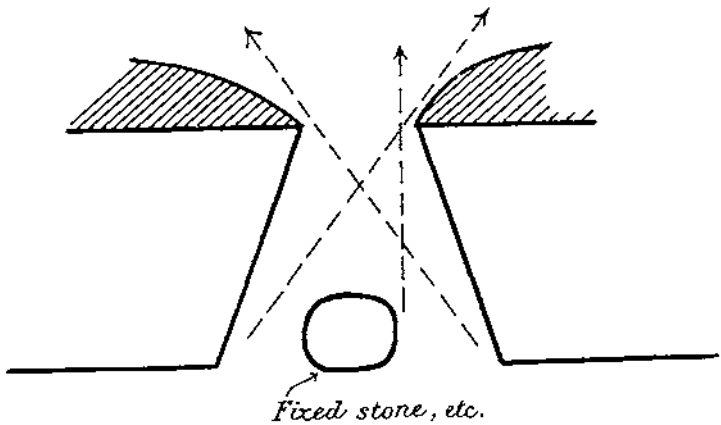


Fig. 9.

Let us now examine how the section of an earth loophole along the line of fire affects its efficiency. *Fig.* 10 shows a section through a simple type of earth loophole on a low parapet on level ground with a height of opening in front and in rear of 10 in. On level ground no depression of the rifle has to be provided for, so earth could be filled in as shown (*abc*, *Fig.* 11) without interfering with the free use of the rifle, the slope *ac* depending on the maximum elevation required. If now still more earth (*a*, *b*, *e*, *d*) is added to make this raised portion of the parapet bullet-proof, the vulnerable height of the loophole is at once reduced to about 4 in., without any compensating disadvantages and with the additional advantage of being less conspicuous. It must be noted that, as the parapet is thus raised 6 in., the trench must be made 6 in. shallower or the original parapet on which the loophole is built 6 in. lower, preferably

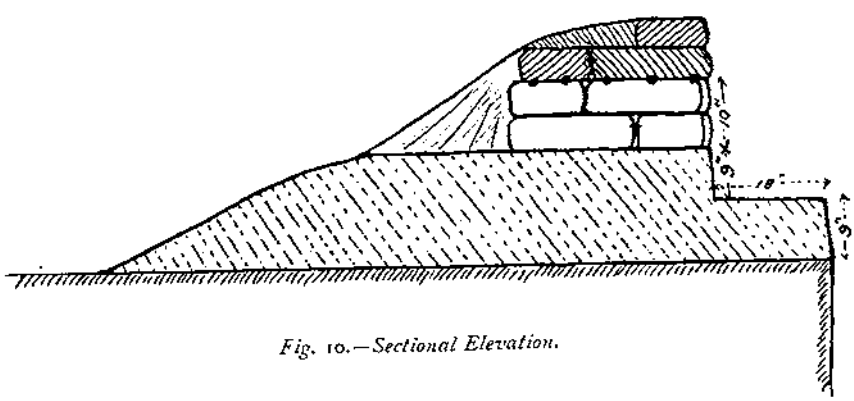


Fig. 10.—*Sectional Elevation.*

the latter as otherwise the trench will have to be widened to obtain the necessary extra earth.

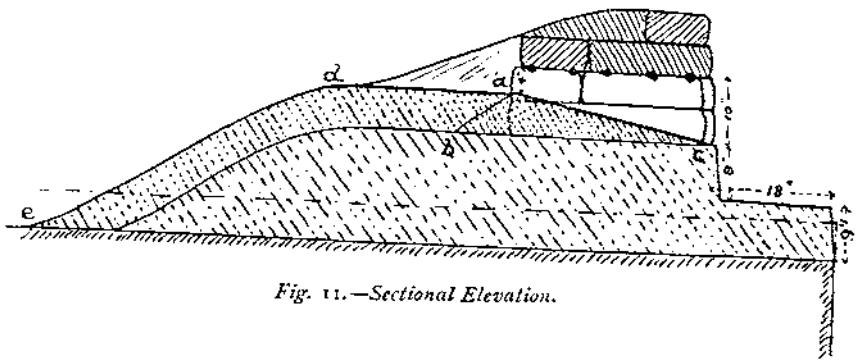


Fig. 11.—*Sectional Elevation.*

If the trench is sited for firing downhill, before starting to build the loophole, the top of the parapet must be sloped off to the lowest line of fire, and the procedure is the same as before (*Fig.* 12). The height of the loophole before filling in must be increased to three sandbags, if a large vertical arc of fire is required.

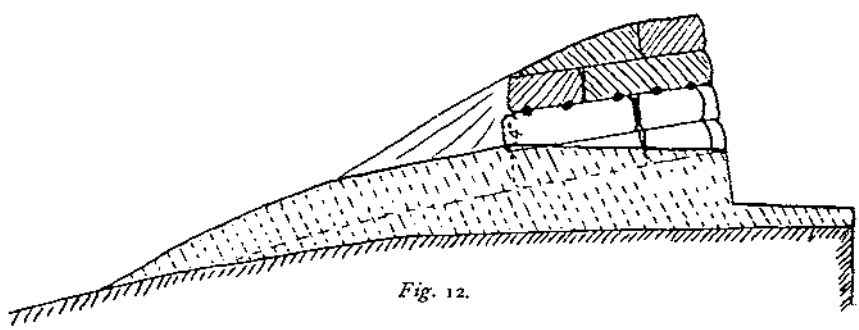


Fig. 12.

When a parapet is first constructed without head-cover on an elevated position, it is not infrequently the case in practice that the superior slope is made too level. The error is perhaps not noticed at first, as by slightly raising the eye a good field of view can be obtained. But where loopholes are added a limit is imposed on the height the eye can be raised, and the parapet has to be sloped off as shown in *Fig.* 13. Under the circumstances it is obviously impossible to improve the cover to any appreciable extent. The same principles apply to parapets sited for up-hill fire.

Great stress is now laid on the importance of affording as much protection as possible from searching fire. In the absence of overhead cover the next best plan is to get as close as possible to the parapet. The ordinary elbow rest is laid down as being 18 in. wide and 9 in. high; but in nine cases out of ten it will be found that the

rest has been made at least 6 inches wider than this, so that the loophole has the appearance of being out of reach. Special attention must therefore be paid to checking this fault ; and when cover from searching fire is specially important, the elbow rest can with advantage be made narrower, say 1 ft., in which case it must also be made correspondingly higher or it will be impossible to use it.

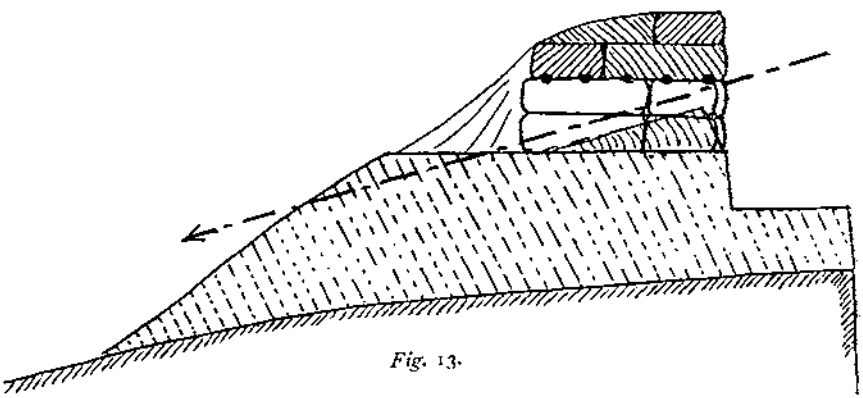


Fig. 13.

As regards concealment, this depends entirely on the nature of the ground surface and the time available. A sandbag loophole is not easily concealed, but it is surprising what can be done under favourable circumstances such as in heather, bracken, or long grass. A few small bushes or herbs planted in front of a loophole, and trimmed so as not to interfere with the view, are a great help in masking the shadow of the loophole and the aperture itself. The latter will nearly always be conspicuous unless masked in this way, or by having some sort of curtain on the inner face. Care must be taken not to transplant coarse weeds which are likely to die and change colour. If the position is to be held for more than one day, most plants except heather will probably require watering until they have taken root again.

It is no use concealing the loopholes if the parapet itself is conspicuous, and the most carefully assimilated parapets are often given away by the appearance of a shaded slope. To guard against this the parapet should be as low as possible, with the superior slope very flat. The free use of comparatively conspicuous dummy parapets and loopholes will also draw attention away from the better concealed works. If circumstances admit, the trenches should be viewed from the front and flanks of the line of the enemy's expected attack and under different conditions of light, before they are finally "passed."

Shingle Loopholes.—If there is a supply of gravel, shingle, or road metal in the vicinity of a defensive position, advantage may well be taken of this fact to make loopholes as follows instead of earth loopholes.

Place one sandbag inside another and fill the inside one with the above shingle, etc. Three such double sandbags will make a loophole, the parapet being completed with single sandbags also filled with shingle.

If higher head-cover is desired, stability may be assured by extra sandbags filled with earth, as shown dotted in *Figs.* 14, 15 and 16.

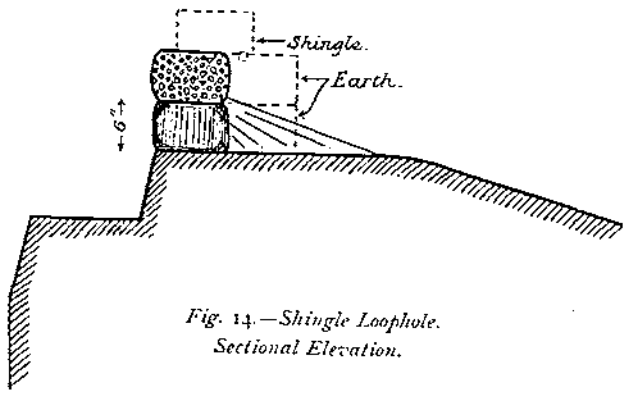


Fig. 14.—*Shingle Loophole.*
Sectional Elevation.

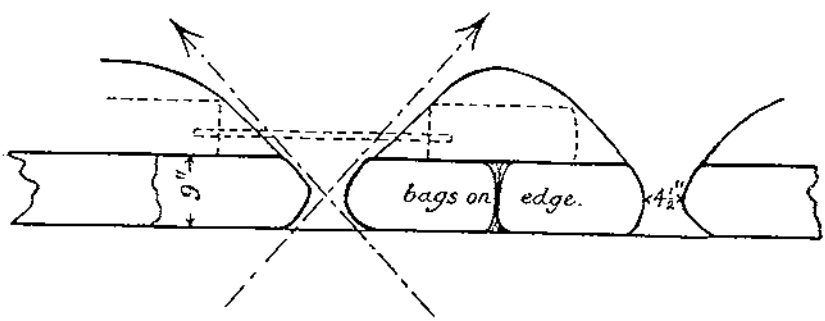


Fig. 15.—*Shingle Loophole.*
Plan.

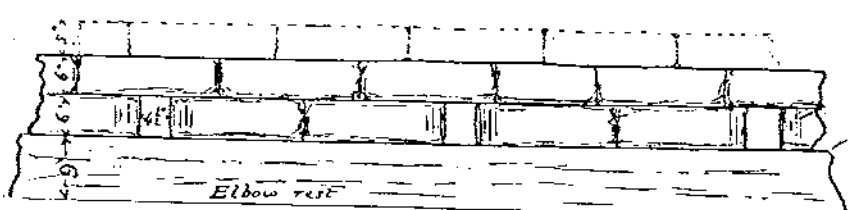


Fig. 16.—*Shingle Loophole.*
Rear Elevation.

The sandbags forming the loophole parapet are placed *on edge* and stamped out until the loophole opening is curved (as shown in plan) and the bag is about 9″ wide and 6″ high. This loophole, which requires comparatively few sandbags, is absolutely proof to within

one inch of the edge all round; and it is almost impossible so to hit the bag on the edge as to cause a serious split.

As a refinement, a little earth might be mixed with a very clean sharp shingle when the latter is used, as such shingle used alone is naturally slightly more liable to cut the bag.

Metal Loopholes.—At Mafeking, the besieged employed a very serviceable type of loophole (*Fig.* 17), an iron plate about 3 ft. × 1 ft. 3 in. and ½ in. thick, bent at right angles and with a small rectangular hole at the angle. These loopholes were embedded into the parapet and must have been most comforting during the fighting at about 200 yds. range. Very few types of loophole would stand the twenty-six bullets which struck one of these plates.

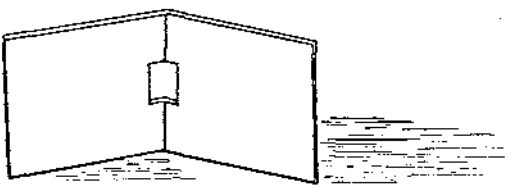


Fig. 17.

The theoretically perfect loophole, which, however, for various practical reasons is hardly within the range of practical utility, even to the keenest Sapper, would be a combination of a pivoted steel plate *a* and a fixed plate *b*.

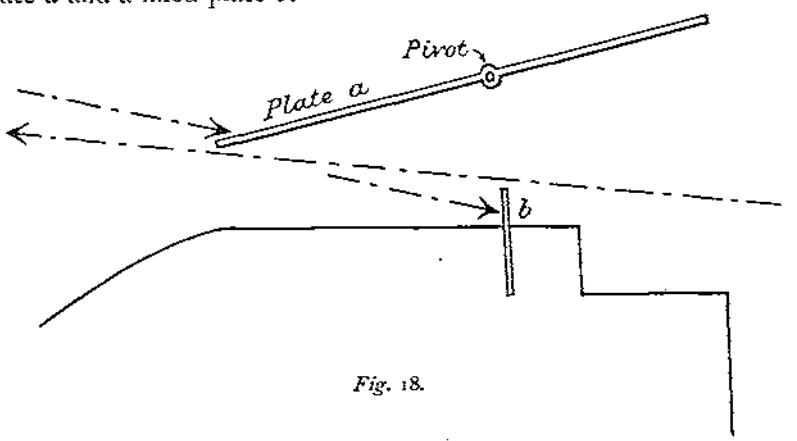


Fig. 18.

The plate *a* must be canted just enough for the bullet to leave at the required angle of elevation for the enemy's firing line. The angle of descent at any range being greater than the elevation, the defenders would be immune!

THE BATTLE OF HASTINGS.
14*th* *OCTOBER*, 1066.

By MAJOR-GEN. E. RENOUARD JAMES, LATE R.E.

IT was my lot, while serving as an officer of the Ordnance Survey, 37 years ago, to accompany the late Mr. E. A. Freeman, M.A., the historian of the Norman Conquest, to the field of Hastings, and to have the privilege of assisting in making a plan of the battle ground. I thus gained an elementary knowledge of the incidents of the great victory won by William of Normandy on which I had previously only the limited ideas of any schoolboy.

