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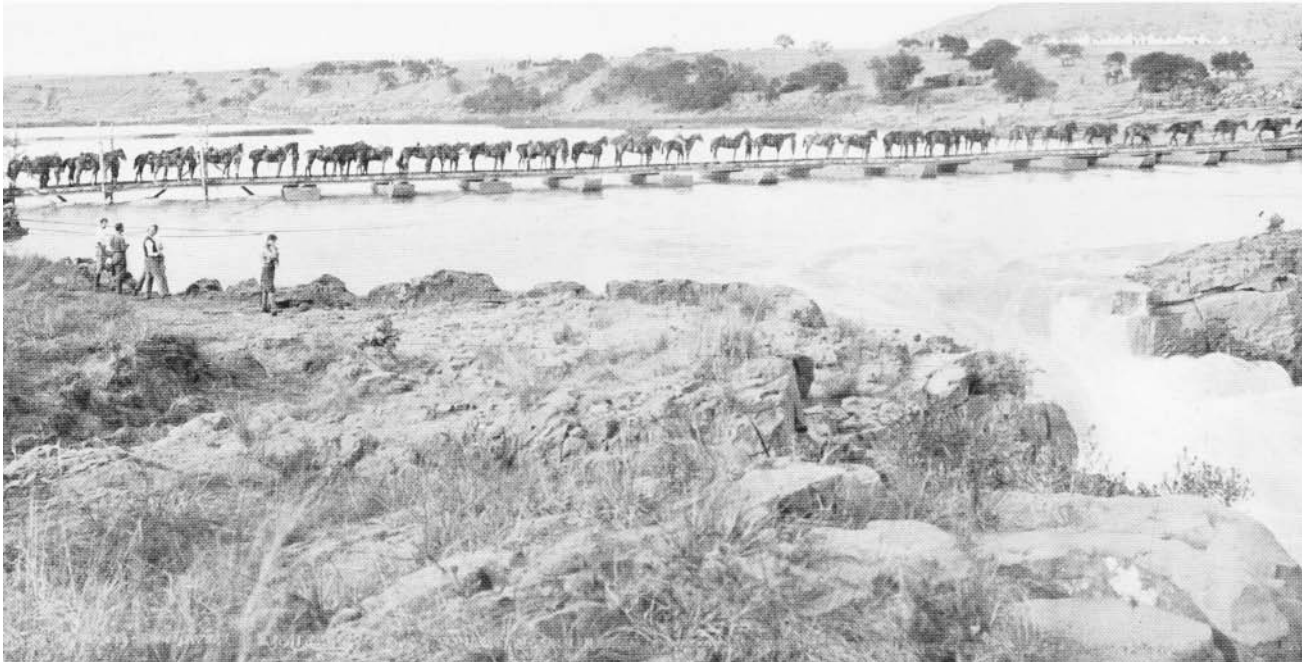
"Heavy" pontoon bridge below Tugela Falls.
Boer causeway about 200 yds. above Falls.

Heavy Pontoon Bridge



Heavy Pontoon Bridge

THE FUTURE OF THE ROYAL ENGINEERS.

By MAJOR A. T. MOORE, R.E.

A DIRECT invitation to contribute to these columns on the subject of the training and organization of the Royal Engineers has resulted in a mild epidemic of *cacoëthes scribendi*, which is evidence of the healthiness of our corporate body and augurs well for the vitality of its principal organ. This outbreak has doubtless been occasioned by the knowledge that a private Committee had been appointed by the War Office to consider the future of the Corps; and the development of the literary scarlet fever may possibly assist in the diagnosing of the disease from which the Corps is suffering—or, rather, supposed to be suffering—and for which the Committee is no doubt expected to find a cure. I say supposed disease because, as a point of fact, the body of the Corps is in excellent health; it only requires some new clothes, a few modern patterns of headgear, and some suitable campaigning boots.

The correspondence having progressed thus far, it may be found useful to recapitulate and amplify some of the main arguments which have been submitted by other writers and add a few further considerations.

IMPRUDENCE OF IMITATING CONTINENTAL MODELS.

First and foremost, change for the sake of change is mischievous. It is unsound to attempt to organize our small British Army on the model of the huge systems on the Continent. The conditions of the recruiting and foreign service of our Army are totally different to those of any other; our forces are liable to serve in peace and war in every part of the globe, from the deserts of Northern Africa to the glaciers of the Himalayas, under climatic, physical, and other circumstances many of which cannot be foreseen. Hence we must proceed on independent lines.

To begin with we must have a greater proportion of engineers than in other armies; these engineers must be artisans, and the majority must be "handy men." There appears to be a school of thought that considers it advisable for our engineers to be modelled on the water-tight compartment system of the German Army. On the other hand, curiously enough, one hears, on equally good authority, that the Germans, having found by recent extra-European experiences that their water-tight compartment system is unsuitable, are seriously thinking of transforming their field engineers (pioneers) into handy men like ours.

WAR ORGANIZATION THE FIRST REQUIREMENT.

Military engineers must be organized and trained for war. We are soldiers first and engineers afterwards, but only to the extent that our peace employment on civil engineer work must be limited to what is useful training for us for the diverse war purposes of the British Army; in other words we are soldiers as well as engineers. Once these elementary facts have been acknowledged the rest will be comparatively plain sailing. Having established a proper War organization we must adhere to it in Peace. In peace every officer and man must first of all be trained for war; when this training has been effected, the personnel can be employed in the manner that will be most economical to the state.

SPECIALIZATION AND DISMEMBERMENT.

Specialization and decentralization are in themselves most desirable virtues. But like other good things they may be carried to extremes. When applied everywhere and for everything, regardless of corollary circumstances, they tend to duplication of staffs and to other extravagances. An absolute specialist is not so useful a person, at any rate in the Army, as one who, in addition to his expert knowledge, possesses some acquaintance with other trades.

Our personnel, certainly our officers, should be 'Jacks of all trades and masters of one,' in addition of course to that one trade, the 'field engineer,' which constitutes our primary right to exist. Every individual, having mastered field engineering, should learn the elements of the various other duties which the Corps is called upon to perform on active service; and he should then definitely take up one of these other duties as a speciality—*e.g.* Machinery, Telegraphs, Ballooning, Railways, Search Lights, Survey—, on which he might always be employed when there is a vacancy for him in that particular branch. When not so engaged he should be utilized in one of the two normal employments of the Corps, that is either with a non-special (*e.g.* field engineer or fortress) unit or on constructional engineering (see below).

The same universality may not perhaps be so desirable for the rank and file, nor possible in the case of short service enlistment. But for officers it is distinctly advantageous; and our so-called specialists have over and over again proved the merits of our versatility by showing conspicuous talent as field engineers on finding themselves in tight places.

Specialization, moreover, may lead to dismemberment of the Corps, though there is no valid reason why this should follow. We have enough branches in the Army as it is; we must have 'the three arms,' their transport, provision, and pay services, their ammunition and matériel supplies, their medical and veterinary aids; but there is

no ground for assuming that the Royal Engineers cannot carry out all the other technical work required.

It must be remembered also that, if the Corps is permanently divided up into separate compartments, *each* compartment must be sufficiently strong for all its probable tasks; hence the total establishment must be largely increased. Under the 'handy man' system, however, any non-special unit can assist another of a separate branch, or even be converted to other uses, as Fortress Companies were for Railway construction in the South African War.

Even if the engineer units are to be specialized, there is no reason why they should not all remain Royal Engineers under one expansive organization, just as transport and supply are included in the Army Service Corps, and medicine and surgery in the Medical branch, and as Horse, Field, and Garrison gunners are still Royal Artillery.

We may now proceed to consider details, but in general terms only. Readers will kindly attribute any semblance of dogmatism to the writer's desire for brevity.

STRENGTH AND ORGANIZATION.

The war strength of the various units comprised under the generic title of Royal Engineers must be based on the above-mentioned axiom that we must have a larger proportion of technical troops than is usual with other armies. At present the proportion is less.

It seems to be generally conceded that there should be one Field Company (with water supply, map reproduction, and telephone repair equipment) to each Infantry Brigade and one Field Troop (with similar equipment) to each Cavalry Brigade; and a Bridging Company, a Balloon Company, and a Telegraph Company to each Infantry Division. The number of Railway and Reconnaissance (or Survey) units cannot be laid down with similar confidence based on experience of our normal war requirements; but the maximum likely to be required should be maintained. There is even less experience to work on with respect to Field Search Lights; the recent war in the Far East has brought to notice the necessity of a telephone organization (either separate or embodied in the combatant units) in the actual firing line; and no doubt Wireless Telegraphy will also be established in the near future.

Over and above all the units mentioned, corresponding with the organization of the strictly combatant units of a Field Army, there must in our case be a considerable number of others for service in fortified posts at home and abroad. These "Fortress Companies" now include the units of the defunct Submarine Mining service.

It appears to be unnecessary and undesirable to organize these units on the basis of a Field Army. The circumstances of the various 'places' are different, and each must be treated independently in the light of

its particular objects and conditions. In some cases the units are required only for the purpose of local defence; in others there is a possibility of their employment as field units in a reinforcing contingent despatched to a theatre of war elsewhere.

It is a question well worth consideration whether the sections allotted to the operation of Fixed Search Lights should not be combined with the Fortress Artillery and the Naval Submarine (including Mining) establishment with a separate Coast Defence Corps under the Admiralty. The personnel of such a Corps might usefully be liable to service afloat, on the principle that in taking up a position for defence it is advisable to look at it from an enemy's point of view. If interchangeable with Naval personnel for the same duties, they might form a valuable reinforcement to the Navy. In any case this system would result in a much-to-be-desired unity of control in our defended ports.

In addition to the whole of the above, and equally necessary, there must be surplus staffs and personnel, chiefly officers, to carry out an unforeseen amount of work on Lines of Communication and for the military occupation of a conquered territory and also the hundred and one equally unforeseen jobs that crop up during such warlike operations as are usually the lot of the British Army. This surplus might be obtained from civil life when required; but the employment of civilians as a reserve for military engineers in war would cause much more dislocation in the engineering profession than the system of having surplus military engineers engaged in peace time on civil work. Moreover a civil reserve would be unreliable as to numbers, and necessarily less efficient than a military surplus trained for war.

One very important point with respect to organization is the necessity of engineers being represented on all Army Staffs, from that of the Army Commander to that of the Brigadier; this is essential in order that engineer work may be foreseen and properly co-ordinated with strategy and tactics. It is obvious that the engineer representatives must be of suitable rank.

FIELD COMPANIES *v.* PIONEERS.

It has been suggested in some quarter that our Field Companies might be reduced to the quality of Pioneers. But this would be a retrograde step, taking us back to the days of the Peninsula War, when our predecessors were criticized as being 'good zealous regimental officers, but not practical and scientific.' Our capabilities in the field are now of a much higher order; and this progress has been due to the fact that our men are artizans and our officers educated in the details of the building trades.

Instead of levelling us down to Pioneers, our aim should be to level the Infantry upwards to the point of rendering them capable of

carrying out all the spade work of ordinary field fortification without assistance. The Field Companies, R.E., would then take their proper places as advisers and instructors in questions of field defence, their actual work comprising the artizans' share of fortification and also map reproduction, instrument repairing, water supply, and other duties of a technical nature.

EQUIPMENT.

Equipment is, for the present, a minor question. It can only be decided on the basis of actual war experience, and those who have the most experience of active service in any one branch of the Corps are the best qualified to decide for that branch.

The only details that it appears necessary to refer to here are :—

(1). The question of enabling field engineers to be carried on the march whenever there is work for them at the end. It is not advisable to have them mounted on horses, nor is it required that they should all be carried at one and the same time; but it is obvious that a man who has been carried over all or portion of a march will execute better work, and do it quicker, than one who has trudged it throughout.

(2). The possibility of reducing the number of patterns of R.E. technical vehicles (or, at any rate, of their parts) and tool boxes by standardization.

(3). The necessity of the horses and drivers of technical vehicles remaining an integral permanent portion of the technical unit, instead of, as in the German army, being provided by the Army Service Corps (Train).

EDUCATION OF OFFICERS.

The basis of our education must, for reasons given below, consist of a thorough grounding in constructional engineering. This might be preceded by a sufficiently long training in the 'art of war' (strategy, tactics, military history, law, and organization, etc.); and should be followed by an exhaustive course of field engineering proper and by elementary courses in the more special duties of the British military engineer. Having been set down on the main road to handiness, every officer should be encouraged (so far as the requirements of the service generally will permit) to deviate into one of the special branches and gain expert knowledge therein. As many as possible might, later on, be given a further practical training in construction by being attached to large engineering and contracting firms, in the same way as some now are to the great railway companies to learn traffic and locomotive details, but for longer periods.

WAR TRAINING AND PEACE EMPLOYMENT.

As stated above the first consideration is training for war.

In the case of the really special units, that is those whose duties have nothing quite analogous in civil life,—*e.g.* Ballooning, Search Lights, Reconnaissance, and Wireless Telegraphy (possibly also ordinary Telegraphy)—this war training must embrace their whole employment in peace. This would apply also to special sections of Fortress Companies. It is this whole-hearted, continuous, one-purpose training that made the late Submarine Mining service one of the most efficient in the Army and is the cause of the competence of the Telegraph companies.

For the other units continuous war training is not essential. After carrying out annually a sufficiently comprehensive course of field engineering (whenever possible in conjunction with 'the three arms'), and in the case of Bridging and Railway companies a further or a partly alternative course in these subjects, they could be employed during peace on work that is reproductive to the State, *i.e.* on what may be termed public works. This is the best training to produce 'handy men.'

Such peace employment could be arranged, if once the general public recognized that war training is the first duty of the engineers as of other branches of the Army, and that any work done for the State during peace time after completion of the war training was a net gain to the State. At present the financial point of view appears to be that time spent on war training by the engineers is a net loss to the State; that the Royal Engineer, because he is better paid than other soldiers—as a matter of fact his pay is not very much higher than that of some other Corps—can only be tolerated so long as he justifies his pay by spending the greater part of his peace time on work that is not his best training for war. It is forgotten that this higher rate of pay is due to higher qualifications, as in every other walk of life. The Garrison gunner gets more pay than the Field gunner, because his scientific attainments are greater; similarly the Cavalryman receives more than the foot soldier; but no one expects all these, and others, who receive more wages than the unit representative—the Infantryman,—to spend a portion of their peace time, representing the difference between their wage and the unit wage, in recouping their extra cost by neglecting the work for which that extra cost was originally sanctioned.

The ultra-military school amongst civilians takes the opposite view that the Royal Engineer should do no work in peace that has not a direct counterpart in war.

As regards the commissioned ranks it might be possible to second officers for tours of service in the Board of Trade, Local Government Board, and Office of Works at home and in similar departments

in the Colonies ; or to employ experienced ones as resident engineers on behalf of the State at all large works in course of construction out of State funds.

At the same time every opportunity should be taken during peace training and manœuvres of employing Royal Engineers in conjunction with the purely combatant arms. It is only by such mutual intercourse that the combatant arms can be taught to appreciate the value of engineers and to use them with proper effect, and, on the other hand, the engineers taught that their true *rôle* lies in proving that "Science is the Handmaiden of War." The personnel of Field Troops and Companies might well be distributed, during the squadron and company training of cavalry and infantry, amongst the units of the brigades to which they belong. The 'surplus' engineer officers, employed on civil engineering, could be kept in touch with war duties by being attached to staffs or to regular engineer units during combined manœuvres.

CONSTRUCTIONAL (OR CIVIL) ENGINEERING.

There remains the normal employment in peace of the personnel required in war surplus to the needs of the regular units. This surplus will consist mostly of officers ; these cannot be improvised when war breaks out, whereas subordinates of adequate capabilities probably could be found in sufficient numbers in the civil engineering profession.

The best training for this surplus, as well as for the non-special units in their spare time, is constructional engineering. In no better way is it possible to obtain that experience in the control of men, money, and materials which produces the judgment, self-reliance, resourcefulness, and adaptability to circumstances on which the reputation of the Corps has been established.

A sound knowledge of building construction and design, in practice and theory, is necessary for the proper understanding of a great deal of military engineering ; and such knowledge is especially required in us for the proper utilization of our men, who are artizans.

Fortification being a purely military subject, it is obvious that this work ought to be entrusted to military engineers.

Barrack construction and, possibly, maintenance might also be in their hands ; partly because a soldier is probably better qualified than a civilian to judge of the requirements of a soldier ; and partly because barracks are in many places closely associated with works of defence, and it is wasteful to have two separate organizations, working independently and possibly antagonistically as to prices, within the same small area. Lately we have seen barrack construction in the army—at home only at present—removed from the control of the Royal Engineers, and maintenance left in their charge. On the other hand, the Admiralty continues to place Royal Engineer officers

in charge of the design and construction of naval barracks and works, but employs civilians to maintain them. It is the wide experience obtained in construction that we require, not the narrow monotony of maintenance; but whether the construction is to be of barracks or of purely civil works is immaterial.

Apart from barracks there is a wide field for the employment of our surplus officers on State works at home and in the Colonies; and every endeavour should be made to procure them such employment. In India, under an appreciative administration with a continuous policy, numbers are employed on Railways and Public Works; and the wisdom of this system has been exemplified time and again by the efficiency of such officers when called upon to carry out works on active service. When and if the restriction of our education and training at home renders us no longer fit for employment on such works, the Indian Government will presumably find it necessary either to afford us a further schooling on its own account or to depend largely on civil engineers for war purposes.

ADMINISTRATION.

The Headquarter Administration in peace must correspond with the Headquarter Staff in war. Hitherto the Corps has suffered in a militant sense in that its chief technical representative at the War Office, the Inspector-General of Fortifications, has perforce been compelled to devote most of his time to that portion of his duties which was most exposed to financial criticism, the administration of works. Hence active service needs have necessarily received less attention than they deserved.

We require at headquarters Directors of the various branches of the Corps which have a separate organization in war, viz.:—Chief Field Engineer, Director of Telegraphs, Director of Railways, and Director of Surveys, all with nucleus staffs. Each of these officials should be an expert in his branch; and each should be subordinate to that member of the Army Council who represents in peace the officer of the Headquarter Staff of an Army in the Field to whom he would be responsible in war.

This system of decentralization might be carried down to the local Commands, wherever there are sufficient troops (in war organization) to justify the procedure. But this is not essential; the main desideratum is to ensure our war requirements being kept in the foreground during peace by proper representation at headquarters.

We must also have an agent to control the enlistment of the men and the distribution of the personnel generally to the various branches. This official has at present no place with an Army in the Field; his duties in the field are now carried out by the Chief Engineer, who has sufficient work of his own to perform; he should have an equivalent in war.

In addition to the above four Heads of Branches and Head Agent, there must of course be an official in the very important position of Director of Fortifications and Works, to supervise what has been aptly termed the 'surplus officer department.'

A useful adjunct to the whole—but independent of them all, and attached possibly to the Military Operations Division,—would be a properly organized and well-manned R.E. Intelligence Bureau. The duty of this Bureau would be to keep the Corps in general in touch with changes and progress in the technical troops of foreign armies by means of periodical bulletins; similar information might be afforded with reference to ourselves, for one half of us is now ignorant how the other half lives and what it does. Officers responsible for any work of exceptional interest within the purview of the five technical branches above-mentioned might well, on its completion, be placed temporarily on special duty to draw up a detailed report for the benefit of others and for permanent record. This procedure is followed with much advantage in India; elsewhere at present there must be a considerable waste of intellect through officers carrying out schemes *ab initio*, either because they are unaware that anything of the same description has been previously executed or because no details of such previous efforts are obtainable. The same practice of reporting would apply to the engineer work in all military operations, and to any particularly serviceable use of engineers on peace manœuvres. All information collected by the Bureau, which is deemed worthy of general dissemination, would be printed and issued at public expense; the comparatively small cost would be amply repaid.

We might even go a step further and place this Bureau under the officer occupying the Presidency of the R.E. Committee, who in this case would have to be absolved from all other duties. This same Committee might be reduced to three experts—electricity and machinery, field engineering, building construction—similarly devoting their whole time to the many intricate subjects that come under consideration.

THE CORPS AT THE BAR.

Ever since the institution of Constitutional Government it seems to have been the privilege of the spending departments of our naval and military forces to be called to the bar of public enquiry. At first sight it is difficult to see why civilian departments of State, most of which are spending in a greater degree, should have remained exempt. Possibly it is by reason of the ancient jealousy of a standing army on the part of the people; or because the militant departments alone have had their deficiencies exposed by the stern test of war; or because the taxpayers get a more visible and more personal result from the expenditure of other departments.

The Navy is now free from the strangling net of public apathy. The Nation has realized the need of a strong Navy as a purely

economic question of national insurance; the Navy demands the money it requires, gets it, and spends it in its own way. Some day the public may further realize that a navy without an army is only half a weapon, and then the Army will come into its own.

The Corps of Royal Engineers, being most in evidence amongst the spending branches of the Army, though by no means the greatest spendthrift, has had its full share of enquiries. Omitting those of which the evidence taken and the consequent report have remained unpublished, it is safe to assert that they have all resulted in an endorsement of the merits of the Corps and an increase to its numerical strength. It often follows on enquiry that a servant of the public, much abused as extravagant and inefficient, is found to be in reality a conscientious, hard-working, sorely-tried individual, who does the best he can with the materials at his disposal and whose shortcomings are not of his own making but the result of restrictions imposed upon him by others.

That the Corps, nurtured on constructional engineering as the essence of its peace employment, has been a success in war is proved by its corporate and individual services in practically every campaign since the Royal Warrant for its establishment, and by the prowess of its ancestors in earlier times. That it has also been of benefit to the State in peace is evidenced by the numerous engineering works of importance which have been executed by it or under its supervision in all parts of the Empire, often when no other agency could have carried out the work at all. That it has been a good school for the highest branches of State employment might be proved by a mere recital of the names of the many eminent engineers and administrators whom it has produced; though many of these attained fame in extra-military employment, yet the fact of their having been brought up in the Corps has added to its prestige and has attracted others of similar calibre to take their places. The truth of these statements will be patent to anyone who reads our two latest biographies—*The Life and Times of Major-General Sir James Browne* and *The Life of Sir Andrew Clarke*.

CONCLUSION.

Some of the other contributors to these columns have hidden their identity under a pseudonym, on the very justifiable pretext that views expressed on such matters as the above should be considered on their own merits without reference to the rank or office of the writer.

Being debarred as editor from taking a similar course, I wish to state that I am in no sense behind the scenes as regards the terms of reference to the present War Office Committee and the decisions at which that Committee are likely to arrive. I have only entered the lists from motives of *esprit de corps* because I have served long enough to feel certain that either over-specialization on the one hand or over-militarilization on the other would be our ruin.

THE ORGANISATION OF THE CORPS.

By 'SILEX.'

IN the November number of this *Journal* 'Nemo' gave us a most interesting article to ponder over. As the Yankee would say, he gets down to business: this is what we want.

The science of Preparation for war has been shown us by the Japanese to be

(1) What the late Lord Salisbury called "the intelligent appreciation of events *before* they occur" and

(2) the businesslike preparation to meet these events: viz., by examining localities, drawing up lists of probable works, with the detail of staff, materials, and training required for execution.

Lord Lansdowne recently made the epoch-making statement that in future the foreign policy of the nation must be definite instead of nebulous; that it must be a policy of embodied principles, of objects with alliances to further them, instead of the old drifting or negative state of "glorious isolation." The Liberal Party, and public opinion generally, may be said to have confirmed this conclusion already.

This change in the political ideal is of first importance to the army. It promises that policy will be more definite, and that, therefore, military preparation will be possible in more decided directions as to likely wars. The work of the Defence Committee has, doubtless, done much to educate our statesmen to this conclusion, and the army may find itself called upon to emulate the Japanese in practical preparation. If so, in no field of activity will more be required than in that entrusted to the Corps of Royal Engineers. It is, therefore, essential that we should put our house in order and be ready to comply with coming demands.

1. WAR REQUIREMENTS.

'Nemo' gives us a clear division of R.E. war duties, viz.:—

(1) Duties of R.E. Field Units working in conjunction with the field army—

(*a*) Duties foreseen and specially organised: field works, bridging, etc.

(*b*) Handy-man duties, trade skill works.

(2) Duties for Special Services behind the field army: to assist, or free the field units to advance—

Administration of Districts, base works, lines of communications, etc.

The whole of these 'Nemo' places under the Chief Field Engineer of the General Staff; because all energies must be directed to one end—the defeat of the enemy in the field. We may accept this as the best arrangement for war.

2. PEACE PREPARATION.

Following the above we require :—

(1) An organisation to study probable campaigns, and work out what will be required from
  (*a*) R.E. units, (*b*) Special services.
(2) An organisation to guide R.E. training and employment in peace to meet these probable duties in war.

'Nemo' invents the term "Surplus Department" to cover the activities of R.E. officers and staff not in Field units. This term, as he will probably admit, is likely to mislead. In no sense are such duties *surplus* in war. They are essential. A better designation—and we want one—would be "Special Service Department."

3. PEACE ORGANISATION.

Here the writer must part company from 'Nemo,' who gives us in peace a Special Service Department too much divorced from Field units. He places the former under the Master-General of Ordnance; the latter under the Chief of the General Staff. Instead of this we require an organisation that will be practicable, that will work these branches together as far as possible, as in war; and which will bring both under the direction of the authority which studies war requirements. 'Nemo' will probably assent to this as desirable, provided the old trouble he mentions is guarded against, viz., the undue subordination of training in war requirements to the meeting of peace exigencies. The sole object of C.R.E.'s must not be to *get works done*, with the R.E. *anywhere* in the scheme; but to adjust the works so as to *train the R.E.* This can only be done with the consent of and proper organisation at the War Office.

Leaving the Railways under the Q.M.G., where they belong, the following is suggested as the War Office grouping :—

Chief Engineer of the General Staff.
1. Director of Field Engineering.
2. Director of Telegraphs.
3. Director of Surveys.
4. Director of Special Services.
  (*a*). Fortifications.
  (*b*). Other Military Works.
  (*c*). Civil employments.
5. Director of Engineering Intelligence.

The above might be under the Chief of the General Staff, though it would be more just to the Corps if the Chief Engineer were himself on the Army Council, and better for that body too.

The great point is that the 5 headings given above require to be co-ordinated under a Chief Engineer because they must largely act together in peace, and can assist each other in training for war. A few remarks as to the functions of branch 5 will make this clearer.

DEPARTMENT OF DIRECTOR OF ENGINEERING INTELLIGENCE.

1. *Training Section.*—Receives and compares the reports of training and works of the Corps; and under the direction of the Directors 1 to 4 circulates all useful information. Also keeps in touch with the Railway Branch, with R.E. Committee, and School of Military Engineering.

