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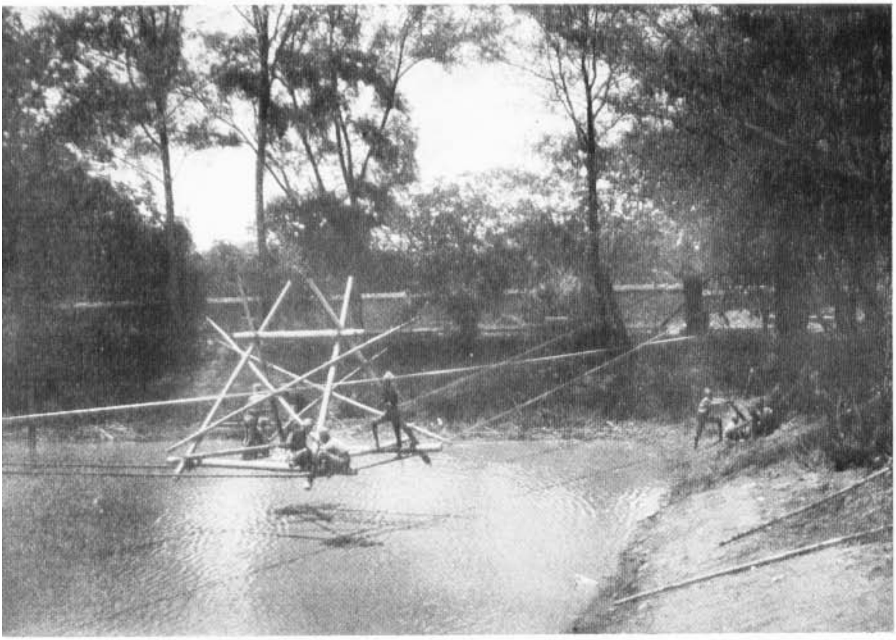
Authors alone are responsible for the statements made and the opinions expressed in their papers.

TRESTLE SUSPENSION BRIDGE, 160 FT. SPAN.

Made with Telegraph Posts by No. 10 Company, 2nd (Q.O.) Sappers & Miners.



1. The centre Trestle in position. – "L.P." posts.

Trestle Suspension Bridge

AN EXPERIMENT IN BRIDGING MATERIAL.

By BT. MAJOR R. L. MCCLINTOCK, D.S.O., R.E.

DURING the last Annual Field Works Course of No. 10 Company, 2nd (Queen's Own) Sappers and Miners, it was desired to construct a Trestle Suspension Bridge on the lines of that shown on Plate 26, Part III., *Instruction in Military Engineering*, but of 160-ft. span.

A sufficiency of suitable spars for the large number of trestle legs required not being available, it was suggested that the light poles of the Telegraph Section ("C" Company) might be utilized for the purpose.

The poles available were of two varieties :—

(1) the "L.P. (Light Pattern) Post," between 16 and 17 ft. long, made in two pieces, and weighing (exclusive of iron socket, which was not required) about 48 lbs., *i.e.* about ⅓rd of its equivalent bulk in timber,

(2) the "F.S. (Field Service) Post," about 13 ft. long, made for mule transport in three pieces, and weighing about 36 lbs.

Both varieties are made of galvanized iron tubes, tapering from butt to tip, and fitting together with fishing-rod joints.

These posts being of very thin metal (especially the "F.S." pattern), it was anticipated that they would either buckle or give way at a joint when used as trestles in a loaded bridge. However, as 44 legs were wanted, and only 12 "Light" posts were available, it was necessary to use 32 of the "F.S." pattern. The former were used for the three centre trestles and the "F.S." for the remaining eight, four on each flank.

The bridge was designed to carry infantry in file or loaded pack bullocks, and the experiment was carried out quite successfully. *Photo* 1 shows the central trestle in position and *Photo* 2 the bridge loaded up after completion.

None of the posts of either sort failed, either by buckling or tearing at the joints or in any other way, though in the case of the slender "F.S." posts one or two flattened slightly where the transoms were lashed to their thin tops.

The possible use in bridging operations of this extremely light and readily portable material may perhaps be thought worthy of note by

R.E. officers. I imagine the "L.P. Post" would stand considerably heavier loads than the above, though I am not so sure about the "F.S. Post."

DETAILS OF CONSTRUCTION.

The details of the bridge are given in case they may be of interest.

Span = 160 feet.

Dip = 1/12.

Camber = 1/30.

Height of roadway at centre above cable = 8′ 9″.

Piers were 7′ 3″ high to caps: 6′ headroom under. (Two creosoted sleepers used for each leg of these).

Number of bays = 16, each of 10 feet.

" 2-legged trestles = 22, each 10 feet high.

" transoms, trestle-supported = 11 }
" " sling-slung = 4 } total 15.

(*Note.*—The telegraph posts were not long enough to admit of the height of roadway at centre above cable being increased beyond 8′ 9″; so low piers, and consequently slung transoms at ends of bridge, became necessary).

Scantlings and Weights of Timbers.

The central trestles were made up as follows:—

4 legs, about 16′ long, "L.P." telegraph poles, each 48 lbs.	192 lbs.
2 transoms, 12′ long × 6″ diam., each 120 lbs...	240 "
2 ledgers, 20′ long × 4″ diam., each 42 lbs. ...	84 "
2 cable ledgers, 15′ long × 8″ diam.,* each 290 lbs.	580 "
4 diagonals, stout bamboos, each 25 lbs... ...	100 "
Total weight ...	1,196 lbs.

Roadway.

Roadbearers: 4 light railway metals (21 lbs. per yard) for each span.

Chesses: mine-casing, about 28 lbs. per foot-run of bridge.

Cables: three 3″ steel cables, stopped together with wire every foot, on each side of the bridge.

Anchors: three 12′ long × 12″ diam. logs, sunk 4 feet, at each end of bridge.

* The 6″ diameter given in the *I.M.E.* is insufficient for cable ledgers, especially in the case of "inner" frames, in which the length of cable-ledger between point of support on cable and lashing to trestle-leg is greater and bending moment consequently more.

Total weight of trestles and roadway = 175 lbs. per foot-run. This, added to the $140 \times 1\frac{1}{2} = 210$ lbs. of infantry in file, gives a total load of 385 lbs. per foot-run of bridge.

Time and Labour: 60 men about 80 hours.

The bridge on completion proved exceptionally stiff as compared with an ordinary suspension bridge of the same span; but this appears to be its sole virtue as a type, as it is tedious to make and most extravagant of material. However, the use of jointed telegraph poles might solve a difficulty when no spars were procurable or when they could only be obtained by carting a long distance.

ORGANIZATION WITH REFERENCE TO FIRE TACTICS.

By 'O.Y.'

In a very interesting article in last February's number of this Journal Capt. J. W. S. Sewell, R.E., pointed out, under the heading of "Tactical Organization," the value of the 3-body system, and the successes the British Army had achieved by the use of this principle in the past; and he discussed the advantages and disadvantages of applying it not only to the organization of the larger units (such as divisions and brigades), but also to that of the smaller units (such as battalions, companies, and squadrons).

In conclusion Capt. Sewell stated his opinion that, if a convenient opportunity occurred, the organization of our army ought to be remodelled on the 3-unit system,—namely that each command should be divided into 3 sub-commands; and that this should affect even the smallest units, the companies and squadrons being divided into 3 sections and troops respectively.

As regards the application of this well-tried principle to the organization of larger units, history tells us that to it, putting strategy and generalship aside, England owes to a great extent her victories in war. However, the late Colonel Henderson, while dwelling on the necessity for all officers of learning military history, shows that it teaches only the principles of Strategy and Grand Tactics, of which the latter deals chiefly with morale and the art of command; and that, when we get into the province of Minor Tactics, we must look more carefully to the way in which modern improvements, inventions, and conditions have modified the principles of Minor Tactics handed down to us from the past.

Colonel Henderson defines Minor Tactics, distinguished from Grand Tactics, as referring to the formation and disposition of the three arms in attack and defence, and says that they concern officers of every rank; they are more or less mechanical, namely the drill movements of the battlefield, dealing principally with material forces, with armament, fire, and formations, their chief end being the proper combination of the three arms. In quoting this, I do not mean that the 3-body system is one of the principles of Grand Tactics, for on the contrary it is the foundation of Minor Tactics; but I wish to show that the conditions of the time play a much larger part in the study of Minor Tactics than in that of any other branch of the science of war.

Therefore there is no doubt that, in making the dispositions of troops for a battle, the first object is to do so in three lines, not only as regards the whole force but also as regards the disposition of the larger units of that force. But in considering the disposition of the smallest units other matters have to be taken into account.

I do not intend to discuss this subject at length, but only to refer to one lesson of the many which bear on the question of the organization of these smaller units.

Now, when considering the principles of the formations of a battalion, the great factor that comes into play is Fire Tactics, and in the organization of a regiment of cavalry this factor is nowadays of scarcely less importance.

We have been told that our success in war is also largely due to the manner in which Englishmen were and are able to handle and shoot their weapons. At Agincourt the English archers decided the fate of the day; in the Peninsular War the skill with which the British soldier handled and fired his Brown-Bess is well-known; lastly the Boer War showed our neglect of the effect produced by the introduction of magazine rifles, smokeless powder, and more powerful ammunition, and brought about the subsequent change in tactical formations.

Lord Roberts, in a speech after a Bisley Meeting, said "High courage, sound health, power of endurance, discipline, organization, and leading are qualities which have enabled British troops to win battles from Crécy to the present day; and though these qualities are as essential now as ever to an army which hopes to achieve great successes, yet, under existing conditions of war, they all become more or less subservient to musketry at the supreme moment of actual conflict with the enemy. However steadily and rapidly troops may have been trained to move, and however boldly and intelligently they may have been taught to take up positions, unless they are able to use their rifles with effect, when they have gained the vantage ground, they will be of little avail for the culminating point of all military training and instruction, viz. the struggle for victory between two forces, each armed with far-reaching death-dealing weapons . . ."

It is clear therefore that Tactical formations must go hand in glove with Fire formations.

One of the chief principles, upon which great stress is laid by the Chief Instructor of the School of Musketry, is the value of working in pairs and the great advantage given to Fire Tactics and their application on the battlefield by the use of the 2-unit system, that is to say of a formation in which each command is divided into two or an even number of sub-commands.

Briefly the advantages this method gives are :—

I. Mutual Support.

II. Observation of Fire.

III. Adaptability to Training.

I. Mutual Support means the help given to one another, more especially in the attack, by individual men, squads, sections, and companies.

To get within decisive ranges without serious loss, the advance of one company must be supported by the fire of that next to it or near it; and as the time to assault is more closely reached the same principle applies to sections, squads, and individual men.

If units have been trained together and taught to rely on one another, mutual support presents no difficulty. If on the other hand they have not been so trained, it is probable that any one unit will work by itself for its own advantage instead of for that of its neighbour and the attainment of the common object.

Training in pairs gives better instruction in bringing enfilade and oblique fire to bear on an enemy's front. It is a well-known fact that men in the firing line under a hot fire rarely think of shooting except directly to their front, although more and larger targets are presented to oblique fire. Men working in pairs would not miss these opportunities, as their mutual support would give the one confidence when he knew that the other was guarding his immediate front. This is equally true of squads, sections, and in occasional cases of companies working together.

II. In the Peninsular Campaign, decisive range was 60 yards, in the Franco-German it was 250—350 yards, and owing to the increasing flatness of the trajectory of the rifle it is now 600 yards; while the new French and German bullets, although not yet issued to the troops, ensures a standing man being hit within a range of 800 yards if aim is taken at his feet. The net result of this is the necessity for accurate judging of distance. No cheap and ready range finder has yet been put on the market, nor would any range finder give the correct elevation of the rifle itself for the range; hence the only reliable way of ensuring good shooting at both short and long ranges is by efficient observation of fire.

Extended formations are now essential, and the initiative and intelligence of the individual soldier must be porportionately greater than in the past. Pairs of men working together can observe the strike of each other's bullets and better shooting is the result. This also, though in a smaller degree, applies to squads and larger units.

At longer ranges it is often necessary to employ a bracket system, termed "combined sights," and here again units divided into an even number of sub-units are more easily handled for its effective use.

III. 'Two is company but three is none' is an old proverb which applies very closely to the good training of the soldier and the efficiency of tactical units.

Of late years the principle of decentralization and the value of company and squadron training have been recognised in our army; and there are few ways which increase the initiative and keenness of subordinate commanders and their men as much as the system of working in pairs and the rivalry produced by the competition between the divisions of a unit.

From the above briefly noted points we see that the principle of pairs goes a long way to overcome the difficulties of modern Fire Tactics and to increase the intelligence and initiative demanded from all ranks by the introduction of scientific improvements. Also that for training purposes and working in the actual fire-fight the 2-unit system is sound when we come down to the organization of the very small units. It can be seen, by working out a diagram of the dispositions of a '9-company' battalion in the attack, that the application of this principle of working in pairs does not interfere with the employment of the 3-body system of organization, which gives us the best proportion for a reserve.

The same principle of working in pairs applies to cavalry, now armed with the rifle, and in a greater degree since the small units, on account of their mobility, are more liable to be employed in seizing and holding detached posts, and the necessity of mutual support, observation of fire, and sound training is even more important than in the case of infantry.

In conclusion we may say that the 3-body principle shows the value of dividing each division into 3 brigades and each brigade into 3 battalions, and possibly also each battalion into 9 companies and each company into 3 sections; but in the actual fire-fight the principle of pairs should be adopted.

THE BRENNAN SYSTEM OF MONO-RAIL TRACTION.

MR. LOUIS BRENNAN, C.B., has kindly furnished us with the following particulars of his system of Mono-rail Traction, which he first made public on the 8th May last, when, in compliance with a request, he exhibited a model vehicle at a soirée of the Royal Society. His long connection with the Corps of Royal Engineers, which arose through the working of the installations of his dirigible torpedo being included in the duties of the Corps and was maintained by his long residence at the Corps headquarters at Chatham, call for the special expression in this Journal of a hope that his new invention will meet with the best possible success.

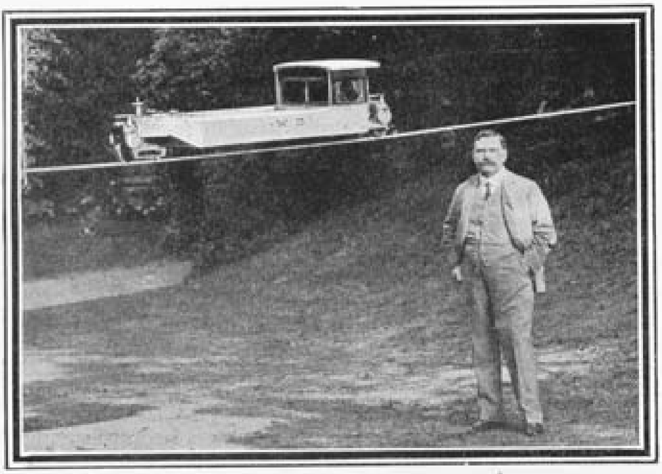
The characteristic feature of this system of transport is that each vehicle, whether it is standing still or moving in either direction at any rate of speed, is capable of maintaining its balance upon an ordinary rail laid upon sleepers on the ground, notwithstanding that its centre of gravity is several feet above the rail and that wind pressure, shifting of load, centrifugal action, or any combination of these forces may tend to upset it.

Automatic stability mechanism of extreme simplicity, carried by the vehicle itself, endows it with this power. The mechanism consists essentially of two fly-wheels, rotated directly by electric motors in opposite directions at a very high velocity, and mounted so that their gyrostatic action and stored-up energy can be utilized. These fly-wheels are mounted on high-class bearings, and are placed in exhausted cases, so that both air and journal friction are reduced to a minimum and consequently the power required to keep them in rapid motion is very small.

The stored-up energy in the fly-wheels, when revolving at full speed, is so great, and the friction so small, that, if the driving current is cut off altogether, they will continue to run at sufficient velocity to impart stability to the vehicle for several hours, while it will take from two to three days before they come to rest.

The stability mechanism occupies but little space, and is conveniently placed in the cab at one end of the vehicle. Its weight is also small.

The road wheels are placed in a single row beneath the centre of the vehicle, instead of in two rows near the sides as usual. They are



Mr. Brennan, with the Model Vehicle passing over the rope bridge.

The Model Vehicle running with a heavy load on one side.

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Brennan System

carried on bogies or compound bogies, which are pivoted to provide not only for horizontal curves on the track but also for vertical ones. By this means the vehicle can run, without danger of derailment, on crooked rails or on rails laid over uneven ground or on curves of even less radius than its own length.

In order that the vehicle may be able to ascend steep inclines the wheels are all power driven, and change gears are provided for use in hilly country. It is also possible to run free wheel down hill at great velocity, so that a good average rate of speed can be attained.

Brakes, capable of being operated by pneumatic or manual power, are provided for all the wheels.

The motive power may be either steam, petrol, oil, gas, or electricity, as considered most suitable for local conditions. In the first instance, however, it has been decided to use a petrol electric generating set, carried by the vehicle itself, for the supply of current to the road wheel motors and to the stability mechanism. Such a vehicle will have the great advantage of being always ready for immediate use, the gyro wheels being kept constantly running while the engine is at rest by the current from a small accumulator.