The interest aroused in my mind was sufficient to cause me to study the battle from a military point of view; and at the earliest stage of my enquiries it became evident that gross misconceptions abound in the popular descriptions. In the following notes, in the compilation of which I have to acknowledge much kind assistance from the Hon. F. H. Baring, it is my aim to correct the prevalent errors.

A very detailed account of the Conquest of England by the Duke of Normandy is preserved in the famous *Roman de Rou*, written in archaic Norman-French, about a century after the events described, by Wace, a canon of the cathedral of Bayeux: English students are familiar with this work by translations, notably that by Edgar Taylor, published in 1837. A graphic representation of the same events exists in the celebrated Bayeux tapestry, the origin of which is uncertain, though it is not disputed that it dates from the 11th century: it is beautifully exhibited at Bayeux, and a traveller in Normandy should on no account fail to make an inspection of it. Although not absolutely in accord, both of these authorities may be accepted as derived from trustworthy sources, if they be not, indeed, based on information given by eye-witnesses. In endeavouring to reconcile and explain the points in which the Romance and the Tapestry differ, modern writers rely much on the records of contemporary chroniclers, among which are those of William of Poitiers, Orderic Vitalis, Guy of Amiens, William of Jumieges, the chronicles of Battle Abbey, etc. But it is unfortunate that the whole of these records are, more or less, biased on the Norman side, while there are very few good authorities on the part of England: this is not to be wondered at, for it was not likely that men would record their own defeat and humiliation.

The principal modern English authority is undoubtedly Freeman, whose great work was published in 1869. I assisted him, as I have

said, in the topographical work of the only original large-scale plan of the battlefield which has been produced ; it may be found in Volume III. of *The Norman Conquest*. As to my share in it, I can only vouch for the comparative topographical accuracy (the Ordnance 6-inch map did not then exist), but disclaim all responsibility for the way in which the position of Harold and the details of the battle are shown. The appearance of the book at once provoked a storm of criticism, which has not abated yet, and among the writers on the subject may be named Mr. Round, Sir James Ramsay (in *The Foundations of England*, 1898), Mr. C. W. Oman (in *The Art of War in the Middle Ages*, 1898), and, recently, the Hon. F. H. Baring. A writer preceding Freeman was Creasy (in *The Fifteen Decisive Battles of the World*, 1851), whose account of the battle is in the main a mere series of extracts from the *Roman de Rou*, with little of definite military value, and need only be referred to by saying it is full of the ordinary popular errors.

If the words of the old authorities are weighed carefully, and allowed their relative credibility, views held by those who have only studied the subject superficially must soon undergo change. We have been too ready, hitherto, to accept grossly exaggerated numbers in estimating the strength of the opposing armies. Freeman seems to have fallen into the trap like the rest ; for although he guarded himself against giving an opinion as to Harold's numbers, it is plain that, in marking the defensive position on the map at so great a length, he sought to provide room for the large number popularly believed to have constituted the English army. It would not have been proper for me, in my profound ignorance in 1869, to question his accuracy ; but a recent examination of the ground, made with the new 6-inch map in my hand, has convinced me (and would, I think, have the same effect on any military student) of the inaccuracy of Freeman's conception. In accepting the belief that Harold's army was so large, it was necessary, consequently, to admit a proportionate increase in William's ; and as the old chroniclers, from whichever side they wrote, exaggerated the numbers on the other side, a mass of error has been perpetuated. It is easy to prove that a very large reduction in the numbers must be made.

Another controversial point, which remains unsettled still, is the nature of the line of obstacles erected by Harold—if obstacles there were at all. While some authorities maintain that the position was covered by a strong palisade and ditch, others contest that there were no obstacles of any sort beyond the shields of the defenders. After the evidence on this point has been stated, it is hoped the readers of these notes will offer opinions which will assist in settling this vexed question.

Other points for consideration are the movements of the forces on either side, and the identity of the sites at which the incidents of the

battle occurred; but these need only be referred to in their place in the narrative.

Following the ancient authorities generally, but quoting from them only when it becomes necessary to compare their evidence, let us make a brief retrospect of the political events which led to the invasion of England. In a genealogical table, to be found in the translation of the *Roman de Rou*, it is shown that William of Normandy claimed cousinship with Edward the Confessor, and, the latter being childless, saw an opportunity of gaining the succession to the English throne. He crossed to England on a visit in 1051, and was received with great honour by Edward. The King had recently quarrelled with Earl Godwin, his father-in-law, who had delivered a son and a nephew to him as hostages for his future behaviour. William begged to have their custody, and sent them to Normandy, with the intention in his mind of retaining them as prisoners in order to prevent their becoming his rivals. On his return to his own dukedom he set up the pretension that Edward had nominated him as heir to the throne of England.

At this stage of the history we are introduced to Harold, who claimed kinship with Edward through Canute, the first husband of the Queen, and is described by old Wace as a noble vassal, the most powerful chief in all England. Harold obtained the King's permission to go to Normandy and bring the captives back; with his mission the Bayeux tapestry opens. He was cast up on the coast of France by a storm, and fell into the hands of Guy, Count of Ponthieu, who gave him up to William as a prisoner. He was entertained with the highest honours, and accompanied the Duke on warlike expeditions against the Bretons, in the course of which he was knighted by William on the battlefield. He was cajoled into making a promise to deliver England to William on the death of Edward, and he was compelled to ratify the same by oath, at a council assembled at Bayeux, before he was permitted to return to England.

In Wace's romantic verse we read that Edward, on his death bed, denied that he had promised the kingdom to any foreigner, and, in the presence of his councillors, formally nominated Harold as his successor to the throne. Another Norman authority, Benoit de Saint More, declares that this story was of Harold's invention, and that in reality he had no title but his usurpation. Whatever may be the truth, Harold seems beyond doubt to have been the King of the people's choice; and unquestionably to have been preferred to the Duke of Normandy. On becoming King he at once repudiated the oath forced from him at Bayeux under terror and false representations as to Edward's alleged promise; and William then resolved on the invasion of England to enforce his claim.

The Duke called his barons and prelates into council, and after much heated discussion induced them to promise their assistance. A

summary of the names of those who were willing to help may be found in the pages of Freeman, who, quoting from various sources, states that 812 ships, with as many knights and men-at-arms as they would carry, were promised; according to Wace, however, the number seems to have been only 752. The King of France, who thought the Duke of Normandy, his nominal subject, was too powerful already, refused his aid; while William's brother-in-law, the Count of Flanders, not satisfied with the conditions proposed by the Duke for the division of the spoil, was only persuaded to promise help faint-heartedly. By clever diplomacy William was more successful with the Pope, who sent him a standard, and consented to his conquering England to hold the land from St. Peter. While the invasion was under discussion a comet appeared in the sky, and was thought such a favourable omen that superstition brought allies from every side; from Brittany, Picardy, Maine, Provence, Flanders, and even, it is said, from Italy. Timber and materials were hastily collected in all the ports of Normandy, and one summer and autumn were spent in building ships and training men. Freeman states that the very trees had not been felled: for this there seems no warrant beyond a representation on the tapestry of a woodman cutting down a tree. But, undoubtedly, the ships were built hurriedly, and it was not possible for them to be of any considerable size; we may suppose that the largest were no bigger than the fishing boats on the north coast of France at the present day. Wace states that he heard his father say the number of ships which sailed for England was "seven hundred less four" (which allows of a reasonable discount from the 752 promised), and that small boats and skiffs carried arms and stores. He had "seen it written, but did not know how true it was, that in all there were three thousand vessels bearing masts and sails"; and Benoit de Saint More says there were three thousand keels (nefs) at least.

These figures, doubtless, are mere guesses made to include the small skiffs which were towed, and in estimating the number of boats which actually carried men and horses we must be limited to the 696 of Wace as quite a maximum. The largest ships represented on the tapestry have only one mast and sail; on one 13 shields in a row indicate as many cross seats, and supposing 4 armed men on each seat we get 52 foot soldiers as the boat's load. In another boat 3 horses with 2 seamen are shown, and in a smaller boat, with rowers, only 5 soldiers. If we analyse the list of donors referred to before, we have another method by which we can form an estimate of the ship-loads. One exceptionally large ship—that of Remigius—was for 20 knights, but those furnished by the Abbot of St. Ouen were, on an average, for 5 knights only; while, in other cases given, the ratio varies from $3\frac{1}{3}$ to $1\frac{1}{3}$ per ship. Three knights per ship, in addition to their esquires, and as many men-at-arms, seems, then, to be as high an estimate as we are warranted in making for the general average

capacity of each horse-carrying ship. As regards the infantry, although a single boat may have carried 50 men, another was for 5 only, and we cannot calculate the average loads as more than 25 men. Finally, if we suppose that not more than 400 of the large boats carried horses, we complete speculative data from which an estimate of the strength of the expeditionary force may be made, as follows :—

400 ships, each with 9 men and their horses...	3,600 cavalry.
296 ships, each with 25 men, the heavy-armed infantry and bowmen	7,400 infantry.
Total	11,000 men.

While this result might easily be varied by using ingenuity in manipulating the speculative data, it may be noted that it agrees fairly with the opinion of Sir James Ramsay that 10,000 men was the maximum number brought across the channel. By no stretch of the figures, however, can we, by a similar method of reasoning, approach near to the 60,000 commonly believed in.

The force which assembled in Normandy is variously reported by the chroniclers; by William of Poitiers it is put at 60,000, and even more, while the Chronicle of St. Maxentius has it at 14,000. But whichever of these is nearest the truth, neither one statement nor the other is evidence of the number of men who embarked. William of Poitiers, in mentioning a messenger sent to William by Harold after the crossing had been effected, makes the Conqueror say that, if he had only 10,000 men such as the 60,000 he had with him, he would go on. We can see plainly that this was mere bragging, and it need not make us change our opinion that the force was not much in excess of 10,000; for the messenger, on his side, had just boasted that Harold had 100,000 men at his back, which William knew well enough to be a gross exaggeration. The old chronicler Wace tells us Harold did not fail for lack of numbers, but that in reality there was about man for man in the opposing armies; which is probably quite true, but with the numbers on both sides diminished, as we see they must be.

For comparison's sake some facts about later invasions are worth noting. According to the best authorities, Edward III. never shipped 10,000 men across the channel; and Henry V., and also Edward IV., only just succeeded in making up such a number. Three statements in Eccleston's Antiquities are as follows:—in 1254, one ship capable of transporting 30 men is spoken of as being of extraordinary magnitude; in 1346, in the expedition to Calais, there were 783 ships, which could only carry 20 men each; and, as late as 1360, three centuries after Hastings, the art of shipbuilding had advanced so little that the largest in an order given was only for 44 men-at-arms. Do

not these facts alone compel us to discredit the exaggerations about the Norman Conquest?

William's preparations were known in England, and to oppose them a fleet was assembled in the Solent, opposite Dives (near Caen) where the Norman ships were collecting. A naval expedition under a Norwegian chief, Tostig, supported by William, harried the southern coast of England, but did not achieve any substantial success. It had, however, the effect of drawing the English ships away; some of them went northwards, some to the estuary of the Thames, and the larger part became ineffective and were disbanded; their absence from the south coast permitted the fleet of William to leave Dives. The Norman ships, driven by westerly gales, took refuge in and about St. Valery, at the mouth of the Somme; this seemed at first to be a misfortune; but in reality it was an advantage, for the channel being almost at its narrowest point at St. Valery, the invasion of England became the more easy.

The fleet waited tediously for a fair wind, and had this not occurred auspiciously it is doubtful if success would have attended the expedition. Very fortunately for William, such a wind came at the time Harold was in the north of England. The passage across the channel was made in one night and without accident, there being just enough wind to propel the ships in a direct course.

William's army landed on the Sussex coast, early on the 28th September, if Wace be correct, rather to the west of Pevensey Bay, quite without opposition. The boats were run up on the beach, just as craft of like size may be seen at Hastings at the present day. But I think it is an error to suppose that the ships were destroyed, as some accounts state; for it seems more probable that they followed the march of the army eastward, and eventually entered the inlets of Winchelsea and Rye, which were used as a naval base later.

The Norman bowmen waded ashore as the ships grounded, and at once extended to the front to cover the disembarkation of the cavalry, meeting with very little opposition. The cavalry, without their armour, landed next; and were followed by artizans, who erected a defensive work near the shore with materials previously prepared to fit together. The infantry then landed slowly; and on the third day the entire force was ready to move to Hastings, where another defensive work was erected, the army being bivouacked, probably, along the heights north of the town. Such was the Norman position when, sixteen days after the landing, intelligence was received by William of the rapid approach of Harold from London.

The sun rose on the 14th October at 6.20 a.m.; but lunar tables show there was a two-thirds waning moon, still high in the sky at dawn, and it is recorded that the morning was unusually light for the season. The army was called hastily to arms, and was in movement at an early hour. As the advanced posts were, probably,

somewhere on the main ridge between Ore and Baldslow, the distance to the front of Harold's position was not five miles; and the line of march followed the watershed line separating two distinct basins, which was then, as it is still, the main road to London. For the whole distance a narrow, nearly level, heathy ridge, from which the slopes on either hand fell quickly away, was followed. The hillsides were largely clothed with woods, and the bottoms of the valleys were marshy. In the distant prospects (which are of well-known beauty), although the trees might conceal scattered scouts and archers, a soldier's eye could search the front so easily that the presence of an enemy in force would soon be detected. The Normans were able, therefore, to march quickly with little risk of encountering resistance until the English main position should be reached.

On arriving at Telham Hill, William (according to all accounts) received the reports of his scouts, and ordered a halt on a site called 'Hecheland' in the Abbey Chronicle, where its position is so precisely described that the Hon. F. H. Baring has been able to identify it closely, at an altitude of 462 feet above sea level, on Telham Hill, at exactly two miles from the English line at Battle. The place may be traced by referring to the 1-inch Ordnance map, where it will be found close to the name 'Blackhorse hill' in small print. Local tradition, for which no foundation has been found, has wrongly fixed the halting place at the site, a mile nearer Battle, on which stands a windmill.