Example.—A special service officer is employed on bridges, and reports on useful devices for repairing iron girders in war. Report passed to Director 1, who decides to circulate it to Bridging Companies. R.E. Committee asked to provide for experiments.

2. *Intelligence Branch.*—Collection of engineering information for possible war operations. These would be designated by the War Office Intelligence Department.

(*a*). Ports and Landing-places abroad are indicated. Information collected as to local supply of materials, best way of importing stores, prices and markets. Existing piers, stores, water supply, etc., and estimate of additions likely to be required.

(*b*). Other Works up country. Likely centres for hospitals, etc., and information as above.

(*c*). Probable Special Service Staff for various campaigns, and arrangements to mobilise.

(*d*). Intelligence affecting Field units *re* waterways, bridges, roads, soil for fieldworks, woods, local tools and materials, etc., in various countries.

The utility of a Chief Engineer would be assured by his being continually reminded of the requirements of war by review of this intelligence work, for he would see what would probably be wanted from the Corps in war. He would then take good care that the training and employment of Units met this, and would hold the balance between the exponents of what an Engineer soldier should *look* like and what he should *be*. He would direct and support the Chief Engineers of Commands in this matter of training. They would consult with their C.R.E.'s as to each year's programme of work for

(i.) Field unit duties.

(ii.) Special service duties and works for trade skill.

In conjunction with the Staff this programme could be drafted. For such periods as could be arranged the branches of the Corps would be brought together as far as possible. It is surely unsound to divorce them altogether. In practice we have to provide for the many stations where R.E. units *must* perform all-round functions, and the work be evenly distributed. Even if practicable, separation would not be good. A Special Service Department whose junior personnel was exempt from military duties would tend to become civilian and to forget the war service reason of its existence; whilst Field Units, cut off from works, would tend to degenerate into pioneers.

FIELD UNITS' TRAINING.

We must sympathise with the desire to shine on peace manœuvres. It is essential that the Corps should work with other arms in peace, and very good for those other arms as well. But we cannot afford to overdo it. Manœuvres offer little opportunity as a rule for trade skill—for what the Sapper mostly does in war. In a few years the Cavalry and Infantry will lean very little upon us in the matter of Field engineering. We can improve our methods and the following suggestions, often mentioned, seem worthy of attention.

1. Annual field works to be carried out on manœuvres with other arms.
2. Where this is not possible, the programme of work to be based on a tactical scheme, *i.e.* siting, etc., for a definite use.
3. Evolution of fieldwork drills to replace most infantry drill for all R.E. but recruits. Examples:—

   (*a*). Given a tactical scheme. Extending over a position and laying out works, distributing stores, measuring and estimating clearings, obstacles etc.; calculating for Infantry parties and their control.

   (*b*). Given sketch of a standing camp. Laying out blocks, running out a water supply of galvanised piping (any sapper can be taught to do this).

Such drills would be more interesting to an inspecting General than a feeble infantry repertoire, though they would be done with few words of command after telling off. Their great utility would be the demonstration that the smart bracing moral action of drill can be imported into such work of useful nature. The idea requires to be dissipated that the motions of trade skill must be of the slack and sloppy order.

SPECIAL SERVICES.

1. Officers on special civil employments of a nature useful for war. These might be open to officers who have passed for promotion to Captain, and who have qualified in the training described later as "Superintendence." It is of very doubtful utility to send young officers through special courses before this.
2. Works connected with the army, such as Fortifications and Barracks. It is here that every officer should acquire the knowledge by *practice* of Superintendence. It is the kind of engineering essential for war, and should guide
   (*a*) The general education in construction at the S.M.E.
   (*b*) The conditions of R.E. employment on works.

If the Reader will now cast his eye over Appendices I. and II., he will see what is meant by Superintendence. He may gather that these statements attempt to provide for war exigencies, for they are, in fact, based on experience of large works during and after the war in South Africa. R.E. officers were then called upon to display their general engineering skill, organising powers, and business experience as to civil methods and market resources, often to the extent of a monthly detailed expenditure of £10,000. There was no War Office scheme, there were no detailed plans of sites, etc., no detailed estimates, and no large contractors to do the work. This is the situation to be expected in war, and for which we should be trained.

It may be said that most of the training indicated could have been obtained in peace under the normal system of Division work at home. To this it must be replied that in practice it never has been. It is time to look facts in the face; to consider, not what officers *should* do, but rather what they have done, and are likely to do. The first lesson of statesmanship is to take account of human nature as it exists in the sinful state, and not to legislate for a community of angels. We may ascribe to original sin what is deplorable in the following statements:—

(1). Intelligent officers will not display keenness in unintelligent work. Such is the duty of watching contractors execute the designs and estimates of other people, when without authority to do anything.

(2). They will learn little as to organising works and business methods if a contractor does it all.

(3). They will learn little about market prices and types of stores if they never have to select stores because War Office contracts, etc., allow no latitude.

(4). They will learn little as to economy of labour if they do not make small contracts themselves and watch R.E. and civilians on piecework.

(5). Summary—no power, no interest: no interest, no efficiency.

The above ideas are not new, but are merely a statement of what has often been said in excuse for the full-blooded and vigorous who neglect their "bricks and mortar." There is no reason to take up a hopeless attitude, to say that works at home *cannot* be made instructive and so we had better do without them. Such are the counsels of Despair. The enlightened policy of "applied knowledge" is being pushed in the training of most branches of the army, and in promotion examinations. The great results already attained have astonished everyone. It may, therefore, be taken for granted that any well-thought-out scheme facilitating similar training in *applied* engineering on works for the officers and men of the Corps would have the approval and support of the highest authorities at the War Office, and the sympathetic concurrence of our civil masters in addition. No one will deny that the Engineer with only theoretical knowledge is about as much use to the army in war as the book tactician.

"Nemo" does not say definitely that the Field Units should not be employed during peace on works, where Superintendence can be learnt by the Officers and the raw artisan youths enlisted attain skill and experience at their trades. But his scheme makes no adequate provision for such training. He appears content to secure a pioneer training only for the men, whilst the Officers get what engineer training they can by circulating through the "surplus" department. Are the units to be employed on works at all; and if so, where is the controlling authority to adjust the rival claims at stations of pioneer and engineer training? These claims have to be adjusted, and it appears that the trouble has hitherto been that we have lacked a good organisation at Headquarters to make this adjustment, to study the requirements of each, and provide what is necessary to meet them. Hence, we find the advocates of pioneering discontented, alleging that field duties are sacrificed to Works; whilst the champions of engineering grumble that Works are not organised in a way to develop the engineering qualities demanded in war. The present writer believes that both requirements can be met in the manner he has indicated; and that the *rôle* of engineer is the more important, since it includes that of the pioneer. Moreover, the rapid advance of other branches of the army warns us to raise our centre of gravity in the scientific scale, not to lower it towards the pioneering *rôle*.

The ideal we have inherited is not that of a Pioneer Corps but of an Engineer Corps, with an historic roll of achievement too long to be inscribed upon any single banner. It is, surely, not for us to resolve this noble inheritance of unlimited boundary into the walled enclosures of a group of pioneer bodies with their soul-less programmes of occasional effectiveness. If prone to do so, let us honestly own that we be pigmies who find the shoes of the giants before us too large for our diminished proportions. For, when such a catastrophe overtakes us we may truly say "Ichabod"—the glory has departed.

APPENDIX I.

SCHEME OF TRAINING.—OFFICERS.

GROUP I. OBLIGATORY.

A. Subjects now required for promotion.
B. S.M.E. Courses.
C. Superintendence—(*a*). Theoretical—S.M.E.
(*b*). Practical—3 years on works. (In or attached to Field Units).

GROUP II. SPECIAL.

1. Works, including Fortifications.
2. Water Supply and Drainage, including pumps, septic tanks, etc.
3. Electric machinery, motors, search-lights, lighting, etc.
4. Steam machinery.
5. Railways and Roads.
6. Telegraphs.
7. Bridges.
8. Surveys and Map reproduction.

REMARKS.

(i.). No officer to take up Group II. until passed as efficient in Superintendence.

(ii.). Officers then to submit to Group II., being given their choice of subjects as far as possible.

(iii.). After reasonable opportunity of becoming "Master of one" subject in Group II., officers to be encouraged to keep up their qualifications as "Jack of all trades," especially in 1, 2 and 7.

APPENDIX II.

SUPERINTENDENCE.—PART I. THEORETICAL.

1. OFFICE WORK.

1. Clerking:—Registration and correspondence; dealing with other departments and staff; general survey of books of Regulations; hints on practical points.
2. Finance:—Powers in, and methods of procedure.
3. Draftsman's Office:—Records; distribution of work; sun printing.
4. Approximate Estimates; Tables on the "square" system for each trade.
5. Business:—Home market for supply of materials; catalogues; leading firms; prices and discounts; trade newspapers; conditions of delivery and acceptance.

2. ORGANISING FOR PROJECTED WORKS.

1. Hints on sites; preliminaries to consider as to lands, water rights, drainage disposal, etc.; site plans.
2. Staff to be collected, and what duties to be clearly laid down; office requirements.
3. Hints on collection of materials; arrangement of stores and yards; police and fire precautions.
4. Workshops; hints on small plants and labour saving machines types and cost.
5. Management of transport on works.
6. Labour camps and sanitation.

3. EXECUTION.

1. System of laying out details and verifying sites.
2. Storekeeping and upkeep of stores; sawmill regulations.
3. Distribution of work; methods of supervision.
4. Hints on daywork, on piecework, and small contracts.
5. Tricks of various trades as to materials and labour.
6. Infantry working parties, organization and payment.

SUPERINTENDENCE.—PART II PRACTICAL.

1. Office Work.

Officers to see and initial files before P.A.'ed. To be exercised in making approximate estimates on the "square" system and comparing with detailed estimates as a check.

2. Organising Works.

Officers given small works to execute instead of contractors by lump sum. Make small contracts by trades, or distribute work by piecework to civilians and R.E. Estimate profits by keeping records of work done (by square system) for money earned and compare with prices given. Arrange duties of staff, provision of stores, working of transport, etc.

3. Execution.

Officers given latitude as to choice of materials and prices. Study market and civil outside practice.

Officers given latitude in fixing fair rates of labour by piecework and daywork.

4. War Office Control.

By visits—(*a*) to give advice and assistance, (*b*) to control by inspection of Results.

W.O. Inspector of Works, assisted by

A. *W.O. Information Bureau.*
   (*a*). Type designs Branch.
   (*b*). Market supply, lands, contracts, etc., Branch.

B. *Consulting and Travelling Inspectors* who are specialists for
   (*a*). Designs and materials.
   (*b*). Water supply.
   (*c*). Drainage.
   (*d*). Electric lighting, gas, machinery.
   (*e*). Organisation, contracts, lands, finance.

These travelling Inspectors circulate information between Districts, and also keep the W.O. up to date.

ORGANISATION AND TRAINING OF FIELD ENGINEERS.

By 'QUOTA.'

SOME interesting articles on this question have been published at various times, but they all appear to assume that the organisation of R.E. units should be based on war considerations. It may sound almost like a paradox to question this assumption ; and yet I venture to think that, to make any practical headway in the matter, it is better first to consider our peace conditions.

Under ideal circumstances, with a treasury pouring out gold into the army coffers, it would be folly to allow anything to stand in the way of making our organisation as perfect as possible for war ; but unfortunately these circumstances are ideal ; economical efficiency is more likely to be the watchword of the future than real efficiency. It remains for us to make the best of the matter, and to become as efficient as possible for war provided always no large peace expenditure is entailed. The question whether the policy is sound or unsound is not a subject for discussion ; the fact remains that it is the actual policy ; and that being so, it must occupy a position of first importance in any discussion on organisation in the army.

There is no doubt that this is perfectly well realised by the army in general, and that many an elaborate scheme, after being propounded and discussed in army circles, is finally crushed by someone observing that economy forbids. It would be much better to start with this principle instead of introducing it at the end to demolish castles in the air. Applied to our Corps it reduces the question of how best to organise R.E. units for war to how best to organise R.E. units for peace and still leave them as efficient as possible for war.

To answer this question is a very different matter to propounding it. To answer it perfectly would be to produce a scheme whereby R.E. units performed efficient and economical public service of an instructive nature in peace time, and yet remained able to leave this work for occasional periods of military training, and eventually, when war broke out, to drop it altogether and take up effectively the numerous war duties of R.E. troops.

Such economical peace services are particularly difficult to find for

units organised in anything approaching large numbers. It may occasionally be possible to employ a company as such on useful work in peace time, but the opportunities of doing so are extremely rare. The only really practical way out of the difficulty seems to be to reduce the peace strength of R.E. units to skeleton dimensions and devise means for filling up this skeleton in time of war.

The system of reservists of course effects this to some small extent, but there seems no valid reason why this system should not be carried much further. There are some special reservists who have never served in the regular army at all, and who join the regulars only in war time; such men did particularly good service in the South African war. While not advocating an exactly similar arrangement I should propose something on the same lines but on a much larger scale.

Special reservists would form by far the majority of the R.E. companies. They would pass through their recruit's training as volunteers, or perhaps as regulars doing a six months' course in the Training Battalion, and would then at once join the reserve. Instead, however, of their never serving with the units in peace time, it would seem possible to arrange for their joining company headquarters for, say, a month's training every year.

The company headquarters would then consist of some 20 N.C.O.s and men under one officer. The remainder required to bring it up to war strength would be employed on their technical work in peace time, and would be usefully gaining experience at their trades; they would either be in government employment, or on some of our large railways, or perhaps with some big firm of contractors. To compensate these employers for the inconvenience of losing their men for the yearly training or for war, and to induce employers to engage special reservists, some small subsidy should be allowed by government, just as is now done to register horses. To compensate the men for their military obligations, they should receive a retaining fee as reservists do now and a comparatively high wage while training or on actual service.

The expense entailed by this would be more than covered by the large reduction in the number of regulars. The civilian employers would not necessarily suffer much from the annual loss at the training periods, because each company in any particular branch could do its training at a different time.

The method of training and employing the N.C.O.s offers more difficulties. These, however, might be drawn from among those who have served in the regular portion or nucleus of each company; and as, owing to their small numbers, it would be possible to afford them a good rate of pay, it should attract a very good class from whom to select. In order to ensure a sufficient supply, N.C.O.s could be drafted into the reserve after a comparatively short service,

and there continue to receive advances in promotion. Each company would of course retain its own reserve with its own N.C.O.s.

Under these conditions it would be possible for N.C.O.s and men to become thoroughly acquainted with each other in peace time; and in war time, instead of nearly half the company being suddenly formed of reservists who neither know each other, their N.C.O.s, or their officers, a company would already be in the eminently desirable condition of the happy family.

The ordinary reserve required to make good casualties would be maintained as it is at present, only a smaller number would be required.

No provision has been discussed for training in larger units than companies because, although this is greatly to the advantage of the officers, nothing of importance is thus gained for the N.C.O.s and men. While training, however, the company would be at full war strength, and this is at present an unattainable desideratum.

The employment and training of the company officers is a much more difficult question, and it is on the possibility of effectively arranging this that such a scheme as the one proposed must largely depend. The officers of each company should, as far as possible, train with it in the annual course, and in the meantime they must somehow be usefully employed. A greater use of the present system of giving civilian or semi-civilian employment, with a regular period of company routine work, might meet the case. For instance, in addition to the officers permanently with the company, at least one other might be employed (as Division Officers are now) in such a way that a month's course a year would be possible. To make up the full establishment a greater number of officers than is now the case would have to be lent for purely civil occupations. These would be unable to take the regular month's course of training each year, but would instead be compelled to do purely military service for at least one year in five; while they were on civil work army funds would of course be relieved, though possibly a subsidy might again be necessary in the shape of part payment from army funds. It might also perhaps be arranged for junior officers to be attached to regiments for a year or so after leaving Chatham, to go through the regular routine of regimental duties; and, being freshly imbued with the latest ideas, they might be useful for fieldworks instruction.

There is yet another point to be considered and that is the employment of the company nucleus when not training. It may be assumed that this would consist of picked men of a high educational standard, encouraged by good pay and prospects of joining the non-commissioned ranks. The usual company routine would be reduced to a minimum because of the small numbers to be dealt with, and great facilities could be given for more advanced training and instruction.

In conclusion I should like to add that, as no real solution of the question can be arrived at without exhaustive discussion and criticism, there has been no attempt to suggest more than the merest outline of a scheme for R.E. organisation; that this scheme could only be applied by degrees; and that it would of course be unsuitable for units, such as the Bridging and Balloon Companies, which are organised for specialised war services.

THE FORTRESS INCUBUS.

By COLONEL E. M. LLOYD, LATE R.E.

A DISCUSSION has been going on in *The Times* under this heading which is of some interest to officers of the Corps. It was started on September 9th by 'Our Military Correspondent,' the writer of the luminous articles on the Russo-Japanese war which have been lately republished.

In the first months of the war he argued forcibly against any attempt on the part of the Japanese to drive the Russians completely out of Manchuria. By getting possession of Port Arthur, Korea, and Vladivostock they would 'sever the vital chord,' and put an end to the dominion of Russia in East Asia. "Port Arthur in Japanese hands is unassailable by land; Korea can be defended for the greater part by a chain of defensive works across the 100 miles of the narrowest part of the peninsula on the principle of Torres Vedras; even if Vladivostock cannot be held indefinitely against the might of Russia, which remains to be proved, it can be stalemated and rendered useless by the occupation of the islands commanding the entrance to the port."

If the loss of these places would be the loss of East Asia it would seem to follow that Russia was right to hold on to them. But in April the Correspondent spoke approvingly of Dragomiroff's advice, that Port Arthur should be evacuated. In June he described it as a 'marine trap,' likely to prove the ruin of the Pacific squadron and of the Russian strategy on land. He recalled the words of Lord Salisbury in 1898:—"I think Russia has made a great mistake in taking Port Arthur; I do not think it is of any use to her whatever." Lord Salisbury was no doubt looking at the matter from a political point of view, and was not free from bias. Sir George Clarke, no devotee of fixed defences, remarked at the time:—"There is probably no naval or military officer in this or in any other country who would agree with this opinion. . . . For the moment Port Arthur and Talienwan are no sources of strength. In less than ten years the Russian position in Manchuria will be unassailable, and Port Arthur, having regard to its geographical position, will be quite as strong as Cronstadt or Sebastopol. In substituting Port Arthur for Vladivostock as her principal naval station in the Far East, Russia gains immense advantages" (*Russia's Sea Power*, p. 152). He assumed, of course, that the necessary steps would be taken to turn

these advantages to account. He credited Russia with an energy and ability which have been more conspicuous on the part of her antagonist, and he reckoned on a margin of time which was not allowed her.

But even under the actual conditions Capt. Mahan held that Port Arthur was a valuable asset. In the middle of August, 1904, after the failure of the last sortie of the ships, he wrote :—"Whatever the cause and wherever the fault, Russia, though much the greater in ultimate resources, permitted herself to drift into war unprepared, and gravely inferior in force upon the decisive scene of conflict. This was especially the case upon the sea, the control of which was, and has continued, so absolutely essential to Japan that apart from it she would be helpless for the offensive action she had to take. Under these circumstances two things were necessary to Russia—delay in order to gather her resources, and promptitude in repairing the neglects of the past. Herein appears the importance of Port Arthur : it has obtained delay. The time occupied in the siege has been ample for a government which recognized that the whole Japanese movement turned upon the control of the sea, to have despatched a fleet which by this time could have reached the scene, and very well might have turned the scale—allowing only for the fortune of war."

"If the Japanese decide to attack Port Arthur," said the Correspondent (June 15th), "we shall witness either the apotheosis, or the unregretted demise of the first-class fortress." It seemed not unlikely at that time that Metz and Sedan would be repeated on a smaller scale, that Port Arthur would soon fall into Japanese hands and Stackelberg's relieving army be cut off. These things, however, did not happen. Port Arthur held out for eight months, and its garrison paralysed three or four times their own numbers. By so doing they were of the utmost service to Kuropatkin when he took the offensive in October and fought the battle of the Shaho, and they gave the Baltic Fleet, which was then leaving Libau, more than two months to reach the Pacific.

Seldom has expenditure on fortifications been more fully justified, if we recognize that it is their part not to gain victory but to gain time. But the result did not lead the Correspondent to admit that he had made a mistake. He continued to argue that Port Arthur had been an incubus to the Russians and ought to have been abandoned : "Port Arthur has been a far worse entanglement to the Russians than Ladysmith to the British in South Africa" (December 17th). The comparison reminds one that, if Ladysmith had been provided with siege guns in storm-proof batteries when it was made a store depôt, it would have been no entanglement at all.

Since the war came to an end the Correspondent has gone on from the particular to the general. He allowed at first that "fortification, intelligently employed and kept in its proper and very subordinate

place, is useful," and that naval arsenals should be secured against raids. It was the creation of a vast place of arms defended by 30,000 men and 400 guns that he quarrelled with (June 15th, 1904). Perhaps reflection showed him that if the thing is worth doing at all it may be worth doing effectually. At any rate, in his article on 'The Fortress Incubus' he is not careful to discriminate between the different classes of defensive works. He appeals to history to show that "fortresses, forts, and fortified positions are nothing but an incubus"; not a single instance is given to exemplify the right use of them.

In his comments on Turenne's campaigns Napoleon wrote :—"Il est des militaires qui demandent à quoi servent les places fortes, les camps retranchés, l'art de l'ingénieur; nous leur demanderons à notre tour comment il est possible de manœuvrer avec des forces inférieures ou égales sans le secours des positions, des fortifications, et de tous les moyens supplémentaires de l'art." In his remarks on Rogniat's book, he said that Vauban's system of fortresses had saved the capital when Louis XIV. met with reverses, and again in 1793, and that Paris itself ought to be fortified. While field fortifications are "always useful, and never hurtful, if they are intelligently made," he was against relying on extemporised fortresses (places du moment) as Rogniat proposed; they would need very large garrisons and their ill-protected magazines would be destroyed by shells.

Ignoring these well-known utterances, the Correspondent called Napoleon (as he also called Vauban) as a witness on his behalf, and quoted a passage from a letter to Eugéne Beauharnais (January 20th, 1807) :—"Les places fortes sont souvent embarrassantes, affaiblissent une armée, et sont la cause de la perte d'une bataille ou d'une campagne." A guileless reader might conclude that the Emperor is here discouraging his stepson's *penchant* for fortifications; nothing of the kind. Napoleon had told Eugéne four months before to put Osopo, on the upper Tagliamento, in a condition to stand a siege. It should be capable of defence by 500 men, but fit to receive ten times that number. He was dissatisfied with the project which Eugéne sent him, and it was in criticising it that he incidentally made the above remark.

This is a fair illustration of the Correspondent's method of argument. A review of the great war from 1792 to 1815, made in the same one-sided manner, is said to show that armies and countries were either ruined by fortresses or drew from them no serious advantage, and this lesson is said to be confirmed by the war of 1870. The article drew several letters in reply; some (from naval officers) supporting its conclusions, others calling in question the writer's version of the facts, or bringing forward fresh ones. Of the many points raised only a few can be touched upon. Colonel Hale dissented especially as regards the latter end of the war of 1870, 'the People's war' :—"Admitting,

but solely for the sake of argument, or rather of avoiding argument, that during the first war the three fortresses he names, Paris, Metz, and Belfort, were each an 'incubus,' we find in the second war that, but for the counterbalancing influences of social and political passions, and of military incompetency in high places, the fortresses of France, including in that term Langres and the northern fortresses, would have proved to be the salvation of France."

'Minimus' pointed to St. Jean d'Acre as an instance of a small place which had arrested Bonaparte, and Fort Bard as one which checked him and threatened to baffle his plan of campaign. The Correspondent dealt with these two cases at some length and with some asperity (September 23rd and October 14th and 23rd). He denied that Bonaparte's discomfiture at Acre was due to "the rotten walls and towers of that miserable seaport"; it was due to the British navy. This could only mean that the walls were superfluous, and that the Turks, with the aid of Sidney Smith's sailors, could have beaten the French army in the open field. He went on to argue that, having taken three places out of four, Bonaparte had practically done what he wanted to do, and it was time for him to go back to Egypt. The two months' siege, the eight assaults, the loss of men and prestige, Napoleon's own language about 'cette misérable bicoque' were left unnoticed.

As to Fort Bard he accepted Napoleon's statement that it did not delay his march for a day. We know that Berthier discovered on May 19th that Fort Bard presented a 'very serious obstacle'; that Lannes was told that the fate of Italy and perhaps of the Republic depended on its capture; that as he could not take it, he was sent on by mountain paths to hold the mouth of the Val d'Aosta as best he could with infantry alone; and that it was in the night of May 24th—25th that the first French guns (two 4-pounders) were taken through the street of Bard under the guns of the fort. Whether this actually meant delay or not matters little; there must have been something wrong with the works or with the garrison for such a thing to be done at all.

Of the defence of Genoa by Masséna the Correspondent said:—"There is nothing to show that all the great results of the Marengo campaign would not have been as well or better obtained had Masséna retired upon Suchet instead of holding Genoa and being forced to capitulate." This, as 'Minimus' pointed out, was not Napoleon's opinion. He wrote to Masséna that he had a fine position at Genoa, which he should make the most of, to engage the enemy's attention while the reserve army was descending into Italy. He should keep four-fifths of his men there, and not fret about his communications with France. So in his comments at St. Helena Napoleon blamed Masséna for not having drawn Suchet to him. The wish to get possession of Genoa, which was known to be starved out,

detained nearly half of Melas's army there for ten days after the reserve army had reached the plain of Piedmont. In a work lately issued by the German General Staff (*Die Festung in den Kriegen Napoleons und der Neuzeit*, reviewed in the July number of the *R.E. Journal*) the defence of Genoa is given as an example of the right use of a fortress, to further the plan of campaign by self-sacrifice if need be.

Torres Vedras, which the Correspondent had proposed eighteen months before to take as a pattern for the defence of Korea, now came in for its share of disparagement.