Everything points to great economy resulting from making the vehicles wider in proportion to their length than on ordinary railways, and it has therefore been decided to make the first experimental wagon 12 feet wide, or one and a half times as wide as usual. For civil work in the Colonies the vehicles will probably be two or three times as wide, if not more.

The rail, which is of ordinary section, only requires to be the same weight as one of the rails of an ordinary line in order to carry the same load on the same number of wheels. The sleepers only require to be one half the length to give the same area of support to the vehicle.

Flying lines of railway can be laid with great rapidity over uneven ground with only a slight expenditure of labour. Specially designed construction vehicles, also on the mono-rail principle, equipped with electric gear for handling the rails, can be kept at the rail-head for the purpose. It is confidently anticipated that, working in this manner, it would be possible to keep up with an army on the march and to supply it with all its requirements.

Bridges are of the simplest possible construction, a single wire hawser stretched across a ravine or river being all that is necessary for temporary work. These hawsers can be built up on the spot from separate wire rope strands, so that the transportation of them becomes an easy matter. Strange to say the lateral swaying of the hawser does not disturb the balance of the vehicle, and the strongest winds will fail to blow it off. In other cases of bridge building a single row of piles with a rail on top suffices, or a single girder carrying the rail may be conveniently used.

The expenditure of fuel is considerably smaller than on ordinary lines, owing to the absence of flange friction on curves and to the vehicles running without oscillation or jolting.

The speed can be from twice to thrice that of ordinary railways, owing to the smoothness of running of the vehicles and to the total absence of lateral oscillation.

Vehicles provided with their own motive power can go anywhere that a single rail is laid. Besides carrying a substantial load themselves they are also capable, on tolerably level country, of supplying current to other vehicles unprovided with power-generating plant, thus running as trains.

It must not be understood from the foregoing that the utility of the invention is confined to vehicles of the dimensions described. One of its most valuable applications will consist of its adaptation to vehicles of more ordinary dimensions, which will serve on feeder lines to the existing railways or on pioneer lines in new countries such as the Colonies. By this means it will be possible to construct lines at the minimum cost, and give settlers a means of getting their produce to market with great speed and economy. For such work the vehicles will be provided with gears which will enable them to climb, heavily loaded, the steepest inclines, thus doing away with the necessity for cuttings and embankments, the cost of which would be quite out of the question in such localities.

The advantages claimed for this system may be summed up as follows :—

Small first cost and cost of maintenance. This is obvious as only one rail is required, and the line need be only half the ordinary width or even less. Moreover, as the vehicles can negotiate steep gradients much work will be saved in the matter of tunnels, cuttings, embankments, and bridges.

Saving of material required for construction of line in the way of rails, bridges, sleepers, etc.

Capability of vehicles taking curves.—The fact that the vehicles lean inwards to the correct angle when taking curves secures them from derailment at the highest speeds.

Large carrying capacity of vehicles.—It is certain that for high-class transcontinental lines the vehicles will be very large compared with those on existing railways. Besides the advantages connected with passenger traffic, great advantages will also arise in the transport of goods and materials, as many commodities can be carried in bulk instead of in small parcels as they are at present.

High Speed.—Very high speeds are expected to be attained on high-class lines laid on this system, owing to the total absence of the lateral oscillation which is caused on ordinary lines by the impossibility of laying two rails exactly level and parallel with each other. From twice to thrice ordinary railway speeds are to be expected.

Less Fuel Consumption, owing to absence of flange friction and of oscillation.

Perfect comfort in travelling, owing to there being no oscillation.

Safety.—Travelling will be much safer owing to the absence of danger of derailment at high speeds.

Mr. Brennan's early days were spent in Australia, when his personal experience of the hardships of travel over the rough tracks of that country led him to consider what might be achieved in the way of ideal travelling, if man could discover how to rightly apply the materials and sources of nature to the purpose. Leaving aside the larger question of aerial flight, and confining himself to travel on the surface of the earth, it seemed to him that the simplest and most ideal roadway would be a single rail laid on the ground. But there appeared to be practical limitations to the use of such a roadway, since the centre of gravity of a vehicle travelling on it would have to be above the points of support and would have to balance itself against such upsetting forces as a shifting of the internal load, varying wind pressures, and centrifugal force when passing over curves.

Under the stress of perfecting his dirigible torpedo, there was little time for the inventor to follow up his idea of railway transport. But, whenever opportunity offered, he returned to the subject, and carried out experiments in balancing unstable bodies. Moving internal weights, etc., did not yield any results, and the first system that seemed to offer a possible practical solution was to react on the inertia of a fly-wheel of which the axis was parallel to the rail. It is evident that a torque to oppose any upsetting force can be obtained by this means; but, on experiment, the difficulties in the way of arriving at a complete practical solution on these lines proved to be so great that recourse was had to other methods.

Mr. Brennan next turned his attention to studying the gyroscope, as it seemed possible to him that a solution of the problem might be found hidden in this instrument which behaves in apparently so paradoxical a manner.

The principle on which it works can be seen and studied in a spinning top, and anyone who studies such a top will find how different all its movements are to those with which we are familiar. This principle is called the gyrostatic action of rotating bodies, and is unquestionably the most difficult to explain, as it is to understand, of all the movements known in mechanics.

It is not proposed to enter into a detailed description here, but reference to *Fig.* 1 will give a rough idea. Suppose A to be a fly-wheel with its axis in pivots in a circular frame B.

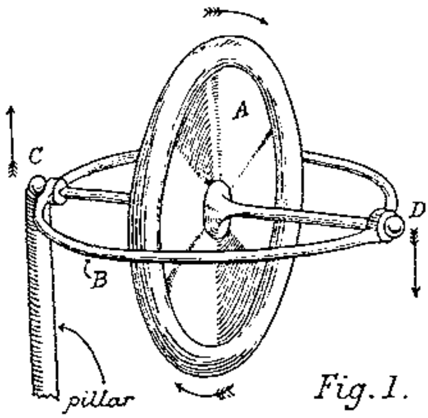

Fig. 1.

If the wheel is made to spin rapidly in the direction shown by the arrows, and the end C of the axis is placed in a hollow or cup at the top of a pillar so that the wheel is spinning in a vertical plane, the axis of the gyroscope will not, as might be expected, rotate in a vertical plane owing to gravity pulling down the end D.

But the axis will rotate in a horizontal plane. The end D will come forward (*i.e.* towards the reader), because the wheel always tries to place itself so that its spin will be in the same direction and the same plane as the couple tending to rotate the axis. This movement is called the 'precession' of the gyroscope. (The direction of the precession can be reversed by spinning the wheel the opposite way, or by supporting the other end of the axis).

If this natural rotation or precession is assisted by any external force (*e.g.* the hand), a torque will be produced which will actually raise the end D of the axis of the gyroscope. This assisting force will thus be doing work against gravity, although it is applied in a horizontal plane; if it is continued long enough the gyroscope will rise until its axis becomes vertical, thus placing itself in a position of equilibrium.

The principle on which stability can be maintained can therefore be summarized thus:—Accelerate the precession of the gyroscopic wheel and a torque is obtained in a plane *at right angles* to that in which the wheel is revolving.

Fig. 2 is a rough diagrammatic sketch to illustrate the principle of the stability mechanism in the Mono-Rail vehicle; but the diagram is incomplete in some important details.

As both vertical and horizontal curves have to be dealt with, there are two gyroscopes or fly-wheels, rotating in opposite directions, the axes being normally parallel to the axles of the road wheels; the two fly-wheels are so geared as to produce a combined effect, which prevents curves on the line interfering with the stability-giving power of the mechanism. The actual position of this mechanism is immaterial; it may be in the cab in the front end of the vehicle (as in the model), or under the centre of the floor, or at the back end.

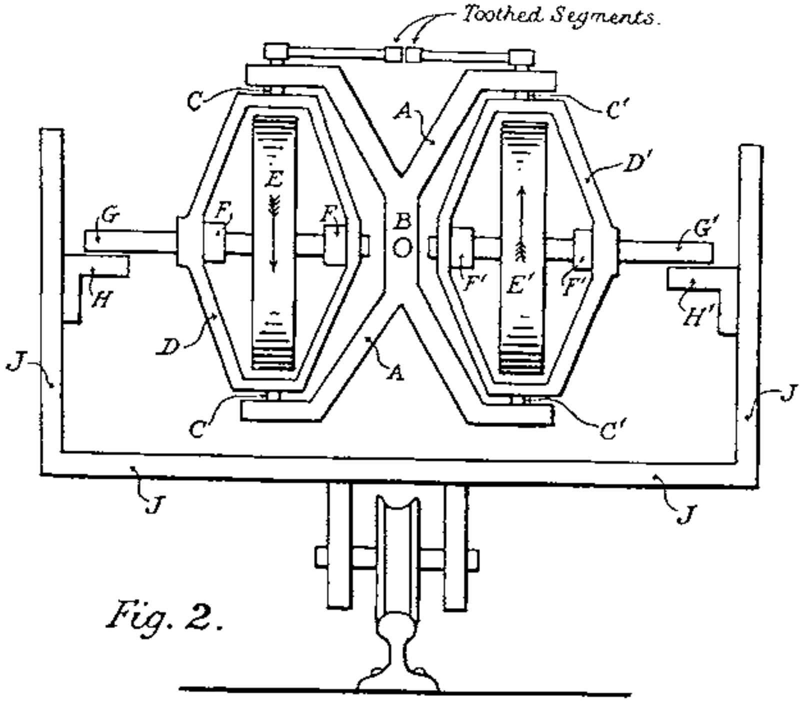

Fig. 2.

In the model the main frame (A) of the stability mechanism is carried on trunnions (B) which are longitudinal to the vehicle, the trunnion bearings being fixed to cross-way partitions or bulkheads. On this main frame are pivoted, on vertical trunnions (C, C, C′, C′), the vacuum cases (D, D′) which enclose the fly-wheels (E, E′) and also carry their bearings (F, F, F′, F′). The ends (G, G′) of the axes project from the vacuum cases. Fixed to the body (J, J) of the vehicle are segmental brackets (H, H′).

The action that occurs when an overturning force is brought to bear on the vehicle is as follows:—The main frame of the stability mechanism, being trunnioned fore and aft, is prevented by the gyroscopic action of the fly-wheels from tilting with the vehicle, and the projecting end of the axis at the rising side of the vehicle comes into contact with its corresponding bracket. Two effects are then produced. Firstly, the bracket presses against the axis of the fly-wheel (E) and thus tries to disturb the planes of rotation of the fly-wheels. This causes the fly-wheels to precess, *i.e.* to rotate on the trunnions (C, C, and C′, C′), and owing to this precession they resist any tendency of the vehicle to yield to the upsetting force. Secondly the rotating axis (G), pressing against the bracket (H), is caused by friction to roll along the bracket and to accelerate the natural precession of the fly-wheel. This acceleration of precession causes the axis of the fly-wheel to press on the bracket (H) with a greater force than that tending to overturn the vehicle, and thus brings the vehicle back into a position of equilibrium.

The actual arrangement used by the inventor for automatically controlling the precessional movement of the fly-wheels is of a more complicated character; the exact details have not yet been divulged. The mechanism is fully covered by numerous patents in all the principal countries.

The model exhibited is 6 ft. long, and contains two 5-inch diameter fly-wheels, running at about 7,000 revolutions a minute. The motive power for all purposes is obtained from a small secondary battery, the power required to drive the fly-wheels being only a small proportion of that required to drive the road wheels of the vehicle. In the full-sized experimental vehicle, now under construction, which is to be about 40 feet long and 12 feet wide, and expected to carry 20 tons, the fly-wheels will be 3 ft. 6 in. in diameter. In the full-sized vehicle 5°/₀ of the gross load is considered an ample allowance for the weight of the fly-wheels. But it is anticipated that in standard ones this amount will be reduced to 2°/₀—3°/₀; and that all of this weight will be saved by reduction of weight in other parts of the vehicle, so that the proportion of tare to weight carried will be less than in any existing form of railway wagon.

The model, fully loaded, successfully negotiates gradients of 1 in 5, turns almost within its own length, and has carried a 10-stone man over a wire rope stretched across a span of 50 feet. It thus demonstrates clearly the practicability of the system on a small scale, and gives every evidence that on a large scale the results will be even better and that it has before it a very great future.

DESIGN OF STABLES AND ACCESSORIES IN SOUTH AFRICA.

By Lieut. B. H. Wilbraham, R.E.

Climate. The following notes refer only to stations situated on the high veld. All garrison towns in South Africa are on the high veld, with the exception of Cape Town where the barracks were constructed many years ago.

The first point to consider is the climate. As a rule in South Africa it does not rain. When it is wet, the rain comes down in torrents, and clears up again quickly. Ordinary English drizzle and fog for days and often weeks on end are practically unknown. For several months in the year there is no rain at all, but frequent high winds, causing dust storms. In summer the sun is very strong, though it is not nearly so overpowering as in India. Also all the year round there is a very great difference in temperature between day and night—sometimes a range of 50° or 60° F. in twenty-four hours.

Horses are very liable to a chill if taken out on a cold night or morning from a warm stable. Hence stables should not be too warm.

Requirements. The requirements to meet the altered climatic conditions in South Africa are :—

(1). Protection from sun.
(2). " " rain.
(3). " " wind and dust storms.
(4). Temperature in stable to approximate to that of air outside.

Local Usage. Before going further it is worth considering what the inhabitants of the country do. A common type of stable used by the farmer consists of a stone kraal about 20 yards square with an open shed along the windward side. One or both ends of this shed are roughly enclosed to form loose boxes (*Fig.* 1).

Sometimes the kraal is only about 24 feet wide. In this case the shed occupies about half (*Fig.* 2). One end of the shed is enclosed as above, and the other end forms a somewhat larger box.

If the sheds are used as loose boxes the entrances are closed by slip rails. Frequently they are not closed at all, so that the horses can wander at will over the whole kraal.

In either case the shed is of the roughest description. There is no attempt at drainage, and the dung and stable litter are left untouched. Perhaps once a year, if the farmer is energetic, the stable is cleaned out. Owing to the sun and free circulation of air these stables are

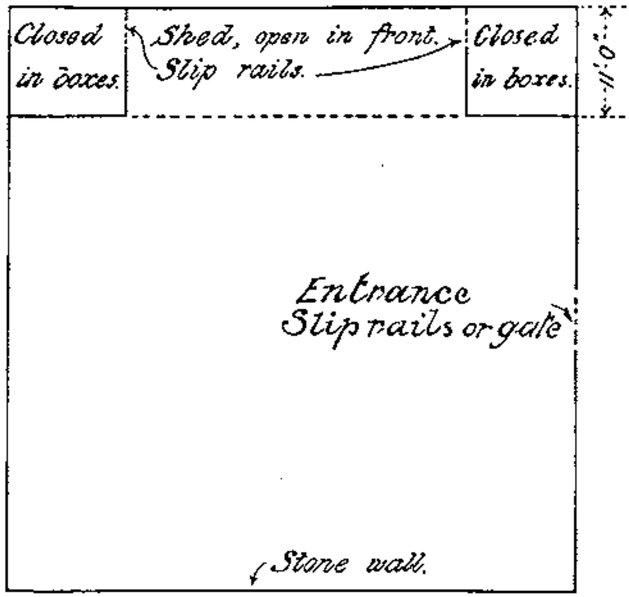

FIG. 1.

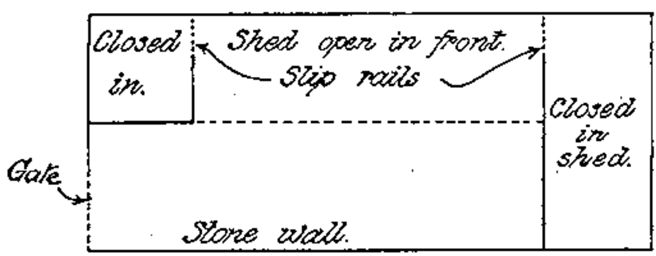

FIG. 2.

not so offensive as might be expected. The horses seem to thrive in this type of stable, and do not suffer from "thrush" or other diseases of the foot which the state of the floor might be expected to produce.

STABLES BUILT BY R.E.

As the cantonments were built out of wood framing and corrugated iron, these being considered the most economical materials, the stables were made similar. They were not lined with match boarding or rough boarding.

Had the barracks been built in masonry or brickwork, the stables and accessories would most likely have followed suit. Whether this would have been to the advantage of the horses is doubtful, as the stables would have been too warm at night. In South Africa troops may be required at very short notice for active service in the country. By being kept in open stables horses become much hardier and are always fit to be taken out 'on trek' at once.

The stables built by the Royal Engineers at Bloemfontein, O.R.C., may be divided into four classes :—

(*a*). Small Stables.
(*b*). Troop Stables.
(*c*). Mule Kraals.
(*d*). Remount Depôt Stables.

(*a*). SMALL STABLES.

