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CONTENTS.

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Each article must be accompanied by the name of the author, but the question of publishing it over his signature or under a pseudonym is left to his discretion.

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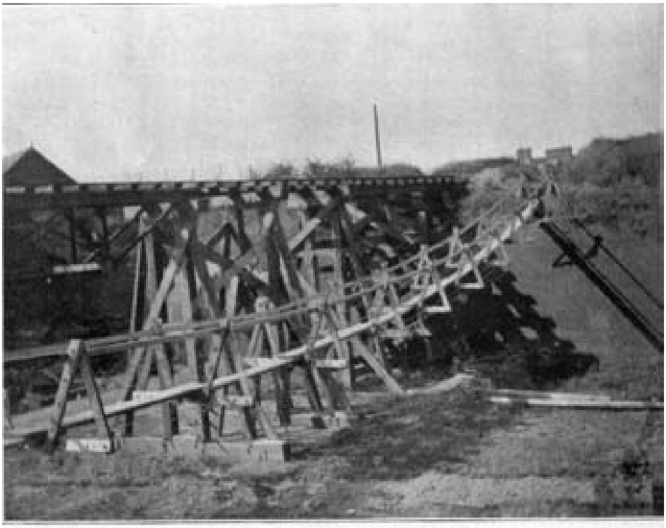
Barr and Stroud Rangefinder, FQ Type

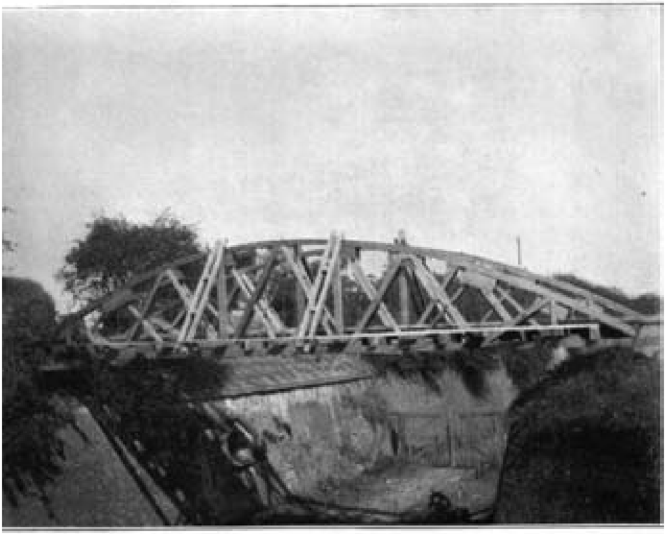
BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 1 METRE BASE,
FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

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.



1. Light Suspension Bridge: Span 132 feet.
To carry Infantry at 4 paces distance.



2. Bowstring Girder Bridge: Span 50 feet.
To carry Infantry crowded.

Bridges

3. Trestle Bridge to carry 3' 6" Railway.
Span 334 feet; maximum height 40 feet.

Bridge

SOME IDEAS ON FIELD WORKS.

THE following extracts from the reports on the Annual Courses of several Companies are published as being worthy of general study.

1. REDOUBT CONSTRUCTED BY THE 17TH (FIELD) CO., R.E.

The chief point is the reduction of the loophole to the smallest possible dimensions (*Fig.* 1 of *Plate* I. at end).

The loopholes were made continuous, 3 inches high in the clear. They had to be made so as to fire down a slope of $\frac{1}{7}$ and also at extreme elevation on to a hill about 3,000 yards distant. To effect the latter a second arm rest was constructed below and behind the normal one. The method of firing is shewn in *Figs.* 2*a* and 2*b*).

The view from the loopholes is as good as from the parapet.

The profile of the redoubt was very low, and long grass was planted just in front to break up the straight line of the loopholes. It was, however, found impossible to entirely hide this line, so very shallow trenches were dug on the face of the hill, parallel to the loopholes and at varying intervals. It was then impossible to distinguish the loophole line from these trenches from any distance, and the trenches were not deep enough to afford any cover.

Another point of interest is the addition of a few inches of shingle on the crest of the parapet to prevent bullets penetrating into the loophole.

2. A LIGHT SUSPENSION BRIDGE, TO CARRY INFANTRY AT 4 PACES DISTANCE, MADE BY 29TH (FORTRESS) CO., R.E.

Photo 1 gives a good general view of the bridge, the span of which was 132 feet and the final dip $\frac{1}{15}$.

The material used consisted of galvanized iron wire, breaking strain 1,000 lbs. per square inch, $6'' \times 6''$ deals for the end frames, $4'' \times 2''$ planking for the intermediate frames, $\frac{1}{2}''$ iron bolts.

The suspending cables were 12 in number, and each consisted of 2 wires seized at every 15 feet with No. 20 wire. The cables were made fast to the anchorages by a round turn and fishplate clips. At one anchorage it was found possible to grip all 12 cables with one fishplate, using 4 bolts. At the other, to facilitate the adjustment of the cables, they were gripped in pairs by half fishplates.

The end frames were strutted and guyed to the anchorages, which were of the usual type of buried log. The 12 intermediate frames were made up as shown in *Fig.* 3.

The roadway consisted of 12″ × 2″ planking.

The bridge was got out by fixing all the cables at one anchorage and threading all the frames on to them near the other anchorage. The cables were then temporarily adjusted and clipped and the frames and roadway boomed out. The cables were finally adjusted, and a single-wire catenary was stretched on either side to prevent horizontal swaying.

In making the anchorage, it was found important to give plenty of room to work in, as otherwise, with so many small cables, much time is wasted.

3. SWINGING DERRICK ON BARREL RAFT, USED BY 1ST FIELD TROOP, R.E.

This was found very useful in placing the trestles of a bridge, particularly a four-legged trestle.

The raft was formed of 29 barrels, 108 gallon, arranged as shewn in *Fig.* 4.

The butt of the derrick spar rested on the centre of a wheel, which was firmly lashed to the tie baulks of the raft. An oak dowel was made to fit into the axle hole, being shouldered to prevent it dropping through, and long enough to stand up 3 inches above the nave of the wheel. The foot of the spar was morticed out to take this dowel, and was bound round with wire at the base to prevent splitting.

4. BOWSTRING GIRDER BRIDGE, TO CARRY INFANTRY CROWDED, ERECTED BY THE 29TH (FORTRESS) CO., R.E.

Photo 2 and *Fig.* 1, *Plate* II., show the bridge in detail.

The top boom was built up of five 10″ × 1″ planks bolted together, and the bottom boom consisted of 10″ × 5″ beams.

The girders were made in the bottom of the gap; and were raised, one end at a time, by means of a derrick.

5. FLYING TRENCH WORK AT NIGHT, BY 43RD (FORTRESS) CO., R.E.

An improved method of constructing flying trench work at night consisted in the use of hurdles (6′ long, 3′ high) instead of gabions.

Each 2 men were provided with 2 hurdles, 1 pick, 1 shovel, and 3 loops of wire (2′ long). On arriving at the site of the trench, the hurdles were driven in, 2′ apart, and the wire loops placed over the tops of the hurdles at the centre and ends.

The two men dug out enough earth to fill the 6′ run of parapet between their two hurdles, the trench being roughly 18″ deep, with a berm of 12″.

On a very dark night, 40 men executed 40 yards of this parapet in 1¼ hours.

6. PILE BRIDGES.

The 2/41st (Fortress) Co., R.E., erected a simple pattern pile bridge.

Such bridges appear to have been much used by the Japanese in the late war, and might profitably be practised by R.E. Companies whenever possible.

7. RAILWAY TRESTLE BRIDGE, CONSTRUCTED BY BRIDGING COMPANIES, R.E.

In July, 1904, and July, 1905, a railway trestle bridge was constructed by the 1st, 2nd, and 3rd Bridging Companies, Royal Engineers, as part of their annual training, over a gap near Curzon Bridges, about 1 mile from Pirbright Camp (*Photo* 3 and *Figs.* 3 and 4). It was designed to carry a 3′ 6″ railway, and was made in four tiers, viz., 3 tiers of wooden trestles resting on a bottom tier of pile piers driven 5′ deep into the ground. Each of the 4 tiers was 10′ high, so that the bridge was 40′ high at the highest part; the bays were 11′ 6″, and the span was 334′. The timber was all felled at the back of the Ash Ranges, whence it was transported to the site of the bridge, distant 2¼ miles.

The first two tiers were erected in July, 1904, and the bridge completed and line laid the following July.

The average daily number of non-commissioned officers and men employed on the bridge was 120, including 4 smiths and 22 wheelers and carpenters. The hours of work were 6.0 to 7.45 a.m., 9.0 a.m. to 12.45 p.m., and 2.0 to 4.0 p.m., total 7½ hours. The number of working days occupied in construction, including the cutting and carrying of half the timber required, was 27½ days.

Trestles consisted of standards, capsills, groundsills, and side struts. Standards were trenailled with oak trenails into capsills and groundsills. Side struts were dogged to capsills and groundsills; to economize iron and facilitate dismantlement only 8 dogs were used per trestle.

The method of construction was as follows:—The whole of the piers of the bottom tier were driven, and a capsill fixed on the top of each. Longitudinal stringers were then spiked down to these, placed so as to come immediately below the legs of the trestles of the next tier. The trestles of the second tier had meanwhile been made, and were then placed into position, those in the centre being lifted by derricks, and those at the ends of the bridge being slid out and then lifted upright by derricks. Stringers were again fixed as for the first tier, and then the 3rd and 4th tiers placed in a similar manner. The bridge was further braced longitudinally by the addition of timbers spiked diagonally to the legs of each trestle.

The trestles near the centre of the bridge were hoisted into position by 50′ derricks and 5″ rope tackles (the spars for these derricks had been brought out from Aldershot); to prevent distortion during raising, the capsills and groundsills were held to the standards by two rope slings placed right round the trestle and windlassed up until taut.

The piles were all driven by hand monkeys, of oak clamped with iron, weighing about 120 lbs., made by the Bridging Companies. The best arrangement for preventing the handles shaking loose from the monkeys is to have the 4 handles fixed to two iron collars which encircle the monkey a few inches from either end and are clamped by screw bolts; additional iron collars are necessary at each end of the monkey to prevent the wood from splitting when striking the pile. This method appears better than bolting the handles through the wood or fixing them to the collars at the ends of the monkey.

The road bearers were round timbers of 9″ minimum diameter or 11″ mean. To take a 3′ 6″ gauge steam engine, for which the bridge was designed, two road bearers of this size would be required under each rail. As however trollies of 2′ 6″ gauge only were available for testing the bridge, and as double road bearers would have necessitated felling more timber, the gauge was reduced to 2′ 6″ and one road bearer placed under each rail. The road bearers were calculated to take a 10-ton live load with a factor of safety of 3. The joints of the road bearers over the capsills were skew joints; the road bearers were spiked to the capsills with 10″ spikes countersunk.

The sleepers were of half round timbers, notched to receive the rails and spiked to road bearers with 8″ spikes.

The rails were single-headed 56-lb. rails without chairs. The rails were connected together with fishplates, and spiked down to the sleepers with railway spikes.

To test the bridge two trollies connected together, giving a 9′ 8″ wheel base, were loaded with 10 tons of rails to represent a 2′ 6″ gauge steam engine; and were hauled across the bridge several times at varying rates. The deflection of the road bearers of the centre span and of spans near the end of the bridge was found to be ½″; there was no trace of settlement or disruption in the bridge.

8. RAISING TRESTLES IN DEEP WATER.

The following method of raising two-legged trestles is extracted from a work by Major V. Deguise, Belgian Engineers.

It has been tried at Chatham and might prove useful, particularly in deep water. It has the advantage that the trestle, when raised, has the necessary longitudinal bracing and handrail already fixed.

A frame of light poles, consisting of two legs and two diagonals, is lashed to the butts of the trestle legs, and the handrails are lashed to the tips, all with a square lashing rather loosely put on.

Both frame and handrails are then allowed to fall back until the lashings tauten and assume an angle as shown in *Fig. 2*.

Light ropes are then made fast to the end of each handrail and to the legs of the light frame.

The whole is then floated out to the bridge head, being steered by means of the ropes.

The legs of the light frame are then made fast to the legs of the last trestle in bridge; and by pulling on the handrail ropes, the trestle is easily raised into position as shewn by the dotted lines in the drawing.

Before floating out, the handrails and the legs of the light frame must be carefully measured and marked at the points where they are to be lashed to the bridge trestle.

OUR IDEAS ON PERMANENT FORTIFICATION: WHAT ARE THEY?

By CAPT. G. WALKER, R.E.

TWO articles in the January number of this *Journal*, independently conceived but treating of the same subject from different standpoints, seem to indicate that we are not altogether indifferent to the fact that our own profession is worthy of study in spite of all that is said to the contrary.

The history of the influence of foreign policy on British coast defences is a subject which, except to the very few, seems, as far as can be gathered, to be quite outside the average man's idea of practical politics; and yet we soldiers prate so much of Military History! Our ideas as to the uses of the study of Military History seem to be bounded by the horizon of that bugbear "D." Is this right? We profess to be Military Engineers. Do we individually ever study that subject outside the official text books? Do we ever set ourselves to think big upon the subject? Have we, any of us, the personal ambition that we may one day be able to mould the defensive policy of the Empire? Our fathers have done it before us, why should we not do the same?

These questions must, it is feared, be largely answered in the negative. The reasons for this state of things seem difficult of elucidation, but there is one which seems to be fairly clearly marked; everybody nowadays seems to be striving to get away from his own profession in order to dabble in somebody else's. So the profession of the Soldier Engineer, than which we venture to think there is nothing more honourable, becomes, to use a modern vulgarism, "left." In these latter days Military Engineering has come to be considered the profession of everyone who wears a red coat, and this is right to a certain extent: every soldier must be able to help himself at a pinch by artificial means. But Military Engineering does not end there. The man who professes it must be soldier and engineer as well, and must be trained to bring his scientific knowledge to the assistance of his military instinct.

The foregoing pious opinions may seem rather indefinite, and the question will be asked—what does it all mean? Let us take a definite branch of the soldier engineer's profession and ask ourselves some questions about it.

Permanent Fortification is said to be a dead art, so far as Englishmen are concerned. "Britannia needs no bulwarks," sang the poet. Doesn't she? It may be waste of time to argue the point; but Britannia will probably, at no very distant date, be very sorely in need of a knowledge of other people's bulwarks. "We shall never again undertake a siege," say others. Shall we not? British military history bristles with sieges. Is military history alone never to repeat itself? and further are we so unlikely to be besieged that the conduct of sieges by other people is not worth a thought? Have we been such unerring prophets in the past that we can afford to pin our faith on our opinions as to the future?

These questions seem pertinent enough and direct enough. The answer would seem to be that the teachings of history ought not to be disregarded; that we professional Military Engineers, instead of allowing the subject we profess to be dropped, should strive to create a school of thought which will be the standard in our own country at least.

At present it is to be feared that we are very far from having any organised school. This is due to a want of cohesion, and also to the fact that, at present, it is impossible for anybody to get any military information other than that contained in the rather highly priced efforts of individual authors.

It is not intended here to carp at the individual author: far from it. The man who has the energy to produce any work, however small, is entitled to all praise. What we want, however, is not isolated individual effort but an organisation within which the individuals can usefully labour and through which the result of these labours may be made available for the use of their fellows.

To carry out this idea we want a sort of "Bureau of Information," which will sift and arrange intelligence supplied to it and furnish professional advice to anybody in need. To do this a director and staff of officers would be required, who should have no other duties than the collation of information and the revision of our professional text books. It is a work that would require a wide knowledge of things military, especially as regards artillery, a branch of study which is often neglected.

So much for the abstract ideas engendered by Colonel Ruck's article. We will now turn to that by Major Clayton.

Here we have a creditable sample of individual effort. The article it is true contains an avowed criticism of two of the few standard works on fortification in the English language. But both books were published several years ago, and Major Clayton's object was no doubt to show what modifications have become necessary on account of the development of artillery and firearms. Sir George Clarke, who wrote with the specific object of infusing some elasticity of method into the art of fortification, did not say that traverse protection was never to be used if required, but that the engineer should be free to use any artifice within his reach to meet the tactical conditions of his day. Fortification is not an exact science and Sir George's book certainly made this clear.

To deal with Major Clayton's ideas of detail :—Taking the plans generally they seem very complicated as regards the slopes. The desired protection from shrapnel could probably be much more easily obtained. Steel loopholes are no doubt admirable, but, from the Japanese experience of the effect of shrapnel, it is probable that in the future some form of overhead cover in addition to loopholes will be essential for the firing line.

The question of artillery is perhaps the most crucial of all those raised by Major Clayton. It is governed entirely by the tactical requirements of individual positions. But, in the absence of any special local conditions, it seems more reasonable to assume that artillery should not be put into infantry works and for the following reasons :—

The best position for any weapon is determined generally by its power and the best method of protecting it. The powers of guns and rifles differ greatly and it is a reasonable assumption that, this being the case, the best places for them will as a rule not be identical.

The power of indirect fire from modern guns and howitzers is great, that of rifles small—why put them in the same place ? By doing so the position of the latter is advertised to that arm of the enemy to which they have no power to reply. Mobility also is reduced to a large extent and this is an important point.

By these remarks it is not intended to deny light Q.F. armament a place in infantry works in particular places ; but only to point out that, in considering any scheme of defence, the best rule to go by is to put each class of weapon where it can best do its work.

The question of the form of superior slope seems rather laboured in the article under review. The actual site will largely affect the question. The idea of counter works on the parapet seems of questionable value. Counter-attacks would probably be more effectively carried out from positions on the flanks of and outside the redoubt.

The positions of electric lights are of great importance. It seems questionable, however, whether they are best placed in the works. Flank positions would probably be better, but these would entail difficulties (not insuperable) of installation.

Generally, it would appear that Major Clayton has regarded his redoubt too much as a separate and self-contained entity, and has not laid sufficient stress on the fact that, to be really effective, all works must complementary to those around them. As regards design simplicity and inconspicuousness, being the main necessities nowadays, must take the first place.

One word must be added in respect of coast defence. Major

Clayton's deductions from the siege of Port Arthur appear to be correct. There is a danger, however, in arguing entirely from one actual case. No one can be responsible for the methods of attack resorted to by others, and it seems of questionable prudence to lay down anything very definite, except, perhaps, that heavy ships will not probably put themselves in the way of destruction by coast batteries as their *rôle* is the destruction of their own kind at sea.

Boom defence covered by guns capable of stopping the blocking merchant man *and* a possible torpedo boat would seem a better way of putting it; and also, in certain places where anchorage has to be denied to the enemy, even the discounted submarine mine may be of use.

This article has been spun out beyond its intended limits, and possibly some statements have been made which will not receive universal approval. Its intention has been firstly to point out how much we all can learn from the previous history of our profession; secondly, to congratulate Major Clayton upon his effort to start discussion on a subject that receives but scant attention nowadays; and lastly, to offer some criticisms on his ideas, which may induce others to take a hand in the discussion and thus to some small extent help everybody.

NOTES ON SHELTER TRENCHES.

By Bt. Col. J. E. Capper, c.b., R.E.

The following notes on Shelter Trenches were written two years ago for private circulation and criticism; they have since then been slightly revised.

I have long thought that our text books on Field Works pay too little attention to general principles; and though the Manuals for Infantry Training are thoroughly excellent, they are of necessity so compressed that it is difficult, without very close study and much thought, to apply the principles contained therein to individual instances.

Since these notes were written Capt. H. F. Thuillier, R.E., has published a work which contains much that is also included here. I venture to hope, however, that these notes may still be of service; and they will answer their purpose if they lead to discussion, and ultimately to the embodying in our text books of principles so clear that no officer can have any hesitation as to the position and nature of defences suitable to the tactical conditions of the moment.

That these clear principles are required, and that nothing is "obvious" to the untaught intelligence, may be illustrated by the following incident:—

At a certain examination of officers for promotion to Major and Captain, the Examining Board being one which no one would accuse of want of military capacity, and the examinees being well up to average standard, one of the problems was the fortification of a rear-guard position along a ridge sloping steeply to the enemy. All of the examinees with the exception of one R.E. officer devoted their attention to attempting to cover the dead ground close under the ridge, and the President himself expressed surprise that this officer should have neglected the dead ground. However, on being informed that this officer proposed to withdraw his troops long before the enemy reached the dead ground, the President was entirely satisfied; but this simple and obvious view of the matter had never occurred to him nor to any other of the examinees.