"The virtues of the parapets of Torres Vedras have been exaggerated. When Wellington retired upon these lines he collected within them 120,000 men of the armies of three nations, 70,000 of these consisting of regular troops, while Masséna began the invasion of Portugal with only 56,000 men and 100 guns. The defence of 50 miles of fortification, containing 150 forts and 600 guns, was a source of anxiety to the British commander, and when the French came upon the ground, on 10th October, 1810, there were eight or nine miles of the first line of works without garrisons. But for Reynier's sluggish action, they might almost have been captured without a fight." Here the Correspondent suggests, without saying it in so many words, that Wellington was quite strong enough to beat Masséna in the open field, that there was no need for him to fall back on Lisbon, wasting the country and driving in the population, and that the works behind which he sought shelter were in fact a danger to him. It would be a heavy blow to his reputation if this were true. Yet Napoleon, when Foy reported the situation to him in November, said :—"Lord Wellington s'est comporté en habile homme ; cette désolation totale d'un royaume est l'effet de mesures d'ensemble habilement concertées. Je ne pourrais pas faire cela, moi, avec toute ma puissance." Lord Roberts gives this retirement into the lines of Torres Vedras as one of the instances of Wellington's masterly combinations which took the enemy entirely by surprise.

General von der Goltz says that if the Turks had followed Wellington's example in 1877 the Russians would have been forced to retreat.

It must be remembered that in March, 1809, less than two months after Moore's army had been driven out of the Peninsula, Wellington had ventured to affirm that Portugal might be defended, whatever might be the result of the contest in Spain, by 60,000 regular troops, half of them British, assisted by 40,000 Portuguese militia. Six months later, when the war with Austria was coming to an end, and there was reason to expect that the whole force of France would be brought to bear on the Peninsula, he again declared that Portugal might be held, or that at all events the British army could be brought away. It was then that he began his works at Torres Vedras, and

any judgment upon them must take account of the possibilities at that time, and not merely of the force which Masséna actually brought against them. Wellington stood almost alone in his confidence. As Lord Liverpool afterwards wrote :—"All the officers in the army who were in England, whether they had served in Portugal or not, entertained and avowed the most desponding views as to the result of the war in that country," and leading members of Wellington's staff wrote home in the same strain.

But if we look only to the actual invasion Wellington's strategy was fully justified. In September, 1810, the French had 280,000 men present under arms in the Peninsula. Masséna had 65,000 men with him, according to Napier, and a corps of 19,000 men was to follow him. He also counted on assistance from Soult. Wellington had only 50,000 men, of whom half were newly-raised Portuguese, when he made his stand at Busaco. He could trust his troops to hold such a position against direct attack, but not to manœuvre in open country against an enemy twice as strong in cavalry; so when the position was turned he fell back to Torres Vedras. There he found reinforcements which brought his regulars up to 66,000, and the Portuguese Militia served to garrison the works. Masséna, who had lost 5,000 men at Busaco, did not venture to attack them. He waited for reinforcements, which reached him in December but did not make up for his losses by sickness.

Whether Wellington should have taken the offensive at that time, when he had the advantage in point of numbers, is of course a separate question, which has little to do with the Lines. "It has been suggested in Germany," says the Correspondent, "that Wellington's failure to crush Masséna, in view of the British general's superiority of numbers, should rather rank as his greatest failure during the war." Wellington discussed the question fully in a letter to Lord Liverpool (December 21st). He came to the conclusion that it was better to leave Masséna alone, although there was a good prospect of success if he attacked him. "Our business," he said, "is not to fight the French army, which we certainly cannot beat out of the Peninsula, but to give occupation to as large a portion of it as we can manage." When Masséna retreated to Spain in the spring he had lost 30,000 men.

We suffer in England, according to the Correspondent, from "our thoughtless predilection for so-called strong places, chiefly owing to the absence of a trained General Staff, and of the resulting doctrines based upon careful and impartial study of the art of modern war." The work already mentioned (*Die Festung in den Kriegen Napoleons und der Neuzeit*) shows how widely the doctrine of the German General Staff differs from the views which he puts forward. It maintains that railways have given fortresses, both large and small, a new value, and that all officers should

concern themselves with siege warfare more than they have done hitherto. The Correspondent says that in 1870 "the French fortresses played an important part in the ruin of their army and their country," and he mourns over the blindness which led France to spend 67 millions after the war on fortifications and armaments. Why does he omit all mention of Germany, which has been strengthening her fortresses from that time to this, is now making an outer chain of forts at Metz, and is building forts near Basle to guard against a French invasion by the gap of Belfort? In fact, as Colonel Henderson has said, "since 1870 it has been recognised that preparation of the theatre of war is one of the first duties of a Government. Every frontier of continental Europe is covered by a chain of entrenched camps. The great arsenals are amply fortified and strongly garrisoned. Strategy has as much to say to new railways as trade; and the lines of communication, whether by water or by land, are adequately protected from all hostile enterprises" (*Science of War*, p. 15).

There is not much sign at present of a predilection for strong places in England. The absence of a trained staff with a settled body of doctrine tells, but in another way: it makes military opinion unstable, and tempts brilliant writers to go all lengths in whimsical paradox.

It is an old maxim, if you have a weak case abuse the other side's attorney. The Correspondent indulges freely in gibes at the Troglodyte school, "who have misdirected our efforts for half-a-century." Engineers, he says, are good servants but bad masters. This is putting the saddle on the wrong horse. It is a question of strategy, not of engineering, whether, and to what extent, particular points should be occupied. Of course engineers are as much entitled as other soldiers to form and express opinions on that question; but does anyone suppose that Napoleon, for instance, left them to settle it? Troops must separate to live and move, yet concentrate to fight; that is the great problem of the military art, and its solution depends on ever-varying conditions. No one laid more stress than Napoleon on mustering in strength on the field of battle; yet he left 150,000 men behind him in German garrisons when he retreated across the Rhine in 1813. It was part of his theory, though not always of his practice, that garrisons should consist of troops not fit to fight in the field and should leave the field armies undiminished. When the strategist has settled what detachments he will make, what points he will hold, it falls to the engineer to do what he can to enable small forces to hold those points securely; and no unprejudiced critic will deny that he can do a good deal.

LANDSCAPE DRAWING FROM A MILITARY POINT OF VIEW.

By Col. L. G. Fawkes, late R.A., with Note by Capt. R. F. Jelley, R.E.

In reply to Capt. Vickers' question in the April number of the *R.E. Journal* I venture to think that the art of landscape drawing has the following military uses :—

(1). Panorama sketches of country occupied by the enemy, as seen from an advanced position, would be a very great help to the officer commanding a force, giving him an idea of the character of the country over which he was likely to move.

(2). Such sketches are most useful in enabling ranges to be picked up quickly. Lieut. R. H. Thomas, R.G.A., showed me a panorama excellently drawn by him when he was in charge of a 4·7″ gun in the war in South Africa ; the ranges to the successive ridges were shown on the sketch, which represented the whole surrounding landscape divided into sections of 10°, the bearings being marked ; the ranges had been ascertained either with a range-finder or by trial shots.

(3). Outline panorama sketches were much used in the South African War as a quick method of indicating an objective. In this kind of sketch conspicuous points, such as houses, trees, etc., should be carefully drawn so that there can be no difficulty in identifying them.

(4). As the art of making topographical sketches educates the eye for ground, so the observation necessary to make an intelligent landscape sketch practises the eye in seeing gentle slopes, which are often unobserved but are very important for an officer who is to teach his men to make use of ground.

A knowledge of the principles of perspective will be found essential and will often save a man from being misled by the deceptiveness of ground.

Parallel lines, such as the sides of a road, furrows, telegraph posts, etc., are often met with ; and when these recede from the eye their vanishing point should be looked for, as it is only thus that the slopes of the ground can be correctly given in a sketch. For example, if the slope ascends from the observer, all receding parallel lines on that slope will have their vanishing point above the horizon ; if it descends, the vanishing point of these lines will be below the horizon.

In *Fig.* 1 there is a watercourse crossing the footpath *abc* at *b*; and in *Fig.* 2 there is a ridge crossing the footpath *def* at *e*; the angles at *b* and *e* would indicate this at once to an observer standing on the other side of the footpath. In these figures V, V_I, V_{II}, V_{III} are the several vanishing points, and HH′ the horizon.

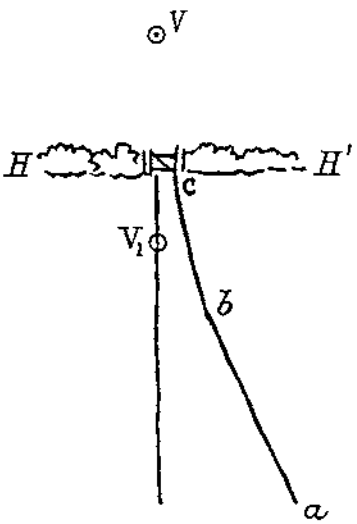


Fig. 1.

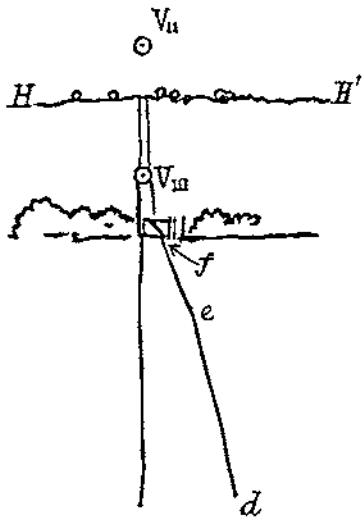


Fig. 2.

In such sketches no time should be wasted in unnecessary shading. Characteristic lines should be selected. Every line should be drawn with deliberation and have a meaning. An unmistakable representation of every feature of tactical importance, such as artillery positions, folds of ground, farms, woods, roads, railways, etc., should be aimed at rather than an artistic sketch.

No near foreground is required, and this simplifies the drawing of trees. The conventional sign for trees in topography can be used, care being taken to make their size proportional to their distance from the observer. Where avenues of trees or edges of woods recede from the observer, they should be placed behind one another as in *Fig.* 3.

Fig. 3.

The accompanying *Plate* shows outline sketches of the battlefields of Woerth, St. Privat, and Spicheren as examples of this kind of work.

In forwarding the above remarks, kindly written for the *R.E. Journal* by Colonel Fawkes, I venture to anticipate two points that may be raised in objection to landscape drawing from a military point of view.

The first is that a camera might take the place of a landscape sketch; and the second is that landscape drawing cannot be efficiently undertaken by any but good draughtsmen.

With regard to the employment of a camera, there is (disregarding the mechanical difficulties of apparatus and reproduction) a great difference between the military values of a photograph and a landscape sketch. The "base" (*i.e.*, the distance between the point of sight and the picture plane) in a photograph is so short that, in order to see the view in true perspective proportion, the photograph must be held uncomfortably close to the eyes. In a sketch, the "base" can be fixed at such a length as to obviate this objection; the length of one's arm forms a convenient and excellent "base."

As regards accuracy, the freehand sketch should and can be easily made with absolute accuracy. As Colonel Fawkes points out, only the characteristic lines should be selected; so that, instead of the bewildering detail of a photograph, a clear and vivid picture is obtained.

With regard to the necessity of being a good draughtsman, this is quite an erroneous idea. With a little patience and effort, a poor draughtsman has nothing to fear about being able to turn out a useful and intelligent sketch. A little consideration will show him that a landscape sketch can be *mechanically* constructed with absolute accuracy.

As a first essay, let the poorest of draughtsmen use a plane table and draw rays to the guiding points in any view. Let him then rule an "horizon," which will be intersected by the rays. The vertical distances from the horizon are then plotted by observing the gradients and laying off the required proportion of the rays.

From these leading strings, he can soon fearlessly advance to the method of holding up the pencil at arm's length and measuring in this way. It will soon be evident that landscape sketching from a military point of view is one of the easiest and most useful methods of training the powers of observation.

R. F. JELLEY.

A TIME-ALTITUDE AND SOME OTHER DIAGRAMS.

By CAPT. D. BRADY, R.E.

AMATEUR astronomers, like other amateurs, are very keen about rigorous precision. The probable error of their observations may be ten seconds or more, but they work out their results to decimals of a second of arc. By the time they have become good observers their tedious computations have killed their keenness; and then, instead of using five-place, or even four-place, tables of logarithms, and ceasing to bother about fractional corrections, they simply cease observing and presently forget all about it. For work-a-day use few people want to know the error of their watches to the last second, or the very precise azimuth of a star.

I do not know of any book or pamphlet that describes graphic methods for solving spherical triangles, that is on a flat drawing-board without computation. Perhaps then the following examples may be of interest.

Results good enough for many purposes may be got by using a good straight-edge, a good protractor, and a sharp pencil, and drawing *big*. It would be absurd to suppose that for precision drawing can compare with calculation. Still, when much may depend on a result and it is therefore calculated, a diagram made with moderate care may not only serve as a useful check against *gross* error but also show, by the boldness of the intersections, whether the observation was "well-conditioned."

Like other graphic methods, the drawings may be used as mere diagrams, and the precise values of the angles computed; but as they are not specially arranged for the use of logarithms, the computation may not be the shortest.*

ϕ is the Latitude.

δ is the Declination of the star (or sun or planet). δ is treated as positive when the observer and the star are both north of, or both south of, the equator; it is to be counted negative when the observer and the star are on opposite sides.

t is the Hour-Angle, that is the arc of the equator separating the meridian of the observer from the meridian of the star.

* The first and second diagrams, with a few lines added, fully represent the ordinary formulæ for $\sin^2 \frac{t}{2}$ and $\sin^2 \frac{\Delta}{2}$.

A is the Azimuth of the star. In the examples it is reckoned from the pole nearest the observer. Astronomers reckon from the other pole; so if the ordinary astronomers' azimuth is required, the supplementary angle must be taken.

h is the true altitude of (the centre of) the star, that is the observed altitude (corrected for instrumental errors) + parallax − refraction. Parallax and refraction may be ignored in graphic solutions.

The Apparent time must be corrected for the difference between Mean and Apparent time (the "equation of time"), and for the distance in longitude (at the rate of 4 minutes for each degree) between the place of the observer and the standard meridian.

To use the Time-Altitude card as a star-finder, all that is necessary is that it should be gummed or tied to the telescope so that the "shadow-line" is parallel to the the telescope. Of course the declination scale and the time scale must be extended to suit the stars wanted. By the use of the Time-Altitude card the altitude is pre-determined; it is only necessary to swing the telescope to find the star.

I have given no detailed explanations with the diagrams; readers of the *R.E. Journal* are not likely to want any. Those interested will no doubt invent other diagrams to suit their particular problems.

*WITH THE PONTOON TROOP IN NATAL, 1899—1900.**

By Bt. Colonel J. L. Irvine, R.E.

PART III.—VAALKRANTZ.

After the retirement from Spion Kop the Pontoon Troop moved to Spearman's Hill, and on the following day, January 29th, returned to its former camping ground near Potgieter's Drift. Increased rations were issued to the whole force, and for the next week the bulk of the troops took a good rest. We busied ourselves repairing and rearranging our equipment, and on the 1st of February threw a "heavy" pontoon bridge (No. 3) across the Tugela at the cutting where the pont usually worked and where the bridge had been thrown across before. In the meantime the 17th and 37th Companies, R.E., were busy blasting and making a road up the south side of Zwaartkop, a high hill to the south-east of Potgieter's Drift and overlooking Skiet's Drift. The Naval guns on Mount Alice carried on a desultory bombardment of the Boer trenches on Brakfontein, where parties of the enemy could occasionally be seen working.

The bridge at Potgieter's Drift, begun at 5.30 a.m., was completed by 9 a.m., and at 1.15 p.m. we again paraded to construct a second bridge north of Zwaartkop. But our infantry working party for digging the ramps and our covering party did not arrive till 2.45 p.m. and the work was not commenced until 4 p.m. The site chosen for the bridge was at a re-entering bend of the river below Zwaartkop, and about half-way between it and the kopjes (commonly known as "Mackonochie Kopjes" from the nature of the ration issued there) in front of Potgieter's Drift, which were occupied by the Rifle Brigade and Durham Light Infantry. The bed of the river was well under cover, being protected from Vaalkrantz by a ridge; but otherwise the conditions for bridging were not very favourable as the banks were about 30 feet high and almost perpendicular, and the stream was strong on the far side; the banks had to be trimmed off to admit of the pontoons being slid down and launched. On the near side four trestles were placed, then eight pontoons, and finally one trestle on the far side, in all 70 yards. As the bridge was required for the passage of artillery only, a "medium" bridge (No. 6) was built. The men worked most energetically, one of the sergeants and three or four of the men working up to their waists in the water, placing the trestles, for over two hours. About 7 a.m. when I sent them

* *Continued from previous number.*

back to camp to get a double ration of rum, their faces were blue and their teeth chattering with cold; a few days later the sergeant got an attack of fever which laid him up for some weeks and was no doubt due to the chill he had got working in the water. The bridge was finished at 8 p.m. The ramp on the south side was made down a donga, that on the opposite bank up the face of the cliff; they were completed on the following day. It was very dark getting back to camp after the completion of the bridge and there was heavy rain.

On the 2nd February the Naval 12-prs. were hauled up the side of Zwaartkop with the assistance of the 37th Company, R.E., and ammunition was carried up by hand. The road up the hill was a very difficult one, and for 100 or 150 yards seemed almost impossible, as it went straight up the face of the kop at an angle of about thirty degrees. Two 15-pr. field guns and the guns of the mule battery were also mounted on the top. The position of the guns was masked by the branches of the mimosa trees growing up the north face and on the top of the hill, and the Boers, although no doubt they knew of their presence, appear to have thought that they were intended to cover the passage of the troops at Skiet's Drift.

On the evening of February 3rd Sir Redvers Buller had a conference of Commanding Officers at which he explained his arrangements for the attack on the Boer position on the following Monday, February 5th.

The enemy's lines were in the shape of a large semi-circle, with their right resting on the conical-shaped hills to the east of Spion Kop. Here, in well-placed epaulments, were some guns from which our Naval 4·7″ guns on Mount Alice were unable to draw any reply until the attack took place. From these hills a high ridge known as Brakfontein, sloping gently down to the river, extended in an easterly direction till it reached a chain of hills curving gradually southwards and ending in the Vaalkrantz position. Over the centre of the Brakfontein ridge ran the road from Potgieter's Drift to Ladysmith. At the southern extremity of Vaalkrantz lay Munger's Farm, in the valley, with a deep donga running close to it and joining the Tugela near Munger's Drift, a crossing which is practicable only at certain times when the river is low. Behind Vaalkrantz extended a gradually rising open plain, ending a few miles away in a ridge, named Roodepoort, behind which at some distance was Ladysmith. The whole distance to Ladysmith was 15 or 16 miles. South-east of Munger's Drift rose a forbidding-looking range of hills, Doornkop, extending in a southerly direction to Skiet's Drift and forming the left of the Boer position. In front of Doornkop were some smaller grass-covered hills and the valley below was planted with crops of maize, now very tall and nearly ready for harvesting. The whole of Brakfontein and the hills near it were most elaborately

covered with trenches, and any attempt to force them would have meant death and defeat to any one daring to attack. The entrenchments gradually weakened towards the east, the Boers apparently not anticipating an attack between Brakfontein and Skiet's Drift, but trusting for cover in this part of the line to the natural difficulties of the ground and to a few stone walls. Along the whole of the front of the position ran the Tugela, fordable only at Potgieter's and Skiet's Drifts.

The British position was much less extended, and had the advantage of forming the chord of the circle of which the Boer lines formed the circumference. It extended from Spearman's Hill and Mount Alice, where the 4·7″ guns were posted, on the left, to Zwaartkop, overlooking Munger's and Skiet's Drifts, on the right. In the centre, on a low hill, were posted the 5″ guns. In front of our left centre was Potgieter's Drift, protected from the enemy on Brakfontein by the semi-circle of low kopjes on the north side of the river; these were occupied by our troops and formed a natural *tête-de-pont*. Sir Redvers Buller's plan was to cross at Munger's Drift and attack the left centre of the Boer position at Vaalkrantz, and so open a road across the plain to Ladysmith, at the same time making a feint on the Brakfontein trenches; and certainly, as seen from the top of Zwaartkop, it looked as if the scheme had the elements of success.

From our splendid artillery position the eastern section of the Boer stronghold could be plainly seen. Of this portion of their defence the long hill Vaalkrantz formed the centre, and the impression gained from the bird's-eye view obtained from the top of Zwaartkop was that once we were in possession of Vaalkrantz we should be able to take the trenches on Brakfontein in reverse. Besides this, Vaalkrantz commanded the plain leading to Ladysmith, and formed a good position, when in our hands, for covering the passage of the river. It is true that Vaalkrantz itself was commanded by Doornkop; but Doornkop was some distance away, and it was at that time unoccupied either by artillery or infantry; and, as far as one could see from our side, it was of so rugged a nature that the mounting of guns on the summit must be a difficult task. It all looked so plain and simple that one could not help wondering whether there was not some trap laid for us. A few of the tents of the Boer laager were visible behind Vaalkrantz, and more tents and a very much larger laager could be seen in the valleys which cut into the side of Doornkop; so that it was evident that this portion of their line of defence had not been entirely overlooked.

On the 3rd February the kopjes north of Potgieter's Drift were vacated by the Durham Light Infantry and Rifle Brigade, and occupied by General Wynne's brigade. General Lyttelton's brigade concentrated in the valley west of Zwaartkop.

All the bridging equipment of the 17th and 37th Companies, R.E., was handed over to the Pontoon Troop, and in the afternoon of Sunday, 4th February, the "heavy" bridge (No. 3) at Potgieter's Drift was replaced by a "medium" one.

At 6.30 a.m. on February 5th, Lieut. Skipwith left camp with two "detachments" for No. 6 bridge to make it quite safe, as the rush of the stream had scoured away the gravel from under the trestles. Soon after this, the feint on the Brakfontein position began, supported by a heavy fire of artillery.

At 7 a.m. the 4th Brigade under General Lyttelton marched off, followed by the Pontoon Troop, taking the narrow road at the foot and north of Zwaartkop. Before this road had been cleared, instructions were received for the Pontoon Troop to move to the front; and the water and ammunition carts of the 4th Brigade, which were then blocking the narrow track, had to reverse and get out of the way, which they had some difficulty in doing.

On reaching No. 6 bridge, which had been made quite secure by Skipwith, who here rejoined us with his men, General Sir F. Clery gave me orders to get a bridge thrown across near Munger's Drift as quickly as possible and to report for further orders to General Lyttelton. Parking the wagons under the brow of a low ridge I rode on and reported myself to General Lyttelton, and accompanied him and his Brigade-Major to make a reconnaissance of the river. When about 500 yards distant I went on alone, creeping down a donga to the river bank. I found a most suitable place for bridging within fifty yards of the point where the donga joined the river. The bank on the near side sloped down gradually at an incline of about one in three to the water's edge; and though it was rather steeper opposite, there was no rock and the ramp would only have to be cut out of the earth. This was most fortunate; for if the banks had been of the same difficult nature as we found everywhere else on the Tugela, the bridging operations would have been extremely difficult, if not impossible. The whole of the valley on the opposite side of the river was covered right down to the water's edge with high-growing mealies. This was one of our greatest dangers; but so far as could be seen, the mealies were then unoccupied, even by scouts. Retracing my steps up the donga, I found a passage across it for the wagons and then reported to General Lyttelton. He ordered me to push on at once and make the bridge (No. 7) at the site selected, and detailed the Scottish Rifles to find the covering party. Sending Lieut. Skipwith down the donga with the dismounted men of the Troop and leaving Lieut. Ommanney to regulate the supply of material, I took the first wagon down to the water's edge, the remainder following as required at fifty yards distance. Two R.E. drivers were told off to each wagon as a precaution in case the Natives bolted, but fortunately their services as amateur ox-leaders and drivers were not required.

The first wagon reached the river bank at 10.25 a.m.; and no sooner had the men started to unpack it than a heavy maxim and rifle fire was opened on us from the hill overlooking Skiet's Drift, about 1,500 yards distant. The guns on Zwaartkop at once unmasked, and, assisted by a battery of artillery in the plain below, tried to put down the enemy's fire; but the Boers were so well concealed that our fire had little effect, and they kept up shooting at the bridge right merrily. Our covering party could do little to assist us, so the construction of the bridge depended largely on the accuracy of aim of the Boer riflemen. The Zwaartkop guns also commenced the bombardment of Vaalkrantz, and before long had driven the Boers from it and set fire to the grass in several places. The reach of the river where we had to cross was enfiladed by the Boers on Skiet's Drift Hill, and the ground on both sides was almost treeless, so that it was impossible to get any cover at all while making the bridge; all one could do was to work away as quickly as possible and hope for success. The first three pontoons were placed "in bridge" without much difficulty, as the majority of the bullets hit the top of the bank about fifty yards on our right (down stream) and only an occasional bullet or ricochet came among us, without doing any harm. But all of a sudden a very heavy fire was opened, and the bullets spat into the water all round and hit the bridge and bank. It was a moment of intense anxiety, and a horrible thought went through my mind that possibly the construction of the bridge might be found impossible and that we might cause all the General's plans to fail. But after a momentary hesitation the men stuck to their work right well and went on almost as steadily as if we were not the target of the Boer rifles. The crew of the "anchor" boat had a particularly unpleasant time of it, for they had to row backwards and forwards among the falling bullets and lay the anchors as if nothing was happening; the two men on the bank, stocking the anchors and bending on the cables, had also a particularly nasty time, as they had to stay still in one place, and could not give vent to their feelings by running backwards and forwards with superstructure. Our first casualty was one of the rowers in the anchor boat, who got a very dangerous wound in the groin, from which however he eventually recovered.

In the meantime a portion of the 37th Company arrived, and started digging the ramp on the south bank. They were soon followed by the 17th Company who, as soon as they could be got across, set to work to make the ramp on the north bank. These men, equally with the Pontoon Troop, had to work exposed to the enemy's fire, and were unable to take advantage of any cover. The river was 70 yards wide, with a stream running at about two miles an hour. At 11.15 a.m., fifty minutes after commencing work, the last bay was put in; a signal was sent to the General, by a signaller of the Scottish Rifles, that the bridge was ready for the passage of infantry; and Lieut.

Ommanney, who had arrived shortly before, was also sent to report. Twenty minutes later, finding the troops did not arrive, I rode off and reported the completion of the bridge (No. 7) to Sir Redvers Buller, whom I found sitting with Sir Francis Clery under a tree a short distance away.

