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TACTICAL ORGANISATION.

By CAPT. J. W. S. SEWELL, R.E.

IN the October, 1905, number of this Journal I endeavoured to analyse the principles of pure organisation. It was there pointed out that such principles placed a limit on the number of units in any one executive command.

It is now proposed to make an attempt to ascertain what exactly is the most desirable number of tactical units in any one command. This involves a brief survey of the principles of tactics.

These principles are as fundamental and immutable as those of strategy; but in their application to the requirements of the moment, it is always necessary to consider—

(*a*). The effect of the conditions of the period; such as destructive agents (arms, etc.), and modern scientific improvements (railways, telegraphs, etc.).

(*b*). The effect of local conditions; such as ground and the nature of the enemy.

The latter consideration must be given due weight on the spot by officers in executive command, when disposing their forces for battle: it cannot be allowed for in tactical organisation made beforehand in times of peace.

To give due weight to the former consideration is a duty in peace of the General Staff, who must evolve a system of tactics by applying such consideration to general principles. The resulting system must then be adopted for good or evil by the whole army, in order to produce that unison of action without which the skill of the greatest leader may prove fruitless.

In these days wars between civilised Powers are not sufficiently frequent to throw adequate light on the subject of the rapid changes in the effect of destructive agents. It is therefore almost inevitable that at the opening of a campaign the system previously evolved by the General Staff will require some modification. A large section not only of the Public, but also unfortunately of Officers who should know better, then becomes hysterical in its denunciation of the whole system; and there is a tendency on the part of individuals to abandon discipline, and to adopt systems experimentally which are entirely at variance with fundamental principles. There is therefore not only urgent necessity that fundamental principles should be absorbed by every officer till they become part of himself; but there are also cogent reasons for the adoption of tactical organisations which, as far as may be possible, will render obedience to these principles difficult to avoid.

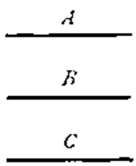
By the study of the series of actions constituting a campaign, it is possible to eliminate the local factors, and gain an insight into the general system of the commander. But to eliminate the factors arising from the conditions of the period requires deep thought and a serious study of the whole History of War. We turn then to the men who have made such study their lifework for a statement as to the residual Principles of tactics left after the elimination of local and periodic factors.

In Colonel Henderson's *Science of War* that deep student has pointed out clearly and forcibly that the greatest leaders of the British Army have attained success in the tactical field by their devotion to the "3-body" principle. But in the application of this principle the system has necessarily varied from age to age.

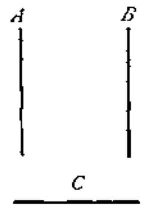
In the Peninsula War, the dispositions of Wellington were with three units in successive lines, and this system held good till the close of the 19th Century. The South African War showed, however, that the second line could not be brought up as a formed body to within decisive range; whilst, if it was thrown into the firing line in waves in open order, the inevitable confusion of units of the first line was intensified to a dangerous degree.

The present system therefore arranges the two leading units in two parallel loose columns (instead of two successive lines), each unit dividing into first and second lines. The respective formations may be represented graphically thus:—

19th Century.

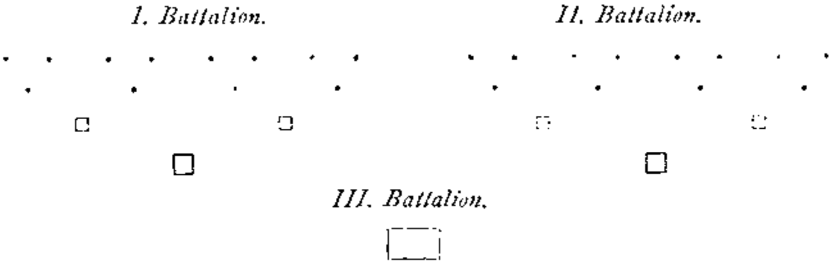


20th Century.

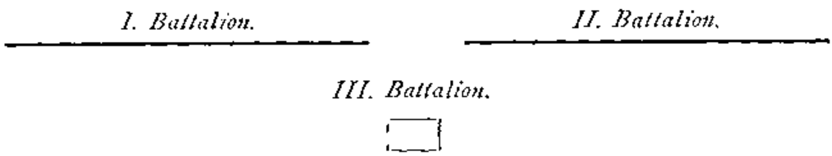


Each unit *A* and *B* being in its turn similarly formed in itself, it follows that the system may be regarded as one in which each command from the Army down to the company is composed of three bodies disposed in a triangle having its base towards the enemy.

In fact, the ideal of the modern infantry attack may be represented generally thus :—



This formation gradually closes up to the final stage of one triangle :—



In defence the formation merely commences at a later stage than the first stage of the attack, but it embodies the same principle.

Thus the principle of disposing troops for battle so that each command is formed into three sub-commands remains as much our ideal to-day as in the days of the Black Prince or of Cromwell or of Wellington.