The positions chosen for Shelter Trenches, and the nature of the Trenches to be constructed, must vary according to the purpose for which they are to be occupied.

The enormous stopping power of the modern rifle has necessitated modifications in the principles governing the choice of positions for the trenches.

THE OFFENSIVE—DEFENSIVE.

In the choice of a position where battle is to be accepted, the main point is to obtain a clear field of fire as deep as possible over the ground in front.

If such a field of fire can be obtained over *open ground* up to 1,000 yards from the position, an enemy attacking will probably be brought to a stop on it.

If he is able to advance over *open ground* to within a very short distance of our trenches, he will in all probability be successful. He could not reach there if our fire was effective, whilst the moral effect of such an advance would probably induce our retirement before he arrived at the closest stages.

It follows, therefore, that in such a case dead ground *immediately* in front of our main trenches is not a fatal disability; and that the main trenches should not be advanced down a slope in order to cover their immediate foreground, if, by so doing, the view of ground within decisive range of, but further away from, our position is thereby lost. Such dead ground must however be covered by advanced trenches at night and in misty weather, and may often be searched by other trenches further along our line.

When, however, cover for the enemy exists to within a short distance of our main position, or where it is impossible to see from it any ground except the immediate foreground, our trenches must be sufficiently advanced to enable us to sweep the immediate foreground with fire.

Trenches in a battle position may, therefore, be well advanced to the forward edge of a plateau, or down the forward slope of, or at the foot of, a hill, provided the view is not lost by making them at the lower levels.

REAR GUARD ACTIONS.

In a rear guard action, it is not our intention (except under extraordinary circumstances) to stand a close attack. Our object is to delay the enemy and force him to deploy, and then ourselves to retire to another position without the risk of excessive loss.

If we can obtain a good view of ground about 1,200 yards to 1,500 yards in front of our position, we can select the front of a plateau; but we should not go down the front slopes, as we shall then have to retire up an exposed slope.

If, owing to undulations of ground or cover in front, we cannot see the enemy till he arrives within decisive range, it is best to occupy the rear edge of an open plateau. He will be held for a time at the far edge of the plateau, and we have a better chance of retiring with safety down the unexposed slopes than we should have of retiring under his fire at decisive ranges across an open plateau. For such positions dismounted horsemen should be detailed if available.

If there are woods on the plateau, the front edge of these woods must be held, and we can retire through them under cover from the enemy's view.

DETACHED POSTS.

In detached posts, where the object is to prevent the enemy reaching a definite point, such as a bridge, stores, etc., so that he cannot destroy it, it matters little how close he can get to the object as long as he cannot actually reach it.

In these cases we require above all to be able to sweep the ground immediately in front of our trenches, and the trenches should be pushed forward in order to obtain this object, even if by so doing ground at a distance is hidden from view.

If the garrison is sufficient, a double tier of trenches may be used to sweep both the immediate and further foregrounds.

Trenches, forming part of a battle position, which are advanced beyond the main position, or where the enemy can advance under cover to 200 or 300 yards, are governed by the same principles as those of detached posts.

CONDITIONS GENERALLY APPLICABLE.

In all cases the following conditions should be fulfilled as far as possible. They are placed in order of importance.

1st Condition.—The shelter trench must be so placed that it can command a view of the ground on which it is to bring fire. Except in rear-guard actions, where long range fire is mostly employed, the field of fire must be cleared as far as possible.

2nd Condition.—Concealment must be considered, both to avoid giving a definite mark to the enemy and to hide the exact position and numbers from the enemy. The shorter the range the more important is the question of concealment of the individual man. Very slight protection to men behind bushes, or in very broken ground, where their heads cannot be seen, is better, at very short range, than thick parapets, over the tops of which men's heads plainly appear. Even the best troops may be disinclined to expose themselves over a parapet in order to fire at a more or less hidden enemy, who is firing at close range; but when concealed from view only, they quickly realize that it is safer for them to fire than to lie without firing.

Where a trench cannot be concealed, it is often well to give head-cover in the shape of logs of wood, or some contrivances raised a few inches above the parapet, which, though not bullet-proof, prevent the enemy seeing individual heads at which to take aim.

Care must be taken that, in placing shrubs, grass, etc., in front of the trench to conceal it, the cover is not so thick that the view is unduly interfered with. At ranges over 200 yards a good natural or artificial background is often sufficient, as it renders men's heads very difficult to see.

Where parapets are necessary, every endeavour should be made to blend them with the general appearance of the ground. For this purpose it is desirable to preserve the top layer of soil dug out, including sods, etc., in order to have material at hand to cover the newly excavated earth.

3rd Condition.—Bullet-Proof Cover.—At long ranges, where artillery fire is to be apprehended, and where the enemy's infantry fire is practically a hail of unaimed bullets, it is a matter of chance whether a particular square foot of ground is hit or not. With bullets falling heavily on a position, men in scrub or broken ground, not well protected, may suffer severely from this fire; therefore every endeavour should be made to give the men as much protection as possible.

Condition 2 must not, however, be lost sight of. Large mounds of newly-turned earth will attract both artillery and infantry fire at long range.

If the position is known to be held, as in detached posts guarding definite objects such as bridges, invisibility of the general lie of the trenches is not so important as in battle positions, where the enemy must remain uncertain as to the position actually held, owing to reconnaissance being very difficult.

4th Condition.—Deception.—Provided your general position is known, try to deceive the enemy as to your exact position by dummy trenches, so as to deflect his fire from the trenches you are really holding. These dummy trenches should be well defined, and should, if possible, have head-cover or loopholes, so that the enemy cannot tell whether they are occupied or not. They can be placed either in advance of or behind the actual line, or in gaps of the line.

Care must be taken that they are not so placed that bullets aimed at them are likely to fall or ricochet into the actual trenches; that the fire from the trenches is not masked by them; and that they will not interfere with making counter-attacks.

If made in advance of the real position they must not afford cover to the enemy if he reaches them.

It follows that, as a rule, they are better made either in rear of or alongside the real trenches. On flat ground it is preferable to use them in gaps; and on sloping ground to make them higher up the hill than the real trenches.

GENERAL.

Trenches need not be continuous, and should not, as a rule, be in straight lines. The parapets should not be carefully dressed off; and all sharp angles should be avoided.

If time admits, zigzag communication trenches can be made, joining up the outlying trenches, or joining these with others in rear in which supports can be placed.

Unless the ground is very favourable, without such communicating trenches it is almost impracticable, when the enemy has arrived at decisive range, to reinforce the trenches from one another or from supports, except by night. They should not, however, be started (unless there is a large superabundance of labour) until the field of fire has been cleared where necessary and the fire trenches are finished.

The principle of keeping men in groups should be adhered to in making rifle pits or short trenches. A trench should, therefore, as a rule, be at least big enough to hold a group. If detached bushes, etc., lend themselves to the making of rifle pits for only one or two men, these should, as far as possible, be grouped together, so as to keep the men of one group in close touch.

No definite rule can be laid down as regards the height of a parapet above the ground; it must vary from point to point, according to the accidents of the ground itself. But parapets should be as low as is compatible with a proper view of the ground which has to be covered by fire. On steeply sloping ground, however, in order to cover the scar made in excavating the back of the trenches, it is often necessary to throw up a comparatively high parapet. This parapet should be carefully treated, so as to blend with the hillside.

If the ground in front is sufficiently even, and time permits, parapets may be altogether dispensed with, the whole of the earth excavated being removed to a distance.

Spreading earth generally makes a mark. Where there is surplus earth it may often be usefully employed by making irregular-shaped mounds as backgrounds behind trenches; and if this can be done, and the mounds made to resemble the foreground, it is the best method of disposing of the earth.

Where there are bushes or banks in the immediate background of the trench, the dug earth can be spread behind them.

In laying out the actual line of trenches, the eye must be placed at the height above the ground to which the parapet is to be raised; it often happens that a view, which is an excellent one for a man standing up, is rendered, by small folds in the ground, very indifferent for a man lying down on the same spot.

It is often necessary, in order to search folds of the ground close to the main line of trenches, to place outlying trenches in front of the main line. Care must be taken, wherever such trenches are used, to see that the men in them are protected from the fire of the trenches behind them, by the ground itself or artificially. In the latter case a considerable portion of the earth dug out from the trenches can often be placed in rear. If it is required for protection in front it will be necessary to put up special parapets to protect the rear of the advance trenches.

Where trenches are broken back, as flanking trenches, they are liable to be exposed to enfilade fire, and sometimes to reverse fire from portions of the enemy's position. This defect can often be obviated by utilising the fall of the ground, making the trench higher up a hillside at the end which is nearest the enemy's position, and also by avoiding straight lines in plan. It may sometimes be necessary to put earth in the rear. This earth need not, if time be short, be made bullet-proof, if it can be so blended with the surrounding ground that the actual position cannot be seen from the enemy's position.

Where time admits, trenches should invariably be studied from the enemy's point of view. Parapets placed well down a slope will sometimes be found to be on the sky line if looked at from the enemy's position, and the sky furnishes the worst possible background for a trench.

SECTION OF TRENCHES.

In deciding on the section of trench to be dug out, it must be remembered that at long ranges the angle of descent of the bullet is great, and narrow deep trenches therefore afford the best protection. At short ranges, where the angle of descent is small, broad shallow trenches will often give as good protection as deep ones.

CONSTRUCTING TRENCHES.

The principles are the same as those which govern the taking up of a position.

The general line of trenches will be given by some superior authority. Each unit will be told off to construct trenches along a definite section of the front, and the exact position of either end of their line will probably be given them, together with the general line they are to adopt. Individual officers commanding units should then decide on the actual position of their trenches.

These trenches may be considerably in advance of, or withdrawn from, the general line, provided sufficient fire is given to the front between the extremities of the line, and that the trenches are not so far advanced or withdrawn as to mask fire from, or be masked by, adjoining portions of the main line of trenches.

In telling off parties to construct trenches, it must be remembered that those on the most important points of the line must be constructed first; and that clearing, where necessary, must go on at the same time as, or even before, the trenches are constructed.

Each commander, in his own degree, must therefore decide on the points in his portion of the line which obviously must be held, and divide his working parties accordingly (allowing first the necessary parties for clearing), and order each party to begin on the centre portion of its own position and work outwards.

Senior officers must most carefully avoid trying to do too much detail work themselves. It is only by entrusting the most junior officers with the actual location of each trench that all can get quickly to work. There is no reason why a junior officer, or an intelligent N.C.O. or private, should not be able to decide on the best site for a small trench as satisfactorily as the best qualified Engineer, *provided he has been properly trained to understand what he is doing.*

If time admits, or if there are more men in any party than are required to construct the trenches on the position allotted to that party, they can be distributed on the less important portions of the line.

If any attempt is made to start at one end of the line and work towards the other end, it may often happen that, from want of men and want of time, important points remain without any sort of defence, while less important points are well fortified.

In the same way, in occupying trenches that have been constructed by other working parties, occupy the most important points first; spread out afterwards, if there are men enough, along the less important trenches.

LOOPHOLES.

The chief object of a loophole appears to be to enable a man to fire with the minimum of risk of himself being shot.

It narrows his field of view, and is, to this extent, undesirable at any range; and this defect is much aggravated at night.

At short ranges, except where it is concealed by heavy shadow or by scrub or grass, etc., it not only affords an excellent mark to the enemy, but tells him the exact point to aim at, and is often a source of weakness in consequence.

At long ranges, the protection afforded by loopholes is greater than that afforded by open parapets; but it is well to remember that the constant use of loopholes is apt to have a demoralising effect on troops who may at any time be required to act on the offensive, where they will miss the complete cover to which they have become accustomed.

At ranges at which a man's head would be visible, men firing over a parapet, with their heads merely concealed from the enemy's view, will probably not suffer more than the same number of men firing through clearly seen loopholes.

In walls, blockhouses, or fortified dwellings, necessarily exposed to the enemy's view, loopholes must be used. But their disadvantage can be minimised, as they can be made very small without much restricting the field of fire; and their exact position can be hidden by painting sham loopholes, or by knocking bricks out of the outside of the walls irregularly and at different levels, so that the enemy will have no more exact target to aim at than the whole building itself.

OBSTACLES.

The main points to remember about an obstacle are :—

(1). That it is not meant to serve as an insuperable barrier to the enemy, but to keep him exposed under fire as long as possible.

(2). That, to be of any use, it must be placed where it is well under fire from the trenches, and close enough to them to be protected at night.

(3). That it must not be so thick as to afford protection or effective concealment to the enemy.

(4). If possible, it should be so placed that the enemy will come on it unexpectedly.

(5). It must not prevent counter-attack.

RÉSUMÉ.

BATTLE POSITIONS.

(*a*). Select positions from which you can obtain a good field of fire over a stretch of open ground between ranges of 200 and 1,000 yards, or more, from your position, and clear on this ground.

If you can do this do not fear too much any disadvantages of your immediate foreground.

(*b*). Get well forward on a plateau or down the slope of a hill.

(*c*). Use deep and narrow, rather than broad and shallow, trenches.

(*d*). Conceal your general position, and do not put up dummy trenches which give it away.

(*e*). Where the enemy can approach under cover to close up to your position, treat this portion of your position as a detached post.

REAR-GUARD POSITIONS.

(*a*). Select positions from which you can retire in comparative safety, and

(*b*). From which you can bring fire at 1,500 yards, or over, to bear on the enemy.

(*c*). Conceal your actual position.

(*d*). Use dummy trenches well in advance, even up to 500 yards or more, of your real position.

(*e*). Keep at the rear edge of an open plateau, rather than have to retire over it under heavy fire.

DETACHED POSTS.

(*a*). Be able to fire over your immediate foreground, and clear it.
(*b*). Use every endeavour to conceal the individual man.
(*c*). Use dummy trenches freely.

IN ALL CASES.

(*a*). Place your trench where it can fulfil its object. To do so place your eye at the height to which the parapet will be raised.

(*b*). Conceal your parapet as much as possible and make it look like the surrounding ground.

(*c*). Make your parapet bullet-proof.

(*d*). Avoid the sky line. Where a parapet cannot be concealed, give head cover.

(*e*). Avoid high parapets, except for command, and on steep hillsides, where they may be necessary to conceal the scar made by the back of the trench.

(*f*). Study your trench from the enemy's point of view.

(*g*). Protect dead ground by outlying or advanced trenches.

(*h*). Do not spread the earth from your trench so as to make a mark. Use any not required for your parapet to form a background, or hide it away unless it is required for dummy parapets.

(*i*). Protect your men from enfilade or reverse fire.

(*j*). In starting work, tell off a party to clear, and distribute the rest on the more important points, leaving the less important to be done later.

(*k*). In hiding your trench, do not unduly interfere with the view from it.

(*l*). Avoid loopholes at ranges where they form a distinct mark to aim at.

(*m*). In using obstacles place them where they are under effective fire from the trenches.

ILLUSTRATIONS.

INVISIBILITY OF MAIN POSITION.

The Boer trenches (at Colenso and Magersfontein particularly) were very well hidden. Quantities of ammunition, both gun and rifle, were expended by our troops with comparatively small effect, as no definite objects could be seen at which to aim.

INVISIBILITY OF INDIVIDUAL MAN.

At the attack by the Boers on a post defending a bridge in the Orange River Colony, the enemy at night got up in thick scrub close to some small outlying trenches manned by a few men.

Four Boers had got down into a small sandy ravine 40 yards from the trenches, where they had ample protection, but had to put up their heads to fire. All were killed.

From heaps of empty cartridge cases picked up afterwards, it appeared that about a dozen Boers were in some thick scrub on the far side of the ravine, from 60 to 100 yards from the trenches. The ground there was level, and there was no protection except from view. None of these men would appear to have been touched, and all got away.

Twelve Boers on open ground got into a deepish hollow about 100 yards from the trenches on another side. Their heads were clearly seen as they fired. After a few shots they were no more seen. On the enemy retiring five hours later a white flag was put up. It appeared that one had been killed, one was wounded trying to get away, the other ten sat down under cover for the rest of the day and then surrendered.

DECEPTION.

In a post where dummy trenches were made, and where trenches existed which had been abandoned, it was found that, on attack, the unoccupied trenches attracted as much, if not more, fire than those near them which were actually held.

In the same post, a number of greatcoats laid along the back of a railway embankment, which could be taken in reverse, suffered considerably from shrapnel, whilst not a man of the garrison was hit by this fire.

THE ORGANIZATION OF CIVILIAN LABOUR FOR DEFENSIVE WORKS IN CASE OF INVASION AT HOME.

By Major F. A. Molony, R.E.

THE recollection of the undue confidence with which the French entered upon the war of 1870 should convince us that we must allow the *possibility* of our Navy suffering a *débacle*. The question whether it be wiser to make this more improbable by greatly strengthening the Navy, or whether we ought to provide a second line of defence on land, is beyond the scope of this paper. Sufficient for the present purpose if we agree on a few collateral propositions.

Organization of civilian labour desirable in any large war to maintain internal order

1st. Any war with a naval Power will greatly increase the number of the "unemployed."

Certain lines of industry will be stimulated, but the risk in importing raw materials will cause many factories to shut down; and, as the price of foodstuffs will rapidly rise, the misery of the unemployed is likely to result in serious riots.

This difficulty is similar to famines in India, and must be met on similar lines, *i.e.* by "relief works." The best will be those which strengthen the Navy, but all the dockyards of the kingdom will not afford work for all the unemployed. If there be the smallest likelihood of invasion, fortification works are next best; because they can employ all trades, can be spread over a large area, and will not be stopped for want of materials from oversea.

and to repel invasion,

2nd. Should one of our Continental neighbours gain naval supremacy in the Channel, invasion will be immediately attempted, in preference to a "starving out" policy.

This course would be demanded by the public of those countries in consequence of the universal instinct to use familiar weapons. As David decided to keep to the "proved" sling, so would Continental Powers make their first effort with their great armies.

which, if made, will be with a larger force than we can meet in the open.

3rd. Should a footing be gained on our shores, the enemy's transports will make repeated passages till they have landed a larger force than we can contend with in the open; because they have the armies to send, and the stake is sufficiently valuable to be worth risking them.

Our enemies may get embroiled with other Continental Powers, and our Fleet may recover the supremacy of the Channel; but we should not count on these advantages. In providing for the great dangers we cover lesser ones. In guarding against a serious invasion, we reduce the danger from raids to a little local and temporary damage.

4th. We maintain both auxiliary troops and fortifications, which are only intended for use in case we are invaded. This expenditure is indefensible unless we make all other reasonable preparations which are essential to repel an invasion. One of the most important of these preparations is the subject of this paper. This organization needed to complete our defensive system.

In the *R.E. Journal* for November, 1905, 'Nemo' recommends that in war C.R.E.s be allotted to Engineer Districts and not to Divisions. This was the plan followed in South Africa at an early stage of the war, for the simple reason that the officer in charge of engineer works in progress cannot be frequently changed. Organization by Districts.

Our engineer organization for Home Defence must therefore commence with the division of the United Kingdom and Ireland into Districts.

Existing arrangements can remain in those cases where the District includes some fortress in which its headquarters and depôt can be placed, and to which all its staff can be withdrawn if pressed by the invader. To permit of the collection of large numbers of workmen, the London defences will include several Districts. Harwich, Dover, Portsmouth, Portland, Plymouth, Pembroke, Newcastle, Queensferry, must be headquarters of others; perhaps also Sheffield and Birmingham, if it is determined to fortify these towns on account of the warlike stores they manufacture.

The London defences will cover so much ground that the question of communications is more important than any other tactical consideration. Hence each Engineer District will comprise as far as possible the lines of one railway company. Thus there will be 3 Districts south of London; the first astride of the S.E.R. (including Chatham), the second astride the L.B. & S.C. Ry., the third astride the L. & S.W. Ry. There are more lines north of London than we need Districts, hence two of them will be told off to feed the first two Districts mentioned above, which, being nearest to the Continent, are the most important.

The boundaries between these districts will be traced down to the coast, partly to define the areas from which each C.R.E. should draw men and materials, but chiefly because defence works will very likely be undertaken at the most probable landing beaches.