When I left the bridge the firing had temporarily ceased, but it reopened with redoubled fury just as I got back. The Boers had used the interval to creep lower down, and a hot fire was now coming from the mealies at a range of from 600 to 800 yards. The fire was much more accurate than before and there were several casualties; and there is little doubt that, had the completion of the bridge been delayed, we should have lost heavily. The fire from the Boer maxim gun was also uncomfortably close, but fortunately always about twenty-five yards short; we always had time to lie down when we heard it begin, and in a second or two the bullets would cut the water just in front of us from bank to bank with a horrible hiss. It was probably due to the men lying down that the Boers never raised the elevation of their gun, as they may have thought that the bullets were going too high; with the slightest increase of elevation the maxim would have absolutely swept the bridge and few would have escaped. On the completion of the ramps all took cover in the donga and our total casualties were then found to be only eight men wounded; three in the Pontoon Troop, one in the 17th Company, and four, one of whom died of his wounds, in the 37th Company. With the exception of the man who was wounded in the anchor boat, all these men were hit when on the bank, and not a single man when working on the bridge. There were many holes in the pontoons and superstructure but no damage was done. Each non-commissioned officer had been previously supplied with wooden pegs, with which he plugged up any holes he could see; but even those that were not noticed did no harm, for the covering of the pontoons is so elastic that the bullet holes closed of themselves. Several men had very narrow escapes: in one case a bullet struck the wood between the legs of a man sitting on the thwart of a pontoon attending to the cables, and in another a bullet went between the fingers of a man carrying a chess. It was very curious to watch the men running to and fro on the bridge; they all held their heads down and slightly inclined to the side as if they were facing a heavy hailstorm.

In the donga we were practically safe except from an occasional dropping bullet. The bridge was left in charge of Lieut. Skipwith and Sergeants Newnham and Grist who volunteered to remain at the head of the bridge, a post of considerable danger if the Boers had crept closer through the mealies; but they soon made a shelter for themselves by excavating a hole in the side of the bank.

About 1.30 p.m. General Lyttelton's brigade began to cross, the Durham Light Infantry leading. They made a rush across the bridge

and, turning to the left, formed up under the bank. The Boers reserved their fire until the troops rushed across the bridge, but again no one was hit when actually on the bridge, though several were wounded and killed on the bank just after they had crossed. After clearing the mealies of snipers the Durham Light Infantry advanced on Vaalkrantz, on which a very hot artillery fire had been maintained all morning by the guns on Zwaartkop and also by the artillery in the plain below. The latter had crossed by No. 6 bridge from their position in front of Potgieter's Drift, where they covered the feigned attack on Brakfontein, to the valley of the Tugela below Zwaartkop. By about 4 p.m. Vaalkrantz was in our possession, having been taken without very heavy losses.

The Pontoon Troop remained all night near the donga. At daybreak next day I sent Lieut. Ommanney for definite instructions about dismantling No. 6 bridge and forming another (No. 8) immediately under Vaalkrantz, while I walked along the river bank to find a suitable site. The Boers had mounted some guns on Doornkop during the night, and immediately after dawn an artillery duel commenced between them and our guns below Zwaartkop. It was a very curious sensation as I walked along, in perfect safety, to hear the shells screaming over my head from both directions. A hot shell and pom-pom fire was also brought to bear on Vaalkrantz, where our troops had built sangars and walls for their own protection during the night. On my way back to our bivouac I saw a large cloud of smoke rise from the top of Doornkop, and it was afterwards ascertained that our shells had exploded one of the Boer ammunition wagons.

Soon after breakfast orders arrived that No. 6 bridge was to be dismantled by the 17th Company and that we were to make a fresh bridge under Vaalkrantz. After a fruitless search among the crowd of troops of all arms gathered together at the foot of Zwaartkop, I found the Company waiting at No. 6 bridge, which they dismantled and packed by 10.30 a.m. I then took the wagons in very open formation across the plain to Vaalkrantz, where Lieut. Ommanney met me with the dismounted men of the Pontoon Troop. Lieut. Skipwith and the two sergeants remained in charge of No. 7 bridge at Munger's Drift.

No sooner did the enemy see us approaching the river below Vaalkrantz than they opened a hot shell fire from Doornkop. The first few shells fell rather wide, but they soon got the range to a nicety and planted shells all round us in a most unpleasant manner. Fortunately the shells had very small bursting power, and beyond making us a bit "jumpy" had no effect. One shell buried itself in the ground absolutely at the noses of the leading oxen of one of the wagons, but these patient beasts went on with their grazing as if nothing had happened. We had some difficulty in getting the native "boys" to bring up the wagons, and in some cases it required rather forcible

entreaty to get them out of the dongas where they had run for shelter. One or two boys however behaved very well; particularly one who was conspicuous all through the campaign by a jauntily worn wide-brimmed black hat and by his martial bearing, and who saluted the officers on every possible occasion in a way that would have filled a drill sergeant's heart with pride. After a good dose of common shell the Boers turned on shrapnel, which they burst over us with great accuracy, but with little success, as only one man was wounded, his hand being ripped open when carrying a pontoon. I was more afraid of the men getting damaged by allowing the pontoons to fall than by the shells; for, when sixteen men have a weight of half a ton on their shoulders* and a shell bursts just over their heads, it is very difficult for them, however well trained they may be, to remain perfectly cool; and if one or two relax their hold, the pontoon almost certainly falls, and in doing so is very liable to strain the backs of those who continue to hold it.

Thanks to the assistance of our artillery, who, as soon as they saw what was happening, turned their concentrated attention to the Boer guns and in a short time silenced their fire, we at last got all our wagons unloaded and the pontoons launched. With the exception of the guns on Doornkop we were quite protected from the Boer fire, as a long low ridge lay on our left flank; and even the Doornkop guns could not see us once we got to work on the river, which here ran in rather a deep channel between steep banks. But beyond being able to work under cover we had not got at all an ideal place for bridging. The river was 85 yards wide, and four feet deep at the near and eight feet at the far side; this made it difficult for placing trestles, which we had to use as our stock of pontoons was exhausted. The banks, especially close to the water, were steep, and covered with long reeds and low willow bushes.

On the near side we placed four Weldon trestles and then ten pontoons, and we were still fifteen yards short of the opposite bank. We then placed two more trestles, using foot ropes and guys to get them in position. This was very difficult, as the river was eight feet deep and we could get no one to stand in the water to assist; and for the last trestle the bottom was uneven and the legs had to be of different lengths. When we eventually got over our troubles, a new difficulty met us. After joining up with the last trestle we found we had absolutely no superstructure left to bridge over the gap of eight or ten feet to the shore. This was an unpleasant predicament, as there was no timber anywhere near from which we could improvise material; and the only thing to be done appeared to be to build out a stone pier from the bank, which was likely to be a very slow and

* In unloading pontoons from wagons the pontoons are carried on the shoulders of two "detachments."

laborious proceeding. Our good luck however again befriended us. Remembering that a small amount of spare superstructure had been left at both Nos. 3 and 7 bridges to replace any that might get broken, Ommanney went off to collect it, and returned in about an hour or so with just sufficient to reach across. If the river had been a few yards wider, we should have found ourselves in a very disagreeable position. The ramps were made by the 17th and 37th Companies, R.E., the former digging the one on the north bank and the latter that on the south.

General Lyttelton's brigade held Vaalkrantz all day, and the first to cross the new (No. 8) bridge were some of the wounded of the Durham Light Infantry. Unfortunately our troops, on occupying Vaalkrantz, found it was not the desirable position it appeared to be when seen from Zwaartkop. Instead of enfilading the trenches on Brakfontein, the latter were able to turn the tables on Vaalkrantz, and Doornkop was also in a position to bring a nasty fire to bear on the southern face of the hill; so that our troops were exposed to both a reverse and enfilade fire, and had they not been entrenched they would have suffered badly. Thus we practically found that, although the occupation of Vaalkrantz was a nasty thorn in the side of the Boers, we could not ourselves advance without being exposed to the risk of very heavy losses. The Boers were able to bring guns and pom-poms into position on the rear slopes of Brakfontein, where they were absolutely safe from our artillery fire from Zwaartkop. It was considered either impracticable or undesirable to attempt to bring our guns on to Vaalkrantz itself.

Towards evening, after a very heavy shell fire on the south-west face of Vaalkrantz, held by the Durham Light Infantry, the Boers made a sudden and determined rush on the position. Seeing the danger their comrades were in, the King's Royal Rifles, who were in reserve, rose from their trenches with ringing cheers, on hearing which the Boers turned tail and departed.

At dusk General Lyttelton's brigade was relieved by General Hildyard's, both moving by No. 8 bridge. A portion of General Hart's brigade crossed No. 7 bridge to relieve the troops holding Munger's Farm. The Boer guns on Doornkop opened fire on the bridge as they were crossing. They had hardly passed, and General Hart was still on the bridge, when a shell burst under his horse, but fortunately without doing him any harm. The burst of the shell broke six chesses and two baulks and made three large holes in the pontoon, but just above the water line, so that no real damage was done.

During the night the Boers made an attack on our right flank at Vaalkrantz, and later in the night another on the left flank, both without result.

The bombardment of Vaalkrantz, with guns, pom-poms, maxims, and

rifles, went on all next day, ninety 6-pr. shells arriving with fair regularity from Doornkop; they did little damage, however, till late in the afternoon, when one burst right in the middle of where the East Surrey Regt. were lying. The boulders, which a moment before appeared entirely deserted, were now suddenly alive with khaki figures, who rushed out to find a new resting place. I was utterly astonished to see so many men there, for, although we were little more than 200 yards away, as long as they kept quiet it was almost impossible without glasses to distinguish them from the rocks themselves. The shell fell close to General Hildyard and his Staff, but they luckily escaped. No one was wounded by the shell, but one officer and five or six men were bruised and crushed by the rocks it set rolling. Soon after that two shells came in quick succession at the bridge; one, skimming close over our heads, struck the south bank beneath the roadway; the other struck the bridge, breaking a chess and chipping a baulk and the leg of a trestle. They must have been chance shots, for the bridge was absolutely out of sight from any part of the Boer position. The bridge was fairly crowded at the time with men filling water bottles, washing, etc., and it was amusing to see the rapidity with which it was cleared. It was very hot sitting on the face of the hill all day, but we relieved the monotony by having a delicious bathe; it was under rather novel conditions for occasional bullets kept on dropping in the water all the time.

About 6.0 p.m. a Staff Officer brought orders for a retirement, and one's heart sank at the thought of giving up the relief of Ladysmith; for it seemed that, if we failed here, no other course was open to us but to leave our beleaguered comrades to their fate. We did not know of the plans for the second attack on Colenso which Sir Redvers Buller had up his sleeve all the time. Soon afterwards I got written orders from the Chief Engineer placing the 17th and 37th Companies, R.E., at my disposal for dismantling the bridges. Having made all necessary arrangements for the work, detailing the 17th Company to No. 7 bridge with half our own men, and the 37th Company to No. 8 bridge with the other half, and arranging for bringing up the wagons, I walked up the hill and reported to General Hildyard for orders.

The retirement began soon after 6 p.m., when it got dark, the ammunition wagons crossing first, and was all over by 9 p.m., when, with the help of the 37th Company, the work of dismantling began. There was a moon for the first part of the night, and one could not help feeling a little anxious as to whether the Boers might discover the absence of our troops from the hill and come and practice their marksmanship on us. Two companies of the Devon Regt. remained behind as a covering party, but, being on the south side, they would of course have been powerless to prevent the Boers occupying the other bank. However, the enemy did not take advantage of the opportunity; and by midnight, by which time it had got very dark,

the bridge (No. 8) was dismantled and the party had started back to camp at Potgieter's Drift. I then rode to No. 7 bridge, but all I could find there was the tail of the rear guard threading its way noiselessly, like a huge dark serpent, along the narrow path. I got close up to the Column (the wagons were leading) before I could hear a sound, and it was too dark to see much. The portion of General Hart's brigade which had been holding Munger's Farm re-crossed by this bridge, which was dismantled and packed with the assistance of the 17th Company. The work here was also completed by about midnight, and both portions of the Troop met at the foot of Zwaartkop, where we were delayed for some hours by an overturned wagon of another unit; we eventually reached our camp at Potgieter's Drift at 5 a.m. Soon after our arrival the Boers planted some of their big shells from Doornkop too close to us to be pleasant, so we hid our wagons among the mimosa bushes.

The retirement of the baggage and stores, of which there was a considerable accumulation at the foot of Spearman's Hill, went on all day on February 8th. It was a very slow process getting the heavy wagons up the steep road to Spearman's Hill; this road was unseen and just out of range from the Boer position, but they amused themselves from time to time by putting shells as close as they could. One of these fell among our horses when they went to water at the Drift; there was, however, no disastrous result except that one of the drivers, who I expect had fallen off in his excitement, but who declared the shell had knocked him off, cut his elbow rather badly.

Between 8 and 9 p.m. Lieut. Skipwith started with twenty-four wagons, with instructions to take them to the Springfield side of Spearman's Hill and to return the next day with the teams and one or two empty wagons.

The retirement of the troops holding the kopjes in front of Potgieter's Drift commenced next day, February 9th, at 10.30 a.m. Elaborate precautions were taken by Sir Charles Warren, who was in command, for the safety of No. 3 bridge during the evacuation of the kopjes. Guns were posted all round and General Coke's brigade occupied good defensive positions. The retirement was very gradual, one company leaving at a time, and was completed by noon, when we commenced dismantling and packing the bridge. A troop of cavalry remained on the kopjes till we had nearly finished and then retired over the Drift. No sooner had they gone than some figures appeared on the crest line of the kopjes and we expected them momentarily to open fire on us; but they turned out to be only some kaffirs from the neighbouring kraals, intent on loot. The bridge (No. 3) was packed by 1.40 p.m.; and we then blew up the pont, and cut its steel wire hawser with charges of guncotton. Thanks to the extra teams with which Skipwith had returned we got up Spearman's Hill without much difficulty and then halted for dinners

and a two hours' rest. On re-starting again at 6 p.m. the sappers were carried in the wagons as they were a bit played out with all their hard work. This precaution turned out to be most fortunate for the day's work was by no means ended. On reaching Springfield Camp, about 8 p.m., an orderly met me with a message to say the Chief Staff Officer wished to see me. On going to his tent I was ordered to throw a bridge across the Little Tugela at Sand Drift. The river was 40 yards wide, and the bridge was completed by 11 p.m. when we took a well-earned rest.

The troops began crossing at 4 a.m. next day and continued all morning. The bridge was dismantled at 4 p.m.; and we then marched off and joined General Hart's command at Pretorious' Farm near Springfield.

On the following day, Sunday, February 11th, we marched with the remainder of the Force to Chieveley. And so we found ourselves back at our old quarters with another passage of the Tugela in front of us.

PART IV.—PIETER'S HILL.

From the 12th to the 19th February the Pontoon Troop remained at Chieveley. Meanwhile the operations were carried out which resulted in the capture of the Boer positions on Hlangwane and Monte Cristo and of their laagers, and in the retreat of the enemy across the Tugela.

Hlangwane Hill formed the left of the Boer position in the Battle of Colenso. Eastwards of Colenso the country was of a very difficult and rugged nature, without roads, cut up by deep and dangerous dongas, and covered as a rule with thick mimosa scrub. It was an ideal country for Boer tactics, and from the commencement of the campaign it had always been a favourite haunt for the enemy's snipers. East of Hlangwane were Monte Cristo and Cingolo, a commanding range of hills running for about six miles in a south-easterly direction and gradually diminishing in height. Between Hlangwane and Monte Cristo, and about 300 feet below, was a wide scrub-covered plateau, rising and falling in gentle undulations. Running in front of Hlangwane, of this plateau, of Monte Cristo and of Cingolo was a deep, dry donga which ultimately joined the Blaaukrantz River south-east of Cingolo. To the west of Hlangwane the Tugela River made a large bend northwards, running in rear of Hlangwane and Monte Cristo through a deep, rocky gorge and gradually turning south again. On the opposite bank of the Tugela and immediately north of Monte Cristo was Pieter's Hill, which eventually formed the left of the Boer position in the subsequent fighting.

About half-way along its length the high ridge of Monte Cristo and Cingolo was divided by a depression or nek, and south-east of

this nek the Boers made little preparation for defence. Their new position south of the Tugela consisted of Hlangwane and Monte Cristo (north of the nek) and of the plateau in between. They were separated from their main position in rear of Colenso by the Tugela River, here about 100 yards broad, in places deep, and with a strong current. The two banks of the river were connected, as we afterwards found, by a low bridge ingeniously constructed of railway sleepers and rails strongly anchored down and running from rock to rock in the shallows above the Tugela Falls, a waterfall near Pieter's Hill. Above the bridge was an aerial tramway with substantially-made platforms, connecting on the northern bank with a siding from the Colenso-Ladysmith railway line.* Two large ponts, afterwards found wrecked and partially burnt, were also in use at this point. There was very little in the bridge to get damaged by floods, which as a rule passed over it without injury; the bridge was too narrow (about six feet) and curved too much for use by wagons, but it made a good roadway for horses. Some distance to the east and below Pieter's Hill was a drift, which was, I believe, used by the Boers in their retreat. With the exception of these crossings the river was practically unfordable except at Colenso, though no doubt there were places where men and horses could cross when the river was low. Hlangwane and the southern edge of the plateau below were very strongly fortified with most carefully hidden trenches, the numerous bushes about this part making concealment easy. Monte Cristo was not nearly so strongly held or entrenched and it is improbable that the Boers expected an attack there.

About three miles east of the Chieveley-Colenso railway was Hussar Hill, towards which the ground sloped gently down from Gun Hill at Chieveley, where the heavy Naval guns were posted, rising again gently at the hill itself. Hussar Hill was separated from Hlangwane by numerous dongas and dry watercourses; it was about five miles distant from Chieveley and three from Colenso.

The danger in advancing by Hussar Hill was that we were always liable to a flank attack from Colenso, and the ground was so broken in this direction that it offered great facilities for Boer tactics. Hussar Hill was waterless and all water had to be brought by wagon from the railway tanks at Chieveley camp; all supplies had to come by road. A railway was planned and partially laid out to Hussar Hill during the operations; but it was never completed as, on our occupation of Colenso, the base Depôt was transferred to the railway station there. Hussar Hill was commanded by both Hlangwane and Monte Cristo, but they were both some distance away; it was about

* The Boers had made a deviation from the railway at Modder Spruit, running east of Umbulwhana and joining the main line again near Nelthorpe.

the same height as the plateau (which I will call Hlangwane Plateau) between these two hills.

After a preliminary reconnaissance the force marched to Hussar Hill on the 14th February and entrenched themselves there, General Hart's brigade remaining at Chieveley to guard the stores and to prevent a counter-attack from Colenso.

From Hussar Hill the Boer trenches on Hlangwane Plateau were systematically shelled, especially at a point called Green Hill, just below the nek on Monte Cristo. The Boer laager could be seen behind this small hill, and it and the sides of Monte Cristo came in for their fair share of shelling, while the Naval guns at Chieveley devoted their attention for the most part to the guns and trenches on Hlangwane itself, distant from them about 8,000 to 9,000 yards. Notwithstanding our occupation of Hussar Hill in strength Boer snipers from time to time crept up the dongas under cover of the scrub, and the crack of the Mauser was frequently heard in the bush close at hand without it being possible to locate the exact position of the firer.

While the bombardment of the Boer trenches was being carried on, General Lyttelton marched his brigade under cover of the hills to the eastern extremity of the Cingolo ridge, and, gradually advancing along it to the nek, drove the Boers before him, the cavalry under Lord Dundonald co-operating on his right flank. He eventually gained possession of the ridge, rendering the plateau below untenable, and the Boers retreated in great haste across the Tugela, their laagers, with stores, ammunition, etc., falling into our hands. In the meantime General Barton's brigade advanced on Hlangwane Hill which it occupied, thus completing the rout of the Boer forces.

On February 20th, at 8.40 a.m., the Pontoon Troop received orders to move to Hussar Hill. After waiting there some little time we were met by a party of Thorneycroft's Mounted Infantry, who informed us they had come as our escort. Soon afterwards a detachment of the Imperial Guides came up, who told us they had instructions to lead us by the nearest way; they took us straight across country over mealie fields and other cultivation; it was all our poor oxen could do to get along at all, and in one deep place we broke a pole of one of the pontoon wagons and had to patch it up as best we could. There was a very steep donga at the foot of Hlangwane; in crossing it two of our wagons turned over and caused considerable delay, and we had some difficulty in getting up the opposite hill. Arriving on top of the plateau about 4 p.m., close to the line of the Boer trenches, our escort and guides differed as to our destination. The officer in charge of the escort said his orders were that we were to go to Blois Farm on our right under Monte Cristo; the Guides wanted to take us down a shockingly bad road to

the Headquarter Camp under Hlangwane. As they were not able to come to an agreement I halted at the junction of the two roads and sent both ways for instructions. The Boers were shelling the ridge about a mile in front of us, but we were quite safe where we were. While waiting for definite orders Sir Redvers Buller rode past and told us we could stay where we were for the night, so we formed up just clear of the road.

Our bivouac was immediately in rear of the Boer trenches, and so I got a good opportunity of examining them. They were mostly of the narrow deep type, now known in the service as Boer trenches, made for men to shoot out of standing, and sometimes with head cover and loopholes. They were very skilfully placed, and as a rule well concealed by bushes, natural rock, etc.; and in cases where these did not exist, branches of mimosa had been cut down and stuck in the ground to imitate growing bushes. Some hundred yards in front of the real trench were dummy trenches, made as conspicuous as possible for the purpose of drawing fire, in which they proved very successful. The real trenches were all lined on the top with sacks of earth, to stop ricochets and splinters from stones, whereas the dummy trenches had no such protection. There were evidences on all sides of the hurried retreat of the Boers; tents were left standing, and cooking and other utensils were scattered around; there was a great quantity of ammunition lying about, principally Mauser rifle cartridges, but there were also the paper wrappings in which soft-nosed sporting cartridges had been packed.

Soon after 5 a.m. on the 21st, Sir Redvers Buller rode along and gave me orders to reconnoitre the river for a site for a bridge, the Troop to wait on ready for an advance. Taking Lieut. Skipwith with me I rode forward towards the river. The plateau on which we had bivouacked ended abruptly in a rocky ridge immediately overlooking the river, the rocks being broken up into huge boulders, giving the crest a very wild appearance, and affording good cover to the men of Barton's brigade who were sniping at the enemy on the hills on the north bank. The road or track leading from the plateau crossed a nek below Hlangwane, then turned right-handed to the Boer bridge. On the left of this road the sides of Hlangwane were furrowed by innumerable watercourses, resembling the feelers of a huge octopus and combining in a deep wide donga leading down to the river Descending this donga, which was occupied by picquets of the Royal Welsh Fusiliers, we reached the river and looked about for a good site for the bridge (No. 9). We eventually decided that the donga itself formed the best approach to the river, which was here rather over 100 yards broad. Immediately below the donga the river narrowed down and fell over a ridge of rocks, forming a very pretty waterfall about 20 feet high. On the opposite side the bank had an easy slope, and beyond was a plateau half a mile wide, bordered on

two sides by low hills, which formed a natural *tête-de-pont* and to a certain extent protected the crossing. To the west, beyond this line of hills, was Grobelaars Kop, rising well above its neighbours; and in a semi-circle, stretching in a north-easterly direction, was a line of hills forming the Boer main position; their right rested on Grobelaars Kop and their left on Terrace and Pieter's Hills, commanding points immediately overlooking the river and about two miles lower down than the donga we had explored. Between the main Boer position and the river were a series of bare rocky kopjes, through which ran the Onderbrook Spruit, all well under fire of their guns and in most cases of their rifles as well.

Retracing our steps along the donga I reported to Sir Redvers Buller, who consented to the site selected. The Pontoon Troop was then ordered up and the 17th and 37th Companies, R.E., were also sent for to make the approaches down the donga.

We got to work at the river at 10.35 a.m. At first the unpacking was very slow as the wagons had to be brought singly down the donga, but soon afterwards the 17th Company arrived and volunteered to help in unloading. The Boers were not long in finding us out, and kept up an intermittent shell fire on us the whole time that the bridge was under construction, without however doing the slightest damage, though several of their shells splashed into the water within ten or fifteen yards of the bridge and one within a few feet of a wagon which the men were unloading at the time. A "heavy" bridge (No. 9) of fourteen three-section pontoons, with three Weldon trestles at the near and two at the far side, was constructed. This made the bridge 100 yards long; but as the bank was found to be very soft two bays were subsequently added, making a total length of 110 yards. The bridge was completed at 1.45 p.m., and our troops, led by the Somerset Light Infantry, at once began to cross; from that time the traffic over it was incessant and went on all through the night. The enemy kept up their shell fire until dark, without doing any other damage, I believe, than wounding a few horses. Our only casualty was a bullock slightly wounded by a bullet when waiting on the top of the nek in the early morning. It was absolutely astounding that so little damage was done; for there was an enormous congestion of traffic on the approaches to the bridge on the south side and a considerable massing of troops of all arms on the plateau beyond the bridge head.

During the whole day of the 22nd a ceaseless stream of traffic poured over the bridge. Wagons and vehicles of all descriptions passed over safely, except for a few minor accidents such as a bullock tumbling over the edge of the bridge or a mule falling into the well of a pontoon. The only serious accident happened to a regimental ammunition cart which fell into the river; when it was hauled out it was found that one of the mules had broken its leg.

In the morning I rode with the Chief Engineer to see what could be done towards restoring communication over the Colenso road bridge; on the way we passed Fort Wyllie, from which the Boers had poured such a terrible fire at the battle of Colenso. Along the front of this hill ran a deep narrow trench with covered ways round each end; on the back or north side the hill was very steep, and immediately under it was a small laager, absolutely safe from any fire that could be brought to bear on it from the direction of Chieveley. The back of the hill was honeycombed with dug-out shelters, and in some cases the side of the hill had been dug away to admit of a tent being put up. It was said that the Boers only kept one man as sentry in the trenches as long as any shelling was going on, but rushed back into them by the covered ways as soon as our troops came within effective rifle range. The railway bridge was an absolute wreck, every girder and nearly all the piers being destroyed; one span only of the road bridge was broken, and this had been purposely done in December by our Naval guns at Chieveley. Colenso village was a scene of hopeless destruction; every house in the village had been thoroughly looted; partition walls had been broken down, and in the shops the fittings had been removed and sometimes burnt, and all windows and doors destroyed. The houses too had suffered somewhat from our shell fire. Curiously enough the Boers had left the railway station intact, but by way of a grim joke they had dragged a dead horse into the booking office, and the stench was awful. While waiting at the station for replies to telegrams, I visited the spot, about 300 or 400 yards away from the station, where our guns had been taken on the 15th of December; the dried-up carcasses of the horses and the broken harness and equipment bore testimony to the struggle that had taken place.

The Boers shelled the neighbourhood of No. 9 bridge at intervals during the day, but did little damage, which was very extraordinary as the place was crowded with troops and vehicles of all sorts. But our guns were now posted on the hills forming the *tête-de-pont*, and engaged the attention of the enemy, who were thus only able to devote very little time to the bridge. The enemy's guns had been shifted from the centre of their position to commanding points on Grobelaars Kop, which was favourable to the bridge as it could only be very indistinctly seen, and they never placed shells nearer to it than 200 yards all day.