Separate stables were provided for the following :—

(1). Groups of four or five married officers' bungalows. The stables were placed as centrally as possible.
(2). Individual bungalows.
(3). Battalion of Infantry.
(4). Field Company and Supernumerary Staff, R.E.

Those prepared for (1), (3), and (4) were of the same design, and those for (2) considerably smaller. Looked at from home standards and compared with the *Barrack Synopsis* there seems to have been a very lavish provision of stabling. It should, however, be borne in mind that in South Africa it is almost essential for every officer to have at least one horse, and for a married officer to have a horse and trap or Cape cart and pair of mules.

Another consideration was that the rent charged by the War Department for the bungalows was very high, so that efforts were made by the R.E. in the country to give as much accommodation as possible.

The type of stable provided for (1), (3), and (4) is shown in *Fig.* 3. The whole of the front was open. There were 12 stalls, 10′ long and 6′ 6″ wide with wooden partitions. In front of the stalls was a 4′ 6″ passage.

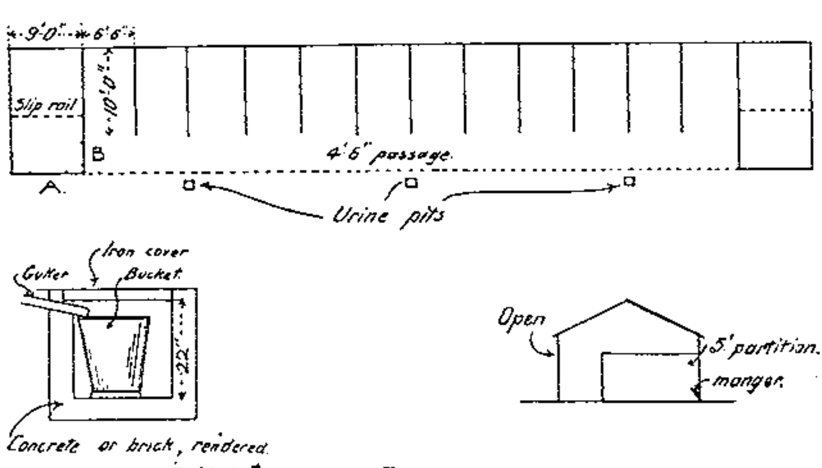

FIG. 3.

In the R.E. stables the ends were used as loose boxes with doors at B, hung in two parts. Across the middle were slip rails to form two loose boxes. In Infantry and bungalow stables doors were placed at A, so that the end part could be used either as a coach house or a forage store.

The floors were of concrete, currented to carry off the urine. There being no water-borne sewage system, three urine pits (*Fig.* 3) were provided. Surface drains were constructed quite independent of the urine gutters, so that there was no fear of the urine pits being flooded out after a storm.

These stables were placed more or less north and south, so that the back was towards the west or prevailing wind.

The type provided for (2) was of course much smaller. The most satisfactory pattern erected is shown in *Fig.* 4. These stables were usually built in pairs.

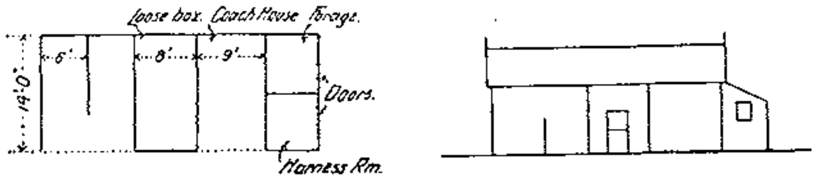

FIG. 4.

Earth floors were tried, but were not satisfactory. Sometimes a concrete floor was provided, but this seems an unnecessary expense. Another form was suitable if well done. Roughly squared cobbles were carefully laid, then grouted in with cement and floated over to a smooth surface. This kind of floor was not currented as usual in stables, but laid with a very gentle slope from the horses' heads outwards.

In addition to the stable in (1) another building, containing 4 separate forage stores, 4 harness rooms, and a common room for general use, was provided. Thus each of four bungalows had its own separate forage and harness rooms. The grooms usually slept in the latter room. The two buildings were placed parallel and about 25 yards apart, thus enclosing a yard, the sides of which were fenced in.

The stables in (2) were usually inside the general bungalow enclosure, thus doing away with the necessity of enclosing a yard.

The R.E. stables and yard were arranged as shown in *Fig.* 5. This was very convenient while mules were used for draught purposes. When draught horses were issued and the mules withdrawn the necessary accommodation was provided in the cavalry lines, where a stable was shared with its proper occupants. This course cannot be recommended. If a 40-horse stable had been erected in place of the existing one the arrangement would leave but small scope for improvement.

In these open stables it is very necessary to have the whole enclosed in a yard, so that if a horse does break loose he cannot stray.

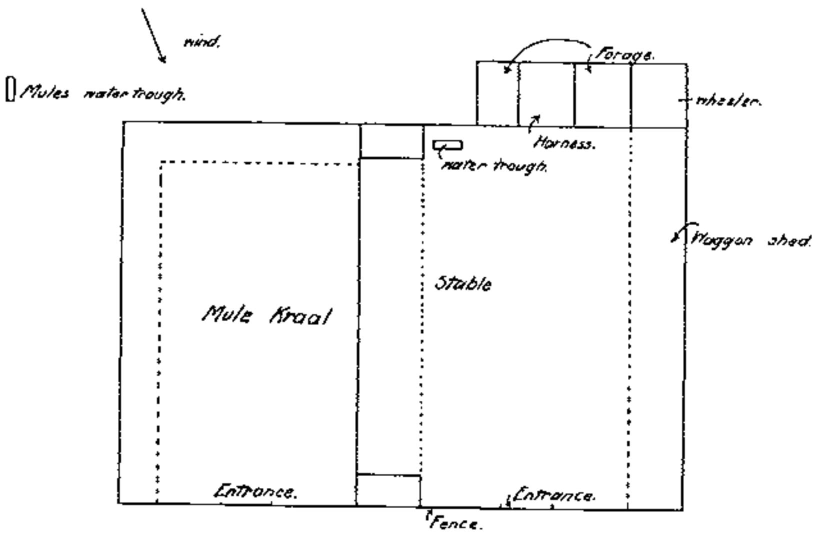

FIG. 5.

(b). TROOP STABLES.

Troop stables were built closed in, but more lofty than the above and with numerous ventilators and hinged flaps. One type for 76 horses had four doors, one at each end and one in the centre of each side, with a passage down the middle (*Fig.* 6).

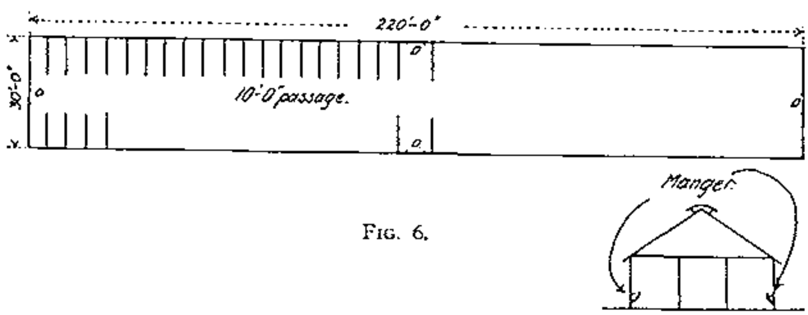

FIG. 6.

The stalls were built according to *Synopsis*, with swinging bales between. Six or seven per stable had wooden partitions instead of bales to accommodate kicking horses.

In front of each stall there was a flap hinged at the top and kept open by a stay similar to a large casement stay. In warm weather these hinged flaps were always kept open. Thus there was an almost continuous open space about 2 feet wide all round. As the bottom of the flap was level with the top of the manger, the hay was often blown out or strewn by the horses. To remedy this a couple of bars were put across the open space. In addition there were windows, hinged at the bottom, above each stall, about 7 ft. from the ground, opened by a fan-light opener. Ridge vetilation was provided along the whole length of the building.

The floors were of concrete and currented to urine pits round the building.

A great objection to this type of stable is the small number of doors in case of fire. In this class of construction fire is a much more important factor than in other types. When once a wood and iron building has caught fire it is hopeless to think of saving it. Of course more doors might be put in, but at the expense of the stalls.

In another type erected the horses' heads were turned towards the centre and there were three passages (*Fig.* 7). Putting out feeds from the central passage was thus very much simplified. There could be any number of doors without sacrificing any of the stalls; about six a side were usually put in.

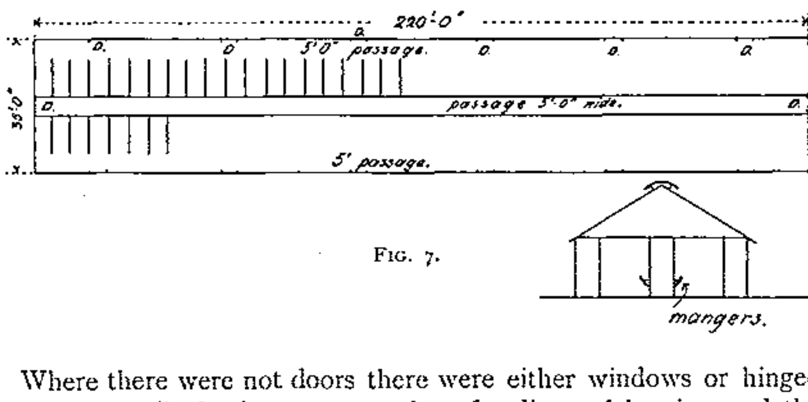

FIG. 7.

Where there were not doors there were either windows or hinged flaps. Accordingly there was no place for diagonal bracing, and the building must have been very weak longitudinally. None ever showed signs of giving way, so perhaps they were really strong enough.

The units who had this type of stable liked it very much. The cost was, however, about 20% per horse more than in the other pattern.

Both these stables were too large, as they were for two troops. It is much better if possible to make stables for one troop only, *i.e.* for about 40 horses. As the establishment is always altering it is well to provide a few stalls in excess of the existing establishment. The best type would be a 40-stall stable with four doors as in *Fig.* 6. Then an officer's stable could be provided in addition; this was not done in South Africa.

In all these buildings great care had to be taken not to leave any sharp sides or ends of galvanized iron sticking up, especially about the mangers. Another point to look to is that all woodwork must be protected from being gnawed by the horses. One method is to cover with galvanized iron all wood that is liable to be gnawed. Another is to creosote the wood frequently; sometimes veterinary officers insisted on this from a sanitary point of view.

Iron bales as used at home were not available, so that wooden ones had to be improvised. 9″ × 2″ deals, covered with galvanized iron sheeting, proved satisfactory.

WAGON SHEDS AND OTHER ACCESSORIES.

Brick dung pits were put up close to each of the above stables. There being no other means of disposal of the stable litter it was burnt in the pits. Hence these pits were always kept at some distance from forage or litter sheds.

Litter sheds, open in front and with concrete floor, were placed between stables.

A good form of water trough was made out of masonry and concrete (*Fig.* 8). This was slightly cheaper than the cast-iron variety in use at home, and has the additional advantage of being practically unbreakable. When mules crowd round a trough they often charge into it or lean against it, and generally one or two try to get into it, especially if very low.

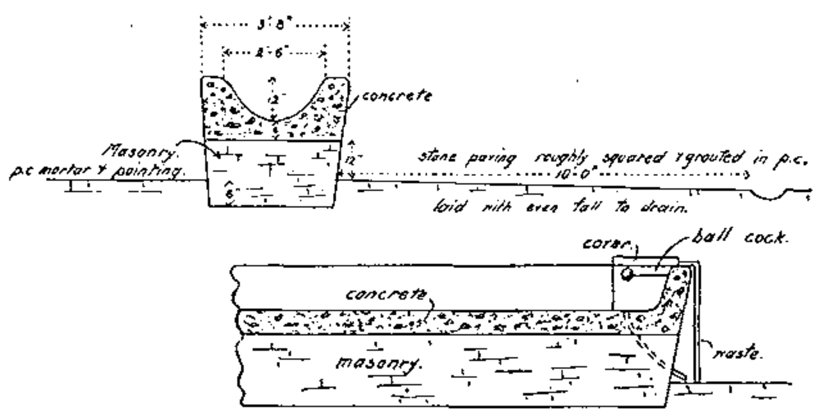

FIG. 8.

One or two wagon sheds of local design were put up, but were not satisfactory. They should be exactly as laid down in the *Synopsis*, but adapted to corrugated iron construction. To protect the back wall from vehicles being run in carelessly, good stone or concrete kerbs should be provided. The kerb should be as near the back wall as the vehicle permits, so as not to waste any room. Of course the kerb for a gun is much further forward than that for a wagon.

There is no particular point about forage sheds. They should not be placed to windward, but in some convenient place where they will do least damage if they catch fire.

In the cavalry lines one harness room per squadron was allowed. This was invariably used as a squadron office, which shows that its provision is not essential. As the authorities at headquarters do not sanction the construction of squadron offices it seems desirable to continue to provide harness rooms, or suchlike recognized buildings, which can be used by the regiment as offices. Perhaps this is a wrong way to look at the subject—all the same it adds materially to the convenience of the troops occupying the lines.

Forges should have plenty of fresh air. It is very trying to a farrier to work all day in summer in a stuffy forge. A type of forge which proved very satisfactory is shown in *Fig.* 9. Both sides of the building were open. The floor was made of ant heap and sand, laid like cement. It was floated off with ant heap and breeze and the surface consisted of cinders.

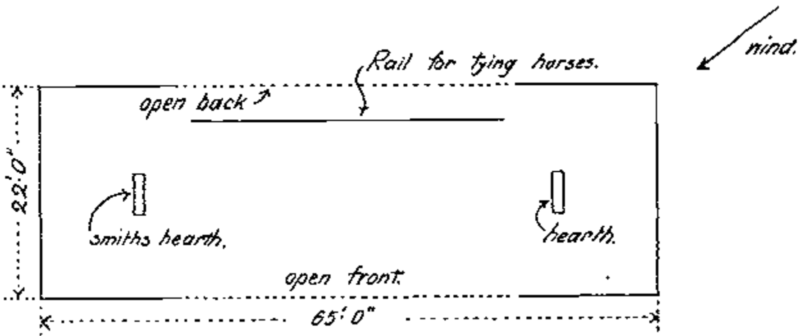

FIG. 9.

Great care should be observed in laying concrete floors for stables. They should be covered with sawdust and kept wet to avoid too rapid setting. If possible they should not be used for six months. If used within six weeks, they will nearly always break up in a very short time.

The stables in question were all sited as much as possible to leeward of the lines, so that any stable litter blown about would not come through the lines. They were also kept as far as possible from kitchens or dining rooms and officers' mess and quarters, the object being to prevent contamination of food by flies which swarm round stables in hot weather.

(*c*). MULE KRAALS.

Mule kraals were of much simpler type than the stables for horses. They consisted of a stone kraal with dry rubble walls, 5 or 6 ft. high (*Fig.* 10). An open shed—about 2 or 3 ft. run per mule—was put up round the kraal, the roof sloping outwards so as to carry the water away from the enclosure. Either the wall was carried up to the roof

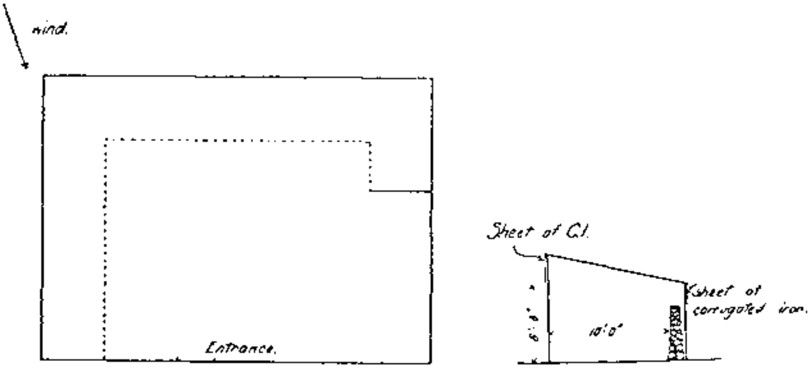

FIG. 10.

or else corrugated iron was carried down the side of the shed to give protection as far as possible. In either case a gap at least 10" wide was necessary just under the roof; this allowed the wind to pass through and reduced the liability of the whole shed to be blown over.

A very important point is to protect all woodwork from being eaten by the mules. Many mules prefer eating wood which has been tarred or creosoted. Every part of woodwork which is within reach of the mules should be covered with galvanized iron. A good method for protecting the uprights is to wrap hoop iron round them from 1' 6" from the ground up to 7 ft. Barbed wire should not be used as it forms an irresistible attraction to a mule to scratch himself on; and this action will in course of time bring the whole shed down.

(*d*). REMOUNT DEPOTS.

The stabling required for remount depots comes under quite a different category to that hitherto dealt with. The first consideration is economy. The garrison in South Africa was continually being changed, and so the Remount Depôt also suffered many changes, both in establishment and site. During 2½ years some of the sheds were taken down and re-erected on four different sites. This was an additional reason for economy in design.

For economy in working the staff must be as small as possible. The horses must be exercised and kept fit for use at once. There must be means of dividing up the horses into different classes, and also of isolating them should any epidemic break out at the depot.