It is often assumed that the forces available to resist invasion should be kept massed at a few central points, with the object of moving against and crushing the invader as soon as the direction of his main attack is evident. This movement would now be carried out by railway, and as easily if the troops to be moved are scattered at a number of railway stations as if concentrated at a few. As all the best landing beaches near London have railways near them, the Coast defence. Reasons for attempting it.

disposition of troops for their defence will scarcely, if at all, delay the assembly of a force to crush an invader; especially as the bulk of such troops would not be actually on the coast but brigaded at junctions in rear.

The length of time for which the invading force first thrown ashore can hold its ground largely depends on the amount of ground it can seize. This amount will be much less if it be strenuously opposed from the very start than if the invading cyclists and mounted infantry are allowed to move a full day's march inland while the defenders are arranging their crushing movement.

It is extremely difficult and unusual for a force moved oversea to bring with it all the transport and supplies it requires. If the invader be opposed only by a screen of troops sufficient to prevent his cyclists dashing inland, the defence will gain the opportunity to remove all transport, cattle, and part supplies, and the difficulties of the invaders will be immensely increased.

The range of modern rifles has allowed defensive positions to be held with very much fewer troops than was dreamt of before 1870. Hence the defence of all the landing beaches from Harwich to Portsmouth could be undertaken by a quarter of our land strength, thus forcing the invader to choose a landing place involving a longer line of march to his objective, London.

Doubtless the enemy's transports would be escorted by cruisers which would direct a hot fire on the defenders; but if these latter were entrenched, and held their fire, they would suffer very little. Even when they opened on the boats, their position would not be obvious to the cruisers. A very few cool defenders would inflict heavy losses on troops in boats.

Still it might be better for the defence to take up a line half a mile or a mile behind the beach, which would make them practically safe from the cruisers and still leave too narrow a strip to give the invaders a fair foothold.

In any case the line to be taken up would need to be strongly entrenched, and civilian gangs would probably have to be employed on the larger works. A great deal of railway work would also have to be done; but this would doubtless be arranged for by the Managers of the Companies, who are officers of the Railway Volunteer Staff Corps.

Possibility of coast defence being undertaken involves dealing with large areas.

The chief point is that the work to be done would probably be spread over a very large area; and the most important part of it, viz., the defences of London, would probably have to be pushed on without the assistance of the troops, who would be occupied elsewhere till the invader had established his landing.

This shows clearly the necessity of very accurate plans of all defence works being prepared beforehand. They will have to be executed by men who have never seen a defensive trench or wire entanglement: and mainly supervised by others whose ideas on the subject of defilade, etc., are of the vaguest. Each work should be drawn out with numerous sections on a scale not smaller than 30 ft. = 1 in., and plans prepared on scales of $\frac{1}{2500}$ and 6 in. = 1 mile, showing everything which it is desirable the civilian gangs should do prior to the occupation of the works. The $\frac{1}{2500}$ and 6 in. plans should also show the order in which the various works are to be undertaken. Hence careful plans needed.

For important works, tracing plans should be prepared, giving all dimensions, and starting from easily found landmarks.

We now come to the actual organization, and will take first the personnel.

Personnel. Over each District there would be a C.R.E. with the usual staff, strengthened by a few extra clerks and draughtsmen.

He would subdivide his district among 4 or 5 R.E. Division Officers. Under these would be 20 or 30 architects, civil engineers, or builders, graded as Temporary Civil Clerks of Works, and about 150 builders' foremen as Temporary Civil Foremen of Works. Each of the latter would supervise a gang of 10 to 30 labourers, who would be kept to the same class of work. It would be impossible to teach each lot everything. Each Clerk of Works should have under him gangs for trenches, gun positions, wire entanglements, clearings, roads, and two or three for redoubts; and with these should be able to strengthen a mile or two of front.

Tools and materials. The greater difficulty is the supply of all these people with tools and materials.

To effect this an "Officer in Charge of Stores," preferably an O.S.D. officer, would have his headquarters at the most important Railway goods station in the District. His business would be to inform the S.O.R.E. what tools and materials were available, and to distribute them to D.O.s as the C.R.E. directed.

He, the S.O.R.E., and the District Surveyor, should constitute a Board, meeting daily, and empowered, within a few guiding limits as to price, to buy what was required.

Advertising should be done by the Chief Engineer of the Fortress; and must describe exactly what is required, where the District Buying Boards meet, and where samples can be seen to govern the supply of such articles as sandbags and anything else requiring to be specially made to meet the demand. The Staff of the Chief Engineer would also have to arrange for the distribution of articles superfluous in any District among others reporting a deficiency.

Pay. The question of paying the working gangs is a difficult one. The R.E. officers would be much too busy to be made responsible for it. The best way would seem to be to make the Clerks of Works primarily responsible, by giving each an Imprest Account for which the Foreman of Works' Pay Sheets would be vouchers; the whole to be checked by the time fixed for the cash payments being always notified to an officer A.P.D., who would often be present, and whose assistants would constantly count the gangs.

It might be sometimes possible to institute piece-work or task-work, but generally the patriotism of the workmen must be appealed to and relied on to get a fair day's labour. The contract system is far too cumbrous to be suitable at such a time; it takes too long to get started, and does not lend itself to the changes inseparable from military operations.

Shelter. The large gangs of workmen we propose to employ would not be able to get lodgings near their work, a great deal of which will be on the Downs, where dwellings are few. It would therefore be advisable to begin work by putting up shelters for them. Where military reserves can be advantageously posted, camps would be formed by stretching tarpaulins, sails, or carpets over scaffold poles rigged as for ridge tents. Nearer the front, the shelters would be of corrugated iron, so that they could be kept very low and inconspicuous. In the redoubts they might be made of brushwood, and at a few important points bombproof field casemates might be needed.

Food. Though we must help our workmen as to shelter and water supply, we need not do so as to food. Sutlers will soon find that money is to be made by supplying their demands. If not, each gang can send a man to forage, and they must pay their own cook. It is undesirable that the superintending staff should be mixed up with questions of supply.

Fighting pioneers. When advertising for workmen, it may also be desirable to add that joining a Corps of Pioneers will carry either free rations or extra pay. The conditions would be that the man must take the oath of allegiance, submit to military law, wear uniform, and drill or shoot for an hour every evening. These men will be drafted into the redoubt gangs, and should soon be fit to defend them, for he must be a poor-spirited man who will not fight for the work of his own hands.

Movements. It remains to discuss how these gangs are to be moved about, for such movements are sure to be necessary. For instance, they might in the first instance be formed on the coast; when an invader has landed, these would probably be moved back by rail to the London positions; when the Field Army is driven in on these positions, the civilian gangs would be moved back to a second, and perhaps eventually to a third, line of defence.

The 7 or 8 gangs under a Clerk of Works would make the best unit for movements, as it would comprise men trained in every sort of work. Hence it might be called a "Company of Workmen." If occupied on the London defences, it would have a few carts belonging to it, usually busy in shifting materials on the works, but during a "move" available to carry heavy tools and kits. Shelters would not usually be moved; the men must bivouac in the new position till they can rig up new shelters.

When used to reinforce an existing line they would usually be sandwiched in between two companies already at work, taking over some jobs from each.

D.O.s of sub-districts.

Division Officers' sub-districts would be made to correspond with the areas occupied by tactical units, usually Brigades, by the transfer of these "Workmen's Companies" from one D.O. to another. As the D.O. would not be responsible for their pay, this could be easily done. The D.O. would live as close as possible to the headquarters of the Officer Commanding the tactical unit. Any alteration in the works required by the latter would be carried out by the D.O. without reference, as long as it did not affect neighbouring sub-districts, when arrangements would of course be made with their C.O. and D.O.

Their relations with O.C.s Troops.

Civilians with the Field Army.

A good many civilians are also likely to be required with the Regular and Volunteer R.E. units; these would require no Civil Clerks of Works, as they would be under the direct orders of the officers of those units. Otherwise their organization could be very much on the lines already described. As they would be moved about more frequently, they would require more transport and probably some tents. "Companies of Workmen" could be transferred from the Field Army to Fortress work, and back again, as the exigencies of the moment required.

It is only necessary to mention the Railway Pioneer Regiment in South Africa to remind R.E. officers of what can be done by organized bodies of civilians.

A NEW METHOD OF POWER PRODUCTION:

THE SUCTION PRODUCER GAS PLANT.

By MAJOR T. E. NAISH, R.E.

AS the question of cheap power is always interesting to an engineer, attention may usefully be drawn to the suction producer gas system, which has many special points of interest.

It is a system by which coal is turned directly into gas by the simplest possible means (through the agency of steam) and used directly in a gas engine.

The engine acts as its own gas maker, and automatically regulates the rate at which gas is made to suit its requirements.

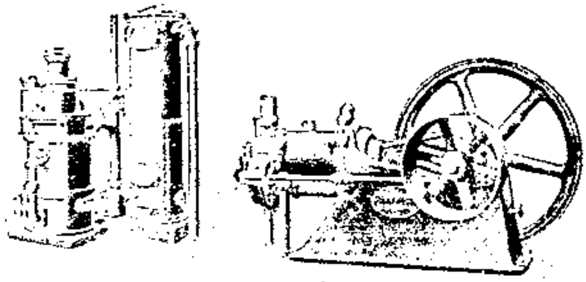
This system may claim to be "the cheapest power on earth," even beating water-power, except in the rare circumstances where fuel is very dear and an exceptionally high fall is available; for it should be remembered that the interest on the large capital often required for developing water-power must be added to the annual cost.

FUEL COST.

Here are some figures that offer themselves for criticism:—the four suction producer gas plants tried at the recent Show of the Highland and Agricultural Society of Scotland at Glasgow ran at a cost of less than $\frac{1}{20}$d. per B.H.P. per hour (see *Engineering* of 17th November, 1905). The fuel used, however, was exceptionally cheap, being Scotch anthracite, costing 9s. 3d. per ton.

Most makers of suction producer gas plants modestly claim $\frac{1}{10}$d. per B.H.P. per hour; based on a fuel cost of 21s. per ton, for which price (or less) Welsh anthracite (pea-size) can be obtained in most towns in the British Isles.

At any rate it is an incontrovertible fact that 1 B.H.P. can be obtained for an hour for 1 lb. of coal under ordinary circumstances, and for as little as $\frac{3}{4}$ lb. of coal under favourable circumstances.



Tangye "Suction" Producer Gas Plant.

PRIME MOVERS COMPARED.

Compare the price of $\frac{1}{10}$d. per B.H.P. per hour for fuel with the fuel cost of other prime movers; and remember that this new system requires no more attention than an oil engine or a gas engine run from a town gas supply, so that it has, in common with these, a very great advantage over the steam engine in this respect.

An *electro motor*, with current supplied at 2d. per unit, will cost 1$\frac{3}{4}$d. per B.H.P. per hour for current.

A *gas engine*, with gas at 4s. 2d. per 1,000 cubic feet (the gas having 600 British Thermal Units per cubic foot), will cost 1d. per B.H.P. per hour for gas.

An *oil engine*, with oil at 8d. per gallon, will cost 1d. per B.H.P. per hour for fuel oil.

A *steam engine* of the single cylinder type with ordinary slide-valve, non-condensing, with vertical boiler, will use from 10 to 20 lbs. of coal per B.H.P. per hour, according to the skill of the attendant and the regularity of the work.

A high-class compound condensing engine of from 50 to 150 B.H.P., with a high-class boiler and first-class attendance, will reduce the fuel account to 4 or 3$\frac{1}{2}$ lbs. of coal per B.H.P. per hour.

The very best marine or stationary engine, with every refinement in the way of condensers, economisers, and superheaters, will not reduce the amount below 2 lbs. of the best Welsh coal per B.H.P. per hour.

SOME PARTICULARS OF THE NEW SYSTEM.

Suction producer gas plants have not hitherto been made of much larger sizes than 150 B.H.P. It is in the sizes from 10 B.H.P. to 100 B.H.P. that the advantages of the system will be principally felt. There is no very great economy of fuel in the large as compared with the smaller plants.

The cost of attendance is hard to reckon. In a factory where a man is already kept to do odd jobs to machinery the extra cost of attendance is *nil*, the charging of the furnace every three hours or so being all that is required.

It only takes 20 minutes to start the gas engine from the time a match is applied to the fuel in the generator.

The fuel in the generator will remain alight all night at an expenditure of only $\frac{1}{60}$ lb. per B.H.P. per hour.

MODE OF OPERATION.

To give a more detailed description of the gas-making process:—The Generator is a slow-combustion stove, through which steam and air are sucked by the "suction-stroke" of the gas engine.

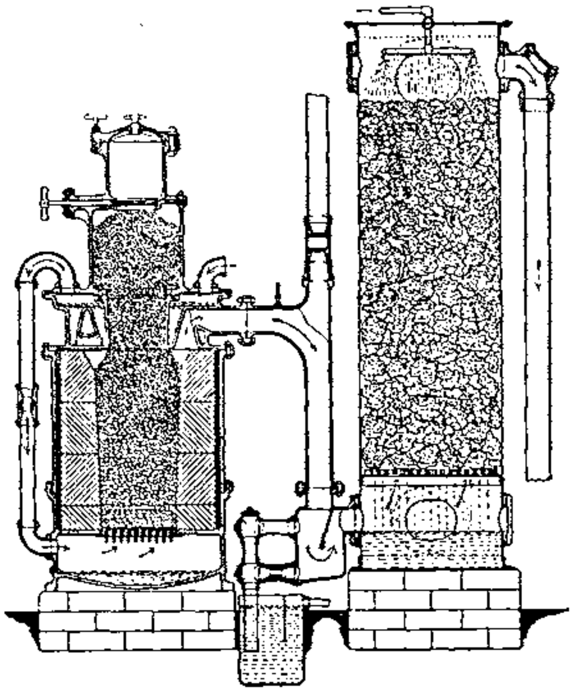
The steam is made from water, contained in the top of the generator itself, which is evaporated by the hot gases rising from the fuel. The air is drawn in over the surface of the water, and carries the steam (which is never under pressure) with it by means of a large external pipe from the top of the generator to the space below the grate.

The water evaporated is replaced by the dribble from a small tap, which should be regulated so that there is a slight overflow from the generator.

The coal is fed into the generator through a hopper on top.

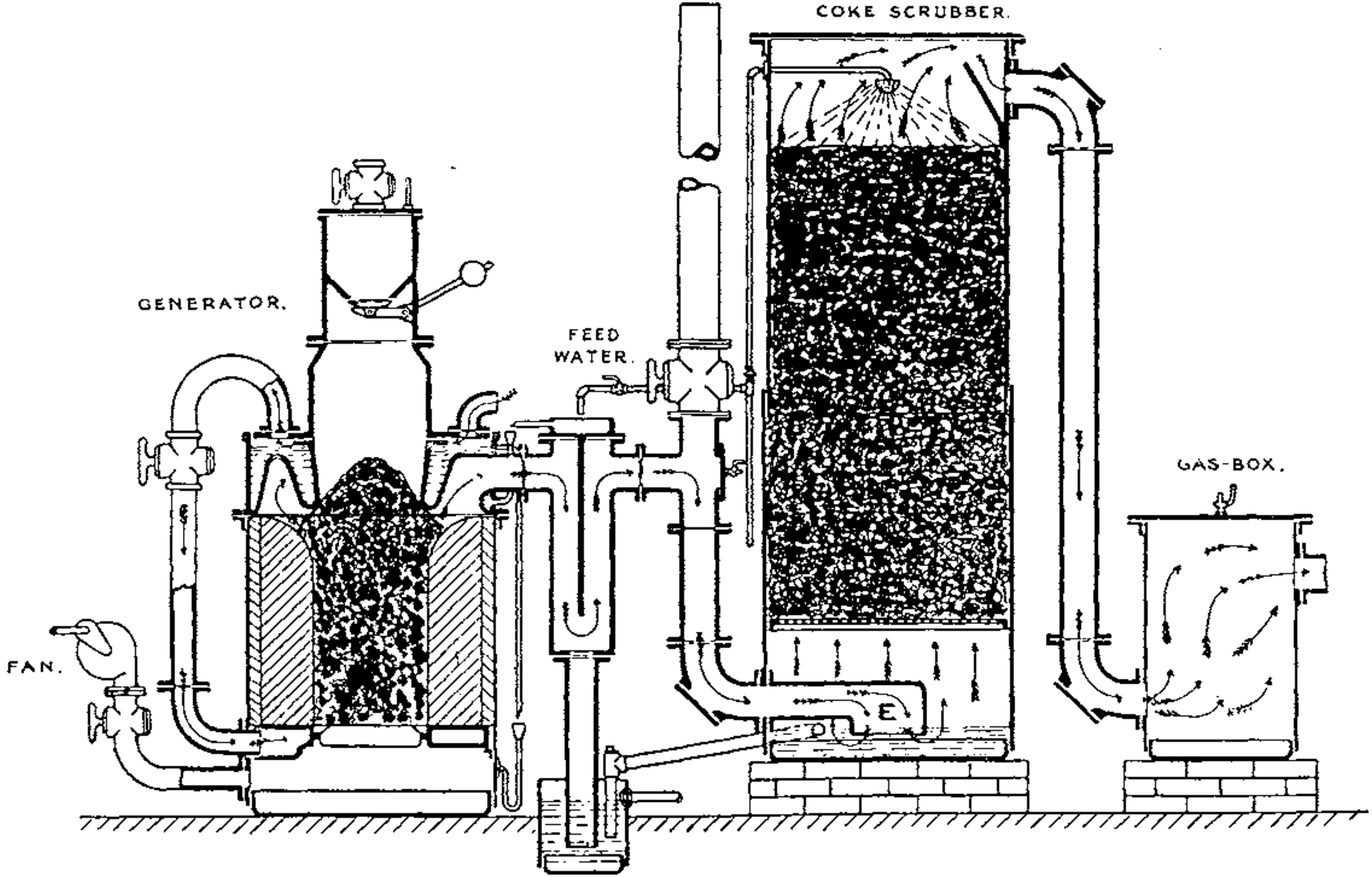
The gas is drawn off and passes through a water-seal to the Scrubber, which may be described as a kind of filter, filled with coke, for the purpose of cleaning the gas of any matter which would be injurious in the cylinder of the engine; water is sprinkled continuously over the top of the coke.

Before the engine is started, a fan supplies forced draught through the fuel.

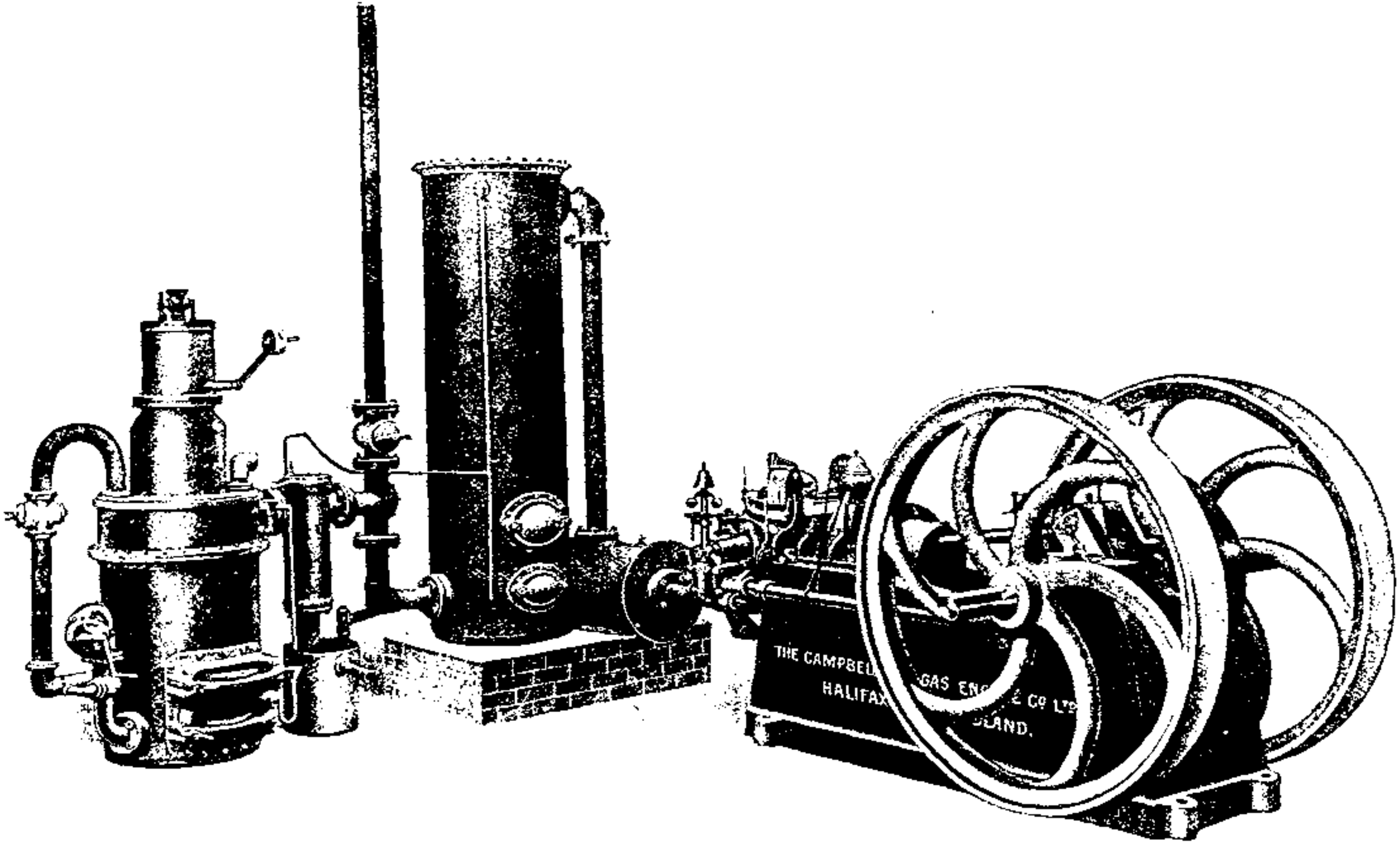


Sectional Elevation of the Tangye "Suction" Gas-Producer.