At 6 p.m. an attempt was made to take the 4·7″ guns across the bridge. These guns on their improvised carriages weighed 6½ tons, and as there was only one set of trunnion holes, the weight was unevenly distributed and the bulk of it was thrown on to the front wheels. Although a second layer of chesses was laid lengthways as runners, there was an ominous cracking when the front wheels came into the centre of the first bay; so the rear drag ropes were manned

and the gun was quickly run back off the bridge before any accident had taken place. Arrangements were made for removing the guns from their "jackets" during the night, thus reducing the weight by rather over 2 tons.

The infantry, who occupied the low hills near the Onderbrook Spruit in front of the Boer position, were exposed all day to a most galling fire from rifles, pom-poms, and artillery, but gallantly kept their ground. At times the fighting was very severe and the casualties heavy, the enemy being able to bring a terrible cross fire to bear from their commanding position on the upper range of hills. There was no cover of any description available, but our troops were able to obtain a certain amount of shelter in hastily constructed sangars on the sides of the hills. Digging trenches was quite out of the question, both on account of the rocky nature of the ground and because any man who exposed himself in the least was at once shot.

At daylight on the 23rd (*i.e.*, about 5 a.m.) the 4·7″ Naval and 5″ R.A. guns with their ammunition were safely passed over the bridge. The Naval guns were taken over in wagons separately from their mountings, but even then the weight was considerable and I breathed a sigh of relief when they were all safely across. With the 5″ guns, weighing 4½ tons, there was not much trouble, as by shifting them from the firing to the travelling trunnion holes the weight was well distributed on the carriage. The traffic on the bridge continued incessantly all day until 10.30 p.m.

At 5 a.m. Lieut. Ommanney left with four "detachments" of sappers for Colenso, in order to erect an aerial tramway across the river there for the purpose of conveying supplies to the troops on the left flank and so relieving the pressure on the bridge. The span of the suspensory cable was 470 feet, and the work was completed by the afternoon of the 24th when the party rejoined. The artillery duel was kept up all day on both sides with undiminished vigour; our objectives were the Boer trenches and sangars on the top of the ridge and their guns on Grobelaars Kop, which were well protected by strong emplacements; while their artillery, besides returning the fire of our guns, distributed their favours pretty generally all round, the bridge coming in for its share. Very little damage, however, was done by the Boer shells.

The infantry maintained their position on the hills; although unable to make much progress, they held their own, and, having improved their sangars, had better cover than on the previous day. In the afternoon General Hart advanced along the river under cover of the railway embankment towards the enemy's left flank; to reach this point he had to cross the Onderbrook Spruit by the railway bridge, on which the Boers brought a very heavy rifle and pom-pom fire, which was the cause of many casualties to the troops crossing. (This bridge, generally called "pom-pom bridge" was sandbagged by

the 17th Company, R.E., during the following night, thus rendering the crossing less dangerous). On reaching the enemy's left flank, a most gallant attack was made by General Hart's brigade (Royal Inniskilling Fusiliers, Connaught Rangers, and Royal Dublin Fusiliers) on the Boer position; but, although they succeeded in taking and holding the lower slopes and the river bank, they were driven back with heavy loss from the main position on Terrace (or Inniskilling) Hill. In endeavouring to reach these trenches our troops had to cross an open glacis of about 300 yards, on which the Boers were able to bring an appalling fire to bear. The Inniskilling Fusiliers in particular suffered very heavily, especially in officers. After dark a furious rifle fire broke out all along the Boer lines and continued for some time; a counter-attack on our positions, both on our right and left flanks, was attempted, but after heavy fighting the enemy was obliged to retire.

At 4 a.m. on the 24th Lieut. Skipwith left with two "detachments" and a wagon load of sleepers and rails to repair the Boer bridge, so as to allow the passage of supplies to General Hart's brigade. It had been intended that this should be done before daylight as the bridge was under fire from the Boer lines; but unfortunately the wagon broke down and the load had to be transferred to another one, so that he did not arrive until after daylight. Although a fairly hot fire was directed on the bridge, the repairs were completed without casualty, the 37th Company, R.E., assisting in the work from the north bank.

The artillery fire continued all day and musketry fire was also kept up, but no determined attack was made on either side. During the afternoon a heavy thunderstorm raged for about an hour, and the rain, coming down in sheets, soon converted the donga into a roaring torrent and made traffic over the bridge impossible for some time.

About 5 p.m. Lieut.-Col. A. E. Sandbach, R.E., came to me and said he had found a crossing place opposite the Boer left flank under Pieter's Hill and that Sir Redvers Buller wished me to go there with him to see whether it was possible to throw a bridge across. We found a steep path, which after repair would be practicable for wagons, leading down from the end of the Monte Cristo range to the river; part of the path was unseen from the enemy's position and the river itself was quite out of sight. Hart's brigade was bivouacked on the north bank immediately opposite, and with the exception of some snipers among the rocks bordering the river there was no firing going on. We both agreed it was an excellent place for a crossing, as, in addition to being unseen, the river was deep, the current not very strong, and the banks easy. About 200 yards above the point selected, and immediately below the Boer bridge, were the Tugela Falls, over which a considerable volume of water was flowing. Having satisfied ourselves we rode back, Lieut.-Colonel Sandbach to

report to Sir Redvers and I to the bridge. About 7 p.m. Sir Redvers crossed over to the south bank, and after sending for me told me the 4·7″ and 12-pr. Naval guns, the 5″ R.A. guns, the howitzer battery, and a brigade division of field artillery would re-cross to the south bank at daylight next day. He also questioned me about the proposed crossing near Pieter's. On account of the slippery state of the bridge owing to the recent thunderstorm all traffic over the bridge was stopped at 8 p.m.

At 4 a.m. on the 25th, the 37th Company, R.E., who were required to make the road down at the new site near Pieter's, the howitzer battery, and a brigade division, R.F.A., re-crossed the pontoon bridge from north to south. They were followed by the Naval and the 5″ guns with their ammunition, and all were got across without accident. The ordinary traffic was then resumed. The 17th Company, R.E., also required for road making, re-crossed at 8 a.m. I received orders to make a "pont" at the new site (No. 10), and soon after daylight Lieut. Ommanney went to Colenso station to collect timber (which we had had sent up there), returning with some good loads at 10.30 a.m.

In the meantime an armistice had been agreed upon between the two armies, to bring in the wounded who had fallen in the attack on the evening of the 23rd and to bury the dead. The sufferings of the wounded must have been dreadful during this time, for the Boers fired at anyone who tried to go to their assistance, and they had to be left lying on the exposed hillside in the glaring heat by day and in the cold air by night without either food or shelter. It was Sunday and never was the day of rest more appreciated; after the strain produced by the constant firing and bursting of shells during the past few days, the temporary cessation of hostilities came as a blessed relief to the troops.

Leaving Lieut. Skipwith in charge of No. 9 bridge with a few men, Lieut. Ommanney and I and the remainder of the men moved off at 11 a.m. and reached the top of the road leading down to the river at 1 p.m. The 17th and 37th Companies, R.E., were still working at it and it was not possible to get our wagons down till 4 p.m. In the meantime we spent a most peaceful three hours down by the river. It was a most picturesque spot: on our left the river poured over the Falls with a dull roar and, after rushing wildly among the boulders below, settled down into a broad even-flowing stream at our feet; on either side the hills rose precipitously to a height of about 500 feet, their tops bold and jagged and clearly defined in outline against the deep blue sky; the sides of the gorge were covered with mimosa bushes, still smelling sweetly though the flowering season was nearly over, and with tall growing aloes. It was an ideal spot either for a picnic party or for spending a quiet Sunday afternoon; with us it was a combination of both, for we first

had our lunch of "bully" beef and biscuit, and then spent the remainder of the time under the shade of the trees reading our letters and looking over the papers which the mail had brought that day. One of the first pictures I saw in an illustrated paper was a very good photograph of the falls we were looking at.

On the arrival of our pontoons, we first put Sir Charles Warren, who had been waiting some time, across to the north bank, and then rowed over the 37th Company, R.E., who were required to make a road up the hill on the opposite side. We then set to work on our pont, which we made of three pontoons (of three sections each) and a decking of timber; and we also constructed trestle ramps as landing places and approaches to them through the scrub. The work was finished at 7 p.m., and after we had some tea the wagons and the greater part of the men were sent up the hill to await us. Lieut. Ommanney and one "detachment" remained to work the pont until the infantry could take it over next day, and I went across the river to see the C.R.E. of the 5th Division, getting back about 9 p.m. We were slowly climbing the hill on the south bank, when, without the slightest warning, a terrific fire broke out from the Boer trenches. It began on the left of their line at Pieter's Hill, but rapidly spread along their whole position. There seemed no reason for it and it was no doubt produced by a scare; as far as I could make out our troops did not reply to it. For a few minutes I and two men with me were in a most unpleasant fix, for we happened to be in the exposed part of the hill where the bullets fell which were aimed at but missed the position held by Hart's brigade. It was a few minutes before we could get under cover, but luckily none of us were hit, though the bullets fell all around us, knocking sparks out of the rocks or burying themselves in the ground with a dull thud. The fire lasted about twenty minutes and then stopped almost as suddenly as it had begun.

We had a fairly quiet day on the 26th, the action being confined almost entirely to an artillery duel. At 4 p.m. I rode to Colenso station to get some more "superstructure" which had been sent up from Maritzburg. No sooner had the unloading of the trucks begun than I received an order to dismantle No. 9 bridge as soon as the Composite Rifle Battalion (details of the King's Royal Rifles and Rifle Brigade) had crossed, and to re-construct it under Pieter's Hill. It was to be ready as soon as possible next day. On getting back to our bivouac Lieut. Skipwith informed me that the Composite Battalion had crossed at 6.30 p.m., but that a message had been received saying supplies for the 2nd Division must be got across before the bridge was dismantled; though we waited two hours for them no supply wagons came near us, so we started work. It was a particularly dark night and I shall never forget the extreme labour it was to get the bridge up the bank and packed on the wagons. It was

by far the longest bridge we had made (110 yards); each pontoon had three sections, and, besides being rather waterlogged owing to the length of time they had been in the bridge, they had in them two inches of mud which had fallen in from the roadway. They all had to be carried up a fairly steep bank, about 15 to 20 feet high, one section at a time. It was all the men could do to manage this, for they were beginning to feel the effect of their hard work and many of them were much weakened by diarrhœa and exposure. There were forty-two pontoon sections to be hauled up and loaded on the wagons, and also five trestles and twenty-two bays of superstructure, the whole weighing from thirty-five to forty tons. About midnight it looked as if the work never would get finished, the men seemed dead beat and could put no strength into their efforts; but by 2.30 a.m., *i.e.*, after working hard for six hours, we got all the wagons loaded. As there was no great object in secrecy, and as we were too far from the Boer lines for them to see what we were doing, we lit a large bonfire with broken material and this helped us considerably in our work.

After giving the men some tea, we started at 3 a.m. for Hlangwane Nek, which we reached in three-quarters of an hour. There an issue of rum was made; and, as there was some doubt as to our proper direction owing to the darkness and the innumerable tracks that went in all directions, we made a halt and the men got a short sleep. I went forward with one of the sergeants to try and find the way; but after tumbling over huge boulders for some time, we gave it up as hopeless and waited for daylight. About 5 a.m. we moved on, reaching the river below Pieter's Hill soon after 6 a.m. A "heavy" bridge (No. 10), 95 yards long, of sixteen bays of pontoons with a trestle at each end, was then put in; it was completed before 9 a.m. The men worked very well, the short sleep they got on the top of the hill having quite refreshed them. We felt so certain that we were nearing the goal for which the Natal Army had been striving so long that Lieut. Ommanney asked me if he might put up a signpost pointing out the way; on the end of a boat-hook he nailed a piece of wood on which was painted "To Ladysmith" and a finger pointing in the direction, and erected it at the tail of the bridge. This sign-board caused a good deal of amusement among the troops as they advanced to the attack.

The south bank, rising as it did almost perpendicularly from the river below, gave us a magnificent artillery position; and here all our guns, both Naval and R.A., were massed, and were able to bring a terrible concentrated fire on to the Boer trenches on Terrace, Railway, and Pieter's Hills at a comparatively short range. The maxim guns were also massed on the edge of the cliff, distributed among the huge boulders and peaks of rock, whence from under good cover they could pour a murderous fire on to the opposite hills.

Seen from below, the hill had the appearance of a mediæval castle hewn by Nature out of the solid rock.

Soon after 9.30 a.m. General Barton's brigade crossed No. 10 bridge, and crept down the river bank for rather over a mile, when they turned left-handed and scaled the steep sides of Pieter's Hill. They were followed by General Kitchener's brigade [General Kitchener had taken over the command of General Wynne's brigade on the latter being wounded a few days before] and by the 4th Brigade under Colonel Norcott. General Hart held the hill in front, covering the bridge. The attacking force was under the command of Sir Charles Warren. A deep and precipitous ravine, along one side of which runs the Colenso-Ladysmith railway, separated Pieter's Hill from the main Boer position on Terrace and Railway Hills. The latter in particular was a most formidable place to attack, the slopes being free from cover and very rough, and the enemy being most strongly entrenched in successive lines of deep works.

Between 9.30 a.m. and 10 a.m. our maxims opened a heavy fire on the Boer trenches at a range of under 2,000 yds.; and the sharp crack of their discharge, coming from among the boulders where they were hidden, gave the impression of a ceaseless infantry fire. Soon the artillery joined in, and from then on there was a continuous roar of gun and maxim fire which was quite deafening to us in the river-bed below. This fire, murderous as it seemed, was probably not very deadly, as the Boers were well hidden in their narrow deep trenches; but it made them keep their heads down, and prevented them from offering as strong an opposition to the infantry as they would otherwise have done. Under cover of the artillery fire the infantry scaled the steep sides of the boulder-covered hills and rushed the Boer trenches in the most gallant manner, capturing the main position about 4 p.m. Firing then stopped for the day; but it was anticipated that it would recommence on the morrow, as the enemy still held a ridge of hills beyond.

Our casualties were heavy, but the Boers also lost considerably, and we took about forty prisoners, who were brought down about 5 p.m. and taken across the bridge; a motley crew they were, care-worn looking and ragged, many of them with their clothes and faces discoloured by the yellow fumes of our lyddite shells; though the majority looked depressed, some seemed distinctly pleased at finding themselves safe in our hands. One of the wounded Boer officers, better educated than his companions, told our medical officer who was attending to him that his men, when they saw the British soldiers rushing on them with the bayonet, began to cry and said they would be killed; but he reassured them and told them that the British were a more civilised nation than they themselves were, and that if they surrendered they would only be made prisoners. It was probably this incident that an eye-witness on the south bank of the

Tugela told me he saw. He said he watched our infantry come up the hill, being fired on the whole time, and then fix bayonets and charge; when they got near the trenches, the Boers, who had been firing all the time, suddenly threw down their arms and held up their hands; our infantry officers rushed quickly to the front, stopped the charge, shouldered arms, and walking forward quietly took the Boers prisoners; it was a brilliant example of good discipline, and of the influence of the officers over their men at a moment of extreme excitement. Two men of the Pontoon Troop were wounded during the afternoon, when sitting on the river bank under what seemed perfect cover.

It was a splendid exploit taking this strong Boer position, where one fire-crowned ridge rose above the other, where the ground was intersected by unexpected dongas, and where the hills themselves, steep and difficult to climb, were covered with rough boulders and with rocks carved by nature into strange fantastic shapes. The enemy certainly deemed the hill impregnable, and indeed it looked to be so. Coming as it did on the day after the anniversary of Majuba, the victory was a welcome one for us, and we were doubly elated by hearing in the morning, just before the battle began, of the surrender of General Cronje at Paardeberg.

Early in the morning of February 28th it was found that the Boers had evacuated that portion of their position which they were holding on the previous night. They still occupied some kopjes near Pieter's station, and our cavalry, crossing the plain in front of them, had to approach with caution. The field guns and howitzers were brought over the ridge early in the day, and placed in position on the top of the ridge overlooking the plain between Pieter's Hill and Umbulwhana; and later these guns were followed by the Naval 4·7″ and 12-prs.

During the morning I rode round the Boer trenches and was much impressed with the strength of the position. Tier rose upon tier of narrow deep trenches, round which the explosion of the lyddite shells had made deep pits and covered the surrounding boulders with their yellow fumes. The trenches were full of ammunition, principally Mauser, of which there was a very large quantity; the bullets had all been dipped in grease and had turned bright green, which gave rise to the report that the cartridges had been poisoned. There were also numerous empty wrappers of packets of soft-nosed cartridges, Martini-Henri ammunition, and also some Lee-Metford cartridges. A number of Boer rifles were found lying about, and were collected and broken; many of them were fancifully carved on the stock with the names of the owners and of the different battles in which they had been engaged; on one that I saw the stock was carved "J. L. Kruger, 1899," the name, I believe, of one of President Kruger's grandsons who was killed in the fight.

The melancholy task of collecting and burying the dead was going on. Our own men were buried in regimental graves, and the Boer dead were collected together in suitable spots and buried where convenient. All the Boers who had been killed or wounded in the early part of the fight had been removed from the hill by their own people and sent off by train; those that we found there were probably killed in the final attack.

The day was spent in bringing the baggage and stores to the north bank of the river; and the cavalry, feeling their way cautiously, pushed on to Ladysmith, which they reached in the evening.

Early on the 1st of March the infantry advanced towards Ladysmith and encamped at Nelthorpe. Getting leave from General Hart, whose brigade was left to protect the bridge head, I rode into Ladysmith. Near Nelthorpe the drift over the Klip River was rather dangerous and the only means of advancing was along the railway line. The swollen state of the river did not however prevent our troops at Nelthorpe from fording it and paying a visit to the deserted Boer camp on the nek below Umbulwhana; here the tents remained standing, showing the haste with which the Boers had left, and our men returned laden with blankets and with a few eatables that were much appreciated after the constant menu of "bully" beef and biscuit which had been their fare for the last few weeks.

Below Umbulwhana, one passed that monument of Boer folly, the dam across the Klip River. It was then about half completed, and as the rainy season was coming to an end the Boers could not have hoped for any result from it until the summer (our winter) of 1900–01. The dam was designed to flood out the town of Ladysmith and render our position there untenable, and the commencement of such a work shows the confidence the enemy had in their power to maintain the siege and to prevent the relief force from succouring the garrison. Everywhere were signs that work on the dam had been continued until the last moment. The dam was made of sacks of earth built across the river; it was about 100 feet thick and 50 feet high, and had sluices to let the flood water escape during construction. On the banks were hundreds of picks and shovels, and sacks, some filled and loaded on to trucks, others abandoned with only a few shovelsful of earth in them; and there were also the deserted encampments of natives who had formed the working party on the dam. These camps were well stocked with mealie meal, and showed unmistakable signs of recent occupation and hasty evacuation.

The first of the Ladysmith garrison whom I met was a brother officer, Lieut. A. B. R. Hildebrand, who was working near the dam, repairing the telegraph line to Colenso. He was very well and cheery, and asked me to go and stay with the Telegraph Battalion in Ladysmith. The Telegraph detachment with the Relief Column was repairing the line from the south, and by working on until the two

parties met, telegraphic communication between Ladysmith and the outside world was re-established in the evening. Pushing on past the Intombi Hospital, where so many of the brave defenders of the town spent their last few days on earth, I reached Ladysmith.

What struck one most on entering was the paucity of outward signs of the bombardment; here and there the end of a house was blown in or a wall knocked down, but there was none of the general ruin which one would expect to see in a town that had withstood a four months' siege. This was accounted for by the houses being well scattered, mostly in small gardens of their own, and being chiefly built of corrugated iron, which offered little resistance to a shell. The Town Hall seemed to have suffered most; there were one or two large holes in the walls of the building, and a large portion of the tower had been shot away. Some of the shops, more especially those of the dry goods merchants, were still open; but in all those where eatables of any description were usually sold there was an entire absence of stock in hand, and this told its own tale. The most striking signs of the siege were the pale, emaciated, fever-haunted looks of the garrison and of the townspeople, and the lack of interest they seemed to take in life. What also struck one was the clean trim appearance of both officers and men, forming a great contrast to the Relief Force, the greater part of whom, both officers and men, had been unable even to wash during the past fortnight and whose clothes in many cases were in rags. The cavalry and artillery horses of the garrison, at least those which had not been converted into "Chevreuil," were in a pitiful condition and were mere walking skeletons.

I spent a very pleasant evening with the officers of the Telegraph Battalion, R.E., hearing their experiences and recounting my own. They were very grateful for a few tins of potted meat, chocolate, etc., which I had brought up in my wallets; and in return they shared with me their frugal repast of trek ox (or horse, it was just as well not to enquire too closely) and mealie meal porridge, a dish which I did not altogether appreciate though they seemed to relish it immensely. It was pathetic to see the care with which they measured out the portions of food, and each one produced his little tin of sugar, etc. The reason for each having his private supply was, they explained, that one might like his sugar with his tea and another with his porridge, and, as there was not enough for both, by having individual stores each one could please himself. They told me of one mess where the senior officer, who either had a grand disregard for the shortness of siege fare or was of a particularly absent-minded disposition, being served first, invariably helped himself to three rations of sugar, leaving the poor juniors to fare very badly in consequence.

The following day I spent visiting friends, one of whom, wounded at Talana Hill, was still in hospital at Intombi, and in going round the

fortifications. It was difficult at first to understand how such an apparently indefensible place could possibly stand a siege where the enemy really meant business; but after a closer inspection one realised that the circle of low hills surrounding the town on three sides, when well entrenched and covered with walls and sangars as they were, offered a strong barrier to an attacking force. The east side of the town was the least defensible, for here there was no protecting ring of hills but an open plain, bounded on the east and north-east by the commanding points of Umbulwhana, Gun Hill, and Lombard's Kop, on the two former of which the Boers had heavy guns. Had the enemy on the 6th January succeeded in taking Cæsar's Camp and Wagon Hill, there would have been little hope of the garrison holding out.

The Relief Force marched into Ladysmith at 10 a.m. on the 3rd March. The Ladysmith Garrison lined both sides of the main road through the town from the railway station to the prison, where some Boers were still in custody. As the Headquarter Staff approached each company of the garrison presented arms and then gave "three cheers for General Sir Redvers Buller and the Relief Force." Sir George White and his Staff were drawn up opposite the Town Hall. Besides the garrison there were small groups of townspeople, who did their best to become enthusiastic; but all, both soldiers and civilians, looked worn out and tired from their recent experiences. Each regiment as it approached was cheered by the garrison and cheered back in return. It occupied about half an hour for the head of the column to march through the streets. On arrival on the plain between the town and the "Tin Camp" Sir Redvers Buller fell out, and the Relief Force continued their march past him, each regiment cheering him heartily as it passed. A splendid body of men they looked, bronzed and hardened by their recent efforts and by exposure to the almost tropical sun, their dirty and worn-out clothes in no way detracting from their fine appearance. How little did one think, as one watched these brave men march through the streets, proud in the knowledge of duty well done, that in a few short weeks enteric fever, the terrible scourge which had already worked such havoc among the defenders of the town, would make such a heavy claim on them and would number so many of them among its victims. Before the Relief Force continued its march northwards, the numerous graves in the Ladysmith cemetery and in the new burial enclosures on the bare hillsides marked the last resting place of many a one now full of life and vigour.

In the afternoon I rode back to Pieter's Hill, paying the "Long Tom" emplacement on Umbulwhana Hill a visit on the way. It was a stiff climb to get up to it. The emplacement was well protected with barbed wire, and besides the ammunition left behind there was a good supply of hand grenades, showing that after their experiences at Gun and Surprise Hills the Boers did not feel too secure against an

attack. From there, after a terrible scramble over huge boulders, I passed through the Boer camp; like all others I came across in the campaign, it was in a horribly dirty condition and littered about with old clothing, rugs, tin boxes, and all sorts of odds and ends, including torn hymn books and bibles, children's lesson books, and English illustrated papers and novels.

Arriving at the river at 7 p.m. I found my subalterns just finishing packing up No. 10 bridge. We moved a little way from the river and bivouacked, but did not have a very pleasant night, for the most horrible smells were wafted to us from all sides. Next day we marched back to Colenso; and on the following day, March 5th, moved by the main road over Grobelaars Kop to Ladysmith, where we remained for the next two months.

MEMOIR.

MAJOR-GENERAL SIR CHARLES W. WILSON, K.C.B., K.C.M.G., F.R.S.

CHARLES WILLIAM WILSON was born at Liverpool on March 14th, 1836. He was the second son of Edward Wilson, Esq., J.P., of Hean Castle, Pembrokeshire. He was educated at St. David's, Liverpool College, Cheltenham College, and the University of Bonn. At an open competition for admission to the Corps of Royal Engineers in 1855 he obtained the second place, and was gazetted to the rank of Lieutenant on September 24th in the same year. After going through the course of instruction at the Royal Engineer Establishment, Chatham, of which Colonel H. Sandham, R.E., was then Director, he was posted for duty to Shorncliffe Camp in 1857. After five months at Shorncliffe Wilson was placed under orders for India and returned to Chatham for a short time, when the orders were cancelled and he was sent to Portsmouth.

Even at this early stage in his career he gave evidence of the capabilities which distinguished him through life, and early in 1858 was selected as Secretary of the Commission, which was appointed to delimitate the portion of the boundary between Canada and the United States, comprised between the Pacific Ocean and the Rocky Mountains. The settlement of this boundary, extending over nearly sixty degrees of longitude, has been a long and difficult operation. The work commenced shortly after the Treaty of 1773 had been made and was only completed in 1874, several Commissions having from time to time been engaged upon the work. Prior to 1858 the eastern portion from the Atlantic to the Lake of the Woods in Longitude 95° had been settled but nothing had been done westward of this point. The territory on the Pacific side was becoming more or less populated, and it became an urgent question to fix the frontier. It was with this object that the Commission was arranged to which Wilson was attached. Colonel Hawkins, R.E., was nominated as British Commissioner, and the work commenced in August, 1858, and was continued until 1863. The line of demarcation commenced at the Gulf of Georgia, opposite Vancouver Island, and was continued along the 49° parallel to the summit of the Rocky Mountains. The country passed through was very difficult, swampy in the western parts and then thickly wooded and very rugged. Little dependence could be

placed on the resources of the country and food and forage had to be brought from a considerable distance. Lieut. Wilson had charge of the interior economy of the Expedition, the transport and commissariat arrangements, and, for some time, of the survey operations. The manner in which he carried out his very arduous duties proved the selection was an excellent one, and, at the close of the work in 1863, he received the thanks of the Secretary of State for Foreign Affairs for the assistance that he had rendered to the operations of the Commission.