Hence the essentials are :—

(1). Economy of construction.
(2). „ maintenance, with means of easily exercising horses and separating them.
(3). Adaptability of buildings for re-erection.
(4). Protection from sun, rain, and wind.
(5). Water laid on to troughs, and plenty of the latter.

Remount Stables erected were based on a scheme devised by Capt. (now Major) Eassie, A.V.D., which he worked with great success during the war.

A, B, C, and D (*Fig.* 11) are open sheds with their backs to the prevailing wind. Each stable has its kraal in front, fenced in. Water is laid on to the troughs W in each kraal. There are slip rails at *g*, which open on to a road along the front of the line of kraals. E is an exercising ring, about 600 yds. in circuit. Each of these kraals will accommodate about 100 horses.

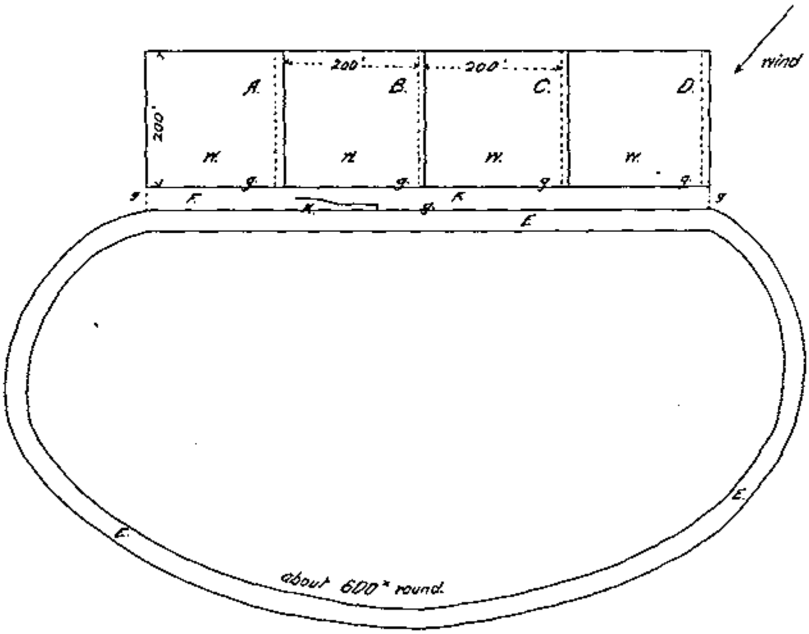

FIG. 11.

As a rule the horses were not tied up, but free to go about the kraal as they liked and to drink when so inclined. To exercise them the slip rails were removed, and they were driven into the exercising ring and then round and round that until they were sufficiently exercised. They were then driven back to their kraal and a fresh lot exercised. Thus all the 400 horses could be exercised by half-a-dozen 'boys' in the course of a morning.

A new horse is sometimes rather free with his heels in a kraal like this, but steadies down very quickly. Altogether there were remarkably few injuries from kicks. Capt. Eassie claimed that this was by far the best way to make horses quiet to handle.

If it was necessary to catch up a wild horse which would not let himself be caught in the kraal, he was driven into the crush K (*Figs.* 11 and 13). Often a dozen other horses had to be driven through it to include the one required. At the end of the crush is a long narrow passage, in which the horse could be quickly caught up by the 'boys' standing beside it. This part of the crush was also very useful to mallein horses in.

The stables were of section as shown in *Fig. 12.* Rings were bolted to the mangers, so that horses could be tied up if required. The floors were made of a gravelly earth, and sloped slightly from the mangers. They needed a certain amount of supervision and maintenance in the cartage of more sand or earth from time to time to fill in holes.

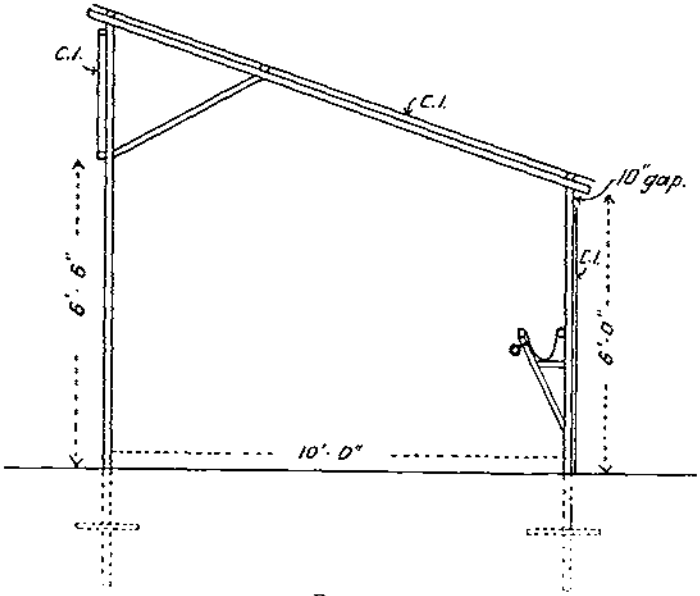

FIG. 12.

To prevent the posts being torn out of the ground by the wind, a couple of pieces of old scantling, about 1 ft. 6 in. long, were nailed across the upright under ground. Also hoop iron was put on over the rafter and purlin, binding them on to the uprights. As in the mule kraals a 10" gap was left for the wind to escape by. These were very necessary precautions to withstand the wind pressure when it got under the roof.

The crush was 4 ft. 6 in. high, and made of 9" × 3" or 6" × 3" timbers bolted together and with the bolts flush with the timber. All angles of the scantlings were slightly rounded or chamfered to prevent splinters or chance of injury to the horses. Along the outside was a step about 1 ft. high for the boys to stand on when catching a horse, and at the end was a gate for diverting the horses into E or F (*Fig.* 13). The two projecting walls are to prevent a sudden backward rush of wild or timid horses when they see the narrow passage in front.

Sick lines for the depôts had sheds similar to those above. They

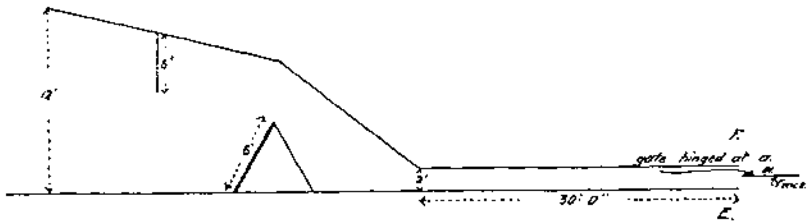

FIG. 13.

were made in 6-ft. bays, so that one bay would make one stall or two could be converted into one loose box. A certain number of loose boxes were provided; they were boarded in all round and had two doors hung in two. The sick lines were divided up into separate groups of stalls or boxes for eight or ten horses, each group with its wire kraal and troughs.

Close to the sick lines were two isolation or segregation paddocks where suspicious cases could be kept under observation. They each had their troughs and water laid on.

The fencing used throughout was "Lamb's Fencing" on wooden posts. It is also called "wire wove fencing" and is an American supply. It is practically a glorified rabbit wire.

In addition to the above stabling the whole farm was divided by barbed wire fences into paddocks for grazing purposes. In each paddock water troughs were fixed and shelters similar to the sheds but without the mangers. (These shelters were limited owing to lack of funds). Water was laid on to all the troughs, which were fitted with a ball-cock in a box at one end. About $5\frac{1}{2}$ miles of piping—chiefly 2" and $1\frac{1}{2}$"—were required to supply water to all these troughs.

The cost of the sheds as above described is $\frac{1}{8}$th to $\frac{1}{10}$th that of the stables in (*a*) and (*b*) per horse. This principle of Major Eassie's seems to be a very sound one, and well suited to South Africa.

In this article the subject of permanent Sick Horse Lines has not been treated. When the writer left South Africa the design had not been decided upon, nor did there seem to be much prospect of any funds being provided. A design after the type of the Remount Depôt —only not so rough—was being discussed.

THE VITAL POINT OF AN ARMED FORCE.*

By MAJOR C. ROSS, D.S.O., *p.s.c.*, NORFOLK REGIMENT.

COLONEL HENDERSON, in *The Science of War*, tells us that war is no exact science, that it has no fixed code of rules, that there is but one good working principle, viz., the concentration of superior force, physical and moral, at the decisive point.

Most of us have, by this time, learnt this principle off by heart; those of us whose duty it is to teach never lose an opportunity of impressing it on our pupils. Concentrate, concentrate, we urge, concentrate at the decisive point. But if we are asked where the decisive point is to be found, many of us become slightly incoherent.

The truth is, that it is very often a matter of exceeding difficulty to say which is the decisive point; it is sometimes as difficult to discover it as it is to find the key of a position. Yet that the principle is true is beyond doubt; for all history tells us that the application of overpowering force is the one true principle of success in war, that it holds true of the national strategy which directs nations, of the strategy which directs armed bodies in the theatre of hostilities, and of the tactics of the battlefield. It is important to go into this question; for the knowledge of any principle is obviously useless unless we also know how to apply it.

A decisive point has been defined for us as one the possession of which gives a tremendous advantage to that force which is able to seize and hold it.

We can easily understand that, in a war between an island power and any other, the sea between the two nations constitutes a decisive point, the command of which will enable its possessor to strike at its adversary—to strike a deathblow if overpowering force is available. We can also easily recognise that, if an island power holds continental territories which are threatened by a continental power, the sea is no longer necessarily a decisive point. Thus, as regards Russia and Japan, the sea, at the outset of the late war, was the decisive point; and the command of it enabled the Japanese to strike at Port Arthur and at the Russian armies in Manchuria. The Japanese, having firmly established a temporary control of the sea, the decisive point

* Lecture delivered at the School of Military Engineering, Chatham, on 14th March, 1907.

was transferred to land, to the point of contact between the hostile armies. But when the Russians prepared a fleet in home waters to again contest the command of the sea, it appeared probable that the sea would again become the decisive point. The Japanese therefore determined to obtain possession, at all costs, of Port Arthur—a possible refuge and base of operations for the new Russian fleet. It was Port Arthur which was now the decisive point. It was, in fact, far more of a decisive point than its mere value as a harbour of refuge and base of operations—in both of which capacities it left much to be desired—would warrant; and, in attacking it, the Japanese would seem to have struck at the moral, or national, spirit of the Russian nation. Its capture, we notice, was instantly followed by serious disturbances in Russia. Now that the Japanese hold Korea and Manchuria, the sea is no longer the decisive point; it has finally, it appears, been transferred to the land, for it is very unlikely that the Japanese will ever again permit the Russians to establish a naval force in the Far East.

And so, similarly, in the case of two continental powers, such as France and Germany, the decisive point lies, not on the sea, but on the land frontiers, in the great fortresses which block the communications between the two countries, or, possibly, in neutral territories by means of which those fortresses can be turned. But the possession of these decisive points is, in itself, in no way decisive; the deathblow remains to be struck. The Battle of Mukden, for instance, had to be fought after Port Arthur was captured.

As regards an army in the field, the selection of the decisive point becomes still more difficult. We can easily understand that a junction of roads, or a passage over an impassable obstacle, the possession of which grants the holder great freedom of action, or enables him to strike at his adversary's communications, or to separate the hostile forces, may constitute a decisive point. But, here again, the possession of such a point, though it grants an opportunity for the delivery of a deathblow, is not, in itself, in any way decisive; the major part of the business, the actual delivery of the deathblow, remains to be accomplished.

Thus Napoleon, in the Waterloo Campaign, having concentrated secretly, seized suddenly on the line of communication between the allied armies, a decisive point, the possession of which enabled him to strike at the allies in turn. Having defeated—routed, as he appears to have believed—the Prussians at Ligny, he delayed his pursuit, fearing lest a vigorous pursuit might drive them northwards to Wavre, and so towards Wellington's army. He then turned leisurely against Wellington, in the belief that the Prussians were in full retreat on Prussia. The Prussians, however, were in full march on Wavre to assist Wellington. It was now the passage over the Dyle at Wavre which had become the decisive point, the possession of which would grant an inestimable advantage to its holder. The Prussians seized it, and were thus able to intervene with decisive effect on the field of Waterloo.

In the Salamanca Campaign, Marmont, having outmarched and outmanœuvred Wellington, threatened the latter's communications; but when, overconfident, he sought to utilise his advantage, and to strike the decisive stroke, he suffered defeat.

Similarly, at Austerlitz, the Austrians and the Russians successfully seized a decisive point, threatening the French communications; but, in so doing, they separated their own forces, and succumbed to Napoleon's counterstroke.

Again, in the Battle of Mukden, the Japanese, suddenly developing a powerful attack on the Russian right flank, threatened the Russian communications and line of retreat. They had, undoubtedly, secured possession of a decisive point; for the Russians immediately commenced their retreat. But the Japanese, lacking sufficient cavalry, were unable to press their advantage to the uttermost, or to convert the Russian retreat into a rout.

We thus see that, as fast as superior force has been concentrated at one decisive point, another one crops up. It seems evident that the possession of a decisive point in war, as in the game of chess, merely means that a strong position has been gained from which a powerful attack can, if sufficient force is available, be directed at a vital point of the enemy.

But where then is that vital point? Where is it to be found? Does it exist? It seems evident that it must exist; for otherwise how can we account for the sudden and complete collapse of an armed force, although it has, perhaps, suffered but little loss? Panic, you will at once say. Yes, that may be so; it may be that the vital point has been touched, and panic ensues. But let us then seek to ascertain which is this vital point.

For some centuries in the Middle Ages, after the collapse of the Feudal System, war was carried on in Europe by means of mercenaries. A well-known mercenary leader, having received a commission from some potentate, would raise his standard, and, from all sides, subordinate leaders with their following would flock to it. The object of these mercenary armies was gain and the accumulation of wealth; their last desire was to fight, except, perhaps, against untrained and half-armed men on whom they could, with little or no risk to themselves, wreak their will and satisfy their lust for blood and plunder. These mercenary armies sought to avoid one another as far as possible; but, as the various countries of Europe became devastated and destitute of supplies, the difficulty of doing so increased. Two rival armies would then manœuvre against each other, each displaying its full strength, and growling like two dogs over a bone, in the hope of terrifying its enemy. The weaker usually retired, leaving the victor in possession of the coveted territory, and went to seek winter quarters elsewhere.

But with the advent of Gustavus Adolphus all this was changed. He had trained, disciplined, and roused the patriotic and religious enthusiasm of his Swedes. He, himself, was filled with the lust of conquest; and his supremacy over the territories he conquered was obviously incomplete so long as the mercenary armies, maintained by his enemies, were permitted to exist. Placing well-deserved reliance on the martial qualities of his men, he boldly attacked the hostile armies whenever he met them, very often in spite of their superior numbers. The courage and resolution of his men, no less than his own superior leadership, won him the victory. In these wars, the opposing armies fought front to front; there was no question of seizing a decisive point, and thereafter, pressing forward to the attack of a vital point. The vital point lay in the spirit of the hostile forces; that one which could, at the decisive moment when fate hung in the balance, display the finer resolution, which could show the greater "grit," won the victory. At the last great battle of Lützen, when the Swedes, greatly outnumbered, were practically beaten, the death of their King filled them with such fury that they returned to the charge and with one tremendous effort swept their enemies from the field.

Gustavus Adolphus has been called the Father of modern war; and Frederick the Great copied his methods closely. Placing reliance on the training and discipline of his men, that is on their manœuvring and fighting capacity as well as on their resolution and determination to win at all costs, putting faith, moreover, in his own superior generalship, he seldom hesitated, though outnumbered by three to one, to attack his enemy in position and entrenched. He sought out the most vulnerable flank and threw his whole weight against it, confident that his half-trained enemy would be unable to alter his dispositions in the time available. On several occasions he was heavily repulsed; but neither he, nor his army, were ever defeated. At the great battle of Künersdorf, his army was almost annihilated; of the 48,000 men with which he commenced the battle, he was left with but 3,000. For the moment he lost courage at the downfall of all his hopes; it was his misfortune, he said, to be still alive. But there was no pursuit; he quickly regained courage, and re-assembled the remnants of his army. He again showed a bold front to his numerous enemies; fortune turned again in his favour; and, in the end, he not only saved his country, but raised it to the position of one of the great powers of Europe.

In all these battles of Frederick the Great we see the same feature, the sudden seizure of a commanding position, or a decisive point, from which a determined and overwhelming attack was directed against the enemy, the object being no less than the utter annihilation of the hostile force. There was no locality on the field of battle, however, which can be termed a vital point; that vital point lay in the spirit of the hostile force. From the moment that spirit was broken down, from the moment that the resolution to win was lost, from the moment all ranks recognised that they were outmatched and outwitted and that victory was no longer possible, the army was beaten. At Künersdorf, though the Prussian army was scattered and driven headlong from the field, their spirit was yet unbroken when, on reassembling, they found that their king had not lost confidence. Though numbers of their veterans had been killed, though only 20,000 men had rejoined the colours, and though many of their best leaders had been lost, yet such was the terror of their name that their enemies, though in overwhelming numbers, feared to attack them. But how if there had been a vigorous pursuit?