Anthracite coal or coke must be used in the generator just described; bituminous coal would form lumps of clinker and prevent the free passage of steam through the fuel, and there would have to be provided a considerable amount of apparatus to remove the tar from the gas. But where circumstances permit the erection of such extra apparatus, the tar forms a valuable bye-product and still further reduces the cost of the gas per B.H.P. per hour.



SECTIONAL ELEVATION OF "CAMPBELL" SUCTION GAS PRODUCER.



30 BRAKE HORSE POWER "CAMPBELL" GAS ENGINE WITH SUCTION GAS PLANT.

Formerly the gas ("producer-gas," "water-gas," or "Dowson-gas") was made under pressure, which involved a large gas holder, a steam boiler, and other complications. The introduction of the automatic "suction" has enormously widened the field of usefulness.

PARTICULARS OF THE GAS MADE AND USED.

Now as to the composition of the gas. The oxygen in the air and water combines chemically with the carbon in the coal or coke, forming (principally) carbonic oxide and (partly) carbonic dioxide. The hydrogen in the water is set free and enriches the mixture. The nitrogen in the air is also set free, but—as also the carbon dioxide—possesses no "power" value.

The resultant gas has a calorific value of about 150 British Thermal Units per cubic foot, as against 550 to 700 B.T.U.s in coal gas supplied by town mains.

About four times as much producer gas as coal gas is required per B.H.P., but very little alteration is required in a gas engine to transform it from using towns' gas to using producer gas; in fact many engines are fitted so that they can be switched on to either by merely turning a cock.

FIELDS OF SPECIAL USEFULNESS.

For power production in factories, and for electric lighting of public institutions and barracks, this system has a great future before it.

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I am indebted to Messrs. Tangye and the Campbell Gas Engine Co. for permission to reproduce the above illustrations.—T.E.N.

THE DEVELOPMENT OF MORAL FORCES FOR WAR.

By CAPT. C. H. VERSTURME-BUNBURY, R.E.

IN studying military history we find three main subjects to claim our attention:—firstly the facts; secondly the general principles of strategy and tactics, derived from a careful consideration of the facts; and thirdly, the more elusive and less palpable effects or phenomena that are referred to as "moral forces," and of which Napoleon has said that they are to the physical forces as three to one.

In our army at the present time the greatest care and attention is given to inculcating in all ranks the necessity of acquiring the habit of acting in accordance with sound principles. But can it fairly be claimed that we give the same attention to the cultivation of those moral forces that are undeniably of such immense value.

Colonel Henderson, in his *Battle of Spicheren*, says:—"Little less remarkable than the knowledge of their profession possessed by all, and the smoothness of the mechanism of the military system, is that spirit of confidence in themselves, their training, and their leaders, of loyalty to king and country, which pervades every rank of the Prussian Army.

"The soldier is treated as an intelligent being, a fit recipient of patriotic ideas and lofty sentiments. He is brought in contact with them from the day he joins the colours; and throughout his service his mental and moral training is considered as important as his physical."

And again, "To create a fruitful and abiding energy in both officers and men, the Prussian system of command, of training, and of decentralization was devised; and the deeper our study of military history, the surer grows our conviction that in so doing they acted in accordance with the greatest of the fundamental principles of war, and that to this quality, not to superior numbers or courage, their extraordinary success was due."

Hamley wrote:—"The world has seen before warlike people and victorious armies, but never before a people or an army who have sought the secret of success with study so thorough and with zeal and self-denial so stern as those which serve the German Emperor."

In many ways we have learnt and adapted much of the German system of army training; and there seems to be no reason why we should not now turn our attention to the development of those forces which give life and power to the principles that are so carefully taught.

Many leaders have possessed the gift of infusing into their troops their own energy and moral power; but the Germans seem to be the first nation to have analyzed the sources of that gift and then to have deliberately cultivated it.

That this power is a real and substantial assistance to success in war there can be no question, and the wonderful victories of the Japanese in the late war in the Far East give another striking proof of its value.

The Japanese, like the Germans—and, possibly, to an even greater extent—seem to realize fully the vast importance of Moral Force, and to cultivate it most assiduously.

Colonel Henderson's words, quoted above, seem to indicate the secret of and the proper method of developing this Force. "The soldier is treated as an intelligent being, a fit recipient of patriotic ideas and lofty sentiments; and throughout his service his mental and moral training is considered as important as his physical."

The introduction of Colonel Henderson's *Stonewall Jackson* as a text-book for examinations for promotion appeared to mark on the part of the authorities an appreciation of the value of Moral Force, for no book could be chosen in which this is more insisted upon or more clearly displayed.

Why should not some system be arranged for lectures to be given to all ranks, with readings from the stories of our own and other great wars and victories. By such means these Moral Forces would be developed; while at the same time fresh interest would be aroused in our manuals and text-books, in which the principles of Strategy and Tactics are laid down, but which, from their very nature, are bound to be somewhat dry and difficult to absorb.

MEMOIR.

Lt.-Col. H. Wilberforce Clarke, R.E.

There has recently passed away one of the most brilliant and versatile of the many good men turned out from the H.E.I.C.'s Military Seminary at Addiscombe.

Henry Wilberforce Clarke, the subject of this memoir, was born in 1840, educated at Cheltenham College, and finally at Addiscombe (1858—1860), which he left, second of his "batch" (the last batch of the old Indian Engineers), as a lieutenant in the old Bengal Engineers (8th June, 1860).

After the usual time under instruction at Chatham, he went out to India in October, 1862, and in May, 1863, joined the Indian Public Works Department, wherein he soon made his mark. A fine career in the P.W.D. might now have been expected for him. Unfortunately his health broke down early (in 1865); and this, with subsequent attacks, necessitated prolonged sick leave to Europe (1865–66, 1869–72, 1880–84), and thus broke up his continuous service in India, and prevented his ever rising to the higher posts of the Department.

Whilst in India he held at times some very good posts, *e.g.*, Assistant to Chief Engineer and Assistant Secretary to Government in P.W.D. in 1865, and again in 1868–69; Deputy Consulting Engineer for Railways, 1876–80 and 1888–89, and Consulting Engineer, 1890.

His sick leaves to Europe led, however, to his seeing a varied service, both in the field and otherwise, in parts of the world not usually open to the old Indian Engineer. Thus he was Assistant Field Engineer with the Abyssinian Expedition (1867–68), was mentioned in despatches for "excellent service," and obtained the medal. After exchanging to home service in 1882, he was selected to project the Suakin-Berber Railway (1884); served as Director of Railways in Egypt in 1884; and was an A.A.G. with the Nile Expedition (1884–85), with which he advanced as far as Dongola, being subsequently mentioned in despatches and receiving the medal with clasp and star. After this he became C.R.E. at Devonport (1885–86), and was C.R.E. in S. Africa, 1886–88. After a further short period of service in India, as Consulting Engineer for Railways (1890–91), he retired in 1891 as a Lieut.-Colonel.

After some years travel abroad he settled down on the small property of Dilkusha, of about 100 acres, at Sestri Levante in

Liguria, favourable to the growth of the olive, vine, orange, fig, etc., and busied himself thereafter in the improvement of their cultivation. He died there of heart complaint on the 5th October, 1905. He was twice married (first in 1872, again in 1897). By the first wife, who died in 1893, he leaves two sons and two daughters. His second wife survives, and contributes most of the materials for this short biography. The two sons are still engaged in the improvement of their father's estate.

Two instances of Clarke's versatility may be given. He was selected from those on the Nile Expedition (1884) to determine the latitude and longitude of certain positions in the Nile valley, a work which would be assigned in India to the staff of the Indian Survey. Again, he had a strong taste for languages, so much so that—in spite of prolonged absences from India—he became a competent Persian scholar, and was selected by the Bengal Asiatic Society as translator of part of the *'Ain-i-Akbari*, and was even a candidate for the chair of Persian at Oxford, 1880. He published, among other works, the following:—A "Persian Manual" (1878), which was adopted by Government for the Indo-European Telegraph Staff. Translations into English prose of four of the great Persian poems:—1. The *Búslán* of Sadi (1879); 2. The *Sikandar Náma-e-Nizámi* (1881), 800 pp.; 3. The *Díwán-i-Háfiz* (1891), 2 vols.; 4. The *Sháh-Náma-e-Firdausi*, 2,000 pp. These volumes have received the warm appreciation of many scholars (including the late Sir H. Rawlinson, Sir Monier Williams, and Prof. Max Müller), and form a lasting monument of the author's talents and industry.

It remains to record some personal traits. Clarke was rather short of stature, and of a genial though somewhat combative disposition; a warm friend, and a good hitter-out (especially in writing) at an adversary. He was familiarly known among his intimates by the "pet" name of "Boxer," and accordingly sometimes passed as "Mr. Boxer" among those who only knew him by this style; thus he was habitually called "Mr. Boxer" by the old tar (familiarly known as "Ben") in charge of the R.E. Boat Club boats (1860–62), much to the amusement of Clarke's companions. Clarke was very popular among the younger officers when he had himself become a senior. An amusing instance of this occurred after a big dinner at the Chatham Mess. After dinner was over (and the seniors had all left the table) there arose a call among the juniors present that Clarke should take the chair and deliver a speech (he being a good *raconteur*, and a humorous after-dinner speaker); as he was about to take his seat, the chair disappeared, and the would-be occupant subsided on the floor to find himself smothered in a shower of rose leaves!

ALLAN CUNNINGHAM,
Lt.-Col., late R.E. (Bengal).

TRANSCRIPTS.

THE JHELUM RIVER HYDRO-ELECTRIC POWER INSTALLATION IN BRITISH INDIA.*

The Government of British India has for some time pursued a broad-minded policy in developing the later possibilities of the immense and valuable country over which it exercises sovereignty, and its officials have interested themselves in providing for the future welfare and enlightenment of the native inhabitants. Among other laudable projects, which the Government has instituted, has been the commissioning of some of the most capable Royal Engineers to plan for and construct public works, such as would aid in the general advancement of the native industries and the development of the commerce of the country.

The first notable project undertaken for the generation and distribution of electricity was that of the Cauvery power scheme, located in Mysore State in Southern India. Work on this plant was started in 1900, the initial installation being completed, after many difficulties, in June, 1902. About a year ago, the second installation or extension of the plant, consisting of 3,610 kilowatts generator capacity, was completed. This increased the possible output of the entire plant to 7,920 kilowatts, making it the largest hydro-electric installation now operating in Southern Asia, if not on the entire Continent.

The chief credit for the completion of the Cauvery power plant is due to Major A. Joly de Lotbinière, R.E., deputy chief engineer of the Government of Mysore, who not only conceived the plan of the installation, but successfully arranged for the financing of the entire project, overcoming prejudices that would have deterred a man less sound in his convictions. He afterwards arranged for the purchase of the entire electrical and hydraulic equipment and supervised its installation.

The power scheme next to be undertaken is the Jhelum power installation on the Jhelum River, in Kashmir in North-West India. This power plant is to be installed near Rampur, about 50 miles below Srinagar, where a six-mile conduit will give a head of water at the plant of about 400 ft. The present plans call for an installation of about 20,000 horse-power.

It is planned to use the power for operating the Kashmir section of the Jhelum Valley Railway electrically along its entire length of 180 miles. A single-phase system of traction will undoubtedly be installed. Possibly the most important immediate use to which the power will be put will be

* Reprinted by permission from *Engineering* of 19th January, 1906.

in operating dredgers for the purpose of deepening the Jhelum River in the Kashmir Valley, and thus minimising the floods which, under existing circumstances, periodically devastate the entire country. The contemplated plant will also allow of the reclamation of a very large tract of land; and permit of the storage of water in Wular Lake, above the power plant, for sale to the Punjab Irrigation Department. Another important use of the power will be for operating the large silk factory at Srinagar, and also for supplying with current the electrical water-heaters in the silk mill. In addition, the power will be utilised for other industrial purposes, and for lighting in Srinagar and in Abbotabad, Murree, and Rawal Pindi, prosperous towns in the British provinces adjoining Kashmir.

After successfully completing the preliminary arrangement for carrying on the important work connected with the Jhelum power installation, Major de Lotbinière was instructed last May, by the Jammu and Kashmir State Council, acting for the Maharajah of Jammu and Kashmir, to proceed to Europe and America in order to interview the leading hydraulic and electrical manufacturers, and to ask those selected to bid upon the machinery and materials for the plant. Carrying out these instructions, he visited the works of those leading manufacturers on both continents who were considered for the work, and personally inspected their manufacturing establishments, as well as power plants in which their machinery was operating.

As a result of this careful investigation, Major de Lotbinière, who had full powers for the acceptance of the tenders submitted, has recommended to his Government that the contracts for the entire hydraulic and electrical equipment be placed with firms in the United States. The contract for the hydraulic equipment was awarded to the Abner Doble Company, of San Francisco, U.S.A., and calls for the hydraulic plant complete from the forebay to the tailrace, including the intake, valves, pressure pipes, pressure pipe thrust-blocks, interior piping, water-wheels and nozzles, hydraulic governors, and all details necessary for the hydraulic equipment. The apparatus and materials are to be delivered at the port of Karachi, India.

The gravity conduit line for the power plant will be approximately 34,000 ft. in length, and for the upper 8,500 ft. will consist of an excavated ditch lined with masonry. The remaining portion of the water channel will consist of a rectangular flume, or a wooden stave pipe, such as has been installed so successfully in connection with plants of this character on the Pacific coast. The flume will have a capacity of over 500 cubic feet per second. The forebay at the end of the gravity line and at the head of the pressure pipes will be constructed of masonry, and will be provided with special head-gates. The sliding elements of the intake gates will be of timber, all iron and metal parts necessary for the construction of the gates being furnished by the hydraulic contractor.

The pressure lines will consist of riveted steel pipes designed with a factor of safety of five, each supplying one of the hydro-electric units. For each pipe-line a stand-pipe and two special vacuum valves will be provided, in order to protect the pipe against injury in case the water should be drawn out suddenly.

At the lower end of each pressure line the last length of pipe will terminate in a flange, which will be bolted to a massive cast-iron thrust-block that will rest on a heavy cast-iron sole-plate or base. The latter will be mounted on a substantial masonry foundation and held in position by anchor-bolts. This fitting will be designed to take the entire hydraulic thrust of the pipe, an ample factor of safety being allowed, so that under the most severe conditions there will be no strain on the branch piping in the interior of the power-house. Each pressure line will consist of a riveted steel pipe, varying in diameter from 30 in. to 36 in., and a 54-in. to 36-in. taper pipe, 10 ft. long, at the upper end. The pipes will be 790 ft. in length, and will deliver the water under an effective head of 400 ft.

The interior piping of the power-house will consist of welded pipe with welded flanges, all piping and fittings beyond the thrust-block being designed with a factor of safety of 10, and subjected to a test pressure of 1½ times the working pressure for a period of five hours.

Twelve main units and three exciter units have been planned for the equipment of the power-house. Each main unit will consist of a Doble tangential water-wheel, with automatic oil-pressure governor, delivering 1,765 brake horse-power to the shaft, under an effective head of 400 ft. Each wheel will be direct connected to a 1,000-kilowatt alternator, the speed of the unit being 500 revolutions per minute. The exciter units will each consist of a Doble tangential water-wheel delivering 285 brake horse-power to the shaft, under an effective head of 400 ft. The speed of the exciters will also be 500 revolutions per minute.

The hydro-electric units will be of the Doble standard two-bearing type, the wheel-runner being fastened on the end of the shaft. For each of the main units the Doble Company will furnish a high carbon open-hearth-steel forged shaft, and two bearings of a special ring-oiling type, provided with revolvable bearing shells. The exciter water-wheel runners will be mounted on the extended ends of the exciter generator shafts.

The water-wheels will be equipped with ellipsoidal buckets, needle regulating-nozzles, and centrifugal water-guards. The regulation of the main units will be effected by means of hydraulic governors operating jet-deflectors. For the exciter units hand regulation will be provided by means of the needle nozzles. The gate-valves for each wheel will be of special construction, with outside screw and yoke, bronze mounted, with by-pass.

The power-house will be of solid masonry construction, and will have a wide verandah as a protection from the tropical sun. A double steel roof will be provided, and two travelling-cranes will be installed for handling the machinery. The transformers will be installed in a bay of the main building or in a separate structure.

The conditions under which the plant will be installed are decidedly out of the ordinary, as compared with similar work in this country. The specifications for the electrical and hydraulic equipment stipulated that no single piece of machinery should weigh more than 4 tons when packed, for the reason that there is 200 miles of road transportation, including a lift over a range of mountains 8,000 ft. high. Transportation in that section of the country is limited to bullock-cart; and no single piece of machinery heavier than 4 tons can be transported, a total of 5 tons, including the trolley (cart), being the maximum weight that can be hauled over the mountains.

Portland cement costs 7·50 dols. per barrel delivered at the site, making its use prohibitive for heavy concrete work. However, there is plenty of natural rock in the vicinity, so masonry construction will be used for the walls of the power house and for the foundations of machines, intake, forebay, etc.

The entire hydro-electric installation will be constructed, erected, tested, and placed in operation under the supervision of Major A. Joly de Lotbinière, R.E. Major H. A. D. Fraser, R.E., and Capt. W. M. Thompson, R.E., will act as his engineering representatives in London. Mr. A. C. Jewett, formerly of the General Electric Company, will serve as installing engineer for the Government. Mr. Jewett was connected with the installation of the Cauvery plant, and his selection as erecting engineer for the Jhelum River installation comes as a well-deserved recognition of his ability.

BULLET-PROOF SHIELDS.*

WAR is becoming more and more an engineering undertaking that must be conducted—to be conducted successfully—on engineering lines. There is no less demand for personal valour than there used to be; perhaps even there is more; but the ever-increasing deadliness of modern weapons tends continually to narrow down the line of separation between heroism and folly.

One man who cuts away a wire entanglement under cover of a shield is of more service to his country than a hundred who lay down their lives in the vain attempt to do it without one. The serious consideration of shields as part of the regular equipment of an army in the field has hitherto been hindered by two objections, one sentimental, the other material. Sentiment is surely a little out of place in matters affecting the position, sometimes even the existence, of nations. The recent fearful losses of the Japanese in attacking the Russian entrenched positions in Manchuria show the absolute necessity for some portable cover for the attackers if they are to have a chance of success. The Japanese themselves found this out after paying thousands of lives for the experience, and in the later stages of the siege of Port Arthur they appear to have extemporised more or less efficient shields out of such plates as were available. The material objection is principally that of adding to the weight of what the soldier has to carry, hampering his movements, and detracting from his mobility. This would be a serious objection as against a shield forming part of the soldier's personal equipment; but it does not apply to shields taken to the front in case of emergency—kept, say, with the reserve ammunition, unless and until an occasion for their use arises, such as the attack of a carefully-prepared entrenched position principally defended by infantry fire. In such a case suitable shields properly used should go further towards equalising the attack with the defence than a four-to-one numerical superiority. Shields of some kind will have to be used if the attackers are to be kept alive while they destroy the obstacles which, by preventing them from advancing quickly, give the defenders time to prevent them advancing at all.