The exact position of the halt is, however, of less importance than the information we gain on the use of armour in 1066. According to the Abbey Chronicle, William and his chief barons had ridden lightly equipped until the halt, when they donned their armour; but this is at variance with both the Romance and the Tapestry, in which they are represented as fully armed on starting from Hastings. The Chronicle may be accepted as more likely to be correct, for it is reasonable to suppose that the fatigue of wearing armour was not customarily suffered until the latest moment before a battle. The armour worn was not, however, as heavy as that of a later date, as it consisted of the hauberk, or chain-mail shirt, as the principal body covering, and not the suit of plate armour, which was not yet in general use; the head was protected by an iron cap with nasal frontals, and the legs were guarded with metal plates. In one account William Fitz-Osbern and his horse are described as wearing complete plate armour; but this is believed to be an anachronism, as there is no authority for the horses in 1066 having worn any armour at all, and they are represented without it on the Tapestry. An incident during the battle leads us to think that William the Conqueror wore a helmet with a close visor; that he wore a mailed shirt we have evidence in the anecdote, repeated by different authorities, that he put on his hauberk, at first, backwards, adroitly using the incident as a good augury for his success.

On learning of the position taken up by Harold, the Duke immediately ordered his force to advance in three divisions. It was probably a surprise to him that Harold had already posted his army strongly; for he had hoped to fall on the English on the march, and by the help of his cavalry and superior discipline to defeat them easily.

The road, which continued to follow the open crest until it approached the site of the modern village of Battle, fell from the height of over 400 feet above the sea until a neck of ground at an altitude of 219 feet was reached. This point is not, as most writers have said, in the valley, but only at a depression on the watershed line. It is important to note this, for the hold on the crest line gave William an important advantage in case of a counter-attack; and, in fact, such was its actual use during the battle. (Reference to the accurately contoured plan accompanying this paper will make this clear). When William reached the neck, where he was out of archery range from the English line, which he now saw extended across his front, he at once ordered a deployment of his force to the right and left.

The dispositions made for attack and defence will be better understood if the movements of Harold, from the time the Norman fleet sailed from Dives until his own arrival on the battle ground, are first traced briefly. After his raid along the south coast had caused the dispersion of the English ships, the Norwegian chief, Tostig, proceeded to support the descent on the east coast made by Harold Hardrada, of which it is unnecessary to speak at length. The King of England hastened northwards to repel this invasion; and concerning the campaign which followed it is sufficient to say that Harold Hardrada suffered a complete and decisive defeat at the battle of Stamford Bridge, fought on the 25th September. The King, it is said, was at York on the 1st October celebrating this victory, when a horseman, who had come from Sussex with all possible speed, brought the news of the landing of William at Pevensey Bay on the 28th September.

Not an hour was to be lost, and Harold returned to London as quickly as he could ride. The bulk of his famous bodyguard had been with him in the north, and he was compelled to wait some days in London, fretting at the delay, while they, or some portion of them, were marching southwards. In the meanwhile half-trained levies were collected hastily, and the manhood of southern England flocked to the standard in Sussex. Harold himself left London on the 12th October, and reached the position on which he made his stand on the 13th. The bodyguard also arrived from York, having marched 250 miles in 11 days; if they were the very men who had fought at Stamford Bridge, it was a wonderful feat. Some writers have supposed that Harold hoped to surprise William by a night attack; but Oman's opinion that the position was deliberately selected is more likely the correct view.

There is some evidence to show that the ancient name of the site

was 'Santlache'; and that 'Senlac,' the name by which the battle is known in France, is a corruption of the old Norman writers from this, possibly intended to denote a pool of blood. We speak of it in England as 'the Battle of Hastings,' and it is therefore so designated on the heading of this article.

From a range of low hills, at a general altitude of 300 feet above the sea, mainly covered with forest at the time of the Conquest, the road from London descended upon, and followed the crest of, a narrow ridge, dividing valleys on either side, which is now marked by the main street of Battle. At its southern end the ridge broadens out in the form of a tongue of ground, running east and west and nearly square to the direction of William's line of march; this was the fine position chosen by Harold. It seems to have been almost bare of trees, as the chroniclers only note one;—a "hoar apple tree." The probable line occupied has been the subject of the most careful consideration on the actual ground by Mr. Baring and myself, and the opinion we have formed is that the defensive position was (as shown on the plan) about 700 yards long and nearly level. On Freeman's plan (Vol. III. of *The Norman Conquest*) it is given a length of 1,650 yards, Harold's left being made to run down the hill in a dangerous manner, this extension being evidently adopted to provide room for the number of men,—20,000 to 25,000—usually stated to have been placed along the ridge. The men are stated to have been in ten, or more, ranks, crowded together ('conglobati' being the word used to express their formation); and if the length of the line be limited, as we say it must have been, the total number of men who could be packed on the ridge would be 9,900. To this number we may reasonably add 1,000 on the isthmus in rear, and thus we get an aggregate of 10,900. Possibly, also, there was a horde of peasants in the woods at the back; but these were a useless encumbrance, and doubtless vanished like a summer cloud when the English defeat became evident.

The slopes from the position fell quickly away towards the front. The gradients are as follows:—along the centre, 1 in 15; on the left flank, 1 in 22; and on the right, 1 in 33; the slopes at the extremities of the line bend quickly backwards, and become 1 in 8 on the right rear, and 1 in 4 on the left rear. On both sides of the narrow isthmus the slopes continue steep, and it is evident that the position could only be attacked in front. Flank attacks were but little practised in 1066, and Harold did not think of one as possible. He appears, rather, to have looked on the position as an impregnable redoubt, believing firmly in the ability of his housekarls to withstand any possible attack which could be made. Retreat did not enter his mind; if it had done so, he could have prepared an excellent position for a second stand on the hill at the back; but we shall see that, when defeat came, the retreat was a disorderly rout.

Let us pause to consider how far the number we have arrived at is in accord with what is known of the military power of England in the 11th century. The statement of Benoit de St. More that Harold had 100,000 men at his back may be dismissed as a Norman fiction, or, if he quoted from an English source, as mere boasting. The entire population of the country, exclusive of the unsettled areas, did not exceed one million; and the maximum number of male adults of suitable age for public service amounted at most to 48,770, the number said to have been the constituted military force of the kingdom under the Anglo-Saxon rulers (Hume, Vol. I.). This total may be understood as a paper estimate of a mere militia force, which in ordinary times would have to be divided by four, at least, to reach the number likely to be called out at once. The duty to be done included the preservation of order, the repair of roads and bridges, and (not the least in importance) the protection of game. A large deduction must be made in calculating the number it would be possible to assemble in an emergency, at one place, for actual military operations. Considering these points carefully, the estimate of 10,900 men present on Harold's position seems as large an one as we can reasonably make.

Some, if not all, of the housekarls who had been with Harold in Yorkshire had joined the main body of them at Battle, and we have seen how great was the King's impatience while he awaited the arrival of this splendid contingent. The whole of them present did not number more than 3,000, or about one-third of the force on the position; and apparently they were the only thoroughly trained and disciplined body in the English army. They were entrusted with the defence of the Standard, which at first was planted on the highest ground almost in the centre of the line, a hundred yards or so to the north-west of the site of the ruins of the Abbey Church (subsequently founded by William), to which site it was probably moved before the final stage of the battle.

The housekarls are described as having been equipped with short, closely-fitting leather jerkins, on which iron rings were sewn; they wore the hair long, and their heads were covered by steel caps with nasal pieces, long leather flaps falling over the shoulders; they were shod with sandals, and their legs were bound with thongs. They carried long leather shields, so made as to rest on the ground and lock together, forming a sort of wall strong enough to stop arrows in flight. Among their offensive weapons the chief was the long two-handed axe, with which a horse and his rider could be cut down at a stroke, but which had the double disadvantage that it was necessary to open the shield wall to use it, and that its recovery after the blow was struck was so difficult that its holder, for the moment, was completely exposed. It was necessary, consequently, for a proportion of the men to have other arms—javelins to throw, short swords, and

keen-edged bills—for use until the shields were relocked. The house-karls were noted for their perfect drill in using their offensive and defensive weapons together to advantage.

The light-armed auxiliaries, who were posted along the front and on the flanks, wore, for the greater part, plain leather jerkins, but many were in the ordinary costume of the peasantry. Their arms were various—spears, short axes, bills, scythes, javelins to throw, slings to hurl stones, and even stone hammers. Only a few wore chain-covered shirts, or had the long axe, but very generally they carried some sort of small shield. They had long hair, and their heads were covered with leather caps. They were not well-trained or disciplined, but their bravery is indisputable.

The English had no cavalry and very few bowmen. The few horses which belonged to the leaders were sent to the rear, and, from the King downwards, all fought on foot. The King and his two brothers took up their position near the Standard, on which was Harold's device of a fighting man.

I come now to the point upon which there is the greatest difference of opinion,—the nature of the obstacles, if any existed, which covered the front of the position. In the *Roman de Rou*, written by Wace, a canon of Bayeux, a century after the battle, there is an elaborate description of a palisade and fosse; but no indication of an artificial obstacle appears on the Tapestry, nor does William of Poitiers, a contemporary authority, mention the existence of one. In spite of its minutiæ, the negative evidence of the Tapestry may be set aside, if we regard its design as merely decorative and as one in which, for simplicity's sake, much detail was evidently suppressed. It is noteworthy that although the Tapestry is thought to have been founded on sketches by Odo, Bishop of Bayeux, who was personally distinguished as a combatant at the battle, no allusion should be made to it in the Romance; from which it might be argued that Wace, who possibly worked from manuscript notes left by Odo, purposely ignored the work of women as being, at the best, derived from the same information. On the other hand, although William of Poitiers is said to have been a priest in the suite of the Conqueror, there is no proof that he was on the battlefield himself, and he may have compiled his account from the reports of others. The question of the obstacle thus resolves itself, in great measure, into a consideration of the relative credibility of Wace and William of Poitiers; and it is difficult to conceive that the former absolutely invented his circumstantial statement.

According to the *Roman de Rou*, the position was guarded in three parts, with openings between them. In front of the defenders were raised barricades of ash and other trees, closely joined together. This view is adopted by Freeman (*The Norman Conquest*, Vol. III.), as well as by Oman (*Art of War in the Middle Ages*, p. 153), but is

not accepted by most other writers. Oman points out that a hurdle fence with a ditch in front was a Danish device used in England 200 years before, and thinks that the hurdles at Hastings were not more than four feet high. If he is right, we might go a step further, and suggest that, as the materials were close at hand and plentiful, the words which are translated "trunks of ashes and other trees" refer possibly to something of the nature of an abattis in front of the hurdle revetment. As the attacks were spread over eight or nine hours, something more than the shield-wall would seem to be required to maintain such a desperate resistance. The question for consideration, then, is what the obstacle really was?

Wace declares the English spent the night before the battle in carousing, and gives some picturesque information about the toasts drunk; he also states that the Normans were engaged in religious exercises. But this must be taken as mere rhetoric, if we accept the fact that the Normans were suddenly called to arms, on the morning of the battle, seven miles away, and that the English had hastily occupied the position and were hard at work. Another statement, also unconfirmed, is that Harold and Gurth rode to the Norman camp to parley; it seems more probable, as the King was accused of treachery and perjury, that he would not dare to run the risk of being detained as a prisoner. The truth would seem to be that the march from London was so hasty that the King only reached the position late on the 13th, and at once ordered such defensive measures as were possible of execution in the short time available.

Soon after it was fully light the English perceived the enemy pouring down the slopes of Telham in orderly formation. At this point we may revert to William, whom in a previous page we have brought to the neck, at 219 feet altitude, at which he deployed. He was not yet aware of Harold's weakness in bowmen; but as the central portion of the English line was rather more than 200 yards from the neck, he was able to keep out of arrow range until the movement was completed. The ground lent itself admirably to its accomplishment, for he had not to cross either of the ravines to east or west, but was able to deploy along a contour line, which was about 50 feet below the line to be attacked. The Norman army was in three divisions; and in the arrangement of the line were placed in geographical order. On the right the men of eastern France, Picardy, and Flanders, many of whom were mercenaries, extended from the neck towards the point at which the slopes began to bend round the English position; the Normans, under the Duke's personal leading, covered the centre of the position, their right resting on the neck; and the men from Brittany, Maine, Anjou, and western France were on the left, extended to the top of the steep slope which fell towards the rivulets in that direction. It seems probable that the men of each contingent furnished by a baron or knight were massed separately in

some wedge-like formation under their own chief; the infantry being in front in the intervals between the horsemen, and the bowmen extended in advance of the former. We have no precise evidence to show the exact arrangement, and it would be incorrect to endeavour to indicate it by the usual rectangles; a simple line has therefore been adopted to mark on the plan the general extension of the Norman army at 9 a.m., the bowmen being shown conventionally. The word "Bowmen" is used in preference to "Archers," because the bow used was a very small one, with a considerably shorter range than the famous English long-bow of Cressy, which was not introduced until two centuries later.

But although the precise formation of the units of the Norman army is uncertain, a speculation may be made on the numbers it was possible to deploy along a line generally following the 200-feet contour between the limits east and west at which the slopes turn sharply northwards. The length of the alignment was about seven-eighths of a mile; and as we suppose the infantry were placed between the horsemen, the latter cannot have been at smaller intervals than two-and-a-half yards. Allowing some break between the divisions, and supposing there were four mounted ranks, a calculation gives us 2,464 as the cavalry strength, exclusive of reserves. If we take the infantry in the proportion of two men for each horseman, and the bowmen at one for two horsemen, we can obtain the following result;—

Cavalry (in four ranks)	2,464
Infantry	4,928
Bowmen...	1,232
Total	8,624

As the Normans were stronger than the two other divisions combined, and the Bretons rather stronger than the French, we may suppose the force to have been divided, approximately, as follows:—

	Bretons.	*Normans.*	*French.*	
Cavalry	650	1,300	514	
Infantry	1,300	2,600	1,028	
Bowmen	325	650	257	
Totals ...	2,275	4,550	1,799	men.
Approx. frontage ...	405	815	320	yards.

The results obtained by these methods of reasoning are wholly different from the popularly accepted numbers on the opposing sides. Against 20,000 to 25,000 on the English side, we have, on reasonable grounds, been able to account for 10,900 only; and on the Norman

side, against 60,000, only 8,624. In the previous calculation we came to the conclusion that 11,000 men may have been transported across the channel; and when due allowance is made for reserves, casualties, men left on the communications, and sick, the total 8,624 is as high an estimate as can be made of the numbers likely to have been in line on the battlefield.