And now let us turn to Napoleon. His methods were very similar to those of Frederick the Great. He sought, by the direction of his march, to seize at once on a commanding position with concentrated forces. If the hostile army was superior to him in force, he endeavoured, as at Austerlitz or in the Waterloo Campaign, to separate them into two or more fragments; while, if the hostile force was inferior, as at Ulm and Jena, he seized on its lines of communication, interposing between the enemy and his resources and reinforcements. Having gained possession of the decisive points, however, he delayed not a moment, but pressed forward to strike with his whole weight. In this attack he meant to win all or lose all. He employed his reserves to the last man when the decisive moment arrived. "To be repulsed," he says to his feeble brother, Joseph, "when one has 12,000 men in reserve who have not fired a shot, is to put up with an insult." If his attack was successful, he pressed forward in a vigorous and sustained pursuit. He granted his enemy no repose, no time for recuperation. He departed from this principle, doubtless for very good reasons, at Ligny, but he paid the penalty at Waterloo.

There is one noticeable feature which is common to nearly all the great battles of history. When there is no pursuit, the defeated force escapes with a loss but little greater than that of the victor. Very often, indeed, his loss is considerably smaller. A victory is impossible except with a determined attack; and it is generally the assailant who suffers the more heavily during the progress of such an attack. It is only when one force commences to give way, and acknowledges the superiority of the other, that its punishment really commences; and it is only during the pursuit that its losses become terrible in proportion to those of the victor.

It is, clearly, not so much the actual loss sustained which causes an armed force to admit its inferiority; it is the feeling which gradually permeates all ranks that there is no resisting the enemy. The spirit is breaking. But then, it will be said, it is just this loss which causes this spirit to break; an armed force which can inflict losses on its enemy, while sustaining none itself, will retain its spirit unimpaired. This is hardly true. The Boers, as a whole, sought to inflict the utmost possible loss on their enemy; but the moment it became apparent to them that they themselves must shortly commence to suffer punishment, they thought it high time to be off. It was not in any way due to lack of courage, but rather to a false conception of war. They failed to recognise that great results can only be achieved by running great risks and suffering greatly. At the very outset of the campaign they lacked the military spirit; and they were, in reality, doomed to ultimate defeat if their opponents possessed the resolution to conquer.

This spirit, which seems to be the vital point of a force, and which, if once broken down, leaves that force helpless, is made up of many component parts. There is, first and foremost, the confidence of the supreme leader in his own powers and in those of his men, his knowledge that he is a master of his art, and that his men know it. There is his determination to win at all costs, a sentiment which rapidly permeates through the subordinate leaders down to the rank and file. It is this spirit of confidence and resolution, which the chief infuses into all ranks, that constitutes that military spirit without which, as Clausewitz tells us, an armed force is worthless.

Let us see on what this spirit of confidence is based.

There are many men with a thorough, though altogether misplaced, confidence in their own powers; we have, most of us, passed through the phase at one time or another. Such a man, though confident in himself, will not win the confidence of his subordinates. Every capable subordinate will quickly recognise his incapacity. He has built his house on the sand; and the first heavy blow of misfortune will sweep it away. Of such a type is the 'Heaven-born soldier,' the man who believes that nature has endowed him with such magnificent qualities and such a transcendent brain that he can direct armed forces to victory without ever having given a thought as to how it is to be accomplished and without having studied the methods by which the great masters of war have effected their designs. His confidence is due solely to his ignorance. He believes that the great leaders of history, like himself, were born generals; he has not read their lives, for he does not believe in reading or in 'bookworms'; he does not know that the great leaders were one and all, without exception, deep students of the science of war and of human nature before ever they took a weapon in their hands or set an army in battle array. Hannibal and Alexander the Great were both instructed in their boyhood by their fathers, who had given their lives to the study of war and statecraft. Gustavus Adolphus, before ever he came to the throne, had studied the campaigns of Alexander the Great, and this preliminary study is manifest in his own campaigns. Frederick the Great was a deep student of the campaigns of Gustavus Adolphus as well as of other great soldiers. Napoleon and Wellington had both closely studied the campaigns of all the great leaders. Moltke, as is well known, was the deepest of students throughout his life.

The man who has failed to study is as helpless in the hands of the trained leader as is the tyro at chess in the hands of the great master. He does not even know why he is beaten, but ascribes it to the faults of his subordinates. He lacks the knowledge to enable him to organise, he criticises in place of assisting his subordinates. He scorns to teach; it is beneath him. He also, usually, lacks the capacity. He speaks scornfully of the teacher. "Oh yes," he will say, "if a man is suited to that kind of work, it is all right." He forgets that every officer in an army must be a teacher, must instruct his subordinates, or be worthless.

It will not for a moment be denied that certain inborn qualities are necessary in a leader of men; but these qualities, and possibly many others with which he was not endowed by nature, must be cultivated if he would hope to lead armed men to victory. He must not be unduly elated by success; he must not be cast down by defeat. He must possess the power to display infinite patience, to check the eagerness of his own spirit no less than to restrain that of his subordinates. But when the time comes, when he has foiled the plans of his adversary, when he has weakened him and placed him in a false position, when he knows intuitively that the moment has arrived at which to strike with his utmost power and force, then he must be foremost in ardent vehemence as formerly he had set an example in patience and endurance. And with it all he must retain complete self-possession.

The great leader leaves no stone unturned to instil his own spirit into the force he wields. He rouses their patriotic or religious enthusiasm. Like Alexander the Great, or Cromwell, or the Maid of Orleans, or the Mahdi, he sometimes claims to be the *protégé* of Heaven; or, like Napoleon, he claims the guidance of his star. While promoting healthy rivalry, he seeks to smother jealousy. *Esprit de corps* is all very well in its way, if combined with the higher and nobler sentiments of *esprit d'armée* and *esprit de patrie* or patriotism. But alone, it develops almost inevitably into petty jealousy. When regiments and corps regard one another with envy and jealousy, the sentiment quickly takes a hold of individuals. Many cases are to be found in history where one man, actuated by petty spite, has refused to move to the assistance of his comrade in difficulties. The jealousies of the French marshals was a principal cause of the defeat of the French in the Peninsula. It was the great fault of Napoleon's system. But his chief consideration would seem to have been his own supremacy; and it is probable that he considered it advisable to promote jealousy amongst his marshals as the surest safeguard of that supremacy. Jealousy and spite are, however, quite impossible amongst educated and patriotic soldiers.

The great leader establishes the sternest possible discipline, punishing military crimes, especially those which are calculated to ruin the cause or to sacrifice the lives of comrades, with ruthless severity; for it is only by stern discipline, combined with enthusiasm, that men can be induced to march fearlessly to what appears to be certain death. These were the qualities which, more than all others, pressed the Swedes of Gustavus Adolphus, the Prussians of Frederick the Great, and the Japanese to storm so-called 'impregnable' positions again and again until they had carried them.

The great leader forgives, while explaining the enormity, an error of judgment in a subordinate; for if he punishes such well-intentioned errors he hampers initiative. But he never overlooks carelessness, laziness, or unjustifiable ignorance.

He organises carefully; for he knows that discipline and scientific leadership are impossible without it. But this is not all. Like Nelson he seeks to train his subordinates, to teach them his own methods, to form them into 'a band of brothers.' He knows that those subordinate leaders must be able to command the confidence of their men; and that without their trained co-operation and power of initiative he himself must be quite helpless. More than ever is this the case in modern war, which is an affair of far greater complexity than the war of the middle ages or of antiquity.

These subordinate leaders, in their turn, must train their subordinates; and thus, by degrees, is formed an armed force in which all ranks have implicit confidence in the knowledge and capacity of their superiors, their comrades, and their subordinates. The chief knows that his instructions will be carried out, not in a spirit of pedantic obedience, but with trained intelligence; and that whatever he definitely orders his men to do they will accomplish it or die. The rank and file also know that when they are called on to accomplish an apparently impossible task, that it is not really impossible, but that their chief has adopted measures, of which they know nothing, to second their efforts. They know also that, in any case, their self-sacrifice is demanded of them by every consideration of patriotism, of religion, of duty to their comrades, of discipline, and of tradition—in a word, by the military spirit. They know, moreover, that, if they fail, the enemy will probably get the better of them, and may destroy them all.

If we study the campaigns of the great leaders, we find that, while they fostered the military spirit of their own troops, they struck constantly at that of the enemy. "The great general," writes Colonel Henderson, "whilst raising to the utmost the *moral* of his own men, reckoning up that of the enemy and lowering it in every possible way, does not give his first attention to these points, nor to the numbers against him. He looks beyond them, beyond his own troops and across the enemy's lines, until he comes to the quarters occupied by the enemy's leader, and then he puts himself in that leader's place, and with that leader's eyes and mind he looks at the situation; he realises his weaknesses, the points for the security of which he is most apprehensive; he considers what his enemy's action will be if he is attacked here or threatened there; and he sees for himself, looking at things with the enemy's eyes, whether or no apparent risks are not absolutely safe." He strikes, in fact, at what would seem to be the true vital point of an armed force, the mind of the hostile leader. For leadership is an affair of the mind; physique has little or nothing to do with it. It is true that a man who is in physical pain, whose health has given way, can hardly display to the full the qualities of his mind; and, for that reason, it is desirable that the leader should be in vigorous condition both mentally and physically. But we must not forget that the mind can triumph over physical suffering. There is a notable example in history. Torstenson, the Swedish general of the latter end of the Thirty Years' War, was old and worn out, a bedridden paralytic, who was habitually carried in a litter. And yet, he is celebrated for the sudden and fierce energy of his blows and for the rapidity of his marches. He almost invariably surprised his enemy; and, having defeated him, gave him no time for recuperation, but hunted him over half the continent of Europe. It is a point for us to take note of; for we British soldiers are apt to attach an undue importance to physical prowess, and, it seems to me, too little to mental capacity.

The seizure of the enemy's communications before the decisive battle does not really reduce his actual fighting capacity, or lessen his chances of victory—unless, perchance, his reserves of ammunition and food have been captured, and he is forced to fight on short commons. The real blow is directed at the military spirit of the enemy. It is the surprise, which shakes the nerves, tends to destroy discipline and dislocate organisation, that lowers the fighting capacity of a force. It is the threat to the line of retreat which sets every man wondering how he is to escape if defeated. Every educated officer throughout the ranks recognises that his chief has been outmanœuvred, and his confidence in that chief is shaken. The chief, himself, even when he is an adept in his art, feels that he has met an opponent worthy of his steel, and that he must bring into play every artifice of which he is master, that he must concentrate every atom of his intelligence and imagination in the effort to outwit his adversary and turn the tables on him. He knows, and his men know too, that, if defeated in the coming battle, the army will probably be destroyed. But if his self-confidence is misplaced, he then begins to know it, he commences to lose his self-control, he recognises his incapacity, and his face shows clearly his perturbation of spirit. His despondency flashes through all ranks of his army.

We read in Napier that, before the battle of Salamanca, Wellington was deeply disturbed by the successful manœuvres of his opponent. Can there be any doubt that his staff, filled with anxiety, scrutinised his face closely while he pondered on the methods by which he might endeavour to extricate his army from its false position? Is there any doubt that the troops nearest at hand scrutinised, and read, the serious faces of the staff officers? Is there any doubt that Marmont had struck a shrewd blow, before ever the battle commenced, at the military spirit of the British army? But when Wellington, seeing the increasing gap between Marmont's main body and his left wing, shut up his telescope with a snap and exclaimed, "Now I have him," can we not imagine the feeling of relief, the restoration of confidence, which flashed through the staff and thence to the troops?

The men who composed the Prussian armies at Jena were not so vastly different to those who had won Frederick the Great's battles against such overpowering odds. It is true that, as General von der Goltz tells us, a 'sickly artistic' conception of war had taken hold of the Prussian nation and leaders; but the training of the rank and file, though by no means so strenuous, was still carried out on the principles of Frederick the Great. The army was full of misplaced confidence. And yet we read in Alison that, before the battle of Jena, "the dejected and disordered columns of the Prussians at length effected their concentration." Up to that time a few detachments only of the Prussians had been overwhelmed; the army as a whole had not been touched. The men had, however, been marched this way and that until it had become apparent to every educated officer, at least, that their chief was unable to face the situation or to fathom the designs of his enemy. We read also that this chief, the Duke of Brunswick, was 'thunderstruck' by the news of the French advance. It is bad when the leader of an army is thunderstruck; it is fatal when he shows it. The troops fought bravely enough; but every man, it is probable, knew that his chief had been outwitted and outmanœuvred, and that he was no match for Napoleon. Every man, it is probable, expected that he must fight against overwhelming odds; he had lost all confidence in his leaders; and it is certainly due to these facts that the bulk of the Prussian army was, at Auerstadt, driven back by half their own numbers of Frenchmen. The misplaced and overweening confidence of the Prussian army had collapsed, giving place to hopeless despondency, the military spirit had been broken, the vital point had been struck, before ever the battle commenced.

But, perhaps, Napoleon at Waterloo gives us a better example than any other of a blow deliberately aimed at the vital point, the military spirit, of the enemy. Napoleon, unaware that the Prussians were in full march to the battle-field, delayed his attack in order that the ground might dry sufficiently to enable his artillery to manœuvre —at least, so it has been said. He utilised the time by a pompous display of his army in full view of Wellington's heterogeneous force. He well knew that a considerable part of that force was disaffected, and that other portions were by no means well-trained or well-disciplined. Like Joshua at Jericho, he paraded his tremendous power with banners unfurled and trumpets blowing, in the conviction that the mere display would turn the hostile hearts to water and cause the walls to fall down. And it is probable that he would have succeeded, but for the calm confidence displayed by Wellington and his subordinate leaders, who well knew that Napoleon had been outwitted and that Blucher was marching to their assistance.

Clausewitz tells us that the military spirit thrives on victory ; and that it can only, with the utmost difficulty, be fostered in peace time. The Germans have taken his teaching to heart, as have the Japanese. These nations, recognising that war is the ultimate arbiter in the fate of nations, leave no stone unturned to foster this military spirit in peace time, and to educate the youth of the nation in the sentiments of patriotism and discipline. With us, unfortunately, all classes of society do their utmost to destroy the military spirit, which they regard as 'militarism.' They will, doubtless, in the end, succeed ; but when that happens, there will be no *fighting men* left in the nation ; and when that occurs, the end of the nation, as history tells us, will not be far off.

The national, or fighting, spirit, as all history shows so clearly, is the vital point of a nation, even as the military spirit is of any armed force. It is made up of exactly the same component parts, patriotism, discipline, organisation, the well-justified confidence of the national leaders in themselves and in the rank and file of the nation, the confidence of the rank and file in the knowledge and capacity of the leaders.

It is only when this national spirit breaks down that a nation admits defeat. In the case of a vigorous nation, its armed forces must be destroyed, its territories invaded and occupied, its resources seized, its liberties suppressed, before it can be brought to recognise the hopelessness of further opposition. And, even then, like Frederick the Great's army after Künersdorf, it is unbeaten. But the self-satisfied and complacent nation, full of unwarranted confidence, collapses, like the Prussian nation after Jena, at the first sudden and unforeseen stroke ; the awful shock is too much for its flabby nerves ; like a flash the conviction comes home to every man, when it is too late, that the nation is no match for its enemy, that it has been hopelessly outwitted, outmanœuvred, and outfought. The nation recognises, at last, the appalling fact of its inefficiency, and succumbs without further effort. Overweening confidence falls at the first blow to hopeless despondency. The national spirit is broken, the nerve centre has been pierced, and the nation lies paralysed beneath the heel of the conqueror.

In the late war, the Japanese sought not only to destroy the Russian navies and armies; every blow would seem to have been directed at, and calculated with regard to its effect on, the national leaders in Russia. If the incapacity of these could be exposed, and if they could be brought into disrepute, internal trouble must result, and the strength of the nation must diminish. And more than that, strained relations between the people and the leaders in Russia must react on the leadership of the Russian armed forces in the theatre of hostilities, demoralising both officers and men, and opening up opportunities to the Japanese. If a nation in arms attacks Great Britain, every blow it strikes will be directed at the nerves of our untrained national leaders, and calculated with regard to its effect on the vast and undisciplined masses of the unemployed, the unemployable, and those on the verge of starvation.

But we cannot bring ourselves to believe that an enemy could be so unscrupulous as to strike at our weak points, to strike suddenly and unexpectedly. We do not, therefore, seek to rectify our weaknesses. As with the Prussians before Jena, so with us, a sickly artistic or sickly sentimental conception of war, of life, and of human nature, has taken a hold of us all. The pen, they say, is mightier than the sword, the babbling orator of more value than the trained and educated fighting man. It is a fallacy; but the fallacy is only made manifest when the sword flashes from the scabbard.

A comparison between the British nation of to-day and the Prussians in 1806 is hardly calculated to increase our misplaced confidence. Such a comparison has been ably drawn by the military correspondent of "The Times" in his *Imperial Strategy, 1806 and 1906—a Parallel.* Our countrymen of to-day are filled with a misplaced confidence, which is, I fear, fated to give way to hopeless despondency at the first shock of a serious war. Let us endeavour to break down this false spirit while there is yet time, and to replace it by the true spirit, based on a resolute determination to win at all costs, on a scientific knowledge of what we shall have to do and of the methods by which we intend to do it.