Of course there would be cases where shields would be useless—where the ground was well covered by artillery fire, for instance; but the fact that they were kept in readiness to the attackers' hands would be of no small value, if it did no more than compel the defence to always provide artillery fire when otherwise infantry fire would suffice. Numerous cases occur in every campaign—witness our loss of guns at Colenso—when serious disaster might be averted or important advantage gained, if only the means were at hand to enable a proportion at least of a detachment to advance over, and retire unscathed from, a musketry-swept area.

* *From an article by Capt. T. J. Tresidder, C.M.G., late R.E., in Brassey's "Naval Annual," 1905.*

RESISTANCE AND WEIGHT OF BULLET-PROOF STEEL.

The special steel now manufactured for the purpose is stated by Messrs. Cammell, Laird & Co., who make a speciality of the material, to be proof as under:—

Against Mauser or Mannlicher rifles at	20	yards	...	$\frac{1}{4}$ inch,
„ Lee-Metford or Lee-Enfield at	200	„	...	$\frac{3}{16}$ „
„ „ „	300	„	...	$\frac{1}{8}$ „
„ „ „	500	„	...	$\frac{1}{10}$ „
„ „ „	700	„	...	$\frac{1}{16}$ „

that is for normal impact; against oblique impact the efficiency of each thickness would be greater.

The approximate weights for these thicknesses per super. foot are respectively 10 lbs. 4 ozs., 7 lbs. 11 ozs., 5 lbs. 2 ozs., 4 lbs. 1½ ozs., and 2 lbs. 9 ozs.; so that it should not be difficult to design very efficient shields of a sufficiently portable nature. It would be not so much perhaps the main attacking party who would use them, as their pioneers, who, under cover of them, would destroy or neutralise the obstacles constructed by the defenders to check a rush.

THE NEW GERMAN RIFLE BULLET.*

Two of the most important properties which a military rifle can possess are great ranging power and a flat trajectory.

These properties depend mainly on two factors, high muzzle velocity and high sectional density, *i.e.*, a high ratio between weight and cross section of bullet. A third factor is the shape of the bullet, more particularly the shape of the head, by which the resistance of the air is considerably modified.

Considerations of recoil, weight of rifle, etc., make a heavy bullet incompatible with high muzzle velocity; and in order to keep the sectional density as high as possible, it has been found necessary, as the evolution of the rifle has progressed, to reduce the diameter of the bullet as well as to reduce its weight. In modern military rifles the diameter of the bullet varies between 0·32 and 0·26 inches, the corresponding weight of bullet being from 244 to 163 grains.

The German military authorities have been experimenting for some time past with a view to increasing the muzzle velocity of their rifle to approximately 3,000 feet per second, in order to insure the flattest possible trajectory at decisive ranges, a consideration which they regard as of primary importance.

There were obvious objections to doing this by reducing the calibre of their rifle from 0·311 to 0·256 (or some smaller calibre), which would be the first method to suggest itself. Apart from the great cost involved in such a change, there are certain objections to a very small bore, *per se*, viz., diminished wounding power and increased difficulty of cleaning and keeping in order the interior of the barrel.

The alternative solution was to improve the ballistics of the existing rifle by a suitable modification of its ammunition; and it appears, from a recent article in the *Kriegstechnische Zeitschrift* (1905, *Heft* 9), that this has been effected partly by the adoption of a more powerful charge (whether a new powder is involved is not quite clear) but mainly by the adoption of a new bullet, known, on account of its pointed shape, as the Spitzegeschoss or "S" bullet.

This bullet (a sketch of the reported shape of which, together with further details, is appended) weighs only 154·3 grains as against the 227 grains of its predecessor, or as against the 215 grains of our Lee-Enfield bullet.

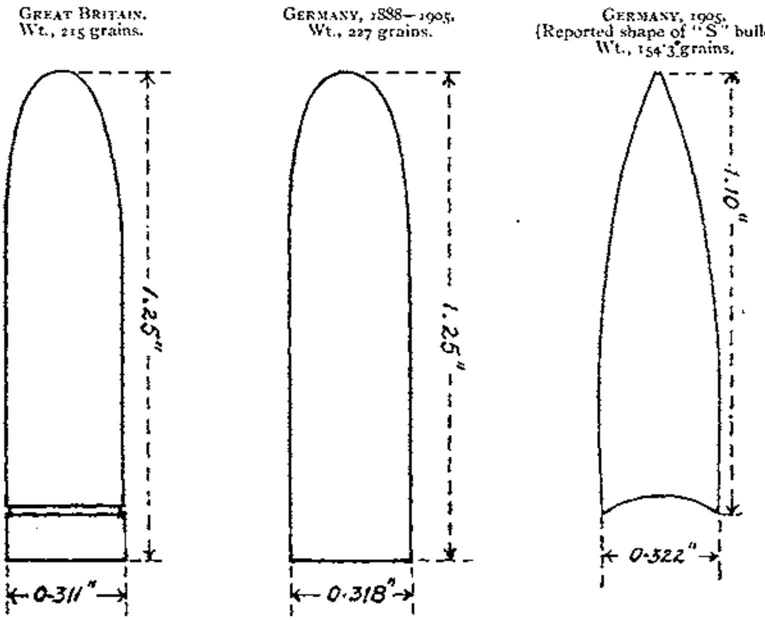
This reduction of 73 grains weight, coupled with the higher pressure given by the new charge, has apparently raised the muzzle velocity of the German Mauser from about 2090 f.s. to about 2900 f.s.

* *Communicated.*

An additional, and by no means unimportant, advantage secured by the reduction in weight of the bullet is that about 15 per cent. more ammunition can be carried than heretofore.

BRITISH AND GERMAN RIFLE BULLETS.

Scale $\frac{2}{1}$.



All three bullets have lead cores, the British bullet having a cupro-nickel jacket, the jackets of the two German bullets being of nickel-plated steel.

* *Kriegstechnische Zeitschrift* (Heft 10, p. 607).

It will be seen that in designing their new bullet the Germans have deliberately departed from the principle, hitherto considered essential, of a high sectional density.

Assuming, however, the correctness of the published data, it is evident that this low sectional density has been compensated for by the altered shape of the new German bullet, which gives rise to a very much lower air resistance than has hitherto been considered possible at normal atmospheric temperature and pressure.

The importance of the alteration in form may be gauged by the fact that, had the normal shape been retained, the remaining velocity of the bullet at about 1,000 yards would have been no greater than that of our bullet, which starts at 800 f.s. lower velocity, while beyond 1,000 yards the heavier bullet would have travelled faster.

As it is, the "S" bullet maintains its superiority in velocity at practically all ranges. Whether it compares favourably with the heavier bullet in accuracy is, however, doubtful.

The greatest advantage given by the "S" bullet in the matter of flatness of trajectory is to be found between 500 and 800 yards. At 700 yards range a man 5 feet 9 inches in height would be hit anywhere along the range, if the muzzle of the rifle were 12 inches from the ground, the sight set at 700 yards, and the ground line aimed at. The same effect would only be produced with our present Service rifle at about 550 yards.

Without experimental data it is difficult to estimate exactly the energy of recoil of a 9-lb. rifle with a muzzle velocity of 2,900 f.s. and a 154-grain bullet, but it would appear to be well below the limit of 15 ft.-lb., which is the maximum desirable in a military rifle.

Two further questions affecting the military value of the new bullet arise: its wounding power, and its penetration.

Taking the striking energy of the bullet as the measure of its wounding power, it would seem that the new bullet is more effective than the Lee-Enfield up to between 900 and 1,000 yards; beyond that range it is slightly inferior, but the difference is not marked.

Apart from its superior striking energy, however, the so-called explosive effect, characteristic of modern high-velocity bullets at close ranges, would probably be occasioned by the "S" bullet at very much greater ranges than is at present the case; possibly up to 600 or 700 yards, as against 200 or 300 with the present bullet. Experiments, however, would be necessary to test this point.

As regards penetration, the advantage must lie with the new bullet at all except extreme ranges.

Diagrams of the new and old German bullets, and of our 0·303 bullet, together with comparative ballistic tables and diagrams of trajectories, are appended.

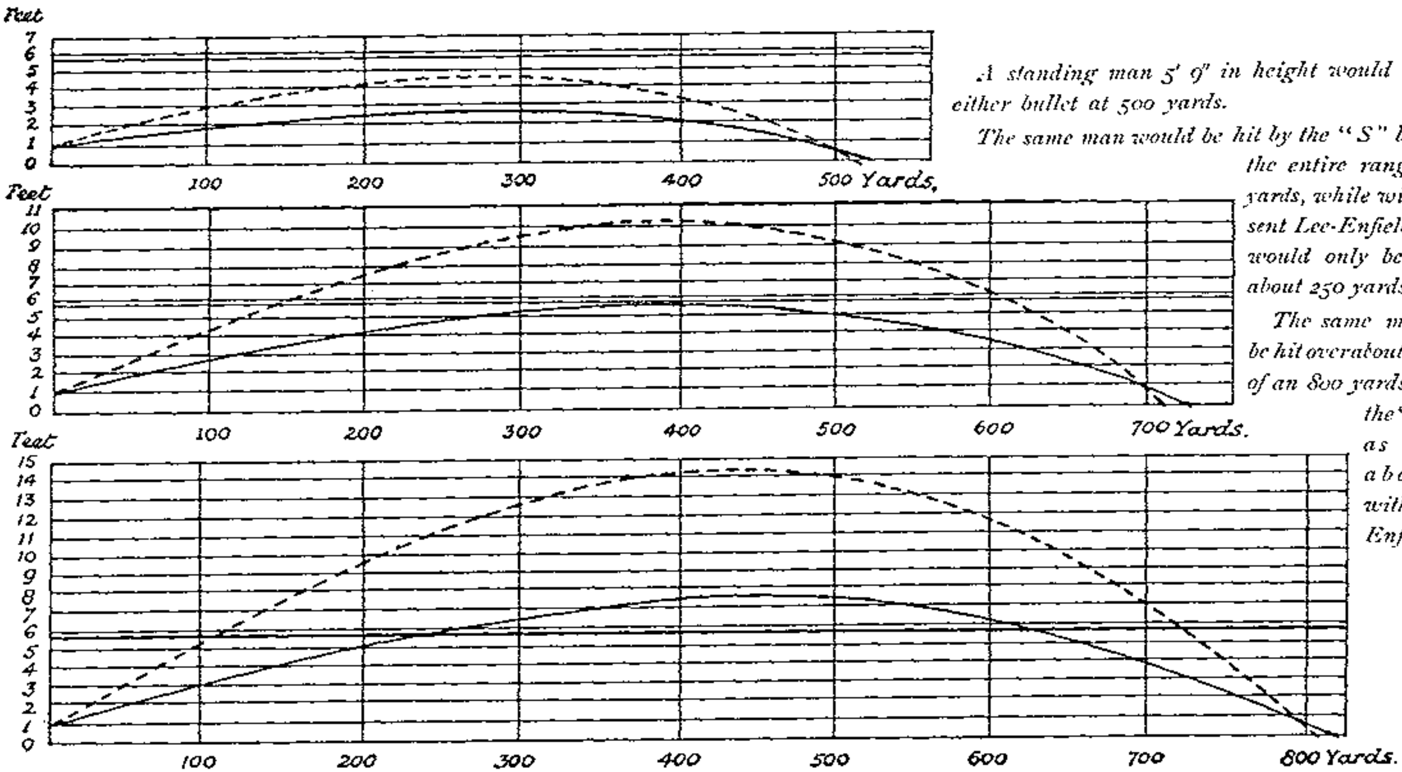
RANGE TABLES.*

Range.	Angle of Projection.				Time of Flight.		Remaining Velocity.		Striking Energy.		Maximum Height Attained.		Angle of Descent.			
	Lee-Enfield. "C"=0·411. "S" Bullet. "C"=0·40.															
	L.E.		"S."		L.E.	"S."	L.E.	"S."	L.E.	"S."	L.E.	"S."	L.E.		"S."	
yards.	degs.	mins.	degs.	mins.	secs.	secs.	ft.-secs.	ft.-secs.	ft.-lbs.	ft.-lbs.	feet.	feet.	degs.	mins.	degs.	mins.
0	0	0	0	0	0	0	2060	2909	2036	2916	0	0	0	0	0	0
200		9		4½	0·32	0·23	1673	2355	1343	1910	0·4	0·2		11		5
400		21		10¼	0·72	0·52	1361	1900	889	1244	2·1	1·1		28		14½
500		29		14¼	0·95	0·68	1229	1712	724	1009	3·6	1·9		40		21
600		37½		18½	1·21	0·87	1119	1538	600	814	5·8	3·0		55		28½
800		59		29¾	1·78	1·30	981	1239	461	529	13·3	6·8	1	36		53
1,000	1	25		45¾	2·43	1·83	886	1039	377	371	24·9	14·0	2	25	1	30
1,200	1	58	1	5½	3·14	2·44	807	930	313	298	42·2	25·2	3	26	2	19
1,500	2	56½	1	46	4·33	3·50	708	803	240	222	83·5	53·5	5	22	3	53
2,000	5	8	3	21½	6·70	5·60	569	642	155	142	198·0	141·0	9	56	7	39

* The "S" table has been calculated upon the basis of the article in the *Kriegstechnische Zeitschrift*.
Similar tables, based upon slightly different data, have appeared in the *Field* of the 16th December last and in the January number of *Arms and Explosives*.

TRAJECTORIES OF LEE-ENFIELD AND "S" BULLETS AT 500, 700 & 800 YARDS, MUZZLES 1 FT. FROM GROUND.

L.E. (upper) - - - - - . "S" (lower) ——— .



A standing man 5′ 9″ in height would be hit by either bullet at 500 yards.

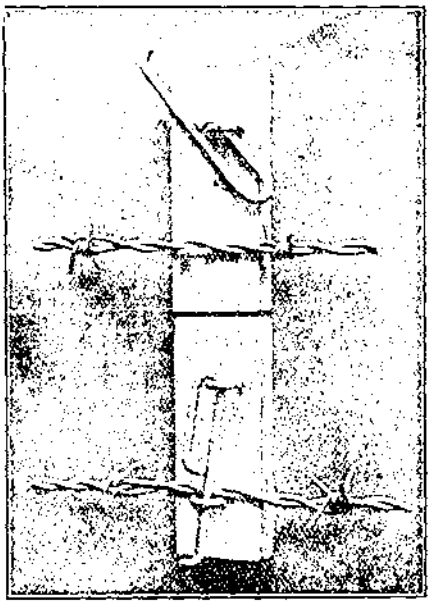
The same man would be hit by the "S" bullet over the entire range of 700 yards, while with the present Lee-Enfield bullet he would only be hit over about 250 yards.

The same man would be hit over about 350 yards of an 800 yards range by the "S" bullet as against about 180 with the Lee-Enfield.

PATENT "THOROUGHPIN" FENCING WIRE ATTACHMENT.*

FARMERS and others have often occasion to need some simple and inexpensive method of fixing fencing wire so that it may be at any time expeditiously lowered and put up again. This want is especially felt during the hunting season and in the shifting of game and poultry runs, and at many other times.

The invention here illustrated consists of a wire pin of (perhaps) two inches in length, looped at one end to about half its length, and slightly bent over at the other end, as in the drawing showing it unfastened. The looped or upper end is attached to the post by a staple, and a similar staple is fixed lower down to receive the free end of the pin. The wire is stretched close to the post slightly above the lower staple, through which the pin is then passed, and remains down by the gravity of its own weight, as shown in the second sketch. It can then be quickly released when desired, but will not come accidentally unfastened, nor will it be affected by cattle.



The attachment is simplicity itself, there are no loose parts, and its cost is trifling. Intended for barbed wire primarily, the "Thoroughpin"

* Reprinted by permission from *Patents* of May, 1905.

is equally suitable for plain or any wire. With barbed wire it also serves admirably when it is desired to join two lengths, as the pin will carry two thicknesses of wire equally well; and if the two ends to be joined are cut near the barbs and fastened under the pin, the claws drawing in opposite directions will catch in it and be held securely.

The invention is the idea of Mr. C. F. Howland, Thame, Oxfordshire, who is himself a practical farmer, and fully understands the requirements of the case.

REVIEWS.

AMERICAN REPORTS ON MILITARY OPERATIONS IN SOUTH AFRICA AND CHINA.

(U.S.A. War Department, Washington).

THIS is a bulky volume, containing the reports of the United States Military attachés on the South African War, and also reports made by American officers on the operations that led to the relief of Pekin and the crushing of the Boxer rising. In addition, there is a lengthy summary of the various operations, so that in many cases two accounts are given of the same incidents. The volume, therefore, does not provide as much information as its outward appearance promises. It further shows signs of careful editing, and the reader is sometimes tantalised with a row of asterisks, at the very moment when he thinks he is about to come upon some information of unusual interest.

The historical value of the work is not very great, because the attachés were not present at any of the operations previous to Paardeburg, nor did they see any of the fighting in Natal. The absence of any large scale map of Tientsin and the surrounding country renders the accounts of the various actions that took place in its vicinity quite unintelligible to anyone who is not acquainted with the locality. The account of the operations in China is inferior to that issued by our War Office; but the latter unfortunately is confidential.

However, the very generous and friendly criticism of our troops and their doings renders the book a pleasant one to read, and the comments on the various operations are extremely valuable. The gist of the criticisms that are scattered through the book is given in the following extracts:—

THE SOUTH AFRICAN WAR, 1899—1902.

British Strategy in South Africa.

The failure of the Natal force to co-operate with Lord Roberts' army is the only part of our strategy that is criticized. "Had even a portion of the Natal force entered the Free State through the almost unguarded passes, and operated in conjunction with Lord Roberts' army from Bethlehem north, the result would have been decisive and conclusive."

British Tactics.

The general impression conveyed by the criticisms of the various operations is that the British tactics were often unnecessarily aggressive. Frontal attacks were sometimes pushed home before the flanking columns could make their presence felt, the battle of Driefontein being quoted as a special instance. The attaché with the Boers considered that the thin firing lines employed by the British failed to give them the necessary superiority in fire effect.

British Organization.

There are practically no comments on the British organization, so it was presumably considered suitable.

British Personnel.

The rank and file are lavishly praised. "They have not the individuality and resources of our men, but for indomitable courage, uncomplaining fortitude, and implicit obedience they are beyond criticism."

The officers, however, did not win such unstinted admiration. "The majority of the British officers look upon their army service as a mere incident in their lives, shortly to be given up for the delights of country and town life; few of them make themselves proficient in those innumerable details necessary for a professional soldier to know, and rely too much, far too much, on the non-commissioned officers to assume those duties which rightly and properly they themselves should perform."

It will be remembered that about the time these reports were written the English newspapers were full of similar criticisms; they were probably truer when they were written than they are now.

British Cavalry.

It was noticed that the British cavalry had not been sufficiently trained in dismounted work, and the American cavalry are held up as a model. "Our cavalry, combining as it does the essential advantages of both mounted infantry and cavalry, renders unnecessary the two distinct branches, but it should have a gun firing a larger bullet, for the ·303 bullet will not stop a horse."

"The saber scabbards of the British cavalry were lined with wood or cork, and a keen edge was kept on the blade for some time. They are really a cutting weapon, not merely a steel club as ours must always be with nothing inside the scabbard to protect the edge."

Cavalry armed with steel clubs cannot be said to possess all the essential advantages of that arm. It was observed in China that the American cavalry preferred to use their pistols to their sabres, and several of our cavalry officers expressed doubts as to whether the men had been taught to consider shock tactics as part of their proper *rôle*. They lacked, in fact, just those qualities that should distinguish cavalry from mounted infantry.

British Artillery.

"The artillery has shown itself in my opinion to be the best branch of the combatant service. The field and horse artillery guns were not of the most modern type, and were very often outranged by the enemy's; nevertheless the gunners, both officers and men, have demonstrated that they are as good as the most critical commander could desire."

The attaché with the Boers writes:—"The British artillery always strongly supported the attacking infantry, and kept up its fire to the last minute."

The effect of the heavy guns was more moral than physical.

"The balloon with the British army has been of unestimable value to it. It usually ascended about 2,500 yards from the enemy's line and secured valuable information especially for the artillery." British Engineers.