The juggling feats of Taillefer, and the dramatic episode (mentioned by Wace) in which he sacrificed his life, may be passed over as without military interest; and we now reach the point at which the actual fighting commenced. Soon after 9 o'clock the preparations were complete, and William ordered a general advance along the front. In the armies of the 11th century, previous to this battle, the majority of the fighting men had usually been cavalry, while the infantry had been a much despised arm. But at Hastings footmen were employed in larger proportions, for two reasons—the difficulty of transporting horses over the sea, and the reputation recently gained by the English infantry. William's tactics were, after preparing the attack with his bowmen, to assault with infantry, not caring how many of the despised arm he sacrificed, and to charge with cavalry when the defence was shaken. The infantry, whose hair was worn short, were in most respects very similarly clad to the English; some had chain shirts and iron caps, but the greater number wore leather jerkins and caps, while many had the simple blouse of the French peasantry; their legs were bound with thongs, and they were shod with sandals; their arms were short axes, spears, daggers, and broadswords. In discipline and courage they were not inferior to the English bodyguard, and in all respects were better than the English light-armed levies. But their opponents had the great advantage of being posted on the top of a steep slope, and it was the first experience of the Normans against the famous housekarls, with their shield-wall and two-handed axes. If there were any engineering obstacles, these also had to be surmounted; but even if there were not, the task before William's army was a most difficult one. We cannot wonder, then, that the first assaults failed at every point. A desperate resistance was encountered, and the storm of missiles of every description showered on the assailants is described as quite unprecedented.

On the left, as may be seen from the plan, the Bretons advanced up a comparatively easy slope, and doubtless reached the English line more quickly than the Normans in the centre; being unsupported, at first, on their right, the full opposition was concentrated against their attack; they were thrown into confusion, and fell back in disorder. It had been strongly impressed on the English that the only hope of gaining the day depended on their remaining steady on their own ground of vantage; but the ill-disciplined levies on the west of the ridge, seeing the Bretons retiring, could not restrain their excitement, and rushed down the hill in pursuit, crying

"Victory." Their triumph was short-lived, for William's highly-trained cavalry on the slope in the centre lost not a moment in attacking the pursuers in flank; and it is reported that very few of the brave Englishmen were left alive to return to their lines, though some of them may have escaped through the wood on the west. In the repulse and retreat of the Bretons occurred the greatest loss sustained by the Norman army during the whole day. The baggage guard even was in danger, and indeed for a short while there seems to have been an absolute crisis. William of Poitiers states that the issue of the battle was in doubt and hung in the balance until 3 o'clock. The valiant conduct of Bishop Odo in rallying the flying Bretons is specially noticed by William of Poitiers; he is shown on the Tapestry clad in coat-of-mail, striking into the *mêlée* with a mace (being an ecclesiastic he was not allowed to use a sword). Duke William himself also assisted in arresting the flight; a rumour had spread that he had fallen, and he is reported as having lifted his visor to show his face in order to re-assure the army that he was alive.

The Norman army fell back along the whole line to re-form. Many times during the day the attack was vigorously renewed, and as often failed. The stand made by the English has been compared to that at Waterloo, but there was an essential difference between the cases, arising from the unsteadiness of the light-armed men; had they stood doggedly on their ground like Wellington's squares, the issue of the battle might have been quite other than it was. William was personally foremost in the fray, but still his cavalry could not penetrate the English line.

Towards the afternoon, remembering how the light-armed men had left the line in pursuit of the Bretons in the morning, he conceived the idea of feigning defeat in order to tempt them to do the same again. But this time his retreat was made in the direction of the Hastings road, where he knew the advantage of higher ground would soon be on his side; and at the critical moment the French on the east fell on the disorderly crowd of pursuers on their flank, and effected immense slaughter. This manœuvre seems to have been repeated more than once, with the result that the English strength was so materially weakened that it became necessary to concentrate for the defence of the Standard, thus leaving their right insufficiently guarded. The Normans on the west, who were only waiting for this to happen before renewing their attack, succeeded, about 3 o'clock in the afternoon, in getting to the top of the hill behind the line on the English right. The cavalry were now able to move rapidly along the ridge, on fairly level ground, in the direction of the Standard, round which the housekarls maintained the shield-wall unbroken, the low-aimed arrows of the Norman bowmen being caught in the shields. This being observed, the bowmen were ordered to give greater elevation in order that their shafts should fall at a high angle on the

English rear ranks. The arrows "flew thicker than rain," and before long one pierced the eye of Harold. From this moment the issue of the battle was no longer in doubt. William, however, continued to engage the housekarls hand to hand in a prolonged struggle; his men suffered much from the terrible two-handed axes, but gradually gained a footing on the high ground. King Harold and his two brothers fell fighting to the last in defence of the Standard; and it is stated that the crowd round it was so dense that the wounded were trampled under the horses and the living marched over heaps of the dead.

William, from the top of the hill, noticed that the English left was gradually becoming weaker, and sent an urgent order to the French division, which was engaged down the outer slope in completing the defeat of the last sortie, to detach a body to assist the main attack at the east end of the ridge. From the *Carmen de Bello Hastingensi*, we learn that Eustace of Boulogne, with two Norman knights and a body of stragglers hastily collected, came up in obedience to the order, and got inside the line on the extreme English left. I cannot, myself, consider this as the first time the English line had been penetrated, as I believe Mr. Baring does, but I think Eustace's attack very possibly hastened the English flight, the day having been virtually lost long before.

It was dusk, and nearly 6 o'clock; all the leaders had fallen, and the housekarls lay dead to the very last man round the captured Standard; the few survivors, mainly the light-armed militiamen, broke at last, and fled in complete confusion in all directions.

I have frequently discussed the incidents of the battle with Mr. Baring, and in company with him and Sir Augustus Webster, the owner of Battle Abbey, have examined the ground. In nearly every particular I am in full agreement with him, but in one respect we differ in opinion. He attributes a larger share in the battle to the French than I do, and does not accept my view that the first penetration of Harold's line was by the Normans at the west end of the ridge. According to my reading of the chronicles, the repeated mention of the Normans and Bretons in the description of the late stages of the battle shows that the principal scene of the fighting at that time was the Norman left-centre and left; while, on the other hand, little is said until the final phase of the action of the French division, beyond the mention of the assistance given by it in repulsing the sorties on the Hastings road. It seems to me that the penetration of the line by the French at the east end was, as I have stated in other words, nothing more than a final movement in support of the men already fighting on the hill; and that the victory would have been equally assured if it had not taken place.

The horses of William's army had been saddled twelve hours or more, and were thoroughly tired out; and I imagine the final pursuit must have been made by the French, whose mounts were the only

comparatively fresh animals. Most of the fugitives ran towards the north-west, in which direction for half a mile the ground was fairly level and open; the pursuing cavalry, in their fury, appear to have lost all discipline, cutting down the helpless English mercilessly. It was by this time almost dark, and the reckless riders failed to notice that the ground was intersected by the head of a ravine about half a mile from the position on which the Standard had stood. Its steep bank was concealed among bushes, and became a death trap into which a large number of horses and their riders fell. The retreating English turned a moment in their flight, and took a last revenge by killing every fallen Frenchman; their further pursuit by the Norman army was abandoned.

The site of this disaster, which the chroniclers refer to as "the Malfosse," is erroneously marked on Freeman's map on the east side and at the left-rear of the battle ridge. Sir James Ramsay perceived it was on the west side, but marked it much too near the Standard. The site now indicated was suggested by Sir Augustus Webster, and Mr. Baring has proved that he is correct. It would take too much space to give the documentary evidence quoted by him in support of his arguments, which I accept as most convincing.

The present state of the battle ground is difficult to compare with what it must have been in 1066. There can be no reasonable doubt that the ruins of the Abbey Church founded by William the Conqueror mark the exact position on which stood the English Standard at the end of the battle and where Harold was killed; and on this spot a monument to Harold has recently been erected by a French society. The ground which was then quite open is now covered with trees and gardens, and the even slopes up which the Normans advanced have been completely altered in character by walls, retaining terraces upon which the fine abbey buildings stand. To the east of the position of Harold, and on the line of the Norman approach from Telham hill, the site is covered by the houses of the village and the railway. Although there are many trees on the south-west angle of the battle site, it is the only part of the ground which to some extent is the same in contour as it was in 1066. On the plan an endeavour is made to show the ground as it was at the date of the battle.

The romance of the finding of Harold's body and its supposititious interment on the seashore is too well known a story to be repeated. The English army had ceased to exist. William's loss cannot be stated, but was so heavy that he was too crippled to advance at once. Falling back to Hastings, he obtained reinforcements there before marching along the coast to Romney and Dover; and he was not able to commence his march from Canterbury to London until after December 1st. His exact movements need not be traced further.

MEMOIR.

LIEUT. ST. J. G. SPACKMAN, R.E.

ST. JOHN GAISFORD SPACKMAN, who was killed on October 8th last in an accident while playing polo for the Corps at Campamento near Gibraltar, was born at Christchurch, New Zealand, on November 21st, 1881.

He was the eldest son of the late W. H. Spackman, Barrister-at-Law of the Inner Temple, and of Mrs. Spackman; and was educated at Cheltenham College, where he soon gave evidence of that keenness in everything he did which distinguished him all his life and especially during his service at Gibraltar. He gained an entrance scholarship to Cheltenham in 1896, and after two years there passed into Woolwich, having earned the golden opinions of all with whom he was brought in contact. He was a very good French scholar, having spent several years in France, and while at school gave proof of his ability by gaining the silver medal given by the Société Nationale des Professeurs de Francais en Angleterre. He followed this up while at the Shop by winning another prize from the same society. In all his games at school he showed that keenness which was the foundation of his surprising record at Gibraltar, but he was somewhat handicapped by want of size (he always rode about 9 stone) and a damaged knee.

Spackman received his commission in the Corps in May, 1900, and joining at Chatham shortly afterwards went through the usual courses with his batch. At the end of his time there he was ordered to Gibraltar where he arrived in September, 1901. The conditions of the life on the Rock entirely suited his bright disposition and sporting nature; and those of us who were there when he joined must remember the keen way in which he took up both work and sport. He soon proved himself to be the best of comrades, and his unfailing good-temper and his readiness to help others won him many firm friends. A still brighter side of his character was displayed by the way in which he bore the heavy responsibility thrown on him by the early death of his father. His work was always thoroughly well and conscientiously done, while his success in the various forms of sport was little short of phenomenal. In the annual Hunt Point-to-Point Race alone he set up a record which will probably stand for many years to come, being placed in the first ten on all five occasions when

he rode. He was 9th (with a fall) in 1902, 8th in 1903, 2nd in 1904, 10th (with a fall) in 1905, and 2nd in 1906. On the last occasion he won the Individual Prize, and also the cup presented by Lord Charles Beresford and the Officers of the Channel Fleet. He also met with great success on the only occasion that he joined a pig-sticking camp in Morocco. He took up racing very keenly, both training and riding his own ponies; and among his many successes were the Subalterns' Cup, a two-mile steeplechase, in 1904, and the Hunters' Flat Race in 1904 and 1906. His victory in the Hunters' Flat Race of 1904 will long be remembered by those fortunate enough to see it, and his win in the steeplechase for the Berkely-Milne Cup last May was also one of his happiest efforts. He was among the best polo-players in the Gibraltar garrison, in fact in his place as No. 2 he had few equals.

In September, 1906, he was ordered home, and was hoping to close his connection with Gibraltar sport by helping the Corps to win the Annual Polo Tournament, one of his most cherished ambitions. Right well did he play his part, and it was in the final game, when success seemed almost certain, that the accident occurred. He is gone; and while the Corps loses a good officer, his friends are left to deplore the loss of one of the best of sportsmen and a true and valued comrade. He lies buried at the North Front, Gibraltar, the scene of many of his sporting successes, in the shadow of that Rock on which those five happy years of his short life were spent.

TRANSCRIPT.

THE STRATEGIC TRIANGLE AND THE ENGLISH ALLIANCE.*

To exist without sea power is a material impossibility for the United Kingdom. Its growing population of 43 millions, with a restricted agriculture and highly developed industries, necessitates an enormous maritime activity and very large imports of food and raw material.

This statement is universally acknowledged, and no lengthy statistics are required to prove it; but a few figures may well be given in order to accentuate the fact. According to the *Statesman's Year Book*, Great Britain and Ireland in 1905 produced 45½ million cwts. of wheat and imported 116½ million cwts. (in round numbers); that is to say, the country only produced 28 % of the people's needs. Similar figures might be quoted with respect to other cereals, flour, meat, sugar, etc. The same statistical volume registers for 1903 some 133 million lbs. of home-grown wool against 639 million lbs. imported; and importations of 1¾ million lbs. of cotton and 30 % of the total of iron ore.

Without any further examples it may be accepted that the United Kingdom absolutely cannot exist within its own frontiers, and that a successful blockade would cause an insuperable crisis in the labour market and trades, serious economical troubles, and before long, however great the preventative storage in peace time, a famine.

Moreover, the United Kingdom forms the heart of an extensive Empire, of which the united existence cannot even be imagined without assured liberty over the intervening seas that link up the numerous dependencies scattered all over the globe, some of them (such as India and Canada) incapable in themselves of providing for the defence of their land frontiers.

In proof of the importance which is attached to this aspect we may cite the diligent study in England of the question of "Commerce Protection in War," which has been a subject of discussion at the Royal United Service Institution and a problem in recent Naval Manœuvres.

There is no doubt that the work of the 20,000 mercantile vessels registered in the United Kingdom constitutes for the life of this country a circulation of blood, the suspension of which would seriously effect the whole normality of the national organization.

* A *précis*, by permission of the publishers of the *Revista de Artilharia*, of an article contributed to the August, 1905, number of that Journal by Capt. Henrique de Paiva Conceiro, Portugese Artillery, who kindly provided an English translation.

The following five main lines of sea traffic, all marked at intervals by permanent stations, ramify from the centre, England, to the extremes of the great Empire :—

1. *North-Westwards.*

North Atlantic Ocean — Trans-Canadian Railway — Pacific Ocean. (Stations :—Halifax ; Esquimalt).

2. *Westwards.*

Mid-Atlantic Ocean. (Stations :—Bermuda ; Jamaica ; Barbadoes).

3. *South-Westwards.*

South Atlantic Ocean—Cape Horn. (Station :—Falkland Is.).

4. *Eastwards.*

Atlantic Ocean—Mediterranean Sea—Indian Ocean—China Seas. (Stations:—Gibraltar; Malta; Alexandria; Aden; Colombo; Singapore; Hongkong; Wei-hai-wei).

5. *South-Eastwards.*

South Atlantic Ocean—Cape of Good Hope. (Stations :—Sierra Leone ; Cape Coast Castle ; Ascension ; St. Helena ; Capetown).

From Capetown this route may be prolonged (*a*) to India (Station : — Mauritius) or (*b*) to Australasia (Stations:—Melbourne, Sydney, Brisbane, Hobart, Auckland).

In connection with these oceanic roads we must consider the telegraph cables which are their complement. Through certain powerful private companies England to a great extent dominates the whole mesh of the submarine cables of the world. According to the contracts between the Government and these companies, official messages always take precedence, no aliens are employed at the stations, and in war the Government can assume entire control.