On his return from North America, Wilson was employed upon Defence Work at Chatham until August, 1864, and then undertook a duty which greatly affected his future career. At that time Miss Burdett-Coutts (now Baroness Burdett-Coutts) was much interested in the question of providing a good water supply for the City of Jerusalem. She was advised by a Committee, of which the late Dean Stanley was a prominent member, that, before the question could be properly discussed, it was quite necessary to have an accurate survey made of the town and surrounding country. Dean Stanley applied to the Secretary of State for War, who placed the matter in the hands of General Sir Henry James, Director-General of the Ordnance Survey. The conditions were that the sum of £500 was to cover *all* expenses. It was settled that an officer of the Royal Engineers would be allowed to do the work on the understanding that he received no extra pay whilst so employed and paid all his own expenses. The appointment was offered to several officers, who, not unnaturally, declined it. Wilson heard of the proposal, and at once wrote to Sir H. James, to say he was willing to do the work on the conditions proposed. Some of his friends thought he was foolish and that he would not succeed in carrying out the work. But the result proved the correctness of his judgment. He proceeded to Jerusalem in August, 1864, and completed the survey in rather less than a year, having expended only a few pounds more than the original estimate. The work included not only the survey of the town and surrounding country, but also plans of the Haram Area, held so sacred by the Mahomedans, and a series of levels from the Mediterranean to the Dead Sea. Besides Wilson, the party consisted of Sergeant Macdonald, R.E., and four sappers, and so admirably did all work that by the time they left Jerusalem the Royal Engineers were looked upon as people who could be allowed to go anywhere and do anything. The plans and reports were published by the Ordnance Survey at Southampton, and remain, up to the present, the standard work on Jerusalem as it now exists.

Wilson had been promoted to the rank of 2nd captain on 20th June, 1864, and on his return to England, proceeded to the Ordnance Survey. He did not, however, remain long at Southampton, but returned to Palestine in November, 1865, to take charge of an expedition for the Palestine Exploration Fund. This Fund was

established in June, 1865, by a Committee of which Dr. Thompson, the Archbishop of York, was chairman, and Dean Stanley one of the leading members, for "the prosecution of systematic and scientific research in all the branches of inquiry connected with the Holy Land." The principles upon which the work was to be undertaken, and which have been rigidly adhered to for forty years, were :—

1. That whatever was undertaken should be carried out on scientific principles.
2. That the Society should, as a body, abstain from controversy.
3. That it should not be started, nor should it be conducted, as a religious society.

There can be no doubt but that Wilson's great success in the conduct of the survey of Jerusalem was a prominent factor in the original starting of the Society, and, it is not too much to say, that he has been its mainstay up to the time of his death. His loss to the Society is irreparable. It was natural that the Committee should have looked to him from the commencement and that he went out as their first explorer. He proceeded to Palestine, accompanied by Lieut. S. Anderson, R.E., and carried out a preliminary survey over a great part of the country. The latitudes and longitudes of a number of points were fixed, a line of azimuths was carried from Banias to Jerusalem, and many plans and drawings of ancient sites and buildings were made. This reconnaissance may be regarded as the starting point of the vast amount of survey work and archaeological researches, which have been carried out by the Palestine Exploration Fund. Wilson was elected as a Member of the executive committee of the Fund on his return to England.

After the completion of his work in Palestine, Wilson was appointed to the Ordnance Survey of Scotland and was stationed at Inverness from 1866 to 1868. On January 22nd, 1867, he married Olivia, daughter of Colonel Adam Duffin, of the 2nd Bengal Cavalry. He acted as Assistant Commissioner on the Borough Boundary Commission of 1867. In October, 1868, he undertook the Survey of the Peninsula of Sinai, the expenses of which were met by public subscription. As the amount of money raised was scarcely adequate to meet the cost of the survey, Wilson agreed to go out on the same terms as those he had accepted when engaged on the survey of Jerusalem. The maps and reports were published by the Ordnance Survey, and contain a mass of useful information respecting Mount Sinai and the surrounding districts. The survey was completed in May, 1869, when Wilson was ordered to the War Office as Executive Officer in the Topographical Department, of which he was appointed Director in the following year. In 1869 he was elected a Fellow of the Royal Geographical Society and selected as official Member of Council of the Royal United Service Institution.

In 1871 the Topographical Department was expanded into the Intelligence Department, of which General Sir P. Macdougall, K.C.B., was appointed Chief with the rank of Deputy Adjutant-General, and Wilson continued as Executive Officer of the Topographical Branch, ranking as Assistant Quartermaster-General, until March, 1876. He received the civil C.B. in the following year for the services he had rendered in the formation and organization of the Intelligence Department, of which he may be regarded as the founder. He was promoted Major, Royal Engineers, on May 23rd, 1873.

During the period spent at the War Office he continued his work in connection with geography and exploration. He received the Diploma of the International Geographical Congress at Antwerp in 1871, for the Jerusalem Survey, and was elected Member of Council of the Royal Geographical Society and of the Society of Biblical Archæology in 1872. In 1874 he received the distinguished honour of being made a Fellow of the Royal Society for his work in Jerusalem, Palestine and Sinai, and was President of the Geographical Section of the British Association the same year.

After leaving the War Office, he was specially employed at the India Office on the compilation of a map of Affghanistan, and received the thanks of the Secretary of State for India for the manner in which the work was carried out. On the completion of this duty he was appointed to the command of the Ordnance Survey in Ireland, and held the appointment until March, 1879. During the period of his service on the Ordnance Survey, Wilson was selected in 1878 as British Commissioner for the delimitation of the Boundary of Servia in accordance with the International arrangement under the Treaty of Berlin. For this duty he received the thanks of the Government, and was promoted Brevet Lieutenant-Colonel on April 19th, 1879.

Shortly after returning to the Ordnance Survey at Dublin he was chosen for a very important position in the East. This was the appointment of Consul-General for Anatolia which he held from April, 1879, until August, 1882. His duties necessitated constant travelling through Asia Minor, frequently under difficult conditions, and, while carrying on his official work, he was able to collect a great deal of valuable geographical information, of which much is available for the public in the handbook for Asia Minor and Constantinople, which he edited for Messrs. Murray some years afterwards. During the period of service in Anatolia, Wilson was employed on a special mission by the Foreign Office to Bulgaria, Roumelia and Macedonia, and also on a tour of inspection of the Consular posts in Asia Minor, Syria, and Palestine. He received the thanks of the Government for his services, and was created K.C.M.G. in 1881. During the same year he became regimental Lieutenant-Colonel in the Corps of Royal Engineers.

In 1882 the political trouble in Egypt was ended by the successful

campaign of General Sir G. Wolseley against the army of Arabi. It was recognized that the services of Sir C. Wilson, from his intimate knowledge of the East, would be of the greatest value, and he was ordered to proceed from Asia Minor to Egypt and to be attached for duty to Sir Edward Malet, the Consul-General. He arrived in Egypt during the campaign, for which he received the medal and Egyptian star, and reached Cairo shortly after its occupation by the British troops, where his first duty was to see that the safety of the Museum of Antiquities at Boulac, and of the Public Library were secured. He was then ordered to look after the Egyptian political prisoners, to inspect the prisons, and see that justice was done. He was next appointed on behalf of the British Government to watch the trial of Arabi and his associates; and to him it was greatly due that the affair, which presented great difficulties, was brought to a satisfactory conclusion. Wilson received the thanks of the British Government for the services he had rendered and was promoted Brevet Colonel on April 19th, 1883. In addition to the work under the Consul-General, he was attached to the staff of Lord Dufferin, who was sent on a special mission in connection with the re-organization of Egypt. On the completion of his duties in Egypt, Wilson returned to Dublin and again took up the charge of the Ordnance Survey.

During the period when he was in Egypt, Sir C. Wilson had devoted much attention to the state of affairs in the Soudan where the rebellion against Egyptian authority, which had commenced in 1881, was gradually spreading. In September, 1882, he made a Report to Sir E. Malet on the condition of the country and strongly recommended that two British officers should be sent to Khartoum to report on the steps that would be necessary to ensure pacification. The proposal was approved by the British Government and Lieut.-Colonel Stewart was ordered to proceed to the Soudan, respecting which he forwarded an interesting Report in February, 1883, and pointed out the measures which should be taken for improving the condition of the country. Unfortunately the British Government failed to realize the intimate connection between Egypt and the Soudan, and disclaimed any responsibility for the latter. This is not the place to discuss the Soudan question. Suffice it to say that the rebellion spread rapidly and that early in 1884 General C. Gordon was sent to Khartoum to report on the condition of affairs and to withdraw the Egyptian troops. His task proved to be an impossible one and he was besieged in Khartoum by the rebel forces. At last England woke up to the situation and an expedition was despatched up the Nile. But it was then too late and Khartoum fell before it could be relieved. Sir C. Wilson was selected as Chief of the Intelligence Department with Lord Wolseley's force and proceeded to Egypt in September, 1884, with the rank of Deputy Adjutant and Quarter-master-General. Lord Wolseley arrived at Korti on December 16th,

1884. The scanty information which was received from General Gordon showed that Khartoum was in a desperate condition. On December 30th Colonel Sir Herbert Stewart was ordered to proceed across the desert towards Metemmeh in command of the Camel Corps and halted at Gakdul where he formed a depôt and returned to Korti for reinforcements. He started again for Gakdul on January 8th, 1885, and Sir C. Wilson accompanied him with orders to see General Gordon in Khartoum, if possible, and to inform him that a British force was approaching to relieve him. Stewart's force started from Gakdul for Metemmeh on January 14th and after a severe action at Abu Klea, and further fighting, in which Stewart was severely wounded, arrived on the banks of the Nile on January 19th. Stewart being incapacitated, the command of the force devolved on Sir C. Wilson. The village of Gubat was occupied and placed in a state of defence on the following day and steps taken to secure the safety of the small British force, which was in a hazardous position, surrounded by thousands of the enemy. On January 21st the steamers, which Gordon had sent down in September to meet the British troops, came up and reported that they had been waiting for the arrival of the latter. Gordon had sent these steamers as he believed that the British force should arrive at the Nile in October, and they had been cruising up and down the river, constantly fighting with the rebels for four months.

Captain Lord C. Beresford, R.N., who had been sent by Lord Wolseley to take command of the steamers, prepared them as quickly as possible for the journey up to Khartoum, and they were ready to start by the morning of January 24th. In accordance with his instructions, Wilson proceeded to Khartoum leaving Colonel Boscawen in military command at Gubat. He took two steamers, *i.e.*, the "*Bordein*" and the "*Tell Hoween.*" The Nile was low and travelling was in consequence very difficult. In ordinary times, steamers would not have attempted to pass the sixth cataract at that period of the year. It took four days to go up the river and on arriving near Khartoum on January 28th it was found that the place had fallen and Gordon had been killed on the 26th.

It will be remembered that, at the time, an attempt was made in the press to throw upon Wilson the blame of arriving too late and being therefore responsible for the failure of the expedition. But a more unjustifiable accusation was never made. The expedition failed because it started too late, and Wilson was not sent to relieve Khartoum but to let Gordon know that the British force would arrive some time later. His orders were most distinct. The important portion of them was as follows :—

"As soon as Lord C. Beresford reports that he is ready to proceed with one or more steamers to Khartoum, you will go to that place with him and deliver the enclosed letter to General Gordon, I leave it open so that you may read it.

"Orders have been given to Sir H. Stewart to send a small detach-

ment of infantry with you to Khartoum. If you like, you can, upon arriving there, march these soldiers through the town, to show the people that British troops are near at hand. If there is any epidemic in the town you will not do this. I do not wish them to sleep in the city. They must return with you to Metemmeh. You will only stay in Khartoum long enough to confer fully with General Gordon. Having done so you will return with Lord C. Beresford in steamers to Metemmeh."

It is matter for thankfulness that Khartoum had fallen before Wilson reached it. Imagine what Gordon would have felt had Wilson met him in the midst of the starving people and given him the message. "I am not sent to help you and cannot stop with you, but there will probably be a British force to relieve you in about six weeks."

On the return journey from Khartoum to Metemmeh both steamers were wrecked, and Wilson and his party had to remain on Mernat Island until taken off by Beresford who came to their relief in the "*Safieh*." Wilson left Gubat on February 6th and arrived at Korti on the 9th. Lord Wolseley immediately telegraphed to the War Office an account of the journey to Khartoum, and the Secretary of State for War replied—"Express warm recognition of Government of brilliant services of Sir C. Wilson, and satisfaction at gallant rescue of party." On the conclusion of the campaign, Wilson returned to the command of the Ordnance Survey in Ireland in June, 1885. For his distinguished service in the Soudan he was mentioned in despatches (see *London Gazette*, August 25th, 1885) and was created K.C.B.

Wilson remained in Dublin until November, 1886, and was then nominated as Director-General of the Ordnance Survey, an appointment which he held until March, 1894. He was promoted Temporary Major-General on February 22nd, 1893, and Major-General on February 15th, 1894. The civil distinctions which he received in the years under review were as follows:—Hon. D.C.L., Oxford University, 1883; Hon. LL.D., Edinburgh University, 1886; Member of Council, Royal Geographical Society, 1887—1890; President of the Geographical Section of the British Association, 1888; Member of Council of the Royal Society, 1889—1890; Hon. M.E., Dublin University, 1893.

The moment when Wilson became Director-General was important in the history of the Ordnance Survey as the work to be undertaken in the future was not definitely fixed, and there was a probability that the staff would be considerably reduced notwithstanding the large and important work that remained to be done. He obtained authority for the revision of the Irish Survey on the $\frac{1}{2500}$ scale, and commenced the survey of Lancashire and Yorkshire on the same scale. He succeeded in commencing the revision of the small scale maps, which had practically been left unaltered for many years,

and in initiating a system for bringing them up to date. He also devoted much attention to the organization of Survey Sections for employment with an army in the field, and the result has been that the Military Topographers trained by the Ordnance Survey have done excellent work in South Africa and the British Colonies. It is really difficult to speak in sufficiently high terms of the improvements which he introduced, working, as he always worked, in a quiet way but ever advancing in the direction of real efficiency and for the advantage of the public service.

After his period of service on the Ordnance Survey, for which he had done so much, came to an end, he was unemployed for nearly a year and was then appointed, on January 22nd, 1895, as Director-General of Military Education at the War Office, a position which he held until retired, under the age clause of the Royal Warrant, at 62 years of age on March 13th, 1898.

But although retired from professional life, his interests in the subjects of geography and exploration continued unabated. He devoted much attention to the work of the Palestine Exploration Fund and supervised the excavations by visits to the Holy Land. In 1901 he was unanimously elected Chairman of the Executive Committee of the Society in succession to Mr. James Glaisher, F.R.S., who had occupied the position for twenty years. The Society owes a great debt of gratitude to Sir Charles Wilson not only for the constant care and attention which he devoted to the work, but for the very valuable papers that he contributed to the Quarterly Statement. Of these perhaps the most important was a series of articles on the Holy Sepulchre at Jerusalem. He had intended to publish these in book form, and was engaged upon this up to the time of his death. The Committee of the Fund have decided to complete the publication, and it will undoubtedly be the standard work upon the subject.

Sir Charles Wilson died at Tunbridge Wells on October 25th, 1905, after a few months' illness. His funeral, which was at Tunbridge Wells, was attended by representatives from the War Office, the Royal Geographical Society and the Palestine Exploration Fund, besides many personal friends. His loss to those who knew him well leaves a gap that nothing can fill.

C. M. WATSON.

TRANSCRIPTS.

LESSONS OF THE RUSSO-JAPANESE WAR.

IV. ENGINEERS.*

SINCE the days of Todleben, Russia has always been strong in Engineers. The defences of Port Arthur were of vast strength, and the temporary works thrown up around them of scarcely less importance than the scarped castles on the limestone rock behind them.

During the battle of Liaoyang, Kouropatkin caused a huge *tête du pont* of semi-permanent works to be constructed on the west or left of the position. *La France Militaire* holds that this combination of works was of great strategical value as it enabled the Russian Generalissimo to use two army corps only, protected by these works, to watch Generals Nodzu and Oku, whilst he concentrated the rest of his forces on the north-east of the town to face the enveloping movement of Kuroki. The works erected to the south of Liaoyang, under the superintendence of Colonels Jdanof and Vinovski, deserve more than passing mention. The credit of their construction belongs to the East Siberian Sapper battalions. Of these the 2nd were taken prisoners at Port Arthur, and the 1st elsewhere employed, so the 3rd and 4th are the units that probably did most of the work. The profiles were strong, and constructed so as to give the greatest possible development to front, or direct, rifle fire. In the interior slopes were placed barrels, sunk in the earth, constantly filled with rifle ammunition. This idea, borrowed from the Turks at Plevna, enabled the infantry lining the parapets to pour a continuous and intense rifle fire on the glacis and all the ground in front of the works, without having to trouble itself about the difficulties of supply of ammunition under fire. This matter, as all infantry officers know only too well, is a difficult one, and its successful arrangement by the Turks and Russians is to be noted. In the angles, or *pans coupés*, of the works, which resembled blunt lunettes, were placed quick-firing guns mounted *en barbette*, so as to command an all-round fire. These guns could be easily run down under cover by the ramps of approach. Under these ramps and the whole parapets, with twelve to eighteen feet of earth cover, were the shelters, in which the garrisons of the works slept, fed, and passed their few leisure hours. These retreats were approached by steps; the width of the entrance being small the danger from shell-bursts was reduced to a minimum. Outside and all round the works was a complete barrier of wire entanglements

* Reprinted by permission from the *Broad Arrow* of 28th October, 1905.

and *trous de loup*, or pits provided with sharp stakes. These obstacles were directly under the fire, not only of the infantry, whose rifles lay on the superior slope, but of the quick firing-guns in the angles of the works before described. Owing to the configuration of the ground it was not possible to give these works all the necessary advantages of site. Many of them were commanded by hills to the south, and from 4,000 to 6,000 yards from them. As these were in the occupation of the Japanese they mounted heavy guns there that they had used at Port Arthur. But the results of the bombardment from this heavy artillery were but meagre. Brought up at such labour it failed either to breach the works, to subdue their fire, or to cause serious casualties in the ranks of the defenders. The Japanese found it necessary, as we have already expressed our opinion it will be, to call in the aid of the field artillery. The direct defensive rifle fire and the mutual flanking fire of the works rendered nugatory all the Japanese efforts to take them by infantry assault. The attackers lost enormously, whilst the garrisons of the forts suffered little, their total casualty list amounting to only 300. Not one of these semi-permanent works was taken. When the retreat commenced, and the ground between them was vacated, the fire of the forts still denied it to the enemy. The works themselves were only vacated on the 3rd September at 6 a.m., by the order of the General Commanding-in-Chief.

It will appear from this description, drawn it is true from Russian sources, that it is almost impossible to dislodge good troops from strong semi-permanent works. All the attacks on Bilderling's army on the Shaho position, near Mukden, were repulsed, as well as those above described. Yet these attacks were made by excellent troops, supported by a powerful artillery, including guns of 28-centimètres, say 11-in., calibre. The effects of the bombardment were not sufficient to force the infantry out of its underground shelters, and at the moment of assault its fire, like that of the Turks at Plevna, recovered its full intensity, when the fire of the attacking guns was suspended for fear of killing their own infantry. Whilst we are willing to give full belief to the assurances of the *Russki Invalid* as to the tactical supremacy conferred by semi-permanent works, there is another, the strategical, aspect to be considered. The general result of the occupation of these strong works on the Shaho was to give a false confidence to the Russian Commander-in-Chief. He was, in a measure, justified in the belief that he could hold any force in check. But the works, like permanent fortresses, had their defects. They could be, and were turned. The two army corps that should have been placed more or less in reserve between Mukden and Tieling were not there when they were wanted. Or, if on the spot, they had been so harried and worn out by marches and counter-marches as to be too exhausted to make an effort. These troops had been sent away from the real post of danger, on the west, to assist Liniévitch to the east, in the mountains forty miles away. We have read a good deal in the Russophile press of the gallant stand made by General Liniévitch. But it has failed to report the persistent appeals he made for help to Kouropatkin at a moment when the grand Japanese attack on the Russian right was actually in process of execution. Liniévitch had a fine army of at least 90,000 men, and was

manœuvring in a hilly country with few avenues of approach, all of which he also had blocked with semi-permanent works. It is true that the Japanese on this flank attacked with a desperation and courage that we have not been accustomed to read of in late years. Hecatombs of dead and dying did not prevent them from renewing their attacks day after day. But 90,000 solid Russian troops, with so much artillery as Liniévitch had at his command, should, one would have thought, have been able to contain both Kawamura and Kuroki under the circumstances. Not so; or at all events Liniévitch did not think so. He has the reputation of being a fire-eater, but even the salamander may have too warm a place. And there can be no doubt that Liniévitch's constant calls for help utterly misled the Commander-in-Chief, and indeed the world, as to the real situation. For days we imagined that the Russian left, and not the right, was in danger of being overwhelmed by the Japanese.

The point to insist on is the danger of relying too much on powerful semi-permanent works and of denuding their neighbourhood of the mobile troops in reserve, who should always be ready to meet the development of a flank attack. It has come to pass that flanks must be turned. Central attacks will always be more or less of a containing kind. It would seem then better in some cases to strengthen the centre rather than the flanks by immobile works, holding the reserves always ready to repel the final efforts that the attacking enemy is certain to make on the extremities of the position. If we take the famous instance of the advance of the Prussian Guards on St. Privat-la-Montagne we see that Canrobert's position was strong enough to repel the first attack. The gallant Marshal called on Bazaine to help him with the Imperial Guard from Plappeville. Before the second attack the Saxons, marching round Roncourt, had cut the whole French army off from its retreat on Verdun. It was the want of the mobile troops that forced the French to retire from the stone walls at St. Privat. Possibly semi-permanent works, if they had been erected, would have delayed for another day the victory of Gravelotte. It is rather the combination of semi-permanent defences and mobile troops that will insure success in battle, than too absolute a confidence in the power of either to fulfil the part that should be assigned to both.

A REINFORCED CONCRETE CHIMNEY.*

In the United Shoe Machinery Company's new shops at Beverly, Mass., reinforced concrete has been used in connection with a chimney stack, 141 ft. 1 in. high from the foundations, the construction of which occupied 60 days.

The chimney is 6 feet in diameter inside, and has a foundation 18 ft. square by 3 ft. 6 in. in depth. The concrete in the foundation is composed of one part Portland cement, two parts sand, and four parts stone; and is reinforced with a network of $1\frac{1}{4}$ in. by $1\frac{1}{4}$ in. by $\frac{5}{16}$ in. steel T bars placed horizontally. Similar bars worked vertically into the shaft are bent under the horizontal bars.

The shaft is built in two portions, the lower one being 60 ft. high, and consisting of two shells with a 4 in. air-space between them. The inner shell is 4 in. thick and the outer one 6 in. thick; the space between them is connected with the outside atmosphere by small air inlets. In the first 27 feet of the outer shell 72 vertical bars, the same size as those in the foundation, are used, and these are placed in groups; while in the inner shell there are 12 vertical bars, and horizontal rings of 1 in. by 1 in. by $\frac{1}{8}$ in. steel T's are placed in it every 18 in. The outer shell has also similar rings, but in this case they are placed every 3 feet apart.

The next 15 ft. length of the lower shaft has 60 vertical bars, and 12 bars are omitted in every 15 feet after this to the top of the chimney.

At the height of the top of the inner shell the outside diameter of the chimney is reduced, as the air-space is omitted (the inside diameter of the chimney being unaltered), and a moulding is run round the chimney at this point. From here to the top the concrete is 5 in. thick, with the exception of the moulding at the cap. The vertical reinforcing bars in the outer shell are bent slightly at the top of the inner shell, and are continued through the concrete of the upper part of the chimney to the top. Horizontal rings are also placed in the upper part above the moulding, but are spaced 3 feet apart.

In the construction two sets of wooden forms were used, each set being 3 ft. high, and they were made in sections. About 3 ft. of the double part and 6 ft. of the single part were built per day. The concrete used in the shaft was a mixture of one part cement and three parts sand. The foundation is 12 ft. below the ground-level, and its weight is about 161,000 lb., with an additional weight of earth upon it of about 184,600 lb.

The total weight of the chimney is about 234,180 lb., the weight of the steelwork being about 14,440 lb. The stack is guaranteed to withstand a wind pressure of 50 lb. per sq. ft. and a temperature not exceeding 1,500 deg. Fahr. The maximum pressure on the ground is 2 tons per square foot.

* From *Engineering* of 29th September, 1905.

THE JAEGER COMPANY'S MINIATURE RIFLE RANGE.*

A FULLY occupied warehouse, packed with goods, etc., from top to bottom, in the heart of the City, does not seem to offer much opportunity for a 25-yard rifle range, but the thing has been accomplished, and that without interference to business, without loss of space or of light, and, most remarkable of all, to the entire satisfaction of the London County Councillors, who, very properly, required to be satisfied that the range was absolutely safe before giving their approval.

The necessary dimensions for an efficient miniature rifle range are:— Length, from firing-point to targets, 25 yards. Behind firing-point 15 ft. to 20 ft. for men *firing* (the prone position occupies 6 ft.), for spectators, rifle racks, accommodation for cleaning, storage of ammunition, etc. Anything less than twenty-five yards diminishes the efficiency of the practice, although, where this length is impossible, twenty yards, or even fifteen, will give good results. Width, 10 ft. at the firing-point, to allow four targets. This may diminish, if necessary, to 8 ft., or less, at the target end, but it is better to keep a uniform width if possible. Where there are a large number of members, the individual cannot get sufficient practice with less than four targets, and is likely to lose interest if the number of targets, and consequently the opportunities of firing, are fewer.

On the warehouse in question a space of the required width and length was found outside, and stretching from west to east over three long skylights above the ground floor. On the left, looking towards the target end, the building rises for several floors; on the right hand is an iron railing, separating the premises from the neighbouring ones, which have a similar range of skylights. The first three windows on the left are protected by revolving metal shutters, to be drawn down after business hours, when the range is used; projecting shields, fixed to the brickwork between the windows at intervals, protect the remaining windows. By means of a simple diagram drawn to scale the shields can be so arranged that a bullet which misses one shield will infallibly be caught by one of the other shields. A similar series of overhead shields prevents an unduly elevated bullet from escaping. On the right a continuous sheet of $\frac{1}{16}$-in. steel plate attached to the railing protects the neighbouring premises.