"The field telegraph has been admirable."

"The railway engineering work was always splendidly done, both by the Royal Engineers and Volunteers (railway pioneer regiment). To them is mainly due the possibility of the rapid advance of the army to Pretoria, for without the railway the army could move only slowly, and every bridge and almost all the culverts were blown up between Karree Siding and the Vaal River, and in some places the road bed and rails."

The attachés had no opportunity of seeing any of the work of the Bridging Companies.

"The infantry has done splendidly always, but the reluctance of the soldier to intrench himself, and the indifference of the officers to enforce this most necessary and vital precaution was strikingly shewn upon all occasions. They would pile up a little parapet of stones visible for a long distance but they would rarely ever dig a trench." British Infantry.

"It has worked during this difficult campaign most admirably. The same officer in collecting supplies, collects the transport to haul them and makes all arrangements for their shipment, thus obviating friction, confusion, and unnecessary delay. I consider the Army Service Corps one of the best things I have seen in the British army." Army Service Corps.

"The medical service, hospitals, and all pertaining thereto were generally admirable. There was naturally much overcrowding in the stationary and general hospitals, due to the exceptionally large number of enteric patients. Among the field ambulances were some sent from India, called dhanjibhoys,* very light and mobile, and they did excellent work in quickly transporting the wounded and sick." Medical Arrangements

The attaché with the Boers estimates that they never had more than 35,000 men in the field at any one time. The Boer Strength.

The great error committed by the Boers was their failure to invade Cape Colony at the beginning of the war. This course was advocated by all the younger commanders, but was vetoed by General Joubert. The latter thought the war would consist of some fighting on the Natal border and nothing more. Boer Strategy.

The Boer tactics are too well-known to require much comment. "As a rule his lack of offensive capacity prevented the Boer from reaping the fruits of tactical victory. He was contented when he had repulsed the enemy." Boer Tactics.

"When offensive operations were undertaken, the foreigners had to bear the brunt of the fighting."

The Boer discipline was very bad. The system under which a commando elected its own officers was radically wrong and its effects disastrous. "There were laws in existence to enforce discipline, but the government had made the mistake of not enforcing them from the beginning, when things were going favourably, and did not dare to change its policy when things were going the other way. To the Boer Discipline.

* Thus is immortalised the name of the munificent donor of the ambulance tongas.—J.E.C.

military mind the degree to which inferior officers carried their self-will is unconceivable."

"More than once General Botha and others agreed in conversation that the only force fit to make war with was one composed of men regularly trained and disciplined by barrack life and regularly paid."

When this fact is recognised in England, the re-organization of our military resources should be a comparatively easy matter.

Boer Intrenchments.

The American attachés did not admire the Boer trenches. "Their trail resembled a writhing snake which lessened the danger of enfilade fire. It would be easy to get men into such a trench, but a thundering big job if you wanted to get them out again to make a counter-attack. They destroyed the power of offensive or aggressive action; and the lack of continuity, caused by the separate and distinct holes, made communication extremely uncertain and hazardous. Their only merit was to me their irregular trace; in all other respects they simply demonstrated how a trench should not be made."

General Comments.

Bicycles were largely used by the Boers, but hardly at all by the British; the former seem to have found them very useful for despatch riders.

"As many men as possible should be transported in war either on horseback or by automobiles. A portable military railway seems to be almost indispensable in war. A successful frontal attack is not now one of the probabilities of war; consequently flanking movements done quickly and with as much surprise as possible must be undertaken. It is under such circumstances as these that the value of automobiles and mechanical traction will be found."

The necessity for powerful field glasses and telescopes is insisted on, and it is recommended that a small proportion of the rifles should be fitted with telescopic sights.

THE CHINA INTERNATIONAL EXPEDITION, 1900–01.

The reports on the military operations in China include descriptions of the troops of the various nationalities that were represented. Some of these descriptions are very short and deal with little but the outward appearance of the troops. The following is a selection of what appear to be the most noteworthy features:—

The Russian Troops.

"Their discipline appeared to be excellent."

"A notable feature of their equipment was a travelling field kitchen, consisting of a boiler mounted in a special wagon so arranged that it could be in operation while in motion."

This travelling kitchen is now being tried in India.

The Americans got few opportunities of inspecting the Russian artillery. The guns were of small calibre and of obsolete types.

The Japanese Troops.

The Japanese had several batteries of small calibre and of the old Krupp patterns. They also had a battery of bronze guns which was always very much *en évidence*.

"The drill of the Japanese infantry is characterised by simplicity, directness, and precision. In the battle formation all movements are carried out at a run."

"The compulsory service and strict physical requirements, with the system of reserves, allows Japan to put a large body of trained men in the field at short notice. And if Japan can keep the armament and equipment on a par with her soldiers she is a most valuable ally and a most formidable enemy."

This was written in 1900. It is curious that the Americans and the British were apparently the only nations that at this time formed a true estimate of Japan's military strength and efficiency; the old bronze guns did their duty well.

The French Troops.

The report on the French troops is little more than a bare statement of their organization and equipment, given without any comments except the following:—

"The French Zouaves and Chasseurs d'Afrique were well-developed men, disciplined from long service, soldierly in their manner and appearance. The French colonial troops marched poorly and seemed to be poorly disciplined."

The German Troops.

The marching of the German infantry was good although they were heavily weighted. The Germans brought no tents to China and therefore depended entirely upon billeting. One serious disadvantage of this system is the danger of infection to men and animals. The discipline of the men as far as was observed was excellent.

The British Troops.

Nearly the whole of the British force consisted of native troops from India. The Americans were impressed with the thoroughness of the orders for the mobilization and organization of the China Field Force. The equipment of the troops was considered to be very suitable except as regards the men's boots, which are reported on as being too stiff and heavy.

"The British were the best and most suitably dressed of any nation, and better equipped than the troops of any nation in the field."

The artillery horses (Walers) were not admired. "They require a great deal of grain to keep them in condition and they are lacking in endurance. They are noticeably weak in the hind quarters."

The discipline of the enormous number of camp followers with the expedition was, considering all the circumstances, remarkably good.

The Indian pack-saddle met with approval. "The whole arrangement is simple and inexpensive. It could undoubtedly be much improved by our practical people; but the idea is there and it is good." Those who know the amount of time and trouble that has been expended in designing the Indian pack-saddle will probably not feel so sanguine about its capability of improvement.

The British were apparently the only troops that had any method of supplying the men with ammunition while in action.

"The British troops take excellent care of themselves. Besides arranging for the comfort of their men and animals, they have accumulated supplies of fuel and forage, repaired the British Legation, macadamized streets, put up revetments, etc. There are many indications showing that they are experienced campaigners. The readiness with which they put up small flags on buildings, carts, and stores of all kinds; their skill in finding the supplies and valuables of the enemy; the posting of signs and guide posts—these, and many other details, show an experience in which American troops are deficient. Their officers, also, had superior knowledge of the character of foreign troops and knew how to conduct their intercourse with them, which was another advantage. The discipline of the British troops is excellent."

The marching of the Native infantry on the return from Paotingfu excited admiration. "Without any apparent effort they made from 23 to 25 miles per day by 4 or 5 o'clock in the afternoon."

Special mention is made of the Native Sapper and Miner mounted detachment with the Paotingfu column. "Too much credit cannot be given for the handling and work of the English sappers and miners, who, mounted on horses, with their tools on suitable racks also on horses, rode just behind the advance cavalry and rendered excellent service, repairing roads, filling mudholes and boggy places, and preparing ramps for the camping grounds which were almost always above or below the road level."

On the other hand, a floating bridge made by the Sappers and Miners (dismounted?) with the same column is the subject of adverse comment. "This bridge was a complete failure. The crossing of the British infantry shook it up considerably and it was necessary to repair it before other troops could follow. When the light transport started over, one boat sunk, thus absolutely destroying its usefulness. The failure of this bridge was due to the fact that it was badly located and also that valuable material at hand was not made use of."

Sanitation.

It is interesting to note that the British, Japanese, and Germans all issued strict orders that only boiled water was to be drunk, yet not one of these three nationalities was able to enforce the order. This is surely conclusive evidence that the boiling of all drinking water on active service is impracticable.

General Comments.

"While everyone engaged in the defence and relief of Tientsin did their full share of work and fighting, it is generally admitted that the Russians, who greatly outnumbered the other nationalities, bore the brunt of both, and are entitled to most of the credit for its safety and rescue."

In the capture of Tientsin native city and the subsequent relief of Pekin the Japanese did the greater part of the fighting, as is shown by the casualty list. It is interesting to note that on the day when Tientsin native city was attacked by the allies they lost over 14 per cent. in casualties. The casualties of the British troops engaged at Magersfontein amounted to 13 per cent. This comparison may give some idea of the severity of the fighting at Tientsin.

This long review cannot be brought to a close better than with a short summary of the account of the gallant defence of the Peitang Cathedral and Mission in Pekin. The besieged numbered about 3,000 native Christians, the majority of whom were women and children; the garrison consisted of 30 French and 10 Italian soldiers, one French and one Italian officer. The defence scheme was planned by Monsignors Favier and Jardin, priests of the Mission. At the commencement of the siege the garrison had only 10,000 rounds in hand.

The siege lasted from the 19th June to the 16th August. The Chinese succeeded in placing and firing five mines under various portions of the defences, killing 5 Italian soldiers and 96 other persons; 1 officer, 5 soldiers, and about 94 others were killed by rifle fire, and 1 officer, 11 soldiers, and many Chinese Christians were wounded; 500 Chinese Christians died of starvation. When the Mission was relieved there were only $2\frac{1}{2}$ ounces of grain per head in hand and only 1,500 rounds of ammunition. Probably no one will disagree with the American writer who claims this to be 'one of the noblest and bravest defences known in history.'

J. E. E. CRASTER.

ENGINEERING STANDARDS COMMITTEE: REPORT ON PROGRESS OF WORK.

This Committee has issued from their offices at 28, Victoria Street, S.W., a Report on the work done from its formation in January, 1901, up to July, 1905.

The Committee originated through a proposal by Sir John Wolfe Barry to the Council of the Institution of Civil Engineers to standardize various kinds of Iron and Steel Structures; its task has now been greatly extended, as will be seen below. It is supported by the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, and Naval Architects and the Iron and Steel Institute; and is financed by a small annual grant from Government, by grants from the above Institutions, and by subscriptions from the leading Manufacturers, Railway Companies, and others similarly interested.

The Work has been carried out under a Main Committee, with a Finance Committee, a Committee for Publication and Calculations, and Sectional Committees for the following:—1. Sections used in Shipbuilding (with Sub-Committees on (*a*) Tests for Iron and Steel Material used in the Construction of Ships and their Machinery, and on (*b*) Steel Castings and Forgings for Marine Work); 2. Bridges and Building Construction; 3. Railway Rolling Stock Under-frames; 4. Locomotives (with Sub-Committees on (*a*) Component Parts and Types, (*b*) Tyres, Axles, and Springs, (*c*) Locomotive Steel Plates, (*d*) Copper and its Alloys); 5. Rails (with Sub-Committees on (*a*) Railway Rails, (*b*) Tramway Rails, and (*c*) Tyre Profiles); 6. Screw Threads and Limit Gauges; 7. Pipe Flanges; 8. Cement; 9. Cast Iron Pipes (with Sub-Committees on (*a*) Water, Gas, Electrical, and Sewerage Mains, (*b*) Pipes for Hydraulic Power, and (*c*) Pipes for Heating, Ventilation, and House Drainage); 10. Electrical Plant (with Sub-Committees on (*a*) Generators, Motors, and Transformers, (*b*) Transformers, (*c*) Prime Movers, (*d*) Physical Standards, (*e*) Telegraphs and Telephones, (*f*) Cables, (*g*) Electric

Tramways, (*h*) Electrical Plant Accessories, (*i*) Electric Automobiles); 11. Foreign Correspondence (Electrical).

The following are some of the publications which have already been issued by the Committee:—

1. List of BRITISH STANDARD SECTIONS (included in No. 6).—This Publication gives the sizes (but not the Properties, which are to be found in Publication No. 6) of the following sections:—Equal and Unequal Angles, Bulb Angles, Bulb Tees, Bulb Plates, Zed Bars, Channels, Beams, and Tee Bars. (1s. 1d.).

2. Specification and Sections of British Standard TRAMWAY RAILS AND FISHPLATES.—This Publication contains two Specifications:—(I.) Tramway Rails, (II.) Fish Plates. The sections for straight track vary from 90 lbs. to 110 lbs. per yard, each section increasing in weight by 5 lbs. per yard. Sections are also given of the curved rails corresponding to each weight of rail for straight track. Fully dimensioned diagrams of every section are included. (21s. 3d.).

4. PROPERTIES OF STANDARD BEAMS (included in No. 6). Demy 8vo., sewed. (1s. 1d.).

5. Report on STANDARD LOCOMOTIVES FOR INDIAN RAILWAYS.—This Publication contains the Recommendations of the Committee on Types of Standard Locomotives for Indian Railways. It includes Instructions to Designers, and Drawings for three classes of Metre Gauge and two classes of Broad Gauge Locomotives. (10s. 8d.).

6. PROPERTIES OF BRITISH STANDARD SECTIONS.—This Publication includes all the information contained in Nos. 1 and 4, together with Areas, Weights, Moments of Inertia, Moments of Resistance, etc., for all Standard Sections of Structural Steel. Demy 8vo., cloth. (5s. 3d.).

7. British Standard Tables of COPPER CONDUCTORS and Thicknesses of DI-ELECTRIC.—This Publication includes the Resolutions of the Committee with respect to Standards for Copper Conductors, and contains Tables of dimensions for single, concentric and stranded Conductors, Armour and Di-electric. (2s. 8d.).

9. British Standard Specification and Sections of BULL-HEADED RAILWAY RAILS.—This Publication includes the Specification and Sections of Bull-Headed Railway Rails. The Sections vary from 60 to 100 lbs. per yard, each Section increasing in weight by 5 lbs. per yard. Fully dimensioned diagrams of every Section are included, together with Tables of dimensions, and sketches showing the forms of Standard Tensile Test Pieces. (10s. 9d.).

10. British Standard Tables of PIPE FLANGES.—This Publication contains particulars of Flanges for different ranges of Steam pressure up to 325 lbs. per square inch, and water pressure up to 200 lbs. per square inch. Dimensions of the Standard Bends and Tees recommended by the Committee are also given. (2s. 8d.).

11. British Standard Specification and Sections of FLAT-BOTTOMED RAILWAY RAILS.—This Publication includes the Specification and Sections of Flat-Bottomed Railway Rails. The Sections vary from 20 to 100 lbs. per yard, each Section increasing in weight by 5 lbs. per yard. Fully dimensioned diagrams of every Section are included, together with

Tables of dimensions, and sketches showing the forms of Standard Tensile Test Pieces. (10s. 9d.).

12. British Standard Specification for PORTLAND CEMENT.—This Specification contains the tests for Portland Cement recommended by the Committee. Dimensioned diagrams are given of the Standard briquette, jaws for holding same, needle for ascertaining setting time, and the apparatus for conducting the "*Le Chatelier*" test. (2s. 8d.).

15. British Standard Specification for STRUCTURAL STEEL FOR BRIDGES (to be published shortly).—This Specification will include the tests for Steel used in Bridge Construction, together with sketches showing the forms of Standard Tensile Test Pieces. (2s. 8d.).

16. British Standard Specification for TELEGRAPH MATERIAL.—This Publication contains Specifications for General Telegraph Material, together with Tables for hard and annealed Copper Wire. (10s. 10d.).

17. Interim Report on ELECTRICAL MACHINERY.—This Report gives Standard Pressures and Frequency; Speeds for direct current generators, D.C. Motors and A.C. Induction Motors. Definitions and Standard Test Conditions are also included; the latter are, however, still under consideration and must not, therefore, be regarded as final. (2s. 8d.).

18. Forms of STANDARD TENSILE TEST PIECES.—This contains dimensioned diagrams, and is inserted in all Specifications in which reference is made to the Standard Tensile Test Pieces. (1d.).

20. Interim Report on British Standard SCREW THREADS.—This Interim Report includes the recommendations of the Committee on Screw Threads, their Pitches, Form of Thread, etc. Tables are given containing the dimensions of the Whitworth (¼-inch to 6 inches), the Standard Fine (¼-inch to 6 inches) and the British Association Screw Threads. (2s. 8d.).

21. Report on British Standard PIPE THREADS for Iron or Steel Pipes and Tubes.—This Report contains the recommendations of the Committee on the Form of Thread and the Pitches for Standard Pipe Threads, together with a Schedule of Sizes. (2s. 8d.).

22. Report on the EFFECT OF TEMPERATURE ON INSULATING MATERIALS.—This Publication contains a full report of a series of experiments on the Influence of Temperature on the Electrical and Mechanical Properties of various Insulating Materials. The tests were carried out at the National Physical Laboratory, and also by Messrs. Crompton & Co., Ltd., and Messrs. Siemens Bros. & Co., Ltd. The Report is accompanied by numerous tables. (5s. 3d.).

24. British Standard Specifications for MATERIAL USED IN THE CONSTRUCTION OF RAILWAY ROLLING STOCK (to be published shortly).—This Publication contains some 24 Specifications for Tyres, Axles, Springs (Laminated, Volute and Helical), Copper Plates, Copper Rods, Copper and Brass Tubes, Steel Forgings and Castings, Steel Locomotive Boiler and Frame Plates, Carriage and Wagon Frame Plates, etc. (—s. —d.).

The above publications can be obtained from Crosby Lockwood & Son, Publishers to the Committee, 7, Stationers' Hall Court, Ludgate Hill, London, E.C., or at the Offices of the Committee, 28, Victoria Street, Westminster, London, S.W. The prices quoted are 'post free.'

With the exception of Nos. 4 and 6, the volumes are issued in foolscap size, bound in strong paper covers.

The Committee has also made arrangements for the supply of Commercial sets of Templates in accordance with Reports 2, 9, 11, and 10.

The following R.E. officers have given their services on one or more Committees or Sub-Committees:—

Lt.-Col. R. E. B. Crompton, C.B., Electrical Engineers, R.E. (Vols.); Major P. Cardew, late R.E.; Capt. M. H. P. R. Sankey, late R.E.; Capt. T. H. Cochrane, M.V.O., R.E.; Capt. A. H. Dumaresq, R.E.

A. T. MOORE.

NOTICES OF MAGAZINES.

BULLETIN OF THE INTERNATIONAL RAILWAY CONGRESS.

December, 1905.

THE USE OF STAMPS ON RAILWAYS (AUSTRIA).—Stamps are already used to some extent for the prepayment of goods and parcels, and it is here proposed to simplify the issue of tickets by employing stamps in passenger work.

The essence of the idea is that a paper ticket is employed, to which the affixing of a stamp of a suitable description gives value appropriate to the distance for which available; consequently the variety of different descriptions of tickets necessary to keep in stock is eliminated, in fact only one kind of ticket blank need be kept. On this the name of the destination station and the distance is printed, as required, by a machine into which a die is put, and the stamp is then gummed on.

The stamps themselves must be accounted for, but no stock book of tickets has to be kept, and account keeping is much simplified. Needless to say, the system is no use for through traffic.

The process of ticket issue, however, must be much more complex and slow than that to which we are accustomed. But when rates to a great number of stations are quoted, tickets are not usually kept except for those in most demand; and the process of filling up the blanks, especially when the rate book has to be consulted, is tedious if the work has to be done by pen. Under the stamp system the die is dropped into a machine, a treadle pressed, and the name of destination station and its distance appears on the blank. Stamps to the amount of the fare are then affixed and the ticket sold. Stamps are of different colours according to class, and bear on the face in large figures the distance and corresponding fare. Presumably the fare varies directly with the distance. Complications would arise if any differential tariff were used.

January, 1906.

NORMAL DANGER *v.* NORMAL CLEAR.—This refers to the installation of automatic electrically operated signals, and is devoted to demolishing the arguments of those who are in favour of the "Normal Clear" type. The "Normal Danger" principle has long been generally adopted for hand-operated signals, and every imaginable precaution has been taken to ensure a signal going to the "On" position in the event of any failure. When therefore, at junctions for instance, automatic signals are contiguous to those hand operated, the possibility is introduced of having the section in advance shown clear while the hand-operated signal is against the train. The introduction of slotting would only shift the anomaly a block further on. The "Normal Danger" system certainly needs more wire, but actually the cost of operation is rather less. While in the "Normal Clear" system the signal is not "On" unless it is protecting a train, under the "Normal Danger" system the movement of the signal warns platelayers and others of the approach of a train. Arguments as to facility of ascertaining the working of signals by inspecting from the rear of the train have little weight; such inspection could only be of a very superficial character.