From the very extensive and ramified network of cables we need select for our purpose the four following, which we may suppose to be the main direct military strategical lines :—

1. *Westwards.*

Ireland (Valentia) — Halifax — Vancouver — Fanning I. — Fiji Is.— Norfolk I.—Brisbane.

2. *South-Westwards.*

Ireland—Halifax—Bermuda—Jamaica—Antilles—Georgetown.

3. *Eastwards.*

England (Penzance)—Gibraltar—Malta—Alexandria—Suez—Perim I. —Aden — Bombay — Madras — Penang — Singapore — Labuan — Hongkong.

4. *South-Eastwards.*

England—Madeira—St. Vincent (Cape Verde Is.)—Ascension I.—St. Helena I. ; Capetown.

From Capetown lines run :—(*a*) Up the West coast of Africa by Mossamedes—Benguela—St. Paul de Loanda—St. Thomas I.—Bonny ;

(*b*) up the East coast of Africa by Durban—Mozambique or by Durban—Mauritius—Seychelles Is.—Zanzibar; and (*c*) to Australia by Mauritius—Diego Rodrigues I.—Keeling I.—Perth.

This electric web, by which the dispersed sentry posts of the British Empire are linked to the brain centre, and unity and direction are simultaneously afforded to her far-spread forces, assumes an importance which could be proved by citing historical instances of its diplomatic and military use but is self-evident.

Wireless telegraphy, notwithstanding its valuable services in sea command, does not at present supersede submarine cables for large distances. It also has its disadvantages: witness the instructions to the cruiser *Minerva*, in the English Naval Manœuvres of 1903, to scout 40 miles ahead with the object of intercepting the enemy's messages.

From the above we see evident, in its capital features, the strategical system of navigation and telegraphy as veins of activity and force invigorating the British Empire and ensuring for it an unsurpassed supremacy and unrivalled prosperity.

As, however, this lever of English power is open to attack, we require to examine the probabilities of such an occurrence.

Peoples exist who, from a hard struggle for life and under the impulse of ever-increasing population, production, and trade, are compelled to seek for expansion, for wider territories and more markets, so as to reduce the tension at home. Such expansion follows the line of least resistance, either to neighbouring countries less highly developed or less thickly populated, or to countries over sea. In this phenomenon of expansion we may notice a physical aspect, corresponding to the spontaneous internal pressure of a body that dilates; and also a moral or politic condition which, known as 'Imperialism,' represents the tendency to dominate, one day pacific, another warlike, sometimes proclaiming the excuse of civilizing assimilation, sometimes the fatalistic theory of natural selection.

The manner in which Imperialism displays itself and grows amongst the various nations of Europe, Asia, and America is of greater significance to us in prophecying future collisions than are some of the ostensible diplomatic combinations. The antagonism of diverse Imperialisms may, indeed, be compared to a mathematical equation involving the essential interests of peoples, the predominance of races, and the importunings of a struggle for life. Japan, the United States, England, and Germany are at this moment the most typical.

Japan, pressing Russia back from Korea and, to a certain degree, from China and the Pacific, has marked out for herself a sphere close to her own borders.

The United States, whilst maintaining the Monroe Doctrine, have established naval stations in the Caribbean Sea, in Honolulu, and at Manila, and are about to construct the Panama Canal as a waterway under their control.

For England the Japanese alliance has secured some safety in the East, and also the possibility of a reinforcement to her naval strength in European waters. This alliance seems to indicate that these two

Imperialisms have fairly shared separate spheres of action. As regards the United States, the Hay-Pauncefote convention and the solution of the Alaska frontier question, with other symptoms, appear to show a real disposition, at least on the part of England, to tighten the bonds of friendship between the sister races.

Germany, active, prolific, with flourishing industries, supplies the bulk of emigrants to America; she rules over some islands in Oceania, guards a door in China, promotes economic expansion in Asia Minor, and possesses some colonies in Africa, of which unfortunately the one most suitable for settlement by whites is rather unproductive. A great Empire may, perhaps, consider this a poor estate, deficient in Oceanic stations and in zones for the reproduction of the race under the national flag. Germany, therefore, appears to be most likely to cause the gathering cloud. But, in view of the fickle and kaleidoscopic nature of international relations, it is impossible to say that the storm may not arise in another quarter. A previous volume of the *Statesman's Year Book* alludes "without hostility to the United States" to the possibility of a conflict between England and the great North American Republic, which will soon become the second naval power in the world.

Thus the antagonists to whom we must pay attention are:—Firstly, Germany (or the Triple Alliance); secondly, the United States (or an American group). The Dual Alliance, France and Russia, has for the time lost part of its influence.

The gradual increase of her fleets, in order to obtain a permanent superiority on her own element over the growing navies of her possible adversaries, has been a principle of the Governments of England. Granted the existence of such a superiority, experts have engaged in controversy as to its best utilization in practice and as to the method of naval warfare most profitable to England. There is, however, agreement in the main principle—To oblige the enemy to fight, and to maintain vigilance over his ports. This is a logical principle for a power pre-eminently strong, both absolutely and relatively.

But the principle needs qualifications for several reasons. Similar logic would inspire inverse action on the part of the enemy, namely, to avoid a battle at sea and to operate against the undefended coasts or, especially, the vital merchant shipping: the scale of such action by the enemy would depend on the efficiency of the protective service, the distance between the zones to be guarded, and the limit of torpedo boats. The efforts of certain powers to increase their navies may eventually weaken the relative superiority that has hitherto been the possession of England. The English authorities, with clear foresight and great knowledge, have confirmed the existence of a reverse side to the medal by studying the problem and preparing for the direct defence of maritime traffic.

Thus a direct defence forms an English object in war. As to the method of protecting commerce, three alternatives are discussed, namely, escorted convoys, the policing of maritime routes, and direct pursuit of hostile *Alabamas*. The first system implies the formation of columns; it introduces normality into mercantile circulation; and its efficiency (as does that of the second method) depends on a large number of naval

units. The third means, though requiring less in quantity of warships, presupposes oceanic search and contact with the enemy, an operation difficult of execution.

'Scouting' is the term employed in England for the complicated art of exploring large sea areas with several ships manœuvring dispersed under a connected scheme, which gives each of them a direction and a speed so calculated as to obtain from the whole an extensive drag net with no openings for the escape of the enemy and no disconnections that can hinder an eventual concentration. These searches and, generally, all attack and defence on oceanic high roads mean movement, and that means fuel consumption, so that the whole set of combinations must be worked out according to the position of coaling stations; hence the English phrase 'coal strategy,' and the persistence of its authors in establishing all over the world numerous depôts of Welsh coal, the real nerve of the evolutions of their fleets.

Various means have been employed to lessen the degree of necessity of this storage of coal at ports; for example, colliers, liquid fuel, the increase of bunker capacity. Shipping coal at sea depends upon the condition of sea and weather, and, moreover, colliers in their turn also need coal for themselves; this method must result in sailings to and fro, with waste of fuel and danger of capture. The use of oil fuel does not dispense with the necessity of periodic replenishment, and, according to Jane's *Fighting Ships*, 1905–06, is still in an experimental stage. Finally the art of ship-building meets with difficulties in increasing coal-carrying capacity, on account of the weight of coal, the space required, and questions of stability.

In any case the radius of action of any ship, that is the greatest distance she can cover on her own load of coal, is a variable quantity, depending on the speed and on the conditions of the engines, the sea, and the weather. A French commerce-destroyer, for instance, reached only two-thirds of her expected 7,500 miles. Some writers allude to cruisers with between 10,000 and 15,000 miles limit; but, having regard to published statistics of fuel consumption and bunker capacity in the best cruisers of different navies, we cannot verify distances exceeding 10,000 miles, and this is the lesson of the British manœuvres, if we interpret rightly some pages of the 1900 and 1904 *Naval Annual*. Indeed, experiments tend to show that nominal radii of action must be given large co-efficients of correction in practice; and, as we require some definite figures on which to base our further arguments, we may assume that 8,000 to 10,000 miles (and this is applicable only to the best cruiser groups in each navy) will represent a maximum that can be accepted.

So much for fleets. Submarine cables form a most important instrument in the direction and success of naval operations; they are naturally indicated as objectives for attack, as evidenced in the Spanish-American War. The cut may be attempted either near the actual point of an attack where the cable would be easier to find, or on the high seas, when the greater difficulty of the task would be balanced by the lesser danger of interference. Proper tools for cutting purposes are in existence, and it is said that in depths of less than 500 mètres an attempt might hope for success.

Let us now examine the five sea-roads which, as above mentioned, run from the United Kingdom to its political and commercial dependencies.

The Trans-Canadian Railway, included in the first route, introduces some elements of inconvenience—a double transhipment, and insecurity on account of its proximity to the United States frontier.

The fourth route, through the Mediterranean, though strongly protected, has the drawback that it passes alien military ports which might be hostile, through narrow waters, and through the Suez Canal which might easily be obstructed.

Thus, we have only the remaining three which are both safe and spacious; and these we may call "the Atlantic Routes," for they run either wholly or mostly over that sea.

The Panama Canal promises to be in the future a factor requiring close consideration. It will be dominated by the United States. True we cannot presuppose unconditional free passage for belligerents; but we must allow for the freedom of movement between the west and east coasts guaranteed to the American fleets and only to them.

Thus the *Atlantic*, in all its length, from north to south, constitutes *the key of British communications*.

If we consult the *Statesman's Year Book*, we find the origin of the greater, and also the most necessary, portion of the imports of the United Kingdom; and we can conclude that the command of the Atlantic and of its prolongation in the Indian Ocean guarantees the supply of victuals and of work to this Kingdom, because this is the route of transit from Canada, the United States, Argentina, South Africa, India, Australia, and New Zealand, which countries are the principal providers of cereals, meat, cotton, and wool. The same route affords mutual aid between the Mother Country and its remote Imperial Dependencies.

Evidently the command of the Atlantic is a primary objective for England; and we may now briefly define the problem of this command from the British standpoint.

At any given moment the distribution of the British naval forces is a reflection of the state of world politics and also of the comparative strengths of the world's navies. At the present time the reinforcement of the Channel Fleet denotes preoccupation on the German side; and this fleet, though liable to diminution on account of changes in the political horizon, cannot lose the importance of its *rôle* as a permanent protection in territorial waters. *Mutatis mutandis* analogous conclusions may be drawn in regard to the Mediterranean fleet. Thus two large groups of the best battleships and the proportionate cruisers must always, according to reasonable conjecture, be absorbed in questions of defence that admit of no postponement.

Consequently, even omitting consideration of other naval exigencies of the vast British Empire, however numerous may be her fighting units, the strength purposed to guard the Atlantic must be calculated with relative economy as regards both quantity and quality. And here we may note that whether the attack comes from the North Sea round Scotland, or from the opposite American coast, probably nothing can prevent the attackers choosing their hunting grounds on the lines of the commercial routes.

Thus, on the one hand the strength to guard these routes is limited, whilst on the other the area to watch is almost unbounded; so the solution of the problem must be sought in adequate strategy.

The accompanying map at once suggests the idea that, with Madeira (Lisbon or Lagos) and St. Vincent eliminated, the chain of assistance or support between the extremes at Plymouth and Capetown exhibits remarkable deficiencies, for the first refuge from Plymouth is Free Town, some 3,000 miles distant. But when we insert Madeira and St. Vincent we get, with Ascension and St. Helena, a continuous chain linking England with South Africa. The points mentioned form a line of sentries at suitable intervals, roughly:—Plymouth—Madeira, 12,000 miles; Madeira—St. Vincent, 1,000; St. Vincent—Ascension, 1,400; Ascension—St. Helena, 700; and St. Helena—Capetown, 1,700. These sentry posts, moreover, are well clear of continental coasts, Madeira being some 500 miles from the European littoral, St. Vincent 500 from the hump of north-west Africa, and the two other islands 1,000 miles or so from the retired littoral of southern Africa. The places mentioned thus mark natural stations on the Atlantic road from England to the Cape.

Similarly the map points out Plymouth—Madeira—St. Vincent—Pernambuco as the natural stations connecting England with South America; and in this case the omission of Madeira and St. Vincent would mean an unbroken run of more than 3,500 miles.

Again the map clearly points to the Azores as the first link in the chain connecting England either with North America, or with Bermuda, or with Barbadoes. The Azores indeed stand nearly at the middle of the long journey of 3,000 miles to the two last-named goals. Moreover, in the whole of the North Atlantic we find no points that could be substituted for the Azores on the route to North America; and on the roads to South America and Africa we have only the Canary Islands, of which the position is unfavourable, Teneriffe being some 2,100 miles from Ascension and 2,300 from Pernambuco.

Still referring to the map, let us remember that in discussing methods of protection of sea-borne commerce in war, whether by convoys, by policing of routes, or by direct attack of commerce destroyers, we concluded that 8,000 to 10,000 miles was the practical limit of the sphere of ship-power, and this, moreover, only to be expected from a restricted number of ships; and that later on we concluded that Great Britain could not afford to dispose of her best cruisers for continuous duties in the Atlantic. Since the services of policing and of direct attack presuppose speeds greater than the most economical, and consequently a reduction in the radius of power, it will, for the purpose of argument, be safest to adopt as the sphere limit a distance of 3,800 miles, which is equivalent to 12 days' navigation at 320 miles per day and a coal consumption of 1,800 tons.

With these data we can now consider how the number of cruisers that should be employed and their most economical use is effected by the question whether the coast and the oceanic islands of Portugal can or cannot be counted upon in the strategical problem of the command of the Atlantic. Parenthetically it may be remarked that the British naval

authorities have paid much attention to the matters of vigilance, search, and pursuits in extensive ocean areas, and various methods have been tried in successive naval manœuvres; but we have no means of determining what particular system would be adopted. However, whatever the system may be, the conclusions arrived at on the basis of distances and radii of action may hold good.

Taking first the route Plymouth—Bermuda, if the Azores be ignored, the route must be secured either by a direct service from one base to the other, or by entrusting half the total length to each of two cruiser fleets, each acting from one of the bases. In either case we must calculate 3,000 miles (9 days' navigation) for the complete voyage, which leaves only 800 miles (3 days) for search and chase. But, if the Azores, in their favourable position midway, be available, the dead stretch is reduced by half; and if we have ships operating east and west therefrom, the mileage remaining for offensive service is increased to 2,300 miles (7 days' navigation). The same results are seen on considering the route Plymouth—Barbadoes.

Similarly the route Plymouth—Pernambuco, if Madeira (Lisbon or Lagos) and St. Vincent be eliminated, means a dead stretch without supporting stations. True that Gibraltar lies near the route; but it is really outside the Atlantic, and has the disadvantage of being in a narrow; and to it, rather than to Malta, belongs the *rôle* of base for the Mediterranean fleet. The inclusion of Madeira and St. Vincent divides the route into three almost equal lengths of about 1,000 miles, which, with the 3,800 miles limit of action, leaves 2,800 miles for offensive service.