Behind the target end is a large window, protected, when the range is in use, by folding doors of $\frac{1}{4}$-in. steel plate, with extra metal immediately behind the targets. These doors are closed only when the range is in use. Of the skylights over which the range runs, that nearest to the firing-point is protected by a long revolving metal shutter, and shields similar to those overhead protect the other skylights beneath the range.

* From the *Daily Telegraph* of 22nd August, 1905.

As these shields are perpendicular, they do not appreciably obstruct the light.

Now that the way has been shown the roofs of buildings can in many cases be employed for the purpose of a miniature rifle range. Sometimes a blank wall of brick can be utilised to form one side of a range, ready-made. An existing parapet wall, if not high enough, and if "ancient lights" do not hinder, can be raised a few feet at comparatively small cost. Where questions of interference with light, or of wind-strains, do not arise a large metal tube, 8 ft. wide and 4 ft. high, forms an absolutely secure range. If the lower side of the tube be raised 3 ft. from the foot-level, men can shoot standing into the tube; while, for the prone position, raised platforms can be fixed. There are several excellent and highly practical devices for conveyance of the targets to and from the firing point, whence they are controlled. The best of these combines a disappearing target, for snap-shooting, with the ordinary stationary targets. It will be found in actual practice that not one bullet in many thousands will touch any shield or point in the range other than the target or immediately around it. At the same time, it is, of course, essential that absolute security at every point be provided for.

REVIEWS.

TEXT-BOOK OF TOPOGRAPHICAL AND GEOGRAPHICAL SURVEYING.

By Major C. F. Close, C.M.G., R.E.—(Wyman & Sons. Price 3s. 6d.)*

Major Close has at last filled a gap in technical literature which has long wanted filling. For years past there has been a slow but very steady advance in English geographical schools, the tendency of which has been to place England more on a level with her continental neighbours in matters relating to the acquisition of map knowledge of her widespread possessions beyond the seas than was possible under the restrictions which necessarily distinguished Ordnance Survey methods. No standard work on topography, as applied to continents rather than counties, has previously existed in the English language, unless we make an exception of Mr. Wilson's *Topographic Surveying*, which is certainly a valuable summary of the principles of the art from the American point of view. Major Close leaves nothing to the imagination, although he wisely confines himself to the strict limits of his subject, declining to enter into the tempting field of geodetic discussion (on which science there is already an ample literature), and dealing only with those practical issues which bear directly on the final attainment of sound topographical maps. For the first time, too, we have all those branches clearly defined, and the relative value of the map results properly co-ordinated with the object they are meant to serve. The place of topography in the wider field of geography is well maintained; and the principle that it is just as scientific to make approximately accurate mapping (so long as it will always fill its own place in the world's geography without error and without distortion) as to labour through all the preliminaries of geodetic arc measurements, and thus be left hopelessly behindhand in the practical results of useful map-making, is clearly intimated. In short, it is a practical work all through—as a text-book should be—and it is to be earnestly hoped that it will form the basis of topographical instruction in all the geographical schools of England.

So full and so complete is the work in the matter of forms, tables, and illustrations that it would take a long time to refer to all those features of it which deserve special recognition. The illustrations are excellent, and if any criticism can be applied to them it is that they are almost too

* Reprinted by permission from the November, 1905, number of the *Geographical Journal*.

good. One or two specimens of the very roughest and readiest form of topographical art, as applied by highly trained Indian explorers to districts over which they may have to carry a reconnaissance at the rate of hundreds of square miles per diem, would not have been out of place in a work of this sort.

From the commencement of the book we note that Major Close insists on the importance of a preliminary basis of triangulation, or traverse, for topography, and rightly maintains the advantage of such a basis over any form, or combination of forms, of astronomical observation. His remarks on the preliminary base measurement include a reference to those newer methods which have been introduced by French experts, which render the process of rapid measurement so much more accurate than was formerly possible. It is for this reason, perhaps, that he does not insist forcibly on the necessity for a constant repetition of linear measurements during the extension of the reconnaissance (or "geographical topography"), which was adopted till lately as the best means of compensating error. All the most useful methods of carrying out what we may term irregular triangulation are well explained; but we may, perhaps, note that it has been found in practice *always* necessary to introduce an azimuth value derived from astronomical observation with the computations for interpolating a position by triangulation, whether from three or more points or from two. Whilst Major Close very rightly insists on the uncertainty which attends latitude checks owing to inconstant level deflection, he perhaps depreciates the value of such checks a little too far. The uncertainty must always exist, but in practice it has not been found to invalidate their usefulness to any great extent.

The chapter on the use of subtense instruments for traversing purposes is most useful. It is an essential detail in topographical surveying which is often overlooked. The use of the plane-table is advocated by an expert at the process. One small detail may perhaps be emphasized even further than by the italics which Major Close gives it. *Pins should never be used* to assist the plane-tabler to align his ruler. It is a slovenly expedient which is too often made use of. I have seen a plane-table that looked like a pin-cushion in a military school lately.

The chapter on "Surveys on Active Service" is altogether good. There is a point about map-reproduction in the field which is perhaps worth more discussion. The sun-printing processes (blue prints and the like) can be made use of with far greater facility than either lithography or zincography. The latter may be superior in their results, but the advantage of illustrating the first despatches after an action by a sketch-map made during its progress, and reproduced with the utmost rapidity, are not to be overlooked. It might very well happen that at the close of an extended action covering 8 or 10 miles of front, the position of every brigade could be indicated to the general commanding by means of a series of sketch-maps made during the course of the action, traced and printed within an hour or two, given that light was available. This would hardly be possible by any other means than sun-printing.

On the subject of map projections Major Close is perhaps the best authority in England, and he treats the subject liberally.

The story of British mapping might possibly be considered as hardly appropriate to a text-book; but the moral of it is far too important to allow of its omission. That moral is best given in Major Close's own words, "No system of sketching, no combination of sketches, and no compilation of previously unconnected material, whether sketches, isolated surveys, or from plans, will result in a trustworthy topographical map." The grand ruling principle of working from the whole to a part, and not *vice versâ*, is the keynote of the whole book—the golden rule which must surely govern all English surveys in the great future before them.

The subject of astronomy as an adjunct to topography is well and fully illustrated. Due value is given to the various methods of determining longitude, and Major Close gives expression to the opinions of all experienced topographical and geographical surveyors in his summary of this subject. It might be expressed as follows: "Never take an observation for an abstract value of longitude if you can obtain that value differentially by telegraph; never use the telegraph if you can get a differential value by triangulation."

Taking it for all in all, it is the best book on topography that has yet appeared in the English language, and will certainly serve as a standard guide for all the many geographical schools in the country.

T. H. HOLDICH.

SPECIAL ARMY SCHOOLS FOR THE EARLY EDUCATION OF OFFICERS.

By COLONEL O. E. RUCK, R.E.

This pamphlet, published by Schultz & Son, Gravesend, is remarkable for its concluding recommendation that boys intended for the Navy or Army should receive their early education in a joint Naval and Military College followed by a course at sea. The author considers that from the age of 11 up to 13 the boy should be educated at an approved and inspected school; then interviewed and nominated to enter the joint college, where he would remain 2 years; he would then join a ship in commission for 2 years; and finally, if found suitable, be admitted into an official Military College. The prospect is an enticing one, as such a system might result in a perpetual good understanding between the two militant forces of the nation. Public opinion, however, has not yet ventured so far; the most that is urged at present is the desirability of amalgamating Woolwich and Sandhurst, and giving all cadets for the officer rank of the Army the same military education together; this is a consummation that is much to be desired in these days, when it is more than ever necessary for all branches of the Army to understand each other and to work in unison.

The author arrives at his conclusion after a consideration of the present system of early education of candidates for the Army. 'For military

purposes the foundation of character would appear to be the first requisite.' 'The amount of school knowledge absorbed by the average boy can never be very great'; the number of subjects now taught are so many and so diverse that it seems impossible for them to be learned well; it is however 'a time-worn axiom that if a thing is not learnt well more harm is done in the end than good acquired.' 'They do best in the long run who are strong, do not worry themselves about immediate results, and care not over-much as to early success or the reverse.' 'No system of examination at an early age can secure the very best men.'

At the beginning of last year the advisory board on military education made an attempt to postpone the sharp separation during school life between boys destined for the Army and their fellows; and they instituted a 'leaving certificate,' to be granted on the completion of an approved curriculum at a specially inspected school of ascertained merit, this certificate taking the place of a qualifying examination prior to the competitive. 'Thus a premium is placed on the schools considered to be conducted on the best lines for the martial training of boys; the general trend of military educational authorities being in the direction of a higher standard for all, by means of a lever stimulating the educational powers throughout the country to rise to the occasion.' This new procedure was apparently the result of public school authorities, when criticized for their failure to produce better material for the Army, replying that the material had been cut to shape and that the responsibility rested with the military authorities. Before the system of leaving certificates was instituted there already existed three well-known schools working on the desired lines,—the Imperial Service College, Harpenden (formerly the U.S.C., Westward Ho!), the Military College, Richmond, Surrey, and the Army School at Stratford-on-Avon.

It is considered, however, that candidates for the Army can commence their military education at an earlier age than is now the case. Before the days of competitive examination, the system of nominations produced great Admirals, great Generals, and great Indian Administrators. A retroversion towards older methods is now under trial for the Navy, candidates being selected by interview, nomination, a qualifying examination, and further education under the immediate supervision of the Naval authorities. Cannot something on the same lines be attempted for the Army?

A. T. MOORE.

NOTICES OF MAGAZINES.

BULLETIN OF THE INTERNATIONAL RAILWAY CONGRESS.

September, 1905.

This number consists entirely of reports of the recent meeting of the Congress at Washington, the conclusions arrived at on the various questions, and a summarised account of the discussions at the various meetings. Although one has some doubts as to the representative nature of the discussions, some of the accounts are rather interesting and cast a little light.

THE AUTOMATIC BLOCK SYSTEM.—There now seems no doubt that various quite efficient systems are on the market, and it seems to be established that this is the thing to adopt where no regular Block system has been installed up to the present: but where the traffic is very heavy—and consequently a failure is likely to cause much upset—some provision for manual control is desirable. If there are many stations or level crossings staff is not economised. On the other hand the system protects against other interruptions of the line besides occupation by trains, and with the introduction of corridor trains the same necessity for staff to watch the movement of trains is not felt. The L. & S.W.R. provide telephone arrangements as an auxiliary so that the train men may be able to ascertain the cause of delay if held up by signal.

REINFORCED CONCRETE.—The advantages as a material of Béton Armé seem to be universally admitted. The principal questions raised were as to difficulties in putting in such bridges under lines in operation, both because of time taken for setting and the possible deformation if the load were brought on too soon. It was pointed out that time was saved by this method of construction, as there is no delay in obtaining material such as in the case of bridges which have to be built up in the Shops. Reinforced Concrete is now used extensively in blocks, columns, piles, etc., for railway purposes. The conclusions adopted by the Congress were very favourable.

RAILS FOR HEAVY TRAFFIC.—The discussion was of much interest, but unfortunately space would not admit of giving its whole substance. The principal points brought out were:—(1) The importance of good distribution over the sub-grade of the load. (2) Advantage of enlarging the rail head to save wear on the contact surfaces and so also give better

bearing for the fishplates, which should be of hard metal. (3) Tests. The temperature during rolling is of much importance. In America, owing to the Steel Trust, great difficulty has been experienced in obtaining rails of a sufficiently high standard. (4) The flanges of Vignoles rails should be not less than $\frac{1}{2}''$ thick at the edges to secure good steel.

C. E. VICKERS.

LA BELGIQUE MILITAIRE.

15th August, 1905.

TRAIN-WRECKING DEVICE.—The following account of a device invented by Colonel Simonis, of the Belgian Engineers, may prove of interest.

The invention consists of an automatic circuit closer. Two of these are placed under the sleepers, at a distance apart slightly less than that of the shortest train that it is desired to wreck. The electrical connections are so arranged that the charges, which are placed in the centre of the line, will only be fired when the two circuit closers are simultaneously depressed. The idea is that, by adopting this system, pilot engines or short pilot trains will fail to explode the charges. The apparatus being placed under the sleepers, it is very difficult to detect its presence. It appears that the invention was on view at the Liège Exhibition.

A. J. CRAVEN.

NATURE.

September and October, 1905.

ENGINEERING (*p.* 465).—The opening address, in this section of the British Association meeting at Cape Town, was given by Colonel Sir C. Scott-Moncrieff, R.E. It touched chiefly on the science of irrigation, which has a special interest for South Africa, and on which the best years of his life in India, Southern Europe, Central Asia, and Egypt had been spent.

Pumps and windmills, artesian wells, well irrigation, canal irrigation, and water storage were illustrated by examples of works carried out in various countries. The necessity of drainage being attended to, when designing irrigation works, was pointed out. For a long time no attention was paid to drainage. It was taken for granted that the water would be absorbed or evaporated, and get away somehow without doing any harm. This may hold good for high-lying lands, but alongside of these are low-lying lands, into which the irrigation from above will percolate and produce water-logging and marsh.

In entering on any large project for irrigation it should be considered what will be the effect of pouring water on the soil, for it is not always an unmixed benefit. A dry climate may be changed into a moist, and fever and ague may follow. Brackish water is harmful. In all cases it is important to establish by law the principle that all rivers and streams above a certain size are national property, to be utilised for the good of the nation, and it is advisable that Government should take the initiative in laying out and constructing the canals and secondary channels.

The various modes of distributing and assessing water in Italy, America, India, and Egypt were explained and discussed.

DUST FROM AUTOMOBILES (*p.* 485).—A great deal of bad feeling has arisen against the motorist on account of the dust which he produces, and it has become imperative to see what can be done to minimise this nuisance.

Special treatment of the roads is too expensive to be carried out on a large scale; it is therefore important to modify the designs of cars so that the dust raised may be reduced to a minimum, and also to find some simple means of checking the dust of cars already in use. One of the simplest defects to remedy is the direction of the exhaust, which is sometimes pointed downwards, thereby causing much dust, and an improvement may be made very simply. The exhaust, if suitably directed, may be used to *lay* the dust caused by the passage of the car, by discharging it from a horizontal pipe, taken across the back of the car, having a line of holes along its length. A number of photographs are given showing the dust-raising qualities of various cars, run at a uniform pace on the Crystal Palace cycle track, kept covered with flour of a definite thickness. It was seen that it is possible to make cars comparatively dustless, though the means of doing so are not, as yet, well understood. It was however clearly shown that tool boxes, which are often carried low down behind a car, have a bad effect. Mud-guards, if they come low down, are bad, and it is desirable that the car should slope upwards towards the back.

THE ELECTRIC MICROMETER (*p.* 495).—As knowledge increases it becomes more minutely exact, and the physicist has often to measure lengths much less than anything visible in the microscope. The smallest measurements made with this new instrument due to Dr. Shaw were in connection with the movements of a telephone diaphragm, viz., 1/2,000,000 *m.m.* It is twenty times more sensitive than the interferometer, with which, by using interference bands of light, we can perceive movements of 1/100,000 m.m. In problems on the constitution and molecular properties of matter, there are obvious possibilities before this apparatus, for by it we can bring two surfaces of any hard metal to molecular distance (or less) from one another, and keep them there while any desired physical change is produced in the surfaces, or in the medium surrounding them.

The mode of using the interferometer above alluded to is well explained by Dr. Tutton in the *Times* of 18th October. The instrument

has been used in the determinations of the expansion of gas thermometer porcelain, as well as that of many crystallised substances which cannot be adequately polished.

PHYSIOLOGY.—By Dr. Bruce (*p.* 496).—His address to the British Association at Cape Town is most interesting. It shows how very rich South Africa is in animal diseases, every species of domestic animal having one or more specially adapted for its destruction.

THE FAYUM (*p.* 535) is a circular depression in the Libyan desert, having an area of more than 3,000 square miles. It is situated to the west of the Nile some distance south of Cairo. The lowest part of the district is occupied by the Lake Birket-el-Qurun, which has an area of about 85 square miles; but this area is continually diminishing by evaporation. In historical times, as is well known, a large part of the Fayum was occupied by the Lake Moeris. By successive reclamations of the alluvial lands this lake has been reduced to less than one-eighth of its original area, represented now by the Birket-el-Qurun. Until the year 1898, when the examination was commenced by the Geological Survey of Egypt, little was known concerning the geology of this district, but now the palæontological treasures yielded by the Fayum have made that province famous among geologists and zoologists; the outcrop of strata was crossed, upon which a considerable number of mammalian and reptilian remains lay exposed, many in an excellent state of preservation. It is probable that these remains were brought down from the African interior by a great stream which flowed in a north-westerly direction, passing through the ancient lake occupying the site of the Baharia Oasis. At that period the shore-line would be near the Fayum, and the Nile would flow into the sea near the same point.

W. E. WARRAND.

REVUE D'HISTOIRE.

October, 1905.

STUDIES ON INFANTRY TACTICS IN THE 18TH CENTURY.—Extracts are given from a forthcoming work on this subject, shewing how the "deep order" was started by Folard, was supported by Saxe, and was elaborated by Mesnil Durand.

THE CAMPAIGN OF 1793.—*Army of the North and the Ardennes.*—A history of this campaign, from Valenciennes to Hondtschoote, is about to be published. Parts of it have already appeared in the *Revue*, and the last chapter, describing the battle of Hondtschoote, is now given. The blunders of the British Government in insisting on the siege of Dunkirk, and making inadequate provision for it, enabled the French to bring 45,000 men against the covering army of 16,000. But owing to the inexperience of Houchard and his staff only half the French forces took

part in the battle, and the sole result of it was the raising of the siege. If the French had been better handled the siege corps under the Duke of York might well have been cut off.

THE WAR OF 1870–1871.—*The Army of Chalons.*—By August 25th, Macmahon's army was on the Aisne above Rethel. The German head-quarters were at Bar-le-Duc, 60 miles to the south-east. Moltke was unwilling to check the advance of the German armies towards Paris, but reports from various quarters that the army of Chalons was going to the relief of Metz made him prepare for a wheel northward. He worked out a plan for the concentration of 150,000 men by the 28th at Damvillers, south of Montmédy, in case of need. The evidence he had to go upon, and the arrangements he made, afford a most interesting example of applied strategy.

E. M. LLOYD.

CORRESPONDENCE.

THE PREVENTION OF DAMPNESS DUE TO CONDENSATION IN MAGAZINES.

DEAR SIR,

The Transcript in the September number of the *R.E. Journal* is accurately described by Colonel Seddon as interesting, but at the same time it cannot be said to detail any novel principles.

The broad principle, that air will always absorb moisture up to its point of saturation and will raise to its own temperature that of any objects over which it is passed, has been successfully applied in the construction of our own magazines for many years.

It would in fact seem that we have taken a short step further than the American Engineers, in that in our own service the rules as to the opening and closing of ventilators according to the conditions of weather, which used to be more or less perfunctorily followed by the District Gunner, have now practically been discarded in favour of an automatic system.

In the roof of each chamber is an extract shaft leading to an external wind-revolved cowl, which draws the air with sufficient rapidity through the building. Free inlets are also provided, ventilating bricks in the external walls, and, whenever practicable, open iron-barred gates instead of closed doors at the external entrances of the passages. The brick linings to the walls and ceilings form a further safeguard against dampness, as in wet weather they absorb moisture from the air, subsequently parting from it as conditions become more normal.

Thus in a properly designed magazine a continuous current of air is provided at all times, and even in damp, foggy weather the deposit of moisture is so slight as to be practicably inappreciable.

Yours truly,

H. J. WALKER,

Capt., R.E.

The Editor, "R.E. Journal."

PRECAUTIONS AGAINST FEVERS.

DEAR SIR,

In the admirable article, by Colonel Harrold Fenn, C.I.E., R.A.M.C., in the October number, *R.E. Journal*, on the above subject, there is no mention of a very simple and efficacious preventative of malaria which is not nearly so well known as it deserves to be. It is the essential oil of

the white birch tree, or, what is very nearly as good and more easily obtainable, oil of tar.

The fever mosquito is only dangerous at dusk, and the part usually attacked is the instep. The oil has about the appearance and thickness of stout, but it can be obtained colourless without any difference in its strong tarry odour. If the finger be damped with it and rubbed on exposed parts, no mosquitos or midges will come near for about six hours.

Many others of the essential oils have the same effect, but none, so far as the writer has tried, lasts so long.

This simple preventative has been tested in Norway, Canada, Mauritius, and India by the writer and his family, always with success. By using it he has passed many weeks in some of the most malarial parts of India and Burmah without ill effect.

The oil can be obtained at the A. & N. Stores or any of the principal London chemists.

Yours truly,

H. DE H. HAIG,

Colonel.

The Editor, "R.E. Journal."

RECENT PUBLICATIONS.

The War in the Far East, by the Military Correspondent of *The Times*. ($9\frac{1}{2} \times 6$. Murray).

The Siege of Port Arthur: Records of an Eye-Witness, by D. H. James, Special Correspondent of the *Daily Telegraph*. ($8\frac{1}{2} \times 5\frac{1}{2}$. 10s. 6d. Unwin).

Die Schlacht bei Mukden. Mit 8 kartenbeilagen. (Beiheft zum Militär-Wochenblatt). (Pamphlet. Mittler & Sohn, Berlin).

Die Schlachtfeldbefestigung nach den Erfahrungen des Russich-Japanischen Krieges den einschlägigen Veroffentlichungen, Reglements und der Kriegsgeschichte, von Hauptman des Geniestabes J. R. Malczewski v. Tarnalva. Mit 68 skizzen und 8 tafeln. (Pamphlet. Siedel & Sohn, Vienna).

Report on the Surgical Cases noted in the South African War, 1899–1902, edited by Surg.-General W. F. Stevenson, C.B., K.H.S., A.M.S. (Folio. 7s. 6d. Wyman & Sons).

Im Kampfe gegen die Herero, von Oberleut. E. v. Salzmann. (4to. Berlin).

Sea Power in its Relations to the War of 1812, by Capt. A. T. Mahan, U.S. Navy. 2 vols. (9×6. 36s. Sampson Low, Marston).

Manual of Military Ballooning. Part I. Official. ($7\frac{1}{2} \times 5$. 1s. Wyman & Sons).

Unterricht für die Ballonabteilungen. Official. (Vienna).

Gustav Adolph, King of Sweden: The Father of Modern War, by Lieut.-Colonel Hon. E. Noel. (8vo. London).

The Dickson Manuscripts. Diaries, letters, etc., of the late Major-General Sir Alexander Dickson, G.C.B., R.A. Series C. 1809–1818, edited by Major J. H. Leslie, late R.A. ($9\frac{1}{2} \times 6$. 2s. 6d. R.A. Institution).

The Fighting Man of Japan: The Training and Exercises of the Samurai, by F. J. Norman. ($8\frac{1}{2} \times 5\frac{1}{2}$. 2s. 6d. Constable).

Histoire et Organisation Militaires des Chemins de Fer, von Dr. Joesten. Traduit de l'allemand par le Lieut.-Colonel B $^{o\ o\ o}$. (8vo. Paris).

Principles of Electric Power (Continuous Current), by A. H. Bate. (4s. 6d. Spon).

Elementary Electrical Engineering in Theory and Practice, by J. H. Alexander. (8vo. 3s. 6d. Crosby, Lockwood).

Motor Vehicles for Business Purposes, by A. J. Wallis-Taylar. (8vo. 9s. Crosby, Lockwood).

Portland Cement: Its Manufacture, Testing, and Use, by D. B. Butler. (16s. Spon).

Sewerage and Sewage Disposal, by Prof. Henry Robinson. (7s. 6d. Biggs & Co.).

The Law and Practice relating to Patents, Trade Marks, and Designs, by David Fulton. (12s. 6d. Jordan & Sons).

Radio-Activity, by E. Rutherford, D.Sc. F.R.S. ($8\frac{1}{2} \times 5\frac{1}{2}$. 12s. 6d. Cambridge University Press).

The Great Plateau. An account of Exploration in Central Tibet, 1903, and of the Gartok Expedition, 1904–1905, by Capt. C. G. Rawling, Somerset L.I. ($8\frac{1}{2} \times 5\frac{1}{2}$. 15s. Arnold).

Russia and its Crisis, by Paul Milyoukov. (8vo. Chicago).

The Empire and the Century. A series of essays on Imperial problems and possibilities by various writers, with an introduction by C. S. Goldman. (9×6. 21s. Murray).

Indian Records Series. Bengal in 1756–1757, edited by S. C. Hill. 3 vols. (9×6. 36s. Murray).

Die Weltkrise und die Aufgaben des deutschen Reichs, von H. Oberwinder. (8vo. Dresden).

The Salt of my Life, by F. G. Aflalo. ($8\frac{1}{2} \times 5\frac{1}{2}$. 7s. 6d. Pitman).

Outdoor Pastimes of an American Hunter, by Theodore Roosevelt. (9×6. 12s. 6d. Longmans).