SUPER-ELEVATION ON CURVES.—This appears to be a German rediscovery of the familiar method of deriving the correct amount of super-elevation from measurement of the versed sine of a chord proportionate to the limiting speed.

C. E. VICKERS.

ENGINEERING NEWS.

December 7th, 1905.

WORN RAIL JOINTS.—M. Bouchal, of the Chemin de Fer de l'Ouest, says that the most economical method of dealing with worn rail ends is to cut off the ends and drill fresh bolt holes, practically making new rails slightly shorter than the old. If a rail is estimated to have a life of, say, 50 years in the main line, there is no joint device which will keep the ends from wearing down for that length of time. Experience shows that the great problem of maintaining permanent way lies in keeping the joints from working. There are now plenty of patterns of drills and saws which render the accurate cutting off and redrilling of rails *in situ* an easy matter. Of course, chaired rails would be much simpler to deal with than flatfooted rails dogged to sleepers.

December 28th, 1905.

REINFORCED CONCRETE RESERVOIR, FORT MEADE, SOUTH DAKOTA.—The account given of this piece of work is interesting, as it describes the construction in some detail. The reservoir is for the supply of a "Post" for 8 troops of Cavalry, and its capacity is 500,000 gallons; it is sunk in the ground, and divided into two compartments, each 50′ × 60′ and 16′ high from floor to under side of roof slab. The roof is required to support 24″ of earth, and a snow load of 100 lbs. per square foot.

The walls are about 12″ thick, with reinforcement of horizontal bars, inside ¾″ corrugated at 12″ centres, and outside ½″ corrugated at 24″ centres. There is a series of supporting columns, 14″ square, 16′ 8″ apart in the one direction and 15′ in the other.

The floor appears to be about 9″ thick, reinforced on top side only by longitudinal bars in each direction, making a grillage. Footings under columns and walls are carried down a foot deeper, and are reinforced on the under side also.

In laying the floors and footings a thin layer of concrete was first put down; then the lower series of bars was laid, then the upper series, and both were wired together *in situ*, after which the remainder of the concrete was filled in.

In building the walls the whole skeleton of reinforcement was erected first, the bars being spaced by templates having holes bored at correct distances, and the whole wired together. (This seems to imply vertical rods, but they are not indicated on the drawing). The inside was finished in cement mortar, one cement to one sand, trowelled on.

The writer expresses a preference for placing the mortar against the casing just before the concrete is filled in, rather than the method of plastering afterwards.

C. E. VICKERS.

ENGINEERING RECORD.

November 11, 1905.

TESTS OF REINFORCED CONCRETE BEAMS.—The Chicago, Milwaukee, and St. Paul Railway recently made a series of tests of armoured concrete beams, with a view to ascertaining the most suitable design for flat-topped culverts, of which they construct a considerable number. Particular regard was paid to failure by shearing.

Tests of a considerable number of different arrangements of rod reinforcement were made, and the formula deduced was:—

$$\frac{M}{bd^2} = \cdot 350.$$

No precise results were arrived at as to the best arrangement of diagonal reinforcement; but it was reckoned to be advantageous to use steel of high elastic limit, and not to put in more sectional area of steel than about ·70 per cent. of the area of concrete above the lower layer of bars, or the bars would come too close together.

The following conclusions are noted:—

1. Diagonal reinforcement should be used at the end of all concrete beams.
2. Diagonal reinforcing bars should be brought well up to the top and securely anchored against slipping.
3. Use of small bars is preferable.
4. Use of bars larger in diameter than 1 in. is objectionable.
5. Location of neutral axis varies with amount of steel and class of concrete. With beams where ·75 per cent. of steel is used, as in these experiments, the neutral axis is about $\frac{1}{3}$ of the distance from the steel reinforcement to the top of the beam.

In connection with armoured concrete it may be worth while drawing attention to the warning recently sounded in the Engineering press as to the danger from fire to which such structures are exposed if the armature is too close to the surface of the concrete.

C. E. VICKERS.

NATURE.

January, 1906.

TELEPHOTOGRAPHY (*p.* 227).—Dr. Merzbacher, with two companions, has been engaged during the years 1902–3 in exploring the central Tian-Shan Mountains, which lie north-east of Kashgar. He has been able to correct many errors in existing maps. Each glacier, each valley, each ridge was in turn visited, surveyed, and described. The position of the great peak of Khan-Tengri (23,622 feet) was correctly fixed, but he was unable to climb it, and points out the causes of his failure to do so. The Inglchek glacier was found to have a total length of 45 miles in place of 7 miles as previously supposed. His book contains many beautiful views of mountain scenery taken by the telephotographic process, which was used with excellent results. The view of Khan-Tengri was taken from the north at a distance of about 24 miles.

BEELZEBUB, THE LORD OF FLIES (*p.* 238).—Mr. Shipley, F.R.S., delivered an address, before the British Association at Pretoria, on insects as carriers of disease. He shows that, though King Solomon sent to Tarshish for gold and silver, ivory, and apes and peacocks, and at the present day people mostly go to Africa for gold, diamonds, ivory and game, the great obstacles, which have for generations succeeded in keeping this great continent, except at the fringes, comparatively free from immigrants, are insignificant members of the order Diptera. We can now, however, to a great extent control these troubles; the old idea, that there is something unhealthy in the climate of the tropics, is giving way to the knowledge that the unhealthiness is due to definite organisms, conveyed into man by definite biting insects, and we have at last an explanation of why Beelzebub was called the Lord of Flies.

THE FIGHTING MAN OF JAPAN.—By F. J. Norman (*p.* 271).—The Dutch appear to have been the first to attempt to train a Japanese naval force, and it is a remarkable fact that in the fifteenth century many modes of self-defence were practised by the Dutch that are almost identical with those used by the Japanese in the art of jujitsu. The question is, did the Dutch take their ideas to Japan, or were they taught by the Japanese? The chapter on "Kenjutsu" deals with the affection the Japanese have always had for the sword, and the great cleverness they exhibit in its use. A "shinai" or practice sword is used, made from four strips of bamboo bound together at the handle with a strong leather covering. It is allowable to combine a trip with a hit, as in the illustration one fencer is trying to knock his opponent over with a blow at the neck, at the same time taking his leg from under him with a sort of jujitsu trip. The "sumo" or wrestling between two experts is an event of almost national importance, and the Japanese flock in thousands to the huge amphitheatre, in the centre of which the tussle takes place.

BRONTOSAURUS (*p.* 282).—In 1897 the American Museum expedition to Wyoming discovered the skeleton of the Brontosaurus which is now mounted at New York. These animals spent a considerable part of their lives in the water, but were also capable of progression and of feeding upon land, where during the reproduction and hatching period they had to guard their nests. The estimated weight of the animal when alive is 38 tons, and the length of the mounted specimen over all from head to tip of tail is 66 feet 8 inches. These dimensions may be compared with those of a full-grown "sulphur bottom" whale shown at the St. Louis Exposition, which measured 74 feet 8 inches and weighed 63 tons.

THE VOYAGE OF THE "DISCOVERY" (*p.* 297).—Captain Scott, R.N., in his two interesting volumes, describes the work of the National Antarctic Expedition. The book is illustrated by a series of fine photographs and some beautiful sketches by Dr. Wilson. The two main achievements of the expedition are Captain Scott's fine sledge journeys to the farthest south, 82° 16′ 33″, and to the farthest west that was reached in Victoria land, 77° 51′. This last spirited performance would probably have been even more successful but for the death of the dogs, and Captain Scott considers the journey westward, on to the plateau of Victoria land, to have been more severe than that to the south. He says, "I cannot but believe we came near the limit of possible performance." The *Discovery*, though designed for Antarctic exploration, of magnificent strength, was found to have very poor sailing qualities and a fine capacity for rolling, sometimes going over 90°, lurching from side to side in the most uncomfortable fashion.

W. E. WARRAND.

REVUE D'HISTOIRE.

January, 1906.

STAFFS AND MILITARY CABINETS DURING THE CAMPAIGN OF 1870–1871.—Many examples are brought forward to show how the French generals habitually allowed their aides-de-camp to assume the functions of the general staff, and practically superseded the chief of the staff, with disastrous results. Bazaine was the most conspicuous example, but Macmahon, Wimpffen, Bourbaki and others acted to some extent in the same way.

CAMPAIGN OF 1794.—*Army of the North*.—Unsuccessful attempt of the French forces to raise the siege of Landrecies by an advance from the south (April 21st).

PURSUIT OF THE ENGLISH ARMY BY MARSHAL SOULT (*2nd—16th January, 1809*).—Soult's mission was to pursue the English to their port of embarkation *l'epée dans les reins*. Commandant Balagny complains that he was overcautious in the execution of it. Especially at Lugo, where the two armies faced one another for two days, "Marshal Soult showed an excess of timidity, or at all events of prudence."

WAR OF 1870–1871.—*Army of Chalons*.—In discussing Macmahon's responsibility for resuming the advance on Metz, the writer quotes Napoleon's dictum that a general in chief command in war cannot shelter himself under the orders of a minister or of a prince who is at a distance from the field of operations and does not know the actual situation; if he disapproves those orders, he should insist on their being changed or resign his post. The result of Macmahon's vacillation was that very little progress was made towards Montmédy in three days (August 26th—28th), and two of his corps practically marked time; yet the troops were harassed and disheartened.

E. M. LLOYD.

THE CAVALRY JOURNAL.

January, 1906.

We welcome with sincere wishes for the best of success the first number of this latest Service publication. There is now required only an Infantry Journal to place us in this respect on an equality with the Army of the United States.

The new venture is published with the sanction of the Army Council and under the direction of the Inspector of Cavalry. Its office is at the Royal United Service Institution, the publisher is Mr. C. Gilbert-Wood, and the printers Spottiswoode & Co. The staff consists of Lt.-Col. A. Leetham, managing editor, Col. Hon. O. Lumley, editor, and Lt.-Col. J. W. Yardley, sporting editor; and there are sub-editors representing the Horse and Field Artillery, the Imperial Yeomanry, and Australia, Canada, India, New Zealand, and South Africa.

The Journal will for the present appear quarterly, price 2s. 6d. per copy; but it is hoped eventually to increase the number of issues and to offer substantial prizes for essays and for solutions of tactical schemes. The first year's expenses have been guaranteed, and the whole of the editorial staff are giving their services gratuitously.

This being the first number we need make no apology for a lengthy notice. The Journal appears in a cover of serviceable khaki, with a drawing of a cavalryman at the charge, symbolizing the thrusting spirit of the Cavalry arm. Its size, $9\frac{3}{4}'' \times 7\frac{1}{4}''$, at first sight appears unwieldy, but inside we find this is due to an innovation which deserves the 'sincerest form of flattery'; in order that readers may retain such articles as particularly interest them all the pages are perforated on the inner margin, and any required to be kept can be torn out and bound up in a volume of more normal size; a counsel of perfection would have made each article commence on a right-hand page. Another commendable feature is that each contribution is headed by a summary of its contents.

In a Foreword, Major-Gen. Baden-Powell, Inspector of Cavalry, says he makes no excuse for starting this Journal, for it has long been wanted. "As a matter of duty to our King and to the service it is the business of each one of us to try to improve the standard of knowledge in our branch, and so to make it second to none in efficiency." "Efficiency cannot be gained without knowledge. Knowledge cannot be gained without study of experiences and history."

The Preface states that the Journal is intended for the circulation of information concerning Cavalry matters in our own and other armies, and to bring the varied and scattered branches of our mounted troops, regular and auxiliary, home and colonial, into closer touch with each other by encouraging the development and interchange of ideas. The Contents are to include original articles on Cavalry subjects, translations of important foreign articles on the same, notes and reports of Cavalry progress both at home and in the Colonies, articles on sport, etc. "We British are one of the few nations which do not possess such a publication, and yet of all others we require it most, since our Cavalry comprises so many different species distributed over every part of the world." Being a race of natural horsemen we ought, with the varied methods and experiences (of the different units of the British Imperial Cavalry organizations) combined, to have the very best Cavalry that the world can produce. It is encouraging to us Sappers to see our mounted units here, as elsewhere, pointedly included in the organization of the Cavalry arm.

A coloured frontispiece gives a spirited picture of an Indian sowar galloping after a hare. It is unsigned, but bears a striking resemblance to the sketches drawn by Capt. Dixon during the siege of the "Tin Town" and published under the title of *The Leaguer of Ladysmith*. Amongst the articles of general interest are the following:—

WHAT LIES BEFORE US (THE CAVALRY FUTURE).—Major-Gen. Baden-Powell reminds us that "the mission of our Army is to second the Royal Navy in maintaining peace. If, as a nation, we do not make ourselves strong enough to defend ourselves, we are guilty of provoking others to attack us, and deserve to be smashed." "In making for efficiency in the mounted branch it must in the first place always be borne in mind that our main object is to help the Infantry to win battles." In the American Civil War experience led the men to be individually trained to every kind of action and the leaders to adopt on each occasion that which was most suitable to the local conditions of the moment; thus the action of the Cavalry on both sides was of the greatest value and at times almost overshadowed the doings of the other arms. In the recent Russo-Japanese conflict the Japanese Cavalry suffered from insufficiency in numbers, and had they possessed a proper mounted force Liao Yang would have been a disaster and Mukden a Sedan; on the other hand, the Russian Cavalry had not been properly trained as such, and were thus unable to take the opportunities that offered for playing havoc with their enemy's dispositions both in the field and on the lines of communication; this war is merely a confirmation of the principle of the days of Xenophon, that 'without Cavalry an army risks a great deal and cannot possibly reap the fruits of victory.'

"The careful study of your duties in war is the one and only guide to what you should train for in peace." As regards weapons, the possession of a firearm permits of Cavalry working with greater freedom and boldness. The choice of weapon must depend upon the country and the enemy:—in close and broken country, or when largely outnumbered, the *rifle* becomes of first importance; on open terrains, shock tactics, in combination with fire, are desirable. "But the weapon which is of the highest importance to a Cavalryman is his horse, and practical horsemastership is his most useful qualification."

MOUNTED RIFLES AND MOUNTED INFANTRY.—An anonymous contribution shows that considerable confusion exists as to the *rôle* of these. Mounted Rifles (sometimes called Light Horse, and in ancient times Dragoons), such as most of our Colonial mounted forces, are horsemen capable of carrying out all the duties of Cavalry except shock tactics, for which latter they lack the necessarily long and special training. Mounted Infantry are intended for Infantry action pure and simple, but possess means of conveyance which give them a greater mobility. The confusion of ideas has arisen through Mounted Infantry having on service, owing to the lack of horsemen trained as Cavalry, adapted themselves to the work of Mounted Rifles.

RAIDS AND HORSEMASTERSHIP.—An unknown writer proves that the long-distance rides on the Continent, which originally led to some cruelty due to inexperience, have placed our neighbours in a better position than ourselves to emulate the deeds of our own officer-scouts in the Peninsula. "Fast long-distance riding has proved itself to be practicable for horses and men, provided proper precautions are taken; these precautions can only be ascertained by practice and experience." "It is now known that a horse, if thoroughly trained, and ridden by a man who understands long-distance riding, can cover up to 60 miles at a rate of 12 to 15 miles an hour." Perhaps the best known raid was Stuart's 150 miles (including a river crossing and a fight) in 3 days to Gettysburg with 6,000 men; other long distances are 145 miles in 28 hours, 140 miles in 31 hours, and 170 in 66½. Col. Dodge of the U.S.A. is quoted as saying 'Knowledge of pace and the instinctive feel of the horse's condition is the highest grade of horsemanship.' Experience shows that the best pace for the greater part of a long ride is the canter.

Lieut. Paget-Tomlinson, 7th Hussars, in a prize essay at the Cavalry School at Netheravon, gives some useful hints on horsemastership with special reference to long-distance rides. "The horse must be in perfect condition to start with; and his condition depends entirely on the way he is cared for by his rider in the stable"; everyone knows the usual condition of the 'spare horse,' who has no one permanently detailed to look after him. "Steadiness and regularity of pace are all-essential factors." The rider should practice changing the horse's leading leg at the canter, and even at the trot; he should sit square and steady, and not quit stirrups; he should always slow up to a walk up or down hill; and he should periodically dismount and lead the horse, especially when the going down hill is bad (the horse's back is relieved of the weight and the blood is allowed to circulate freely under the saddle—a sure preventive of sore back). The horse should be watered slightly whenever possible, especially in hot climates; and should receive a small feed, after watering, at each halt of half-an-hour's duration (say after every two hours). The Inspector of Cavalry in his Remarks quotes the following from the second prize essay:—'The first duty of a horsemaster is to ascertain, as soon as possible, the characteristics of the horse of which he is in charge': 'off-saddle completely when halting to rest, and allow the horse when off-saddled to roll.' He also alludes to the necessity of the horse itself being well-balanced; lays down 1 lb. of forage an hour for the 24 hours as the rate of feeding; advises the carrying of meal to make gruel; and refers to the sustaining properties of sugar.

CULTIVATION OF THE SENSE OF DIRECTION (THE STARS AS A GUIDE).—Major Smyth, V.C., The Carabineers, gives three star-charts to show how any man can find his way North and South by Orion, visible, between his rising and setting, from any spot on the earth. A line drawn from the centre star of the belt through the head strikes the Pole Star; a line drawn from the centre of the belt to the centre of the sword may be continued to the imaginary South Pole of the Heavens, roughly determinable from the Southern Cross and the Triangle. Incidentally the writer mentions that in Somaliland the Indian Camel Corps sowars made better despatch riders than the Somalis trusting to their knowledge of landmarks.

DEVELOPMENT OF MOUNTED INFANTRY TRAINING AT HOME.—Col. A. J. Godley, Irish Guards, Commandant School of Instruction for M.I., shows that the three Mounted Infantry Schools at Longmoor, Bulford, and Kilworth, when in full working order, will produce 20 battalions, the men of each company being all from the same battalion of infantry; these 20 battalions are to receive a three months' training every year. Before the S. African War there were only 2 battalions of M.I., the companies then being composed of sections from various units.

CAVALRY: ITS TRUE FUNCTIONS IN MODERN WAR.—Mr. C. S. Goldman, author of *With Gen. French and the Cavalry in South Africa*, and one of the original promoters of this Journal, contributes a warning against the idea, attributed (but erroneously we think) to our authorities, that the great power of modern Cavalry lies in dismounted action. He quotes the leading writers on the Continent—von Bernhardi, von Kleist, and von Pelet-Narbonne—; and from the works of the last-named extracts a criticism of the achievements of our Cavalry in South Africa and a just conception of the proper proportion due to them of the credit for the capture of Cronje. The true *rôle* of Cavalry is summed up in the dictum that they should "fight mounted when they can, dismounted only when they must."

THE CAVALRY OF THE BRITISH EMPIRE.—Major-Gen. Sir E. Hutton draws attention to the great reserves we possess in 'The Cavalry of Greater Britain,' who "make up in the sterner qualities of men what they lack as soldiers in the European sense of the word." Another contributor gives a list of 'The Mounted Forces of the British Empire,' including 2 Camel Corps Companies of the King's African Rifles, the Mounted Infantry of St. Kitts Nevis, and the Trinidad Light Horse.

TETHERING SINGLE HORSES TEMPORARILY.—A tip now used in the Cavalry. Taking, for example, the near side:—Pass the loop of the reins from front to rear between the girths and the horse's side. Draw the near rein tight until the horse's head comes round towards his shoulder. Pass the near stirrup iron and leather through the loop behind the girth. Draw the loop tight by pulling the off-rein forward and letting it hang loose over the horse's neck. Thus tethered the horse can only move in a small circle.

HEIGHT OF POLO PONIES.—'Cavalier' pleads for raising the height to 15·2 hands. Owing to want of stabling accommodation cavalry officers have to buy and sell their hunters and polo ponies each season. It would be a great economy if they could use the same animal for hunting, polo, and parade.

The whole number breathes the spirit of our modern Cavalry, practicability and common sense, derived no doubt from the happy chance of the South African War bringing them into close association with their brethren from the Colonies.