Like reasoning and deductions can be applied to the Plymouth—Ascension portion of the route to the Cape, to which Madeira and St. Vincent supply a complement of the greatest advantage.

Underlying the maritime roads are the cables, all emerging at strategical points. If we examine the list, given above, of the cables selected as the most characteristic, we find that the three first are connected only with British territory. The fourth, that to the Cape, makes use of Portugese territory in Madeira and St. Vincent; but, except for these points, only emerges at two other places, both British, namely Ascension and St. Helena. The *rôle* of the Portugese Islands is thus still further accentuated.

We have above endeavoured to define the connection, in the general strategical problem of the command of the Atlantic, of the group of three maritime positions—Madeira (Lisbon or Lagos), the Azores, St. Vincent—which we call "The Strategic Triangle."

Figures have been quoted, without pretension to exactitude, which is for various reasons unattainable, to illustrate the broad features of our reasoning and its palpable conclusions. Certain factors of course cannot be accurately defined and are moreover inconstant.

Recapitulating, we have on the north side a nation (England) for which the command of the Atlantic is a primary objective, and on the south side another nation (Portugal) which is wedded to the same ocean by important interests in commerce and colonial communications. A clear


Plymouth
Halifax
Azores
Lisbon
Lagos
Bermuda
Madeira
Florida
Teneriffe
Jamaica
Barbados
Cape Verd Islds.
Freetown
Cape Coast Castle
Panama
Georgetown
Ascension
Pernambuco
St Helena
Cape Town
Tristan d'Acunha
Falkland Isds.
Cape Horn

advantage would accrue to both, if, instead of approaching their respective tasks independently, the two parties were to work in combination, dividing the task in proportion to the importance of their respective objects, interests, and capacities. Statistics of population, commerce, and internal prosperity afford a basis on which to define how such a proportion of responsibility could be established. Portugal might undertake the security of her naval bases, insular or continental, and England the security of the open seas.

The only neutrality respected by belligerents is the neutrality of a power that has force to command respect. We must defend our islands of the Azores and Cape Verde; they are, so to speak, continuations of our home continent; and the latter further form a stepping-stone to our principal colony, Angola, the sole territory to which we can emigrate under our own flag. The best method of securing the safety of these insular possessions would be, not to defend each island separately, but to defend them as a whole through sea command, basing this command on one island in each archipelago, and fully equipping the two selected points as military stations with batteries, torpedoes, ammunition, victuals, coal depôts, and dockyards. The same reasoning is applicable to Lisbon or Lagos.

The methods of defence will differ according to whether we are a solitary wheel or a wheel included in the general mechanism of the dominion of the Atlantic; but even if we have to face the hypothesis of having to act independently, the subject well deserves full attention.

REVIEWS.

FELDBEFESTIGUNGS VORSCHRIFT, 1906.

A NEW, provisional, edition of the German "Instruction in Field Fortification," sanctioned by the Emperor on 28th July, 1906, has just been published. It supersedes the edition of April, 1893. Like its predecessor it is a small and convenient volume, 6 inches by 4½, but it contains 111 pages as against 84. Its price bound in boards is 60 *pfennig* or sevenpence.

The general arrangement of the contents, which has been only slightly changed, is :—

Introduction.
I. General Principles.
II. Execution of Field Fortifications.
III. Infantry and Engineer work in Fortress Warfare (formerly entitled "Work in Attack").
IV. Technical Details. This is new, and is divided into
(*a*). Hints on Use of Tools.
(*b*). Tracing Parallels, etc., in Fortress Warfare.
(*c*). Revetments.
(*d*). Construction of Fascines, Hurdles, and Anchorages for Revetments.
Of these (*c*) and (*d*) were formerly contained in appendices.
Appendices.—Tools carried and Table of Penetration of rifle bullets, shrapnel bullets, and shell.

The principal increase is in Chapter III., which is treated in a much more thorough manner, with 28 pages as against 7 in the earlier edition.

The Introduction lays down that all arms are to be instructed in the use of entrenching tools at an early stage of their training; and that knowledge of the proper use of field fortification is to be tested on every possible opportunity, particularly when mixed forces are being exercised. It specially warns officers against constructing field works except under war conditions as to the means available, as such exercises are only misleading.

Engineer troops must not only be able to execute works but must be able to superintend working parties of other arms. Their officers must be prepared to advise commanders on the employment of field fortification in accordance with the situation.

In Chapter I. the general principles laid down are much the same as before, but they are more emphatically and definitely stated. *E.g.*:—in the 1893 edition it was said that "In the attack also the entrenching tool can

find a use in securing and strengthening captured points." The sentence now reads, "In the attack also the entrenching tool will do valuable service in securing captured points and creating new positions whence a further advance can be made; even under fire its employment can be useful. It is the duty of leaders of all ranks to make use of entrenchments independently if the solution of their task is facilitated thereby."

While formerly the premature fortification of a position was accounted harmful, one is now told only that "Fortifications already constructed must not be allowed to influence new decisions if the situation has altered."

A new principle is laid down that the extent of a position will depend on the intention of the leader as well as on the number of troops available.

It is now laid down that "the artillery forms the framework in the occupation of a position"; that is, it must be considered first and the infantry must fill the gaps.

"As a principle one line only will be selected, and strengthened by all possible means." Advanced positions are not recommended, but it is recognised that it may be necessary to arrange for defended pivots behind specially weak parts of a position. The division of a position into sections for the execution of the work is new, as is also its subdivision into independent battalion groups.

Invisibility is very strongly insisted on. "The most effective protection against artillery is attained when the defensive arrangements are not recognisable even through strong glasses." The obstacles used must not betray the position. The use of dummy entrenchments and masks, the shifting of landmarks, the examination of the position from the point of attack, the avoidance of premature occupation of the position and opening of fire, the importance of a good background, and other similar points are repeated and recommended.

It is now laid down that "the time available is the decisive factor as regards the work to be undertaken. Clearing the field of fire and fixing ranges must be done first; cover comes in the second place."

A special paragraph is devoted to the importance of a good look-out. "It must never be interrupted, either before the position is actually occupied or during the engagement. Each body of troops is responsible for the observation of the ground in front of it, not only as regards scouting and security, but also as regards effect of fire. The observers must not be placed so as to give away the position; they must be able to report quickly, and should if possible be protected from fire." Trees, buildings and ladders are recommended as observatories, and it is suggested that observers in the position itself should use mirrors.

Field fortifications "as a principle" (formerly "as a rule") are constructed by the troops who will have to defend them. The Engineers "are not to be employed to do work which can be executed by the other arms, but are to be used for the construction of the more difficult head cover, for communications, and for obstacles and demolitions." "The Engineers may give the infantry guidance (*Anleitung*) if necessary, but the infantry officers are responsible for the work." "Field and foot artillery will execute their own works independently."

At the beginning of Chapter II., "Execution of Field Works," stands the sentence "The illustrations are to be regarded as suggestions and not as sealed patterns (*feststehende Muster*)."

The typical fire-trench is now a deep narrow one, without any parapet (4·59 feet deep, 1·96 feet wide at bottom, with sides as steep as they will stand); in the earlier edition it was wide and shallow (1·64 feet deep and 4·92 feet wide).

There is a picture of a man lying on his left side digging under fire; the excavation is at his right side and the parapet at his head. This is new, as is also the section on traverses.

The illustrations of overhead cover show very solid constructions; the flimsy patterns of the previous edition are omitted.

Two new paragraphs and five illustrations describe pits for machine guns, which are given little or no parapet.

There is an entirely new section on shelters for supports and communication trenches, in which attention is drawn to the dressing stations, cooking places, and latrines, etc., that may be required.

A new paragraph mentions the necessity of guide posts and freehand sketches to show the ranges. Firing at night is also alluded to, but no arrangements for it are mentioned.

Utilisation of existing cover remains much as before; but hedges are now spoken of as masks and obstacles only, and the diagram showing the defence of the edge of a wood is omitted.

The obstacles given resemble those in our own *Manual of Military Engineering*.

Having dealt with fieldworks for the infantry the book turns to the requirements of field and foot artillery. In cover for field guns room for a wagon or for ammunition baskets is left alongside the gun, and both in epaulments and pits the parapet is carried well round the flanks. It is, however, laid down that "cover for the gunners is the first consideration and only when there is sufficient time is cover for the guns to be added," and that to make the former will take 40 minutes. Invisibility, overhead cover, connecting trenches between guns, cover for wagons, and observing stations for all commanders are the principal new points touched on.

In the largely increased section on cover for the "heavy artillery of the field army" it is stated that "cover for ammunition must be provided as it is liable to detonation if hit by shell; it can at the same time be used to cover the men." Masks are said to be unnecessary as the guns should be concealed; but to render balloon reconnaissance difficult, the batteries should have growing plants, etc., transferred to them, so as to make the surface similar to its surroundings. Cover for the observation posts is regarded as most important.

Chapter III. deals with "Infantry and Engineer Work in Fortress Warfare." In the general paragraphs an extensive use of obstacles, comprehensive shelter from weather, good communications, and a telegraph or telephone system are recommended. The first heading is "The investment position and covering position for the deployment of the artillery," followed by "Infantry positions and communications." The strengthened

fire trench is declared to be the best profile for the infantry position, which is to be pushed forward "as soon and as far as possible." "Whether it will be the assault position or whether intermediate positions must be made will depend on the resistance of the enemy."

The execution of trenches and approaches by night and their widening by day are dealt with at some length. Loopholes made South African fashion, through corrugated iron packed with gravel, are illustrated. Sapping, absent in the earlier edition, is now described at length; also the use of corrugated iron for shelters.

Chapter IV. is sufficiently described by its contents. The gabion is not mentioned under the heading of revetments.

It will be seen from the above that the German handbook is by no means so complete a work as our *Manual of Military Engineering* of 1905. It is perhaps noteworthy that a review of the latter (a very complimentary one) only appeared in the *Militär Wochenblatt* last month.

'E.'

REPORT OF THE COLONIAL SURVEY COMMITTEE.

This Committee was appointed in August, 1905, in order that the Colonial Office might in future have the advantage of expert advice on Survey matters. It was recognised that such a body was necessary to ensure uniformity of system and economy of work in the various Crown Colonies in Africa.

The Committee consists of three members:—

A representative of the Colonial Office—H. J. Read, Esq.

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

The Officer in Charge of the Topographical Section of the General Staff—Major C. F. Close, C.M.G., R.E.

The Committee's first annual report is a parliamentary paper (Colonial Reports: Annual. No. 500. *The Surveys and Explorations of British Africa.* Wyman & Sons. 2s. 7d.), which contains much interesting information respecting the mapping done in our African Colonies. Useful suggestions are made for the future as regards Survey policy.

The Committee has perforce to recognise that, with the happy-go-lucky Administration of Empire which we enjoy, it cannot expect any comprehensive policy, with the necessary funds to carry it out. It can only endeavour to secure that various detached efforts shall be utilised to the best advantage. Thus, in a Colony where the necessities of the administration cause various areas to be surveyed for the granting of concessions, taxation, etc, the work so done can be compiled if a network of accurately fixed points exist to form a check and link for such scattered areas. For such a network a proper triangulation should be provided; but funds for this can seldom be obtained, and often the most that can be done is to fix the accurate positions of widely scattered towns by latitudes and telegraphic longitudes, and to take advantage of any work done by Commissions fixing portions of the boundaries.

In recent years local administrations have been making progress in surveying their territories, and the following is a brief summary of the information given in this report:—

Sudan (Director of Surveys, Captain H. D. Pearson, R.E.; Assistant, Lieut. A. E. Coningham, R.E.).—Cadastral surveys in the Dongola, Khartoum, Berber, and Gezereh districts, undertaken for administrative purposes of land ownership and taxation, also some topographical work done in the Red Sea province.

East Africa (Director of Surveys, Lieut.-Colonel G. E. Smith, R.E.; R.E. Assistants, Captain G. S. Knox, R.E., and Lieut. E. W. Cox, R.E.).—Here the Civil Administration started a settlement scheme and advertised it before having any maps on which to issue the title deeds of allotments. A large influx of settlers resulted who clamoured in vain for allotments; and it was reported in 1905 that the usual delay waiting for survey to be made was 12 months. Lieut.-Colonel G. E. Smith's report caused the authorities to institute a Survey Department with himself as Director, and 3 Assistant Directors, a trigonometrical party, and a cadastral party. Annual cost £12,599.

British Central Africa.—A Survey department of one European and three Indian Surveyors started in 1895, and some triangulation was done round Blantyre. The work was pushed forward intermittently to survey privately owned lands till 1903, when a concerted scheme for the Colony was commenced; but no funds are yet available for any systematic triangulation.

Uganda.—A survey department is employed on a systematic survey. So far the progress is:—

Primary triangulation	...	...	...	4,660	square miles.
Secondary triangulation	...	...	...	5,060	,, ,,
Topography, ½-inch scale	...	...	...	3,000	,, ,,
Cadastral, 1:10,000	...	...	...	400	,, ,,

Gold Coast (Director of Surveys, Major F. G. Guggisberg, R.E.; Assistant, Capt. C. B. O. Symons, R.E.).—In 1901 the gold mining boom caused a great demand for concessions, and consequently for maps. A network of rigorous traverses has been carried out, furnishing an excellent framework for topography. A ½-inch map of most of this Colony, in addition to a cadastral map, will be completed by 1908. Much of the cost has been covered by survey fees charged to mining companies.

Sierra Leone.—No survey department. In 1904 Capt. H. D. Pearson, R.E., with the Colonial Survey Section, made a 1-inch map of 250 square miles round Freetown. A compilation from sketches and boundary work has been made.

Northern Nigeria.—No survey department has yet been formed. Maps have to be compiled from sketches and traverses, aided by the work of Boundary Commissions and the interior points fixed in 1905–6 by Capt. R. Ommaney, R.E., and Capt. G. F. Evans, R.E.

Western Nigeria.—About 1,580 miles of theodolite traverse have been done in Lagos, and a certain amount of cadastral work. A survey department is being formed. It now remains to fill in the framework with detail. Considerable success in training native surveyors to work under Europeans has been attained in this Colony.

Southern Nigeria.—A limited amount of network in triangulation and boundary work has been accomplished, and fifty astronomical positions have been fixed.

South Africa.—The Geodetic triangulation has been completed, and a chain of triangles run through Rhodesia. A framework therefore exists on which to base future surveys.

In 1904, a conference in South Africa formulated a scheme whereby the various Colonies might undertake the topographical survey; but funds have not yet been provided. Farm surveys exist from which provisional maps have been compiled. They do not show the form of ground with any degree of usefulness for military purposes.