And now, I will venture to give a word of advice to the young officers who are present here. It is this. There may be some amongst you who have been endowed by nature with the great qualities requisite in a leader of men. No man of you can tell whether or no he possesses these qualities until he is put to the proof. But these qualities will be quite useless to you, to your comrades, and to your country, unless you cultivate them, unless you can gain the power to exercise a rigorous self-restraint, unless you possess not only a capacity but even a liking for hard work. And even then, they will be valueless unless you superimpose upon them a profound knowledge of the science of war and of human nature, which can only be obtained by constant study.

There are very few fighting men in this old country of ours; and it is improbable, unless conditions are materially altered, that we shall be able to withstand the onset of a nation in arms. But if you, the rising generation of British soldiers, can be induced to dedicate your lives to your country, to give every ounce of your capacity and energy to the study of the science of war and to the means by which nations triumph over their enemies, you may, when the time comes, do great things for your country, you may, even yet, save it.

It is no light task you have undertaken, and the time is short in which to prepare yourselves for the vast responsibilities which will assuredly devolve on your shoulders. It may even be that you will be called on to goad your countrymen into action, to force them, against their will, to fight it out to the bitter end, as the only means by which you may hope to save them from destruction. If that time comes, as come it probably will, let us hope that you will act your part bravely and fearlessly, with never a thought for your own interests, as becomes devoted and scientific British soldiers. If, on the other hand, you slack now, if you cannot spare time from your amusements for hard work, why then Heaven help your country. But Heaven will not help it; Heaven has never yet, in the whole course of history, assisted a flabby nation.

TRANSCRIPT.

FIELD FORTIFICATION AFTER THE WAR IN SOUTH AFRICA AND THE RUSSO-JAPANESE WAR.*

THE EFFECT OF MODERN FIREARMS ON FIELD FORTIFICATION.

SINCE the introduction of breech loaders in the latter part of the 19th century there has been an epoch of constant improvement in firearms. The end is not yet in sight and the march of progress is constantly increasing in rate.

The experiences of the last important European Wars, in which the combatants were armed in very dissimilar manner, have only served to increase the keen rivalry on the question of armament.

The improvement in armament during the last decade or so has been exceptionally rapid, particularly as regards the rifle, which now, by its hail of bullets, more than ever decides the fortune of the day. Machine guns and Q.F. guns have also improved out of all knowledge. In fact the recent increase in efficiency of armament has not been equalled in any other period of equal duration.

Thus, although the introduction of breech loaders was a most conspicuous event in the history of armaments, it did not of itself give to the individual weapon that marked superiority over its predecessor which characterised the introduction of magazine or repeating mechanism.

It must further be remembered that the increase in efficiency of firearms must not be judged by their actual comparative effect in war. The number of killed and wounded does not vary directly with the destructive capabilities of the weapons used. In many battles during the last half century the casualties amounted to only 10, 5, and even 2 per cent. of the combatants, and in South Africa especially the casualties were exceptionally low.

As a rule it may be said that improvements in firearms produce an increased discretion in exposing troops to their fire. Civilisation has also had a baneful effect on the fighting powers of armies, and modern wars will usually be decided without very severe losses. In this respect the high percentage of killed and wounded in the Russo-Japanese war speaks strongly for the obstinacy of the struggle and the exceptional bravery of the combatants on both sides.

* From an article by Capt. Vinzenz Reimer, No. 15 Pioneer Battalion, in the February, 1907, number of the *Mitteilungen über Gegenstande des Artillerie-und Geniewesens.*

Taking a general view of the recent improvements in artillery and rifle armament, the following appear to be the most important results:—

(1). The rapidity of fire, both with rifles and field guns, has been enormously increased.

(2). The dangerous zone has grown very considerable owing to the increased range.

(3). The accuracy and effect of single shots has developed very conspicuously.

The effect of these improvements on the tactics of field warfare, and especially on Field Fortification, must be very great.

THE IMPORTANCE OF COVER AGAINST MODERN WEAPONS.

In the most recent wars, namely those in South Africa and in Manchuria, one of the most noticeable features was the continual and elaborate use of artificial cover.

The Boers, as is well known, entrenched themselves on every occasion. The English, who were bent on offensive tactics, were yet obliged to make frequent use of trenches and sangars; and it must be noticed particularly that they entrenched themselves not only when they were compelled after an unsuccessful attack to adopt defensive measures, but also in the attacks on the Tugela and Spion Kop and after occupying Vaal Krantz and during the final struggles which resulted in the relief of Ladysmith.

As regards the Russians they almost always fought from behind cover; and even when they purposed to make a vigorous attack, as in October, 1904, against the Japanese position Bensiku-Jantai, it generally ended in their entrenching themselves in the ground they won.

The Japanese made a most extensive and careful use of entrenchments. Not only did they strengthen their positions by these means, and dig trenches during cessations of hostilities, but their infantry used to regularly dig themselves cover whilst actually under fire and during their attack. If the ground was too frozen to dig sandbags were used, and the men of their own accord, without receiving any order to that effect, would carry sandbags with them when ordered to attack.

It will thus be seen that during the latest wars, under different conditions and in different parts of the world, all the combatants have made the utmost use of artificial cover. Can this be explained by any well-known partiality for fortification and defensive tactics on the part of the particular countries engaged?

In the case of the Russians it may be so. They certainly spent much time and labour upon earthworks, which in many cases were not wanted; and they would sometimes have done better by advancing instead of entrenching themselves. For example the Russian forces in the Kwantung Peninsula in June, 1904, would have achieved far greater results had they advanced against the 3rd Japanese Army, which at the time did not amount to 2 divisions, instead of taking up and fortifying an extensive position, thus giving the Japanese time and opportunity to reinforce their troops. It is difficult also to see what advantage the defence gained from many of the works constructed at Liaoyang, on the Shaho, and at Mukden.

In the armies of other nations, however, we do not find any such marked preference for defence works.

The Boers at the beginning of the South African campaign undoubtedly took the offensive, though it was marked by excessive prudence. Moreover, had they made early use of entrenchments it would be easily explicable. But, being undisciplined troops, and largely composed of men unaccustomed to hard manual labour, they undoubtedly shirked the work of digging trenches or putting up sangars.

The English, on the other hand, could not bring themselves to believe that they would ever need to take refuge behind field defences. Consequently the two forces at Ladysmith stood opposite each other for several weeks without resorting to spade work at all. It was not till after the fight on the 30th October, 1899, that defensive works were begun by the besieged. General Buller's force too left their infantry entrenching tools behind, but soon regretted it, and had to do the best they could with the tools that were left them. (The above remarks seem to have been copied from some German official publication.—C.O.P.).

It is thus apparent that the appreciation of the value of field defences cannot be accounted for by any initial prejudice in their favour on the part of any of the combatants in recent campaigns. On the contrary all the participants started with ideas of purely offensive tactics and only adopted artificial cover because experience proved its value.

Neither can an explanation be found in the peculiar nature of the ground, as field defences were resorted to finally under every condition, in the plains and on the mountains, in sandy soil or amidst rock and scrub.

No, the cause of the increased value of field defences lies in the fact that the tactics adopted in the days prior to the introduction of the magazine rifle and Q.F. artillery are to-day foredoomed to failure. In particular the rapid and exposed advance against a defensive position, which was formerly considered the correct method of attack, is now recognised as involving enormous loss whilst promising very small prospect of ultimate success.

The English at the beginning of the South African war advanced against the Boer positions in their accustomed formation and paid dearly for it, *e.g.* on the Tugela and at Modder River and Magersfontein. Not being so tenacious as the Japanese they generally retired, and were slow to adopt new tactics; a flank attack often offered no better prospect as it only brought them up against an equally strong position. Fortunately the Boers did not make the best use of their initial advantages and the English soon learnt to make use of all available cover. The infantry attack now lasted for weeks instead of hours, and in the constant use of artificial cover began to resemble siege warfare.

The Japanese at the beginning of the Eastern campaign were more successful with their forced attacks, but solely owing to the obsolete methods of defence adopted by the Russians; and when the latter had learnt their lesson and improved their defensive measures, the Japanese were compelled to make constant use of artificial cover in their attacks.

From the experiences in these recent campaigns one may therefore draw the following conclusions with regard to the use of cover.

In view of the efficiency of modern weapons it is no longer possible in a direct attack on a capable defender to attempt an open and uncovered advance.

The concentrated fire obtainable from magazine rifles and the rapidity of fire of modern artillery compel the attacking side as well as the defence to make the most careful use of cover, both natural and artificial.

Natural cover is seldom available. Therefore artificial cover has generally to be resorted to, and this is the real explanation of the extended use of field works in recent campaigns.

DESIGN OF ARTIFICIAL COVER.

VALUE OF INVISIBILITY.

In considering the principles for the siting and design of field works, it will be advantageous to turn again to the lessons learnt in the recent campaigns.

At the beginning of the Boer War it seemed that bombardment of the hostile positions was of no effect; the Boers suffered no loss and were not demoralised. Before General Buller's first attempt to relieve Ladysmith the Boer position at Colenso was bombarded by naval guns for three days; and the English were able to aim and observe without hindrance, as no answer was made to the bombardment. Yet the infantry attack was routed. The reason is to be found in the fact that the Boer trenches were so cleverly concealed that they had not suffered at all.

The same thing occurred at Modder River and many other engagements; and though it may not be possible in European campaigns to conceal the defences so thoroughly, yet the experiences in South Africa prove undisputably the very great value of concealment.

The Russians were not nearly so skillful as the Boers in concealing their works, which usually consisted in the early period of the war of huge earth parapets on most conspicuous positions.

At the Yalu, in spite of strong breastworks (see *Fig.* 1), their artillery fire was silenced by the Japanese guns after 25 minutes; at midday on the same day they re-opened again, but after an hour had to vacate their position.

The Russian infantry trenches (*Fig.* 2) in the early part of the campaign were much too conspicuous, though the interior arrangements were good. The parapet was wide and very high and no attempt was made to conceal it, and the sites selected were too conspicuous. Thus in almost every case they offered an easy target to the Japanese artillery. The rapid success of the Japanese attack on the Yalu was largely due to the effective artillery fire they brought to bear on the trenches.

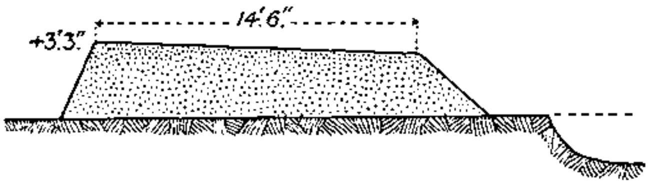

Fig. 1. Russian breastwork for artillery ($\frac{1}{100}$).

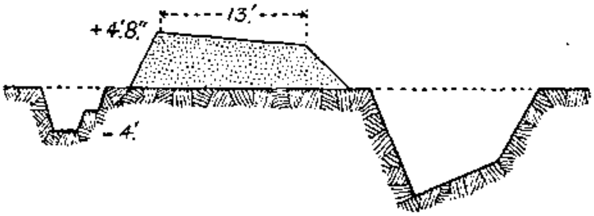

Fig. 2. Russian infantry trench ($\frac{1}{200}$)

The Japanese, on the other hand, appear to have recognised from the outset the great value of invisibility and concealment (*Figs.* 3 and 4). Their artillery in attack and defence was usually behind cover, and was better protected in their temporary works than the Russian artillery in permanent ones.

Figs. 3. & 4. Japanese infantry trenches ($\frac{1}{100}$).

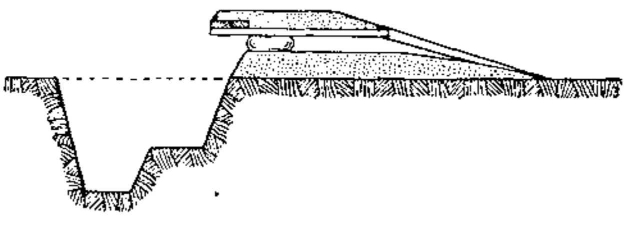

Fig. 5. Russian trench with overhead cover ($\frac{1}{100}$).

The reasons for the value of concealment are easy to understand. The great distances at which battles of to-day are begun, and in many cases decided—a result of the increased range of all weapons—make the task of discerning the enemy's position and movements very difficult.

But while distances have increased the range of the human eye remains stationary. Telescopes and field glasses are limited both in number and power, and do not therefore overcome the difficulty, while the introduction of smokeless powder makes the location of hostile troops harder than ever.

It would therefore be a foolish policy to decrease the difficulties experienced by the enemy in locating his target by adopting a conspicuous type of trench. Moreover it must be borne in mind that field defences cannot be made proof against heavy artillery fire, and therefore their chief protection against this form of fire lies in their invisibility. Well-concealed positions have, too, another, and perhaps more important, advantage than that of eluding fire, namely, that they often cause the enemy to adopt an erroneous line of action which may even directly lead to his defeat.

FORM OF COVER IN DEFENCE.

(*a*). *Infantry Cover.*

The South African campaign offers some good examples of infantry trenches.

The Boer position at Paardeberg was shelled for 10 days by some 90 guns. The defended area, which measured some 2,200 by 1,100 yards, could be thoroughly observed from the English balloons; and more unfavourable conditions for the defence are hardly imaginable. Yet the Boer losses were only 250 out of 4,000 men.

Their trenches were deep and narrow; they could not be touched by direct fire, and only offered a very small target to high angle fire. The sides of the trench were undercut at the bottom in order to offer additional protection.

Both the Russians and Japanese adopted deep and narrow trenches. The latter, indeed, from the beginning of the campaign avoided high relief works. The Russians, however, required experience to teach them.

To further protect the men in the trenches from shrapnel fire the Russians added overhead cover (*Fig.* 5).

Where possible the whole trench may be roofed in with planks, sleepers, doors, etc., and earth laid over all (as in *Fig.* 6), the occupants firing through loopholes. The Russians used trenches of this type in the defence of Port Arthur with the best results. The advanced redoubts were not taken till 20th September, 1904, *i.e.* 51 days after the investment was completed, and then only after very severe fighting.

An entirely covered-in trench of this type gives protection both from weather and shrapnel fire; and forms a substitute for the ordinary overhead cover or for the type with undercut cover for the garrison when not firing (*Fig.* 7).

The removable shield shown in *Fig.* 8 was only a precursor to the completely covered-in trench.

It is obvious that a completely covered-in trench requires no traverses against enfilade rifle fire, and all that is necessary is to build an occasional traverse to localise the effect of a shell falling in the trench.

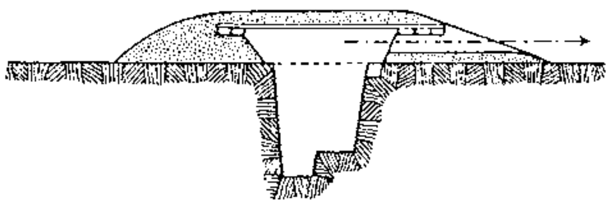

Fig. 6. Completely covered trench (1/100).

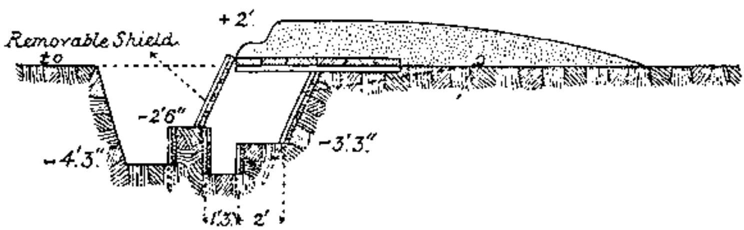

Fig. 7. Trench with undercut cover (1/100).

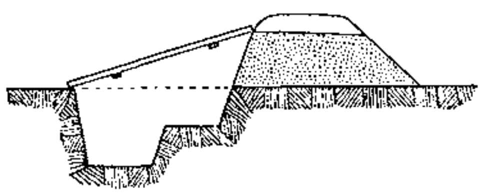

Fig. 8. Trench with removable shield (1/100).

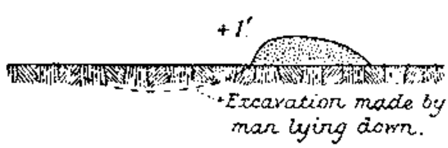

Fig. 9. Japanese trench for prone position (1/100).

(*b*). *Artillery Cover.*

Artificial cover for guns did not play so important a part in the two campaigns as infantry cover. As already stated, it was soon found that greater security was obtainable by eluding the observation of the enemy than by erecting a strong work.

Trenches for the detachment were however invaluable. The introduction of shields on the guns does not alter the conditions much, as they are useless against common or high-explosive shell and also only protect a small proportion of the detachment.

In very open and exposed positions, however, the guns themselves must be protected.

(c). *Cover for Reserves, etc.*

Cover for those reserves which are sent up to the close vicinity of the firing line will be constructed on the same principle as the firing trenches, that is they will be well concealed, with very low command, and will be provided with splinter proof overhead cover.