A. T. MOORE.

CORRESPONDENCE.

THE PREVENTION OF DAMPNESS DUE TO CONDENSATION IN MAGAZINES.

DEAR SIR,

Major Naish, in attributing to me in the last issue of the *R.E. Journal* a belief in a revolving cowl as a sort of universal panacea for dampness in magazines, misses half the point of the application of the well-known principle to which I referred in my letter in the December number.

The principle is based upon the absorbent and drying properties of moving air and its tendency to equalise the temperature of the objects over which it passes. The application is to be found in a system of thorough ventilation.

The two first essentials of thorough ventilation are efficient inlets and out-takes. Revolving cowls will furnish the latter, but the former are of equal importance.

In many magazines, not of the latest type, including several of those of the Halifax batteries as they existed 6 years ago, practically the only inlet is round the edges of a tightly fitting door. Of the two essentials one is insufficiently found.

Major Naish refers to underground Stores, which in summer ran with moisture until holes were broken through their rear walls, when they became at once "bone-dry." It is suggested for consideration whether it was not the improvement in ventilation afforded by these holes that produced this desirable result.

The dryness of the Stores in winter may be accounted for by the fact that their temperature was then higher than that of the external air. Consequently the air that found its way in from the outside, instead of condensing and depositing moisture, expanded, whereby were increased both its capacity for absorption and to a small extent the general circulation and the up-draught through the extracts.

Yours truly,

H. J. WALKER,

The Editor, "R.E. Journal." *Capt., R.E.*

RECENT PUBLICATIONS.

Regulations for the Equipment of the Army. Part I. (1s. Wyman & Sons).

The Russo-Japanese War. Japanese Official Reports, compiled by M. Kinai. Vol. I. ($7\frac{1}{2} \times 5$. The Shimbashido, Tokyo).

The German Official Account of the War in South Africa. Vol. II. Authorized translation by Colonel H. Du Cane, M.V.O., R.A. (9×6. 15s. Murray).

Der Kleine Krieg in Afrika, von F. Ohle. ($4\frac{1}{2}$ mks. Berlin).

Festungskrieg. Eine applikatorische Studie über den modernen Festungskampf. Heft 2. Der Kampf um ein vorgeschobenes Einzelfort. von Major Schwarte. (5 mks. Mittler & Sohn, Berlin).

Wolfe and Montcalm, by the Abbé H. R. Casgrain. (10×6. 21s. Jack).

L'Armée Idéale, par Colonel A. Boucher. (5 fr. 8vo. Lavauzelle, Paris).

Die Fortschritte auf der Gebiete der drahtlosen Telegraphie, von A. Prasch. ($8\frac{1}{2}$ mks. Berlin).

Tables of Imperial, Metric, Indian, and Colonial Weights and Measures, compiled by A. J. Martin, F.S.I. (2s. 6d. Fisher Unwin).

Valves and Valve-Gear Mechanisms, by W. E. Dalby. (10×6. 21s. Arnold).

Theorie und Konstruktion versteifter Hängebrücken, von F. Bohny. (5 mks. Berlin).

Projektierung elektrischer Licht-und Kraftübertraggsanlagen, von P. Stierstorfer. (8 mks. Berlin).

Our Stellar Universe: Steroscopic Star Charts and Spectroscopic Key Maps, by T. E. Heath. (10s. King, Sell & Odling).

Le Bois, par M. J. Beauverie. 2 vols. (20 frs. Gauthier-Villars, Paris).

The Science Year-Book for 1906. First year. Edited by Major B. F. S. Baden-Powell. (5s. King, Sell & Odling).

Urdu Reader for Beginners, by Major F. R. H. Chapman, Instructor in Hindustani at the R.M.C., Sandhurst. ($10 \times 6\frac{1}{2}$. 7s. 6d. Thacker).

Japanese Conversation in Six Months. A new method. By W. A. Adams. (9×6. 4s. Kegan Paul).

A Fantasy of Far Japan, by Baron Surgematsu. (10s. 6d. Constable).

Lectures on Tropical Diseases, by Sir Patrick Manson. (7s. 6d. Constable).

Seamanship for Small Yachts, by F. B. Cooke. ($8\frac{1}{2} \times 5\frac{1}{2}$. 2s. 6d. *Yachtsman* Publishing Company).

SOME IDEAS ON FIELD WORKS

Fig. 1. Redoubt Constructed by 17th (Field) Coy. R.E.

SECTION THROUGH TRENCH

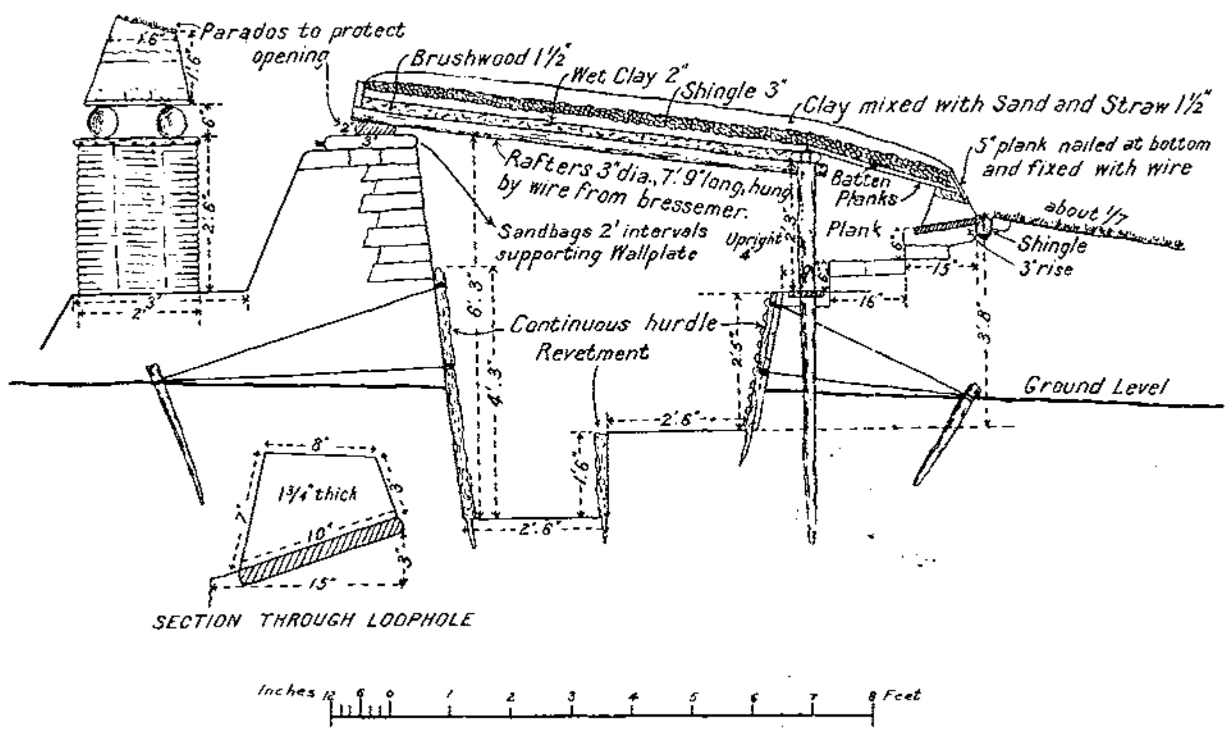
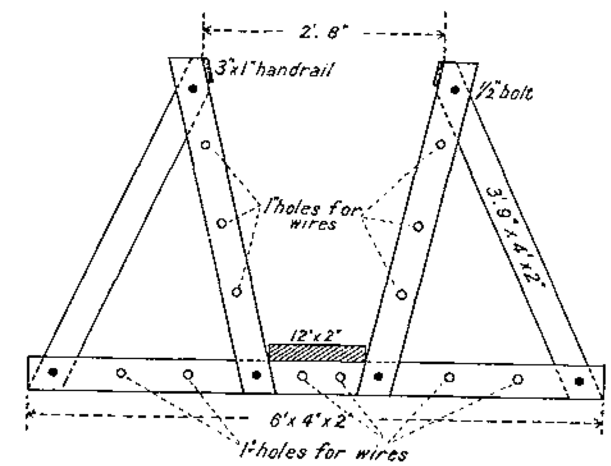


FIG. 2A.

FIG. 2B.

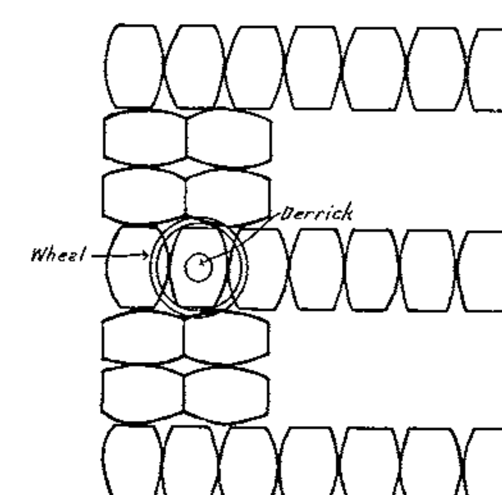
Fig. 3. Light Suspension Bridge at Chatham

DETAIL OF INTERMEDIATE FRAMES



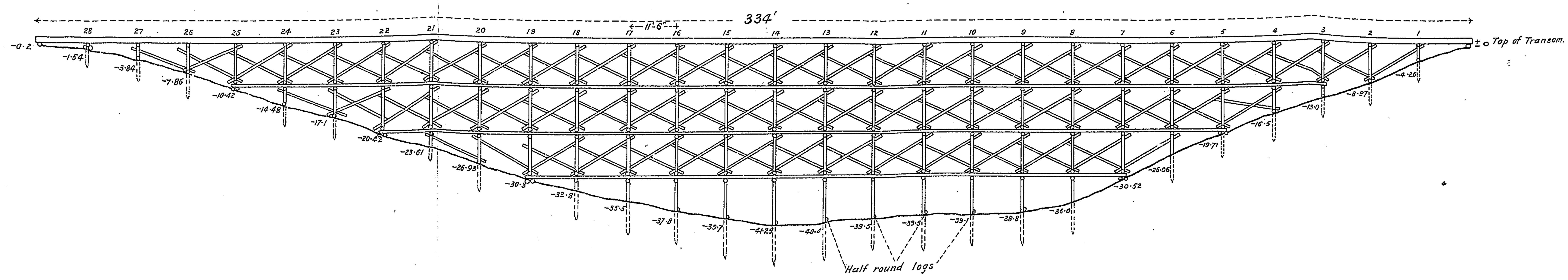
The end frames were of similar shape, but of 6"x 6" stuff.
The holes through which the wires pass were protected with sheet iron.

Fig. 4. Swinging Derrick on Barrel Raft



Some Ideas on Field Works

Fig. 3. Railway Trestle Bridge



Elevation

Fig. 2. Placing Trestles in Water

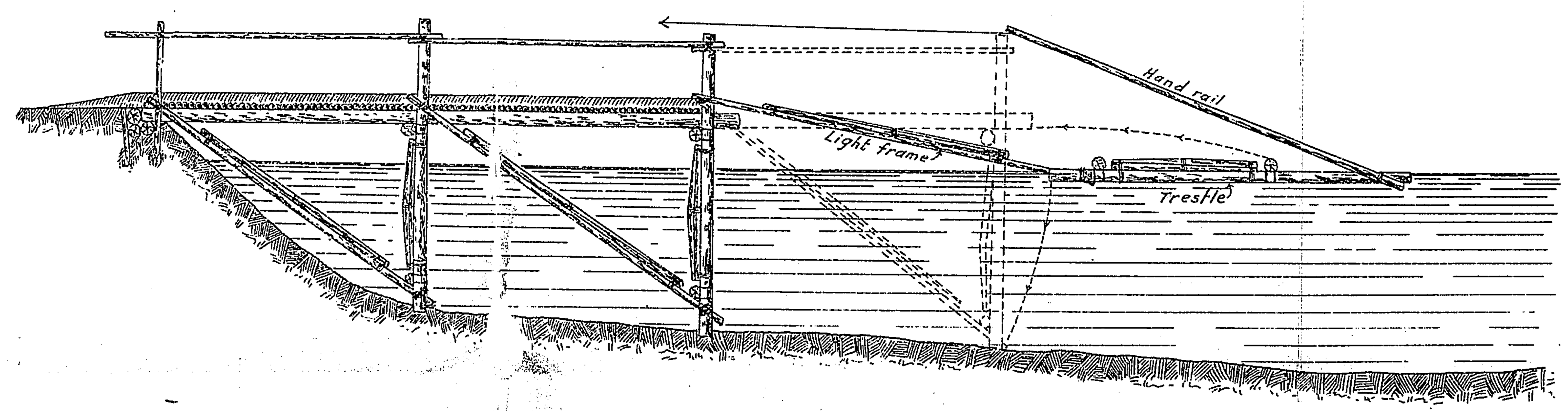
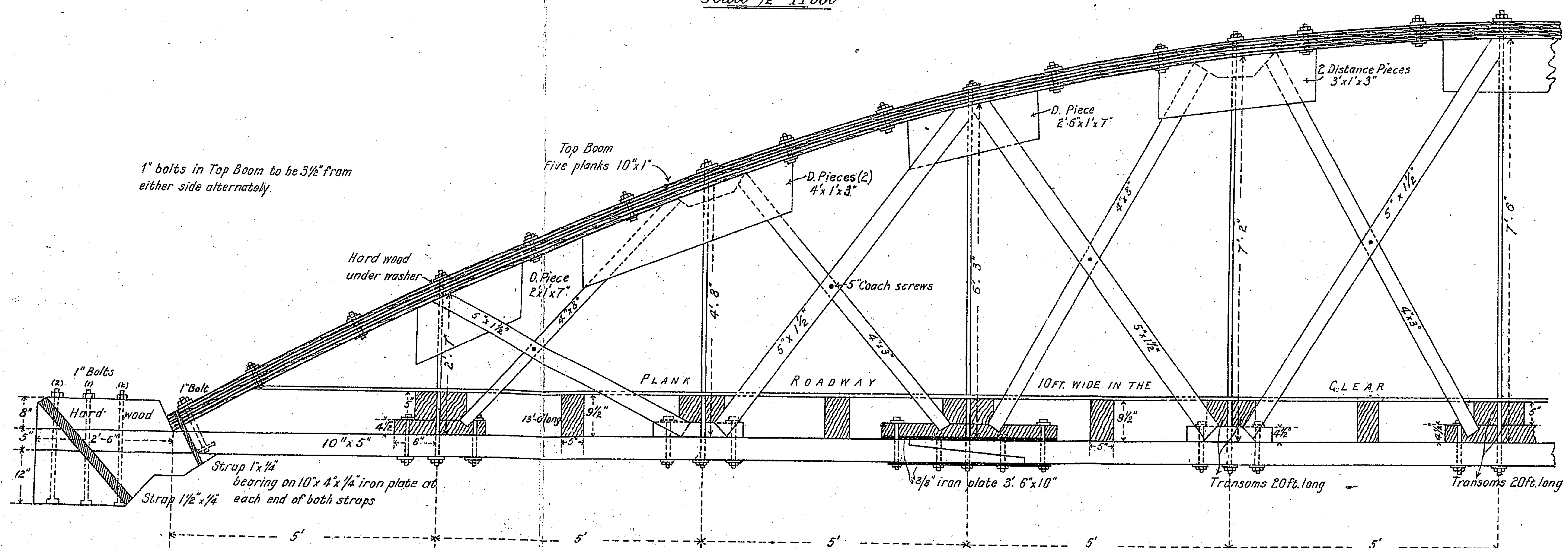


Fig. 1. Bowstring Girder Bridge at Chatham

SPAN 50 FT. LOAD 133 lbs. PER SQR. FT. ROADWAY 10 FT. WIDE.

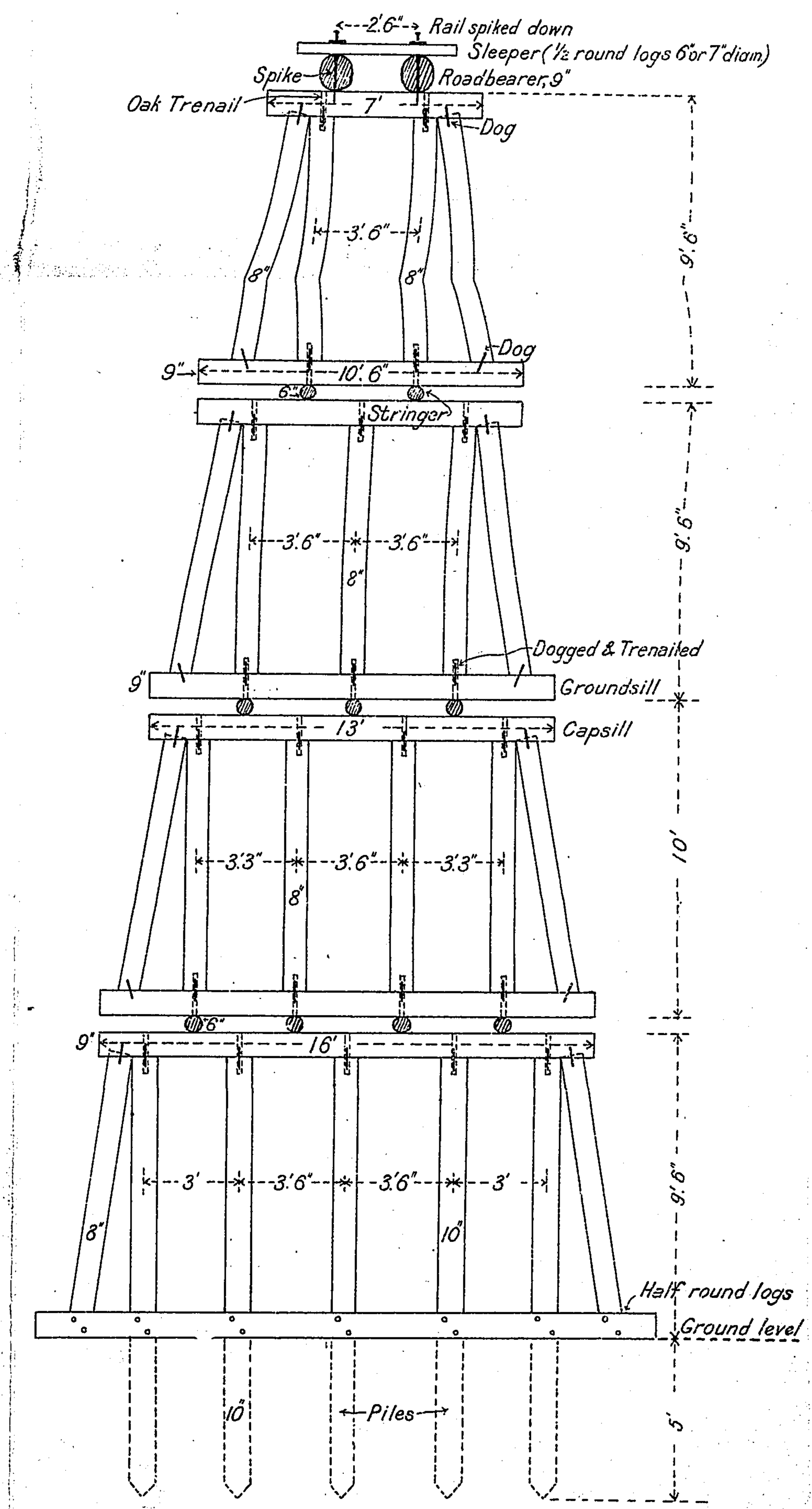
Scale ½" = 1 Foot



NOTE.
Each pair of braces (5"x1½"), except those next to the abutments, to be blocked at two points with 5"x7"x9" pieces, inserted between and nailed. The intersection of the diagonals to be blocked with 1½" pieces, and bolted with ½" bolts, or two 5" coach screws.
The 5"x6" transoms to be bolted together at each end near the tie rod. The 9½"x5" transoms to be secured to tie beams by L angles made of fishplates and fastened with 5" coach screws.
1" bolts to be used throughout, being available to 12" long in store.

Fig. 4. Railway Trestle Bridge

CROSS SECTION OF TRESTLE NEAR CENTRE



NOTE. Diagonal bracing between trestles is omitted for clearness; it consisted of half round 6" or 7" logs.
The scantlings shown were the minimum used.