The War Office has accordingly arranged as a temporary experiment to provide a military reconnaissance of Cape Colony under the direction of Capt. C. G. W. Hunter, R.E. Five officers seconded from regimental duty, assisted by six other local officers available during the non-training season, are doing good work of a cheap and rapid nature. It is a compromise between topographical survey and sketching. Using the Geodetic triangulation as a network, graphic triangulation and sketching are done with the plane table in systematic sheets, and a rate of progress attained of about 20,000 square miles per annum.

The Orange River Colony, in conjunction with the War Office, has pursued a very enlightened policy, providing half the cost of a proper topographical survey on the ½-inch scale. This is being conducted by Captain L. C. Jackson, R.E., and the Colonial Survey Section at the average rate of 21·84 square miles per diem, and will be completed in 1911. Total estimated cost for 47,000 square miles, £18,500.

The very able Report under review contains maps showing the survey progress achieved in the various South African Colonies, and also one showing their boundaries already delimited and those still to be done. It not only collates in a useful form valuable informations as to the surveys of Africa, but incidentally shows the urgent necessity for early reliable surveys of new countries if a progressive policy of economic development is to be pursued.

E. P. BROOKER.

REINFORCED CONCRETE.

By CHARLES F. MARSH, M. INST. C.E., ASSOC. M. INST. M.E., and WILLIAM DUNN, F.R.I.B.A. Third Edition, revised and enlarged.—(Archibald Constable & Co., Haymarket. 31s. 6d.).

It will be remembered that a notice of the first edition of this work appeared in these columns about two years ago, and the interest taken in Reinforced Concrete is indicated by the fact that two editions have been already exhausted.

In the third, now under notice, Mr. Marsh has as a collaborator Mr. William Dunn, who rendered most valuable assistance when the book

was first written, and who is so well known as taking such a practical interest in the development of reinforced concrete in this country.

Since the publication of the work in 1904, the use of this excellent combination of concrete and steel has increased by leaps and bounds and careful investigation has been carried out in many quarters.

In consequence, some 50 pages have been added to the chapter on Experimental Research, which has been brought thoroughly up to date and includes the latest experiments of M. Considère in France, Professor Talbot and others in America and Mr. Dunn in this country. The result of these investigations has been to modify somewhat the data on which previous formulæ have been based, and to give us a clearer understanding of the actual effects in the material under stress.

The chapter on Calculations has been much improved and simplified, and a good deal of unnecessary detail has been omitted, while formulæ for the investigation of bins, silos, tall chimneys, telegraph poles, etc., have been added. The Straight Line Stress Strain diagram has been adopted as the most suitable up to working stresses and this makes for simplicity; and larger diagrams for the investigation of arches have been introduced in this section with good results.

Some new systems of design are noticed, with new types of reinforcing metal.

Under Practical Construction we are introduced to new developments in the use of reinforced concretes (*e.g.* dams for reservoirs, etc.); and under Structures we are brought face to face with the wonderful variety of purposes to which it is applied, ranging from bridges to bins, from sewers to silos, from churches to coffins, from reservoirs to railway sleepers, from warehouses to weirs, from palatial hotels to piers, from sea walls to swimming baths.

Some Appendices on Tests on Pipes, Professor Talbot's most recent experiments, the Prussian Government Regulations, etc., complete a volume which has maintained its title to be considered the standard work on the subject.

The book is brought out in the best style, the printing is good, the paper is good, the illustrations numerous and excellent, and a comprehensive index facilitates reference.

J. WINN.

MODERN PRACTICAL CARPENTRY.

By GEORGE ELLIS.—(12s. 6d. Batsford. London).

Under the above title the author has produced a work which will be found of the utmost use to all engaged in building works, both permanent and temporary.

As a book of reference for all matters included in the carpenter's art, the present volume possesses quite a unique value. Not only is it comprehensive, but the information is supplied at first hand by a practical

carpenter, who has worked at all branches of the trade, and it therefore abounds in practical details, which only an expert, who has handled the tools himself, could provide.

The work is thoroughly up to date and gives most excellent descriptions of such things as derrick tower gantries (now so extensively used in all buildings of importance), the staging in the Thames at Charing Cross for the construction of the "Bakerloo," the Vauxhall temporary bridge, etc., with working drawings showing details of construction.

The scope of the book may be judged from the fact that it deals with roofs from Westminster Hall to a lean-to shed, with buildings from the dome of St. Paul's to piled foundations, from the scaffolding of a spire to the timbering of a tunnel, from the centring of a bridge above to the cofferdam of the pier beneath, from the simplest floor to the most elaborate half-timbered frontage; in fact wherever timber is used here we are told how it should be used.

Some 1,100 illustrations are employed to show in detail every joint, and over 30 double page and photographic plates add to the general excellence of the whole.

The type and paper are of the best; and though the size and weight of the book would prohibit its use as a pocket book, it certainly should be found in every library which professes to contain books of technical interest.

The author is to be congratulated on the success that he has achieved, and the publisher on the way the work has been brought out.

J. WINN.

THE ANATOMY OF BRIDGEWORK.

By W. H. THORPE, ASSOC. M. INST. C.E.—(E. & F. N. Spon, Haymarket, London. 6s. net).

This little book, which is a reprint of articles that appeared in *Engineering*, is well named. The author has collected a most varied store of information on what we may call the complaints and diseases of all sorts of bridges—timber, steel, and stone.

Some of these bridges suffer from their birth, while others become decrepid from age and the ordinary—and extraordinary—vicissitudes of a stressful life.

The book is nothing if not practical. It abounds in hints as to the diagnosis of the maladies of the long-suffering patients, and suggests suitable remedies.

Every engineer who has to do with the design, erection, or maintenance of bridges would do well to master its contents, and those that do so will be saved from much trouble.

The information is obtained at first hand, which enhances its value. A good index makes the book extremely handy for reference.

J. WINN.

NOTICES OF MAGAZINES.

NATURE.

October, 1906.

THE PLANET MARS (*p.* 590).—A detailed account of the observations made by Mr. Lowell during the Oppositions of 1894, 1898, 1901, and 1903, at the Flagstaff Observatory in Arizona has been recently published. Flagstaff is situated on the Colorado plateau in latitude 33° N. The steadiness of the air enabled Mr. Lowell to use large apertures with his 24-inch refractor, and coupled with his keen sight and expertness his observations are of the first importance. Even at Flagstaff, Mr. Lowell was not content with the astronomical conditions of "seeing," and he investigated the conditions of a great number of regions in order to choose the most efficient spot for the observation of planetary details. The conditions in Mexico for the winter months appeared to be favourable, and he consequently transported his large telescope with its dome to Tacubaya, near the city of Mexico, in 19° 26′ N. latitude, a distance of about 1,000 miles, an example of American energy and determination to succeed. He has established the certainty of the seasonal change on the planet's surface; the great number of the "canals," 392 being now mapped out; an increase in the number of the oases which lie at the intersection of the canals; an extension of the canals in the dark regions, which proved that the dark areas were not "seas"; changes of shades of the dark areas, showing that they were not bodies of water; and, finally, peculiar markings, termed nicks, were observed where the canals entered the light regions. Since the publication of this work the author is to be congratulated, the results of his labours having been confirmed by a photographic plate recording the canals. The volume is supplied with 13 plates and 76 illustrations in the text, which will give the reader some idea of the number of Martian markings seen at the Flagstaff.

SPEED AND STABILITY IN RAILWAY TRAVELLING (*p.* 637).—This is carefully gone into, and a formula is deduced showing the "critical" speed on a given curve. There are, however, various unknown factors which it would be necessary to take into consideration to enable a true result to be reached; for instance, there is the unequal compression of the springs, causing lateral displacement of the centre of gravity, rush of water in the boiler, and the extent of wear of wheels and rails.

MEDICAL SCIENCE AND ARMY EFFICIENCY (*p.* 612).—The writer of this article sketches the evolution of our army medical service. In the time of James I. no allowance or provision was made for medicines; those details were to be found by the surgeons themselves, for the cost of which a weekly stoppage of 2d. was made from the soldier's pay! It is not until the time of Marlborough that we find any sign of prominence being given to the medical service of the army, but it was fifty years later that the first reforms in military medicine and sanitation were introduced by

the physician-general to the forces in Flanders. Sir James McGrigor, the principal medical officer in the Peninsula under Wellington, first evolved order out of chaos, and under him the army medical service became an organised body; but in the long peace that followed Waterloo the lessons of old experience had been forgotten, and the army medical service found itself without means to carry out even an antiquated system of professional duty. In 1899 great improvements were made by establishing a corps of 1,000 officers and 4,189 men to meet the needs of the sick and wounded, but there is much yet to be done. During the late war in South Africa enteric and dysentery alone caused 74,000 admissions to hospital and 9,200 deaths. For every man wounded in war 20 sick men are brought into hospital. The unopposed crossing of the Modder river lost us more men from enteric than the battle of Colenso lost us from wounds. Disease prevention is as much a function of the medical corps as disease or wound treatment, and it is to the solution of this problem that the medical corps of the army is now devoting itself, with the sympathetic support of a large number of commanding officers. The army at large, from the highest to the lowest, must be educated to appreciate the need of radical reforms in the direction of preventing disease, and to understand that these cannot be secured "by order" only, but require personal effort on the part of each individual and the recognition by officers of their own direct responsibility for the health of their men.

November, 1906.

THE DYNAMICS OF BOWLING (*p.* 8).—"GREAT BATSMEN," by G. W. Beldam and C. B. Fry.—From the purely cricketing point of view this book must be of great interest, because it proves the wonderful variety of method by which different bowlers effect practically the same result. The movements of the body, arm, wrist, hand, and fingers are all co-ordinated to the one end of imparting to the ball a definite combination of translation and spin. The problem of the dynamics of the "break" is simply that of a rotating sphere impinging obliquely on a rough surface, and is familiar to everyone who has handled a billiard cue. The point of interest to the would-be bowler is how it is effected. This is discussed in the book by Messrs. F. R. Spofforth, B. Bosanquet, and R. O. Schwarz. The introductory chapter by the "Demon Bowler" is capital reading. The questions of swerve and break have much scientific interest. The main fact is that all "swervers" project the ball with the seam as nearly as possible in a vertical plane; in the grip the fingers do not touch the seam, although in some cases the thumb does. The seam is really a roughened zone on which the air may be supposed to exert a greater frictional force than on the other parts of the ball, especially if the ball be new. The volume contains 464 action photographs of some of the most celebrated bowlers of our day.

THE FIRST "MANNED" FLYING MACHINE (*p.* 35).—On October 23rd the first flying machine, "heavier than air," successfully raised itself and its driver, M. Santos Dumont, from the ground several feet, and transported itself by means of its own power a distance of eighty yards. The machine is built on the aëroplane principle and mounted on two wheels.

It is fitted with an eight-cylinder 60 H.P. motor, weighing about 170 lbs., which drives an aluminium fan making 1,000 to 1,500 revolutions in a minute. With its driver the machine weighs about 750 lbs. The äeroplane is shaped like a large horizontal T. The short arms of the T are slightly inclined upwards, and are each composed of three compartments, like three box-kites tied together side by side. At the base of the T is a large compartment, also like a box-kite, which acts as a powerful rudder at the front end of the äeroplane; the operator stands on a platform midway between, and on a level with, the lower surfaces of the two main inclined arms.

This achievement of M. Santos Dumont will no doubt give a fresh impetus to the problem of flight, and experimenters have now before them a successful äeroplane that can serve as a starting point.

P.S.—On 12th November M. Santos Dumont's airship traversed in level flight 220 mètres in 21 seconds, rising to a height of about 5 mètres.

THE PRESSURE OF LIGHT (*p.* 90).—Experiments have now proved conclusively that a beam of light presses against any surface upon which it falls. Maxwell's calculation that the pressure on 1 sq. c.m. is equal to the energy in 1 cub. c.m. if the beam has been confirmed, so that we have a new force to be reckoned with. This is apparently of negligible account in terrestrial affairs; but out in the solar system, when there is no disturbing atmosphere, and when it acts without interruption for ages, it may produce very considerable results. Light pressure may account not only for the formation of comets' tails, if these tails are outbursts of finest dust, but also for the small bodies which appear to abound in our system, and to reveal their existence on any starlight night when perishing as shooting stars.

SYNTONIC WIRELESS TELEGRAPHY (*p.* 105).—Syntony, or tuning between transmitter and receiver, means the emission by the transmitter of sustained vibrations of definite frequency. Only when these are produced is it possible to employ in the receiver a circuit tuned or resonating to this particular frequency. The main difficulty with all methods of spark transmission is to produce these sustained vibrations. Mr. Poulsen has found that by burning the arc in an atmosphere containing hydrogen, by lengthening the arc and by placing it in a strong magnetic field, the frequency can be enormously increased and as many as a million vibrations a second may be obtained. The problem of syntonic signalling is at last nearing practical solution.

W. E. WARRAND.

RAILWAY GAZETTE.

November 9th and November 22nd, 1906.

NEW AMERICAN SIGNAL CODE.—The American Railway Signal Association has now published the result of its deliberations as to the arrangement of signals and their lights. It is a very comprehensive report, though extremely concise, and will no doubt be the subject of much correspondence.

The scheme propounded deals with, (1) the use of the three-position

signal, (2) the indication by signals of instructions required for handling traffic.

As provision has to be made for train order signals (*i.e.* signals to train-men as to despatcher's orders) some indications are provided for which we have no counterpart in European practice.

The most important of the proposals are :—

1. Not less than two lights for any High Speed signal.
2. Distant signal to be abolished as a separate signal, the "Caution" position of a Home, Advanced, or Starting signal being used instead of the "On" position of a Distant signal.
3. The signals to be given in the upper right-hand quadrant, *i.e.* the signal to be raised instead of lowered.
4. Two lights arranged diagonally to the vertical as an indication of an auto-block-signal.
5. The lights are :—*red*, danger; *yellow*, caution; *green*, clear.

(N.B.—Caution is a warning position of the position of a signal ahead).

Day signals are to have two arms representing unlimited and limited (or medium) speeds; and also a low-speed arm, distinguished by being placed apart from the other pair; this latter is to have a dimmer light than the others.

The abolition of the Distant signal is really the most noteworthy of the proposals, the point being that a signal in the Danger position is never to be passed. The precise siting of the Home signals to sufficiently cover the train may, however, present some difficulty, particularly as in America the over-running of signals is a contingency which has always to be borne in mind.

C. E. VICKERS.

RIVISTA DI ARTIGLIERIA E GENIO.

October, 1906.