If time admits, and the position is a very important one, bombproof cover might be provided.

Where cover for reserves who are not in the neighbourhood of the firing line is provided, such cover must be so sited and arranged as to be completely hidden from view of the enemy and protected from shell fire.

(d). *Infantry Cover in the Attack.*

In both campaigns it was found that, in spite of the great improvement in artillery, the weapon that finally decided the day was the rifle.

The percentage of loss from artillery and rifle fire respectively proves this conclusively. In the South African war the losses were almost entirely caused by rifle fire. In the Far Eastern campaign the small proportion of casualties due to artillery fire aroused general amazement; perhaps, however, without adequate reason, since the moral effect of artillery fire should not be overlooked, although it does nothing to increase the casualty list. Even in Port Arthur, where the artillery played a most important *rôle*, the Japanese losses by artillery fire were only 21% compared to 73% caused by rifle fire.

It is undoubtedly due to the fire effect of the modern rifle that the attacking side has to advance with so much caution, and that the defensive has been able to hold its own so well against attack.

The Boers, after one or two unpleasant experiences, entirely gave up all attempts at direct attack; and the English learnt to make great use of night work and artificial cover in attack.

The Japanese, taught by the losses sustained in their attacks, have combined artificial cover into their methods of attack and reduced the whole to an exact system. If it is impossible to surprise a position, the skirmishers advance under cover of night to the first position selected for the firing line, and here entrench themselves. The further advance takes place by short rushes, the positions gained being immediately entrenched.

The trench is at first only for firing from a prone position (*Fig.* 9). It is at first only a protection from rifle fire, but is afterwards provided with a deep trench to offer cover from artillery.

The methods of the Japanese advance will probably be imitated in the future against any worthy and vigorous opponent, and also their organisation of cover in attack. The most important perhaps is the cover against rifle fire. This cover will be of the type shown in *Fig.* 9, and when possible will be deepened afterwards to provide protection from shrapnel fire; but the parapet must always be kept as low as possible.

OBSTACLES.

In the campaigns under consideration attempts at surprise and night attacks played an important part. The Japanese generally waited till nightfall before advancing to the attack.

The value of obstacles has increased owing to the frequency of night attacks. In front of Port Arthur many such attacks were frustrated by the obstacles alone. The extent to which the Japanese troops were checked by the Russian wire entanglements is shown to a certain extent by the fact that every infantry company had to be supplied with 30 wire cutters.

Barbed wire is the best obstacle, because it is little damaged by fire; the next best is abatis.

The obstacles should not be placed more than 120 yards from the work; because, if they are beyond easy hearing distance, they may be removed at night with comparative impunity.

Where possible obstacles should be concealed from view. If time is available they may be placed in a sunken way, so that they may form an unexpected hindrance to the attack. At the same time, in order to prevent its being cut by a man lying down beside it, every entanglement should be completely exposed to the fire of the work it protects.

Mines occupy a special position amongst obstacles. How great a moral impression they create may be incidentally gathered from the accounts of newspaper correspondents in the Far East, who more than once reported that battalions and even entire regiments had been annihilated by the explosion of a mine. It is a fact that such bodies were brought to a standstill and sometimes put to rout by these means; but not more than this.

The Russians made constant use of mines; but automatic mines were rare, the majority being fired electrically from the work. Most of them failed owing to the leads being severed by bullets.

In the future, therefore, it is unlikely that mines will be used directly in front of works, as was the Russian practice, because they are so likely to be rendered ineffective by hostile fire. But automatic mines, placed in hidden positions and consisting of small charges only, would be very useful to check and retard the advance of the attackers, and to act as vedettes in places concealed from the defenders, in defiles, etc., where their explosion would denote the presence of the enemy.

ADVANCED POSITIONS.

The two campaigns under review have clearly shown that the modern rifle enables the defence to keep the attackers at a greater distance than formerly and yet inflict heavier losses on them; and owing to the greater distance the time during which the attacking side is exposed to the fire of the defence has also increased.

The advance of the attacking side to decisive range has therefore become harder and slower; and even when this point is reached the enormous power of the rifle fire of the defence forms an almost insuperable obstacle to a speedy conclusion. In the Far East it often happened that the opponents were so close that they could throw hand grenades into each other's works, and yet they dared not leave their trenches for the final assault.

The long duration of battles in South Africa and the Far East was so universal that where exceptions occurred they can be traced to specific causes, such as the speedy retreat of the attacking side or an obvious want of precaution on the part of the defence.

Nearly all of the decisive battles were of long duration. Buller's second attempt to relieve Ladysmith lasted 9 days and was indecisive; his last attempt took 10 days to accomplish, although he outnumbered the Boers by 6 to 1; altogether the opponents remained opposite each other on the Tugela for 3 months. The investment of Cronje at Paardeberg lasted 10 days. In the sieges of Mafeking, Kimberley, and Ladysmith the English were able to maintain themselves behind most simple fieldworks for months together. It is doubtful if they would have done so had not the Boers been inspired with such respect for the modern rifle.

These periods were repeated in the Russo-Japanese War.

As the duration of fighting increases with it increases also the value of field defences, by the use of which alone a force can maintain itself for such long periods exposed to the fire of modern weapons.

But however valuable cover is to a force, the decisive factor remains always its own fire. Field Fortification therefore must above all things help to develop and increase the fire effect of the force that employs it.

The question of advanced positions must also be considered, their purpose being either to deceive the enemy or to gain time.

They were not very conspicuous in the Russo-Japanese war, though the Russians (with the French and Italians) are strong supporters of them. As a rule their advanced posts were easily captured by the Japanese, and such rapid success raised the spirit of the attacking side and depressed the defenders; even the valiant defence of Kinchau, which only ended with the annihilation of the Russian garrison, appears to have had no other effect.

It is very difficult to convince the public generally that an enforced retreat at one point may be accompanied by success at another; and when advanced posts are captured, as they probably are bound to be sooner or later, a depressing effect is produced on the whole force and also the public.

So also there are weighty objections against fortifications being laid out in rows one behind the other. The large amount of cover required involves a great deal of work, restricts supervision, and attracts the attention of the hostile artillery. False trenches would indeed be preferable.

Many of the laboriously constructed Russian positions were given up before they were attacked at all; but even when seriously attacked, they had no particular value. The most that can be said is that some of the positions in rear held out for a short time, but never to such an extent as to effect the result of the conflict; with the fall of the first or main line of defence the result was decided. The Boers in their single line of trenches held out most successfully; whilst in the defence of the Nanshan position the multiple lines of defence were of no avail.

The chief objection however against multiple lines is that the laborious work involved only has the effect of tying down a number of men to an unimportant place and robbing the actual firing line of their presence; and if reserves are placed therein they get a false idea of their proper *rôle* and remain chained to the spot instead of being essentially a mobile force.

The Japanese saw the weakness of the Russian multiple lines and quickly took advantage of it. Even the Russian engineer officers learnt to condemn them, one Russian colonel saying "The multiplication of lines

NATURE.

April, 1907.

GYROSCOPIC APPARATUS FOR STEADYING SHIPS (*p.* 561).—An old first-class torpedo-boat, the *Seebar*, has been lately fitted up with a gyroscopic apparatus and trials have been made with it by Dr. Otto Schlick on the Elbe. The *Seebar* is 116 feet long, 11·7 feet wide, 3·4 feet draught, and of 56 tons displacement. Her metacentric height was 1·64 feet, and her period of oscillation, or double roll, 4·136 seconds.

The outside diameter of the fly-wheel of the gyroscope was 1 mètre, its weight 1,106 lbs., and the peripheral velocity at which it was run 274·8 feet per second, the number of revolutions being 1,600 per minute. Blades were fitted to its periphery and steam was admitted direct through the hollow trunnions, so as to work the fly-wheel as if it were a turbine.

Still-water rolling experiments were made with the *Seebar*, rolling being set up by the crew running from side to side. It was found that with an initial angle of inclination of 10° and with the gyroscope at rest, 20 single oscillations took place before the extreme inclination to the vertical was reduced to ½°; whereas the same amount of extinction was obtained with little more than two single oscillations when the gyroscope was free to oscillate and the fly-wheel was making 1,600 revolutions per minute; this proved the enormous extinctive effect of the gyroscope.

The principle of gyroscopic action is fully explained in a previous paper by Dr. Schlick. Lord Kelvin designed an instrument, called the gyrostat, to illustrate the more complicated state of motion of a spinning body when free to wander about on a horizontal plane, like a top spun on a pavement, or a hoop or a bicycle on the road. It consists essentially of a massive fly-wheel concealed in a metal casing; and its behaviour on a table, or with various means of suspension or support, serves to illustrate the curious laws of statical equilibrium due to the *gyrostatic domination* of the interior invisible fly-wheels when rotated rapidly.

It is by the adoption of the gyroscopic apparatus that the efficiency of the Whitehead torpedo has been enormously increased. When the projectile is discharged its gyroscope is set going, and it is bound to run in the line it was pointing when the fly-wheel was started; thus all inaccuracies of flight, due to errors of adjustment or even damage to some part, are eliminated.

Experiments have been similarly made by Sir J. Thorneycroft with his steam yacht *Cecili* and also by Mr. Tower with his steady gun platform controlled gyroscopically.

Sir W. White has discussed the further application of the principle to war vessels, and, though he did not commit himself to any definite opinion, it may be said that the impression given was decidedly of a hopeful nature.

W. E. WARRAND.

REVISTA DE ENGENHERIA MILITAR.

January, 1907.

ENTRENCHED CAMP OF LISBON.—The organization of the Entrenched Camp of Lisbon is to be altered in a few details. The whole of the fixed defences are to be placed under a sole military authority. To this end the submarine mining and torpedo services are to be separated, and the former is again to be placed under the War Office, under which department it was originally organized.

ENGINEER TROOPS; THEIR ORGANIZATION AND TRAINING.—By Colonel Dias of the Engineers.—Refers to previous articles by the same author in the *Revista* of May, June, and July, 1906, and then deals in detail with the proposals of Lieut. Ferreira which appeared in the September number. These proposals concerned:—

(*a*). The formation of an Auxiliary Corps of Military Engineers.

(*b*). The formation of Transport Companies for Engineer Services.

(*c*). The attendance of Cavalry and Infantry officers at the Engineer Schools of Instruction.

(*d*). The command of the Parks of the companies of the Engineer Regiment by officers of the Ordnance Corps.*

(*e*). The arms to be issued to the personnel of the Field Telegraph Companies.

Colonel Dias does not altogether agree with (*a*), but considers that the formation of an auxiliary corps of non-commissioned officers, performing the duties of foremen of works and draughtsmen, is desirable. With regard to (*b*) he considers the present system, by which each engineer company has its own transport and drivers, is the more suitable. He concurs in (*c*). As to (*d*) he thinks that the idea is excellent but that it would be difficult to carry out, and prefers giving the command of the parks to mounted sergeants of the companies. If, however, his own scheme of dividing the engineer regiment into 3 battalions (each with its own park) were adopted, he thinks it would be desirable that the parks should be commanded by Ordnance officers. With regard to (*e*) he thinks that Lieut. Ferreira's proposal to arm the telegraphists with carbines, which would as a rule be carried in the telegraph equipment carts, deserves a trial.

APPLICATION OF A LIGHT AFRICAN BRIDGE TO FIELD SERVICE.—An account of experiments made at Tancos in April, 1906, by the Engineer School of Instruction with a form of native bridge used in Africa. The bridge is formed of a number of two-legged trestles, consisting of two standards connected together with a long foot-sill near their feet and a short transom near their tops, planks being laid along the transoms; the whole stiffened by longitudinal braces. It is only suitable for the passage of infantry in single file; but where trees of small diameter (from $2\frac{3}{4}''$ and upwards) are alone available, such a bridge might be useful. Rivers

* *Reviewer's Note.*—This corps consists of two classes:—(1) engineer and artillery ordnance officers, (2) medical ordnance officers. The officers of (1) are obtained from the sergeant-majors and colour-sergeants of the engineers and artillery, who supply the commissioned ranks of the transport company

should be left supported at first. Immediately after the original casing is removed the floor slabs should be temporarily shored and so left for at least a week. Shores should not be removed from under sides of beams for at least three weeks.

April 20th, 1907.

MEADOW ROADS IN CAPE MAY COUNTY, N.J.—The construction adopted for roads across the marshland to the various seaside resorts on the coast is not without interest. The marshlands consist of deposits of soft mud, frequently as much as 25 ft. deep, overlaid by a sod or crust of sedge or grass roots. In many places this sod is not strong enough to support a horse.

The system of construction adopted is as follows:—A foundation is laid of poles and stringers (*i.e.* apparently a sort of mattress) of sufficient area to support the weight of the soil filling and the "pavement," together with the stresses caused by traffic, without breaking down the meadow crust. The sides are protected from wash by curbing and bulkheading throughout the entire length on both sides of the roadway, besides a continuous line of mudbanks compacted along the outer side of the curbing. In more recent construction "ties" have been put in every 3 ft. of length under the pole foundations and spiked or bolted to the piling supporting the side curbing or bulkheading.

The formation is made up with upland soil and finished with a surface of shells and gravel to a height of 2 ft. above mean high-water line. The "paving" found most suitable so far consists of 5 in. thickness of oyster shells covered with 4 in. of gravel, and this has been found to stand the wash of storm tides well.

C. E. VICKERS.

JOURNAL OF THE ROYAL ARTILLERY.

May, 1907.

SIEGE ARTILLERY LESSONS FROM PORT ARTHUR, by Colonel E. G. Nicholls, R.G.A., gives a brief narrative of the events of the Siege, including a discussion of the reasons which first led the Japanese to attempt a capture of the Fortress by a *coup de main* and which, when regular Siege operations became necessary, led them to attack the eastern instead of the western section.

As regards the latter point the author says that, in selecting the point for the attack, the only general rule which can be laid down is that the choice should be made so as to reduce the place in the least possible time and with the least possible labour and loss. It is therefore generally desirable to attack either

(1) The weakest side, *i.e.*, the one likely to offer the least resistance,
or (2) The side which, from its inherent importance, will, if captured, lead to the surrender of the place.

At Port Arthur the western side, including 203-Mètre Hill, fulfilled both these conditions.

Colonel Nicholls enters into a valuable criticism of the Siege, more especially from the purely artillery aspect. With reference to the Engineer operations he considers that the Japanese sappers acquired their knowledge of siege work from experience gained in the Siege itself and had not been specially trained in this particular branch of their duties. There was a lack of method and science, and the absence of a capable guiding hand. Consequently the Japanese, in their eagerness and impatience, were always a stage in advance of the engineer. Thus

(i.). In August the assault was made before any ground had been broken.

(ii.). In October the forts were stormed before the engineers had got into the ditch.

(iii.). In November storming was again attempted before the engineers had got over the ditch and could arrange to blow up the escarp.

This want of high direction only led to a terrible waste of human life. In the end the fortress was not captured until the engineer works had been completed.

On the Russian side the vigour and determination of the defence seems to have been due to the personal supervision of General Kondratenko, and it was not until his death on 16th December that the Russians began to show signs of wavering. The engineer works were skilfully planned and executed, but the artillery positions were badly chosen. The experience of the Siege seems to prove that forts are no places for guns, and that the only weapons in forts should be machine or light Q.F. guns to repel assaults.

Attention is called to the employment by both sides of the old hand grenade and to the use of small bomb-throwing mortars. The grenade has probably returned to stay; for the deep, blinded, and traversed type of trench rendered necessary by modern gun and rifle fire prevents the effective use by the assailant of either bullet or bayonet.

Another remarkable feature was the universal use of telephones, the systems being carried right up into the firing line. Undoubtedly the telephone must play an important part in future siege warfare.

In conclusion Colonel Nicholls derives two great lessons from the Siege:—

(1). Now more than ever the capture of a properly fortified fortress, defended by good troops, can only be effected by resort to regular siege operations, which involve the expenditure of much time, material, and labour, and in which the art of the engineer and the skill of the gunner must first prepare and make possible the infantry assault by which alone final success can be achieved.

(2). Therefore it behoves the officers of every arm to learn the principles and methods of Siege Warfare, and to understand the limitations of the different arms, so that they may not through ignorance be led to embark on operations that must be foredoomed to failure.

A. T. MOORE.

NOTICES OF MAGAZINES.

Engineering Record.

March 9th, 1907.

Classification of Excavation and Embankment.—In America many controversies have arisen from time to time over prices to be paid to contractors for excavation and embankment work, mainly in connection with railway construction. In calling for tenders it is now commonly the practice to give only the number of cubic yards of excavation or embankment, leaving it to the contractor to make a price which shall cover all kinds of material taking the easy with the difficult. This is probably less advantageous than arranging different prices for the different classes of work in the way to which we are accustomed.

Certain companies do indeed classify to the extent of dividing into the categories of "earth, loose rock, and solid rock." But there are difficulties in defining the line of demarcation between these materials; for example, a common specification is "Rocky material which can be removed without blasting is loose rock, and that which cannot is solid rock." It is just the words *can* and *cannot* which prove stumbling blocks. In practice, says the author, it is nearly always cheaper to blast so-called loose rock than to pick or bar it apart; and again undeniably solid rock can be disintegrated by slow degrees without blasting (one can imagine the expert witness getting in some fine work here). Some solid material might be dug slowly by a steam shovel without blasting.