TIME ALTITUDE AND OTHER DIAGRAMS

I

Given $\varphi\ \delta\ h$

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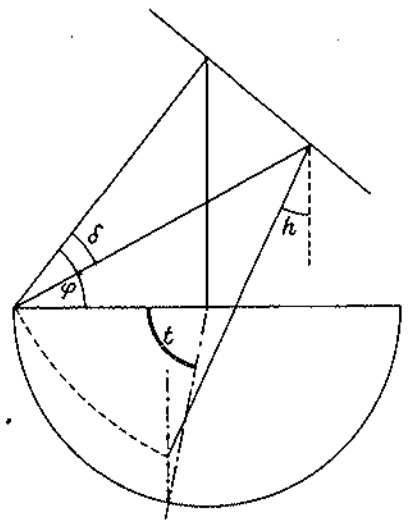

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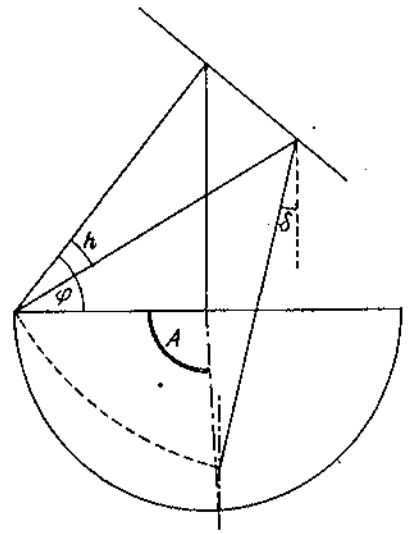

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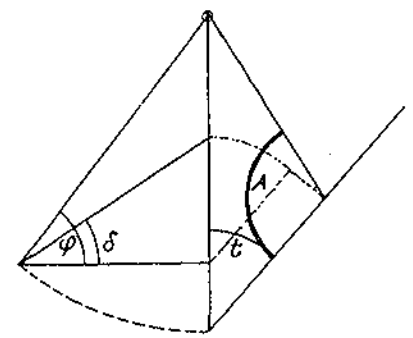

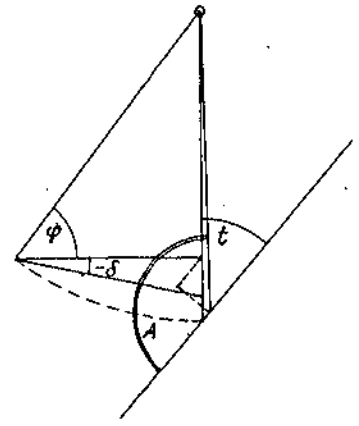

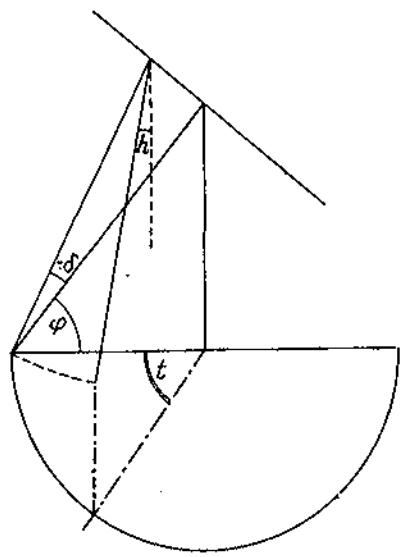

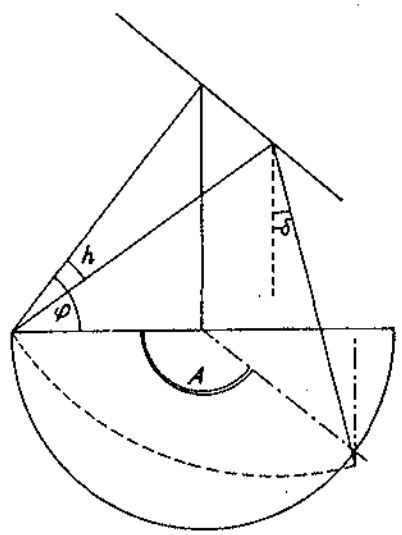

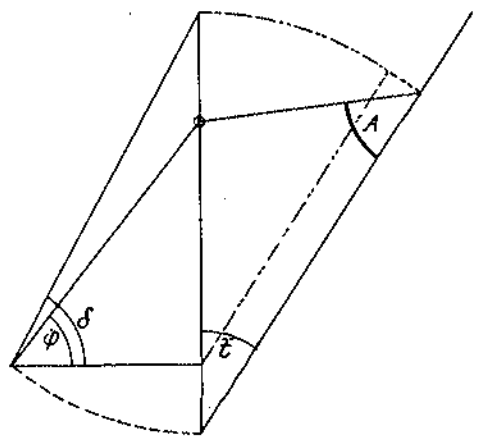

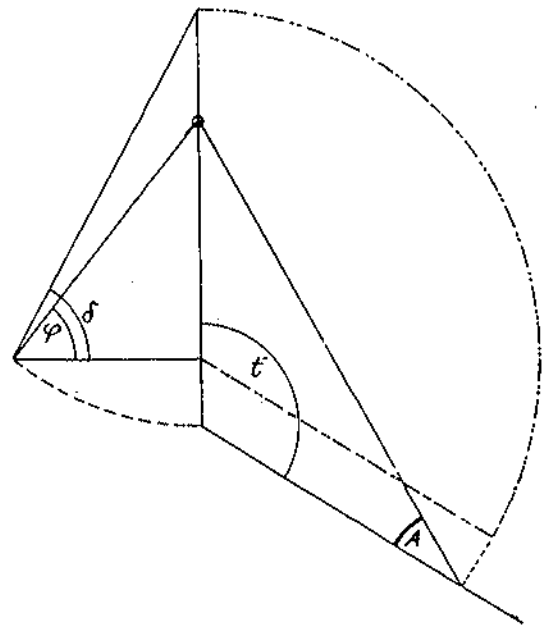

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TIME ALTITUDE AND OTHER DIAGRAMS

I

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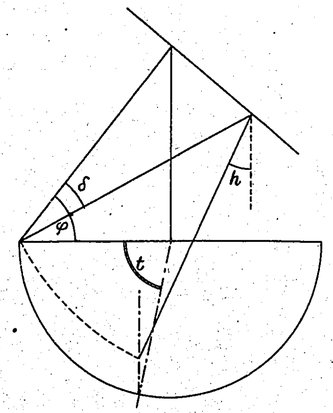

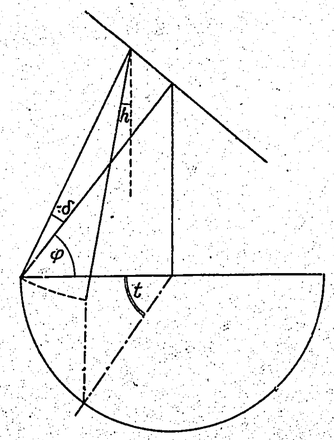

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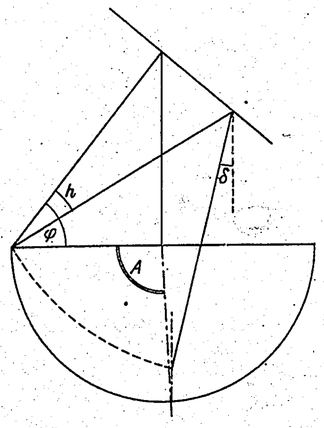

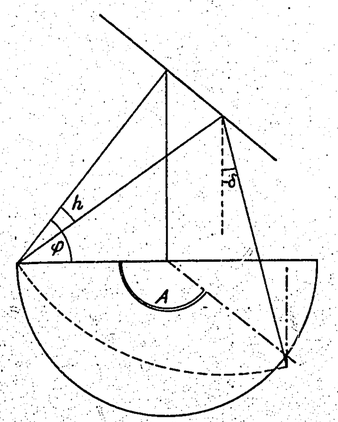

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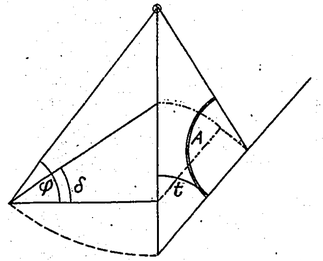
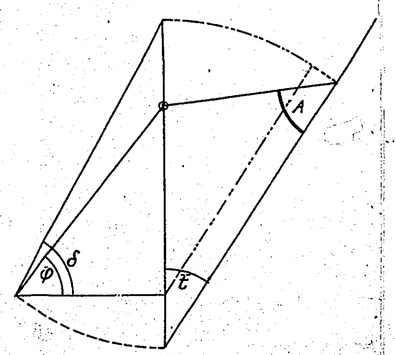
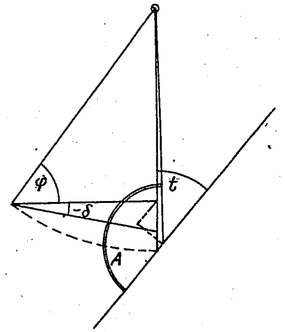
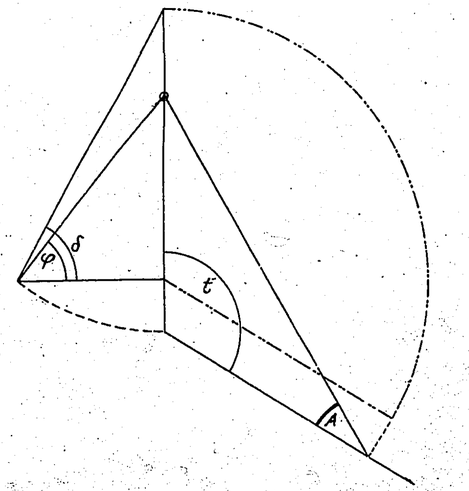
Given φ δ t
Find A

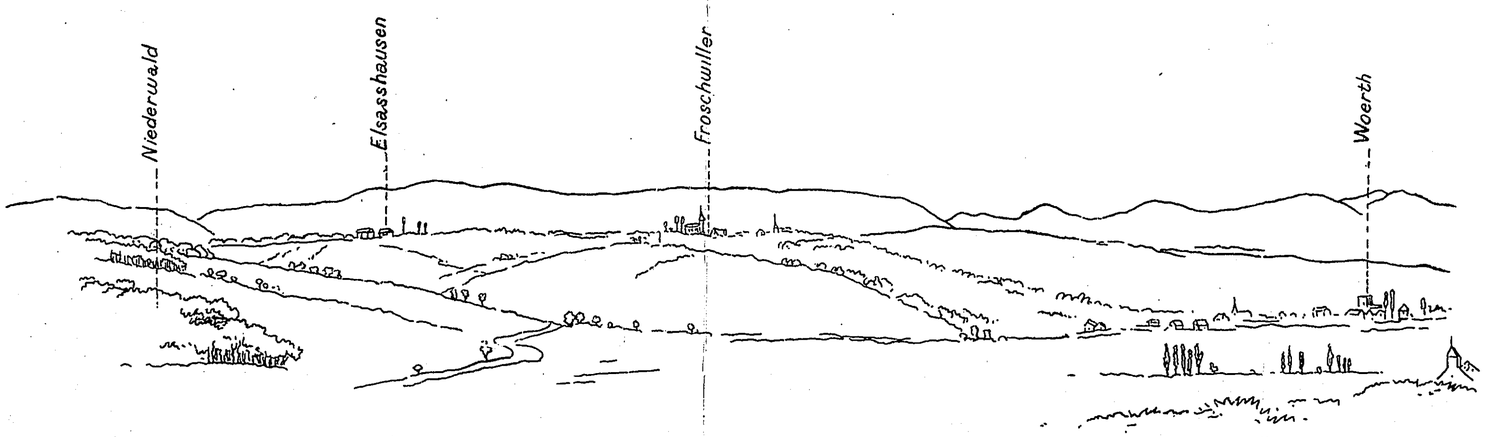




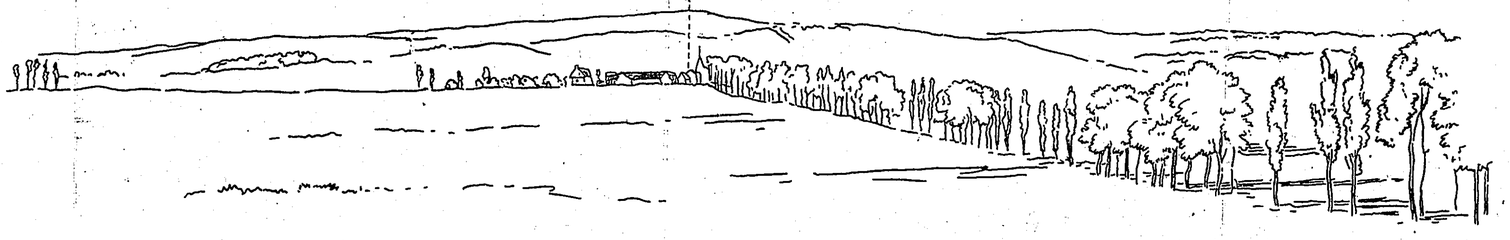




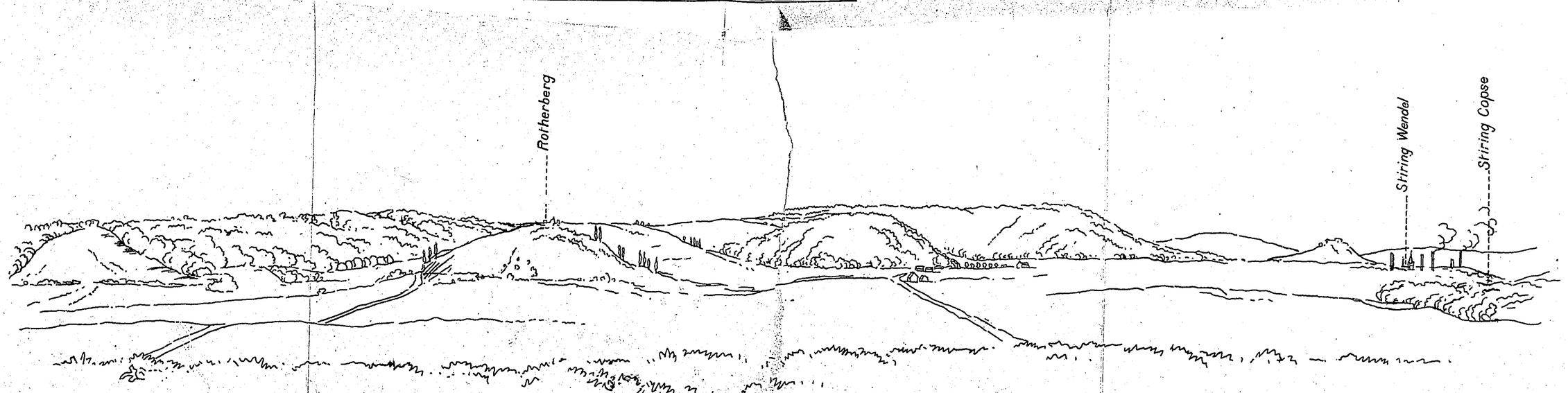
LANDSCAPE DRAWING FROM A MILITARY POINT OF VIEW



WOERTH from the Crown Prince's Position



VIEW FROM ST PRIVAT

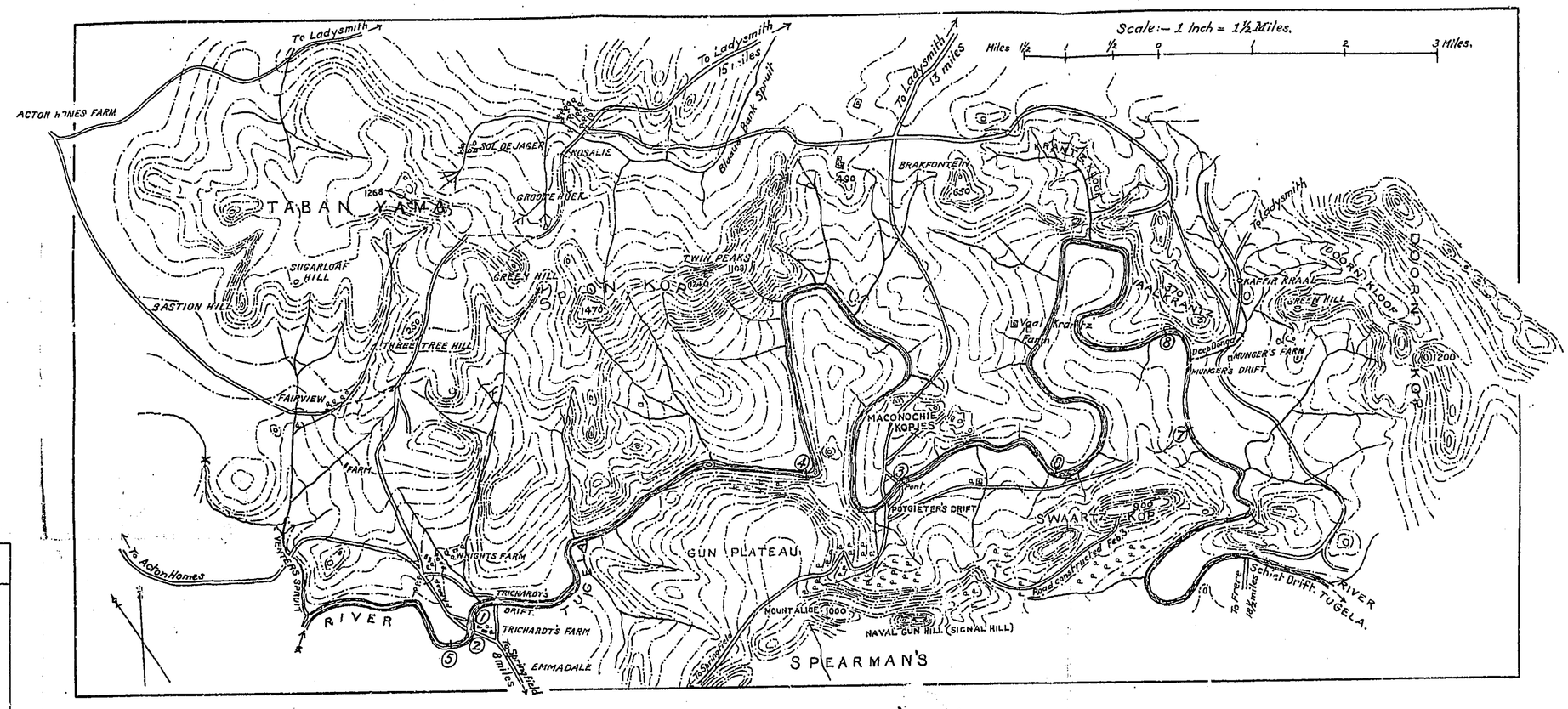


SPICHEREN from the Reppertsberg

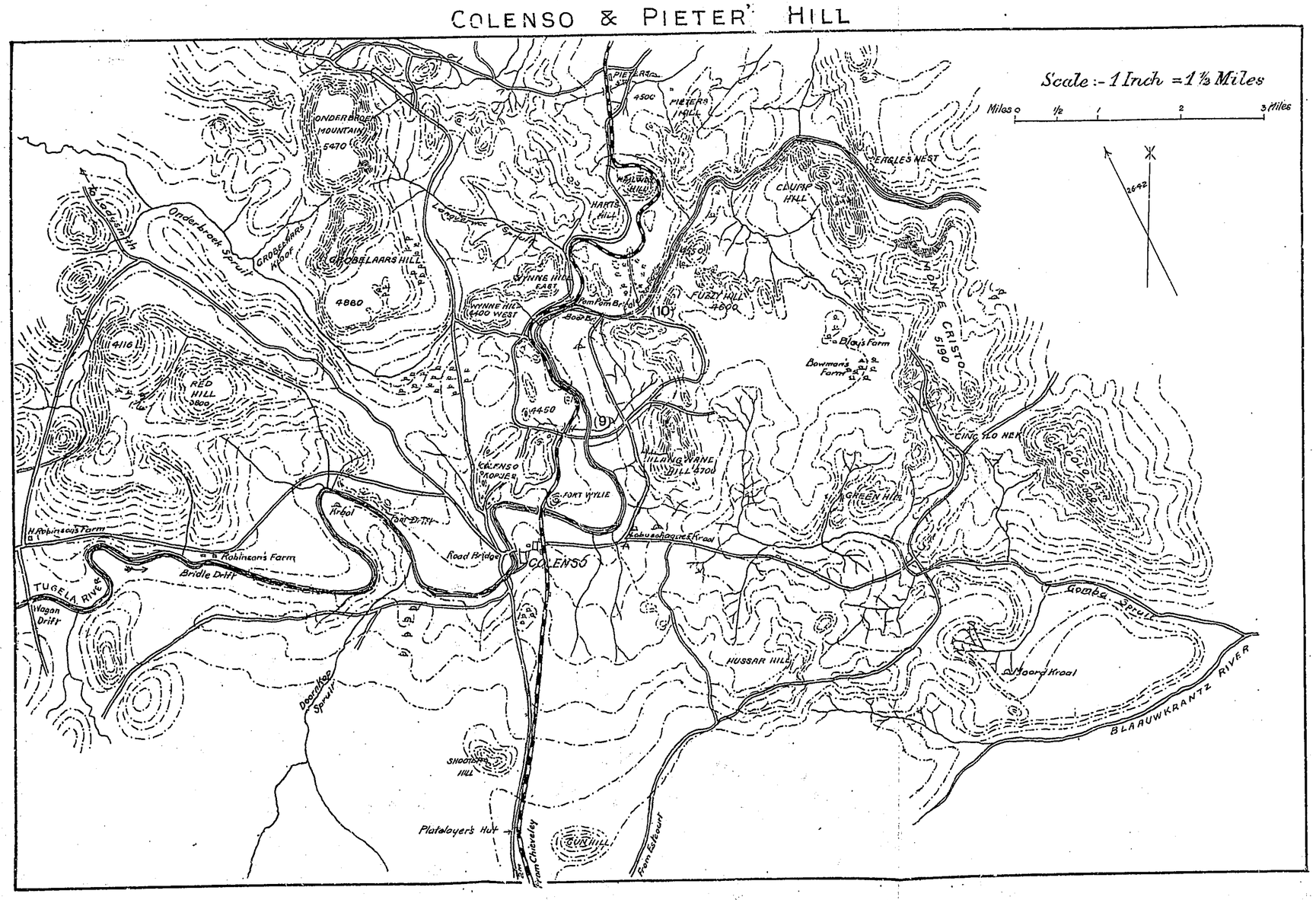
THE PONTOON TROOP IN NATAL, 1899-1900.

(Figures in circles as ③ refer to sites of pontoon bridges)

COLENSO, SPION KOP & VAAL KRANTZ.



COLENSO & PIETER' HILL



REFERENCES TO PONTOON BRIDGES.

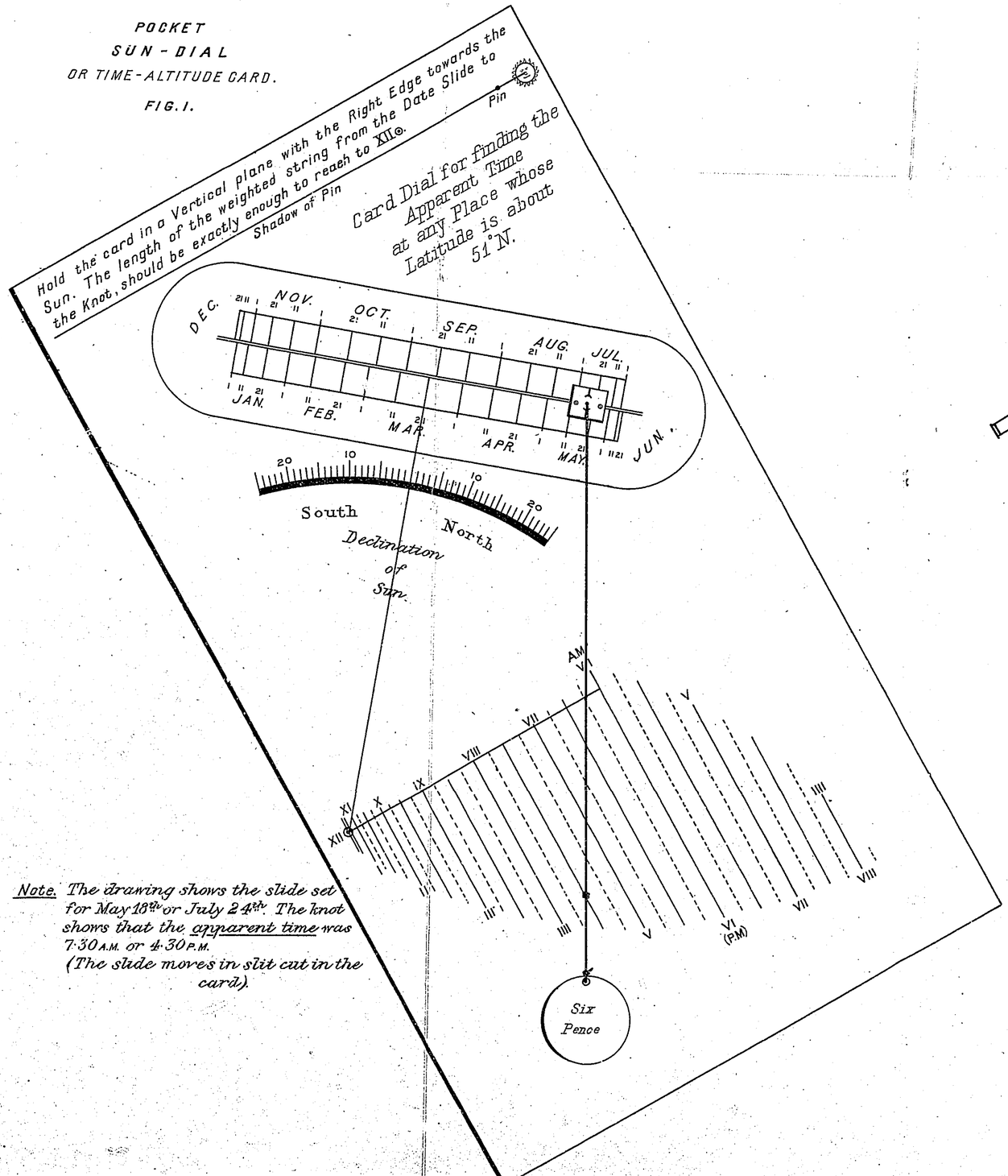
No	Date	Description
1	$17\frac{1}{00} - 19\frac{1}{00}$	Medium
2	$17\frac{1}{00} - 27\frac{1}{00}$	Heavy
3	$22\frac{1}{00} - 25\frac{1}{00}$	Heavy
3 (rebuilt)	$1\frac{2}{00}$	Heavy
3 (reduced)	$4\frac{2}{00} - 9\frac{2}{00}$	Medium
4	$24\frac{1}{00} - 25\frac{1}{00}$	Infantry
5	$26\frac{1}{00} - 27\frac{1}{00}$	Medium
6	$1\frac{2}{00} - 6\frac{2}{00}$	Medium
7	$5\frac{2}{00} - 7\frac{2}{00}$	Medium
8	$6\frac{2}{00} - 7\frac{2}{00}$	Medium
9	$21\frac{2}{00} - 26\frac{2}{00}$	Heavy
10	$25\frac{2}{00} - 27\frac{2}{00}$	Pont
10	$27\frac{2}{00} - 3\frac{2}{00}$	Heavy

Note. In the official account of the action at Vaalkrantz, bridges Nos. 3.6.7.8 were known as Nos. 1.2.3.4 respectively.

The × on the Venter's Spruit marks site of Trestle Bridge constructed on $19\frac{1}{00}$.

TIME-ALTITUDE AND OTHER DIAGRAMS

POCKET
SUN-DIAL
OR TIME-ALTITUDE CARD.
FIG. 1.



Note. The drawing shows the slide set for May 18th or July 24th. The knot shows that the apparent time was 7·30 A.M. or 4·30 P.M.
(The slide moves in slit cut in the card).

TIME-ALTITUDE CARD AS A STAR-FINDER

(The size of the Card is exaggerated to show the extended Declination and Time Scales.)

FIG. 2.