CONSTITUTION OF THE JAPANESE SIEGE CORPS AND PARK AT PORT ARTHUR.—It may be noted that, whilst the hostilities against Port Arthur commenced even before the declaration of war, on the night of the 8th—9th February, the effective operations for the investment and siege of the place were not commenced until June, after the disembarkation at Dalny and the organization of the IIIrd Japanese Army whose duty it was to constitute the Siege Corps.

This army was composed of 3 divisions (the 1st, 9th, and 11th), each containing 12 battalions (with 2 mitrailleuses to each battalion), 3 squadrons, 6 batteries of field artillery, and 3 companies of sappers. There was in addition an independent brigade of field artillery (12 batteries) and a regiment of siege artillery for service of the parks.

During the course of the operations 2 mixed brigades of reservists were added, so that the total strength of the Siege Corps amounted to about 70,000 men, constantly kept up to this number by reinforcements which continued to pour in from the mother country. This army was again increased by an entire division towards the end of the siege, and in November the 7th Division was also sent to Port Arthur. The strength of the Siege Corps then amounted to about 90,000 men.

Dalny, a large and commodious commercial port, on the organization of which the Russians had expended several millions of roubles, became the base. This port, connected by railway with Port Arthur and with the Trans-Manchurian lines, was occupied by the Japanese a few days after the battle of Nansan on the 30th May.

The Commander-in-Chief of the Siege Corps was General Baron Nogi, descended from an old and noble race of Samurai, who enjoyed a reputation for great energy of character. His age in 1904 was 55 years. The hardships and responsibilities of the siege, and the grief caused by the loss of his two sons, both officers, had no effect in bending the strong fibre of his character, as was shown on the field of Mukden, where he gave splendid proof of will and energy.

The Japanese siege park made a progressive development during the extension of the operations; but in every way, even at the end of the siege, it was far from being in accordance with the latest requirements for such an organization.

At the commencement of the siege the park contained little more than a hundred cannon, heavy guns and those of medium calibre. There were 16 of 15-c.m. and about 50 of 12-c.m., and there were mortars of 15-c.m. and 9-c.m. and guns of 10·7-c.m. There were subsequently added about 30 marine artillery guns of various calibres (11, 12, and 15-c.m.) and several 15-c.m. and 9 c.m. mortars of old pattern. The most powerful of the guns was the 15-c.m., of which there were only two; but even these were not sufficiently powerful to cause damage to the Russian works, and it became necessary to send to Japan for 28-c.m. guns of Italian model. Towards the end of the siege the park consisted of about 200 cannon of medium calibre; but among these were several small calibre mortars and guns of bronze and of old patterns, which were of little importance.

The artillery of the attacking force was thus insufficient both in number and in weight of projectiles. There were wanting in the Japanese park some cannon of European siege park model, for example mortars of about 20-c.m. Moreover the 12 and 15-c.m. guns, which constituted the nucleus of the park, were not of modern pattern, and were undoubtedly inferior to those which (according to the critics of to-day) it is necessary to employ for the attack of an important fortified place.

One remembers the decisive successes obtained by the Japanese infantry in 1894, during the war with China, in the attack on the fortifications of Port Arthur, in which the same general Nogi had taken part with a brigade; and there would seem to have existed an inexact estimate of the value of the fortifications more lately constructed by the Russians. This may perhaps have been the reason for the neglect on the part of the Japanese commanders, during the preparations for the war, as regards the supply of siege artillery. In fact, General Nogi trusted in a great degree to the action of his admirable infantry, as was shown by the direction of the operations during the first months of the siege; for the slow and patient work of methodical attack was substituted a system of assaults by infantry in mass, a system which was certainly more rapid, but which, without a sufficient preparation by a powerful and numerous artillery, led to a useless sacrifice of life.

EDWARD T. THACKERAY.

RECENT PUBLICATIONS.

The Russo-Japanese War. Compiled by the General Staff, W.O. Part I. ($9\frac{1}{2} \times 6$. 1s. 6d. Wyman).

The Battle of Tsu-shima, by Capt. V. Semenoff, one of the survivors, translated by Capt. A. B. Lindsay, with a preface by Sir George Sydenham Clarke, G.C.M.G.

Erfahrungen aussereuropaischer Kriege neuester Zeit: II. Aus dem russisch-japanischen Kriege 1904 bis 1905: 1. Port Arthur (Heft 37/38 of the *Kriegsgeschichtliche Einzelschriften*), herausgegeben vom Grossen Generalstabe. ($10 \times 6\frac{1}{2}$. Mittler, Berlin).

Studie über Ljaojau und Mukden, von J. R. Malczewski v. Tarnawa. (3·60 mks. Berlin).

Taktische Tagesfragen mit Rücksicht auf die Erfahrungen im russisch-japanischen Kriege, von Major Hugo Schmid, Generalstabskorps. (4 kr. Siedel, Vienna).

Campagne de l'Empereur Napoléon en Espagne, 1808—1809, par le Commandant Balagny. (12 frs. Berger-Levrault, Paris).

The Army in 1906. A Policy and a Vindication. By the Rt. Hon. H. O. Arnold-Forster, M.P. ($8\frac{1}{2} \times 5\frac{1}{2}$. 15s. Murray).

The Anatomy of Bridgework, by W. H. Thorpe, ASSOC. M. INST. C.E. ($8\frac{1}{2} \times 5\frac{1}{2}$. 6s. Spon).

The Design and Construction of Metallic Bridges, by W. H. Burr and Myron S. Falk, respectively Professor and Lecturer in Columbia University. (21s. Chapman, Hall).

Manual of Wireless Telegraphy, by A. F. Collins. (6s. 6d. Chapman, Hall).

The Manufacture of Concrete Blocks, and their Use in Building Construction, by H. H. Rice, W. M. Torrance, and others. (8s. Constable).

The Economics of Railroad Construction, by W. L. Webb. (10s. 6d. Chapman, Hall).

Properties of Matter, by C. J. L. Wagstaff, M.A. (3s. 6d. University Tutorial Press).

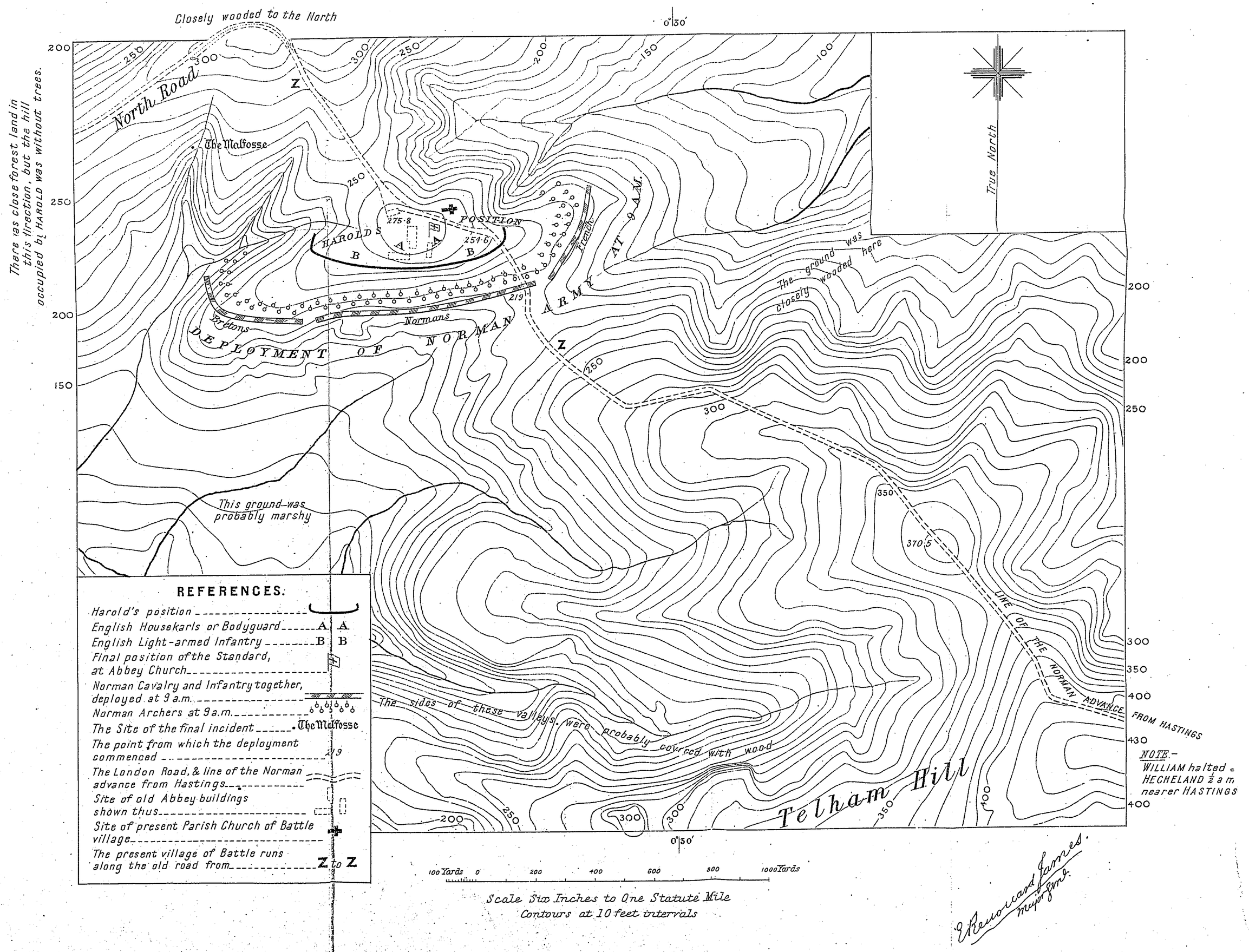
The Lower Niger and its Tribes, by Major A. G. Leonard. (9×6. 12s. 6d. Macmillan).

The Rise and Decline of the Netherlands, by J. Ellis Barker. ($8\frac{1}{2} \times 5\frac{1}{2}$. 10s. 6d. Smith, Elder).

Office Organization and Management, by L. R. Dicksee and H. E. Blain. ($8\frac{1}{2} \times 5\frac{1}{2}$. 5s. Pitman).

THE BATTLE OF HASTINGS.

14TH OCTOBER. 1066.



REFERENCES.

- Harold's position — (curved)
- English Housekarls or Bodyguard — A A
- English Light-armed Infantry — B B
- Final position of the Standard, at Abbey Church
- Norman Cavalry and Infantry together, deployed at 9 a.m.
- Norman Archers at 9 a.m.
- The Site of the final incident — The Malfosse
- The point from which the deployment commenced — 219
- The London Road, & line of the Norman advance from Hastings
- Site of old Abbey buildings shown thus
- Site of present Parish Church of Battle village
- The present village of Battle runs along the old road from — Z to Z

Scale Six Inches to One Statute Mile
Contours at 10 feet intervals

E. Reynolds James
Major Gnd.

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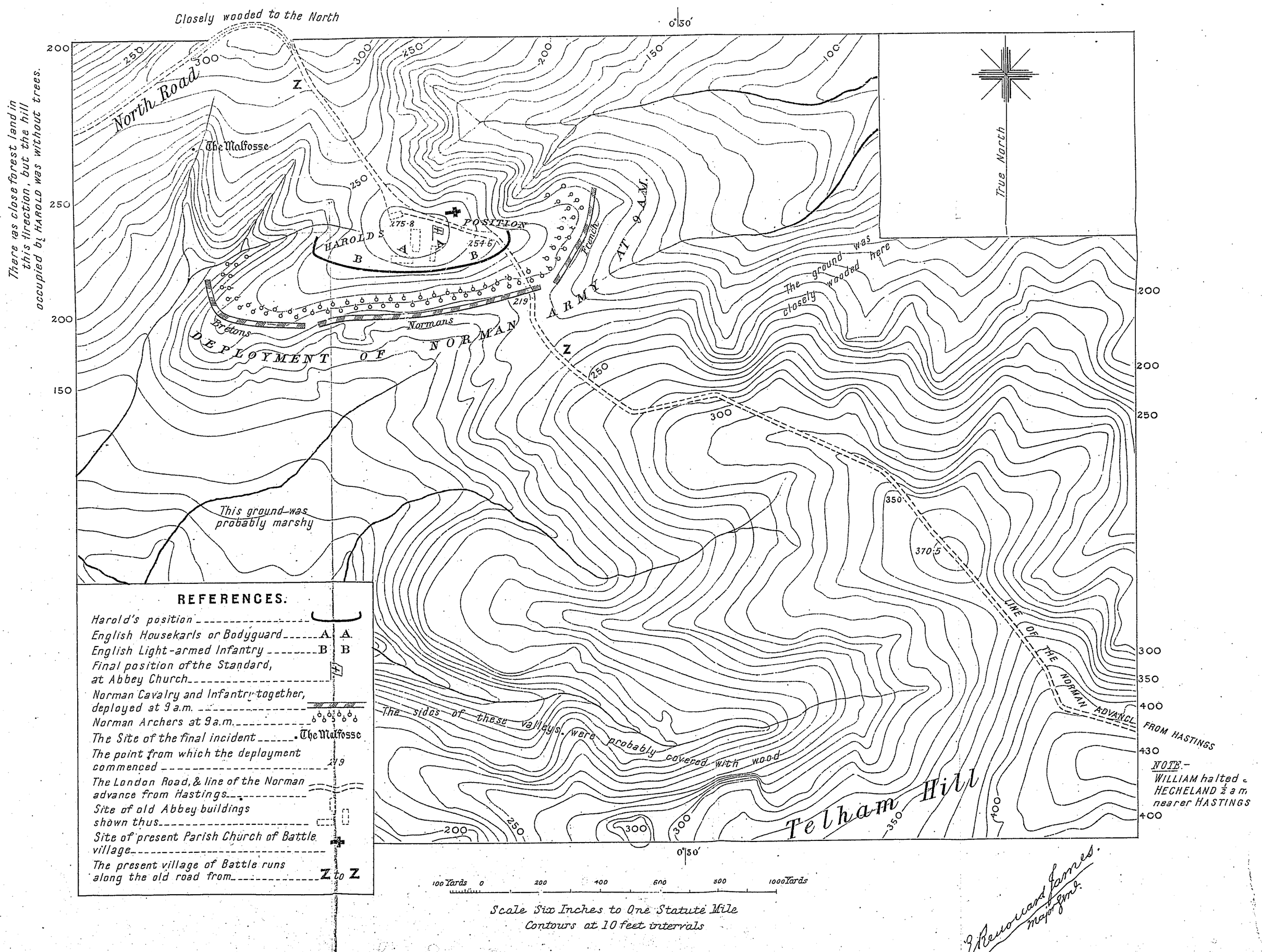

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100 Yards 0 200 400 600 800 1000 Yards

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E. Bevercar James. major gno.