On the whole he thinks that the only satisfactory method of definition is the laying down of certain physical uniform tests, and the following are suggested:—

Earth.—Material which in its customary natural state can be ploughed, *i.e.* could be ploughed cutting a furrow 10" wide and 10" deep, the plough being drawn by a team of four horses or mules at reasonable ploughing speed.

Loose Rock.—Earthy or mixed material, not susceptible of ploughing as above, capable of being picked apart by two men serving, one man shovelling or loading by hand: solid rock in separate masses exceeding 1 cub. ft. each and not exceeding ½ yd. cube: use of explosives not barred.

Solid Rock.—Rocky material in masses, exceeding ½ cub. yd., which cannot be picked apart or displaced without explosives and cannot be barred apart by men working as above.

It is to be remarked that this classification does not provide any distinction between the very varying degrees of hardness of solid rock. The amount of time needed for preparing blast holes and the actual amount of blasting required to shatter or loosen the rock sufficiently to admit of its removal vary immensely with its quality.

The author also comments on the old practice of specifying that embankments "must be carried up in layers of two feet thick"—a practice commonly more honoured in the breach than in the observance.

Again, contracts commonly specify against subletting. He remarks rather pertinently "the sub-contractor exists because his services in detail as foreman, manager, or contractor, combined with his financial interest in results and his special plant, at times conduce to more efficiency than could be obtained in any other way."

April 6th, 1907.

INSTRUCTIONS FOR REINFORCED CONCRETE FIELD WORK.—The following hints are worth extracting:—

Casing.—All joints must be fairly tight, so as to prevent leakage of the liquid mass and consequent honeycombing in the concrete.

In making casings and centrings remember that the cost of timber is a large item of the total cost. With a little ingenuity and forethought repeated use can be made of each piece of timber.

Reinforcing Steel.—The steel as received should be checked, assorted, and stored. Steel should be free from loose scale, but a thin film of rust is not objectionable. Oil or paint coating is objectionable. Bars should be cleaned, if necessary, with wire brushes.

Placing Concrete.—Casings must be clean and free from shavings or foreign matter before the concrete is placed. The concreting ought to be carried on continuously. If it is necessary to cease placing the concrete, *e.g.* at end of day's work, the cessation in beams or girders should take place at the centre of the beam in a vertical plane or else over the centre of a supporting column, in the latter case making a vertical joint and allowing half the column to become a bearing for the adjoining beam. In slabs break the concrete over the centre of the beam.

Beams and slabs should be filled to their top surface at one continuous operation.

In building columns, the column box should be inspected by looking through from the bottom before commencing filling. In filling it is essential that air bubbles be expelled by puddling or joggling the concrete with a wedge-shaped rod.

Concrete must not be disturbed or walked over after it has begun to set.

The date of execution of each of the concrete portions of a work should be marked on the plans; and it is advantageous, for purpose of future reference, to make up a sample block, 6″ × 6″ × 6″, of the concrete used each day.

Removing Casing.—Before removing any casing the superintendent should personally satisfy himself of the condition of the concrete. It should not only show sufficient hardness but should ring when struck with a hammer.

At the end of not less than two weeks the posts supporting floor slabs may be loosened and lowered a couple of inches, being so left 24 hours while the slabs are inspected; the bottoms of the beams and girders of defence constitutes a weakness rather than strength, as the complicated works and obstacles in front relieves the attacker of all fear of a counter-attack."

Whenever the defence aims at obtaining a decisive victory one line of defence must suffice, in order that there may be at disposal a large mobile force; for in these days of outflanking movements a strong mobile reserve offers the best, if not the only, chance of ultimate success.

LAYING OUT POSITIONS.

The experience gained in these recent campaigns shows that, in spite of the improvements in firearms and the increased power of resistance they confer on the defence, no success can be obtained by a purely passive defence.

The Boers, soon after the campaign had begun, adopted an attitude of passive defence, which entirely robbed them of the fruits of their initial successes. Three times on the Tugela they repulsed the attack of the English relieving army, but never followed up their advantage. Thus they gave the enemy time to recover, and were themselves eventually forced to yield. During the seven days conflict on the north bank of the Tugela, the English were frequently repulsed and entire brigades retired in disorder, but the Boers were quite content with their momentary success and indeed granted an armistice. At other points of the line the English had gained possession of some of the works; instead of collecting all available forces to drive them out, the Boers allowed them, on account of the armistice, undisturbed possession of the heights they had won, and gave them every opportunity of preparing for further attacks. The only time the Boers attempted a vigorous counter-attack was at Spion Kop, where the English by a night attack had gained an important height in the Boer position; the Boers attacked them on all sides, and not only turned them out but induced the English general to give up his attempt.

In the Russo-Japanese war the passive attitude of the Russians was often the cause of their misfortunes. On the other hand the Japanese were exceptionally vigorous in defence. In the fight at Wafangku the Russians made a strong attack on the 3rd Japanese Division, which was entrenched; and the 2nd Brigade of the 35th Russian Division threatened to outflank the Japanese position. The Japanese at once sent out a cavalry brigade, which attacked and repulsed the Russian force.

Success can only attend a policy of activity and initiative, and the defence must have at disposal mobile forces not tied in any way to any particular position.

One of the most important lessons in fortification is to economise the force actually in the firing trenches in favour of a mobile reserve. The increased efficiency in firearms permits of greater economy in this direction than was formerly possible, as the front need not be so thickly occupied, and intervals are less a source of weakness than they used to be. *Points d'appui* must however be held in strength, and such points will be rare and only on the most important positions.

Another point of great importance must be considered when selecting a defensive position. Frontal attacks are now very serious undertakings, therefore the value of investment or outflanking has increased, and this must be carefully taken into account.

The flanks of a position now require increased attention. They must not only be well situated, but they must have an excellent field of fire, and wire entanglement or other obstacles should be erected round them in well-concealed positions. But the best way of securing the flanks of a position is by taking an active offensive at these points; if this is contemplated, great attention must be paid to the communications between the flanks and the position of the main reserve.

SIEGE OR OPEN WARFARE.

The student of the South African and Russo-Japanese wars cannot but ask himself whether Europe also is confronted with an era of siege warfare.

As far as the weapons now in use are concerned the answer must be in the affirmative, as modern firearms have so strengthened the resisting power of a well-entrenched force that a vigorous defensive policy holds out great prospects of success.

The excellent quality of the roads and communications in Europe lend themselves naturally to outflanking and investing movements, and such movements tend to the type of position warfare which formed the main feature in the two latest campaigns.

There is however a more important factor than the modern firearm to be considered in this connection and that is the quality of the personnel. It is more than doubtful whether the armies of European states will be able to withstand, as well as did the Boers, the Russians, and the Japanese, the nervous strain caused by the unceasing hail of bullets and shells from modern ordnance.

Frequent instances were reported from Manchuria of Russian soldiers going mad under the strain, and Russians are heroically brave in passive endurance. The Japanese also on occasions refused to obey the command to advance against the murderous Russian fire at Port Arthur. We cannot hope that European endurance will surpass that of Russians or Japanese.

In conclusion one more point which has some bearing on Field Fortification may be considered with regard to these two recent campaigns. Victory in each case lay with the side that displayed the greater energy.

British determination, in spite of mistakes and distances, ended in victory over a patriotic people who were at the beginning of the campaign better armed, more numerous, and thoroughly acquainted with the theatre of operations. The Japanese won in spite of the enormous strength of their rivals. But both Russians and Boers were lacking in energy or history might tell a different tale.

It is energy that will in the end always decide the fate of campaigns; and in considering the Field Fortification of the future we must bear in mind that all schemes for the shelter and defence of troops must be subordinated to the dispositions for adopting a vigorous offensive when opportunity offers.

C. OTLEY PLACE.

330 yds. wide, 16 ft. deep, and with a current of 10 miles an hour, have been crossed by this means. The article, which is continued in the February number, is illustrated by photographs, and treats the various cases in considerable detail.

HISTORICAL DOCUMENTS (18TH CENTURY).—Reprint of a "Memoir on the Exercise of Military Thought" by the Count of Schaumbourg-Lippe, Marshal of the Armies of His Most Faithful Majesty. Recommends officers to study their profession both by reading military works, and by solving military problems which are to be set them by the colonels of their regiments. Though published in 1782 the memoir bears a strong resemblance to the orders and regulations on the subject issued at the present day. It may be interesting to give a list of the works recommended :—

The Art of War, by the Marechal de Puysegur, 2nd Vol. especially.
Memoirs of the Marquis de Feuquieres.
The Instructions of the King of Prussia (Frederick the Great) to his Generals.
The Memoirs of Montecuculi.
The Military and Political Reflections of the Marquez de Santa Cruz.
Practical Art of War, by Ray de St. Genies.
Small Wars, by Grand-Maison.
A Treatise on Small Wars, by La Croix.
Field Engineering, by Clairae.

February, 1907.

SOME EXTRACTS FROM THE REPORT OF ENGINEER REGO LIMA ON HIS MISSION TO THE MINES OF CASSINGA IN 1898.—Continued from page 472 of the previous volume.—Cassinga is located on one of the tributaries of the Cunene in the Ambuella district of Angola. This portion of the report deals with the journey from San Pedro de Chibia to Quipungo. A good description of the country and its geological features.

HISTORICAL DOCUMENTS—CIRCULAR OF THE COUNT OF LIPPE CONCERNING SCHEMES AND EXERCISES FOR THE ATTACK AND DEFENCE OF FORTRESSES.—This circular was issued in September, 1773, to the Governors and Commandants of the principal fortresses of the kingdoms of Portugal and the Algarves, and directs them to prepare defence schemes for their respective commands, the schemes to be sent to the War Minister. Great stress is laid on their value, and the commanding officers are directed to mobilize their fortresses on the 1st or 2nd day of every month. The Engineers on these occasions are to point out to the officers commanding each work and covered way how the troops should be employed according to the different modes and periods of the attacks; what they should do in the covered ways, places of arms, ravelins, tenailles, etc.; the use of traverses, caponiers, counterscarp galleries, etc.; how the enemy's lodgments should be prevented; the dispositions for resisting all kinds of assaults; operations for retaking works that may have been lost; means of communication, and of retiring when it is impossible to hold out any longer. The whole circular is conceived in a most modern spirit.

M.

REVUE DU GÉNIE MILITAIRE.

March, 1907.

VENTILATION OF CONCRETE CASEMATES.—The system described consists of a centrifugal air pump, which delivers a stream of fresh air through a perforated pipe laid below the guard beds, with which the casemates are furnished. The minimum allowance of fresh air is 5 cubic mètres per man per hour. In the absence of any description of the French casemates, it is not easy to understand why so complicated a system is necessary.

UNDERGROUND SHELTERS.—The Japanese during the late war constructed a number of subterranean dwellings for their troops. The simplest were square or round holes 9 feet in diameter and 6 feet deep, roofed with millet stalks. The most usual form was a rectangular excavation 15′ × 12′ × 6′, covered with a roof of millet stalks and mud. At one end was a mud wall containing a paper window and a door, and at this end a ramp led down to the shelter. Several hospitals were constructed in a similar manner.

THE PURIFICATION OF WATER.—A large quantity of permanganate of potash is first added to the water; this destroys all microbes. To get rid of the permanganate some manganese sulphate is added, which causes all the manganese to be deposited as manganese dioxide, leaving only a small quantity of potassium sulphate dissolved in the water.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

March, 1907.

THE NEW TENDENCY OF SIEGE TACTICS AND PREPARED FIRE FROM FORTRESSES.—A long and able article by Capt. Ottolenghi of the General Staff. The general scope is antagonistic to a too rigid system for the preparation of fire from siege batteries in fortresses, as involving great labour and cost, whilst there is a chance that, when the time comes, it may be found impossible to employ the fire.

The prepared fire of to-day is an ingenious conception, which, when proposed 20 or 30 years ago by Colonel Bellini, was expected to give the best practical results in relation to the then prevalent ideas regarding the attack and defence of fortified places. Since then several lustres have passed. The technical procedure remains the same, but the tactical considerations have greatly altered and have conduced to entirely new views of the art of fortification and siege tactics. If siege warfare was carried on according to the principles which regulated it thirty years ago, and if at the same time artillery could only be employed from the places fixed at the end of a time of peace, no one would take exception to the prepared fire of to-day. But it is not so! In the face of the mutability of such an idea, and of the feverish progress incessant in all branches of military activity, a rigid technical system, which is not susceptible of rapid radical changes, which renders difficult the adoption of expedients in cases of unexpected emergencies, and which does not take into note that in siege warfare as in field operations the conduct of the operations should be essentially tactical, requires to be modified or abandoned.

With an over-rigid system the defender will not be able to take up positions selected at the moment outside and at a distance from the permanent works, and he will thus be unable to make use of his entire forces. It is exactly this selection of positions that cannot always be foreseen in time of peace, because it is frequently governed by the actions of the enemy. In positions hastily taken up it may not be possible to prepare the fire in accordance with the prescribed regulations, and this shows the necessity of preparing in time of peace, with great care, only what may be called the *constant elements* of fire, and of taking such constant elements as a basis for calculating *in a hasty manner* (in the time that may be available after the declaration of war and before the investment of the place) all the other elements necessary. For the determination of these latter a method should be adopted which can easily be modified or radically changed and adapted quickly to all the new circumstances, foreseen and unforeseen, in the defence of a fortified work.

THE EMPLOYMENT OF BALLOONS IN THE RUSSO-JAPANESE WAR is dealt with in the Supplement No. 95 (February, 1907) of the *Internationale Revue*. The Siberian Balloon Company, formed during the war, arrived at the theatre of operations at the end of June, 1904, and proceeded as soon as possible to join the Xth Corps. It had 90 wagons, 26 with the first detachment and 64 in a second detachment behind. After a very fatiguing march, much delayed by the bad state of the roads, the company was sent to Kudsia, 40 k.m. to the east of Liaoyang, on the left wing of the Russian position. At about 15 k.m. from Kudsia the balloon was inflated and the first ascent was made on the 23rd July, General Slutchewski, commanding the Xth Corps, being present. The Japanese positions, distant only 5 k.m., were fully reconnoitred, and it was possible to distinguish individuals. The company in accordance with orders came by Liaoyang toward Haitchang, but was not employed there because the Russians had retired.

Having been placed under the orders of the General Commanding the Engineers it again came into action on the 23rd August; and on the 31st it was able to observe the Japanese forces which were endeavouring to accumulate on the right Russian wing. Marshal Oyama himself admitted that he had been obliged to modify his dispositions owing to observation by the balloon.

The Japanese artillery from their well-concealed camp fired upon it with shrapnel. Some of the projectiles exploded very near to the balloon, both before and behind it, but without causing any losses. Later on it was again exposed eight times to a similar fire, but always without effect. This experience confirms the difficulty of hitting a balloon, and even when it is struck the effect is not necessarily fatal. The Russian balloon was a spherical one, silk, on the Riedingen system.

On the 1st September the balloon was again utilized for taking observations, and sustained the enemy's fire without being struck, although the projectiles aimed at it were a source of danger to the IVth Siberian Corps in its rear.

The Company arrived at Mukden on the 6th September, 1904. Later on it participated in the offensive movement on Scia-ho, accompanying the advance guard of the Xth Corps. On the 5th October the balloon made a few ascents, and observations were made of the positions of the enemy's batteries. It was again fired at several times without any effect except a small wastage of the gas.

The Company then returned to Shahepu and Peitapu. Three crosses of St. George were awarded to it for its brilliant services.

On the formation of the IInd and IIIrd Army Corps of Manchuria it formed the nucleus for the Aeronautic Battalion of East Siberia.

Little experience was gained in the employment of balloons in fortress warfare. At the commencement of the siege Port Arthur did not possess any, and some material sent in the skiff *Mancuria* was captured by the Japanese. During the siege Lieut. Lawron constructed a spherical silk balloon and a canvas kite, but the material used was ineffective. Later on there was a failure in the supply of gas.

The Japanese also adopted a balloon of special construction; but they were far from obtaining satisfactory results. It was of little use for observing the movements of the enemy's ships; and the observations made were not sufficiently accurate to enable them to regulate the fire of heavy artillery. It was only after the capture of the 203-Mètre Hill that they were able to obtain a direct view of the Port and bring an effective fire against the Russian ships. If the balloon service had been better organized, it might have rendered unnecessary the capture of this hill, which was taken at such great sacrifice.

The experience gained from the employment of balloons in the late war has not been very rich in results; but it has shown once more that the pack wagons should be as light as possible, and that hostile fire cannot easily place balloons out of action. It is more important to note that in all cases an improvised service is of little value; only a complete organization, fully experimented with in time of peace, can give good results in war.

EDWARD T. THACKERAY.

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Scouting and Reconnaissance in Savage Countries, by Capt. C. H. Stigand, Roy. West Kent Regt., author of "Central African Game and its Spoor." In pocket-book form, with scales on cover, and blank ruled pages. (7 × 4. 5s. Hugh Rees).

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