From the foregoing consideration there would appear to be a *prima facie* argument for the organisation of each command in three sub-commands.

Now let us consider existing organisations.

The Cavalry is organised into brigades each of three regiments, each of three squadrons. The squadron is composed of four troops, but the arguments for and against this arrangement are unknown to me.

With the Cavalry Brigade, as also with the Army Corps and the Infantry Division, are special troops ; but as these do not form part of the normal fighting disposition of these commands, they do not affect the argument in favour of the 3-unit system.

Field Artillery is organised into brigades of three batteries, each battery being composed of three sections.

Further, the moribund Army Corps consists of three Divisions, and the new Infantry Division is to consist of three Brigades—a great step forward, or rather back to the old British system.

In the lower commands in the Infantry we find the imprint of the Germanising ideas, which prevailed after the Franco-Prussian war, in organisations based on the idea of a 2-line system of tactics. For very forcible arguments against this system students of tactics may be referred to the pages of Henderson's *Science of War*. It is true that a 4-unit command may be disposed in accordance with the 3-line system to a certain extent by placing three units in parallel columns in first and second line; but a reserve of one-fourth at the outset of an action is the absolute minimum permissible, and the alternatives are to break up a unit, which is obviously objectionable, or to have a reserve of one half, which entails most of the disadvantages of the 2-line system.

It is in fact difficult to make a sound disposition of a 4-unit command in accordance with the accepted principles of tactics; whereas it is natural to dispose of a 3-unit command in accordance with those principles.

The objections to a 4-unit command apply in a considerably less degree to an 8-unit command. But the command in action of 8-units constitutes, as was shown in my previous article, a departure from the principles of organisation, which, as in the case of all departures from principles, can only be justified by exceptional conditions.

Let us imagine the 3-unit system carried out in its entirety. The brigade would revert to the 3-battalion brigade: each battalion would consist of 3 echelons, each of 3 companies: and finally each company would be formed of 3 sections.

As regards a company this involves no crucial difficulty; and as each of the two sections in front line might be commanded by a subaltern, it would replace in the hands of those officers executive command which at the present day is only existent in theory.

The suggested organisation for a battalion involves no such radical change as might at first appear to be the case. No administrative change is necessary in peace; but on mobilisation a ninth company must be formed of reservists. The administrative work of a company is so simple that it would be unnecessary to maintain the cadre of this company in peace.

Again, as regards the suggested 3-company echelons. These would be only tactical units, and no more administrative units than are half-battalions. As regards officers to command these units, there seems to be no just cause or impediment why the senior officer of a 3-unit body up to a battalion should not command the whole body and one unit as well—the unit in reserve of course: in the sister-service an Admiral commands the whole squadron and also one division of that squadron. So far then such an organisation would involve neither extra expense nor any radical change.

There remains the question of the brigade. Now, although it need hardly be any longer accepted as an axiom that the strength of a brigade must be the same as that of a German brigade, yet it would almost appear that as regards the brigade we have now become inextricably involved in the 4-unit organisation.

The present war establishments provide two brigades of field artillery per (2-brigade) infantry division; which gives a proportion of about 4·5 guns per 1,000 bayonets, a proportion which, though smaller than the standard of some armies, is on the whole accepted as reasonable by most critics. But if the infantry brigade were reduced by one battalion, we must either have 3 brigades of artillery per (3-brigade) infantry division, giving a proportion of 6 guns per 1,000 bayonets, which would be too expensive; or we must have 2 brigades of artillery per (3-brigade) infantry division, giving a proportion of only 4 guns per 1,000 bayonets, which is lower than the permissible minimum.

If a remedy were sought by maintaining the war strength of a 3-battalion brigade at the same figure as that of the present 4-battalion brigade, it would be necessary to increase the war strength of battalions by one-third. To do this would entail either :-

(*a*). Increase of peace strength.
or (*b*). Increase of number of reservists rejoining on mobilisation.

Either alternative would practically involve an entire reconstruction of the organisation and distribution of the Infantry.

That the difficulties to be overcome in either case are very serious will not be denied by anyone who has studied the lecture by Major-General Miles on the Army System (see *Journal of the R.U.S.I.*, October, 1906). The problem may interest those who have time and talent for actuarial calculations based on a study of the statistics of the Adjutant General's department.

It thus appears that the prospective advantage of a 3-unit organisation for an Infantry brigade are probably weighed down by the grave difficulties of creating such an organisation; whilst the task of surmounting the disadvantages of a 4-unit system may be confidently left to the men selected to command brigades of British regular infantry.

It has, however, been a frequent experience of the Staff in past campaigns to be called on to organise, in the actual theatre of war, higher commands from a mass of units possessing no higher organisation than that of the battalion. When we consider the strength and distribution of the regular forces, and the organisation of the auxiliary forces, it seems probable that similar experiences await the Staff in future campaigns.

Let us hope that, when such occasions arise, circumstances will permit of the adoption of that 3-unit organisation which is as traditional in the British Army as it is sound in principle.

*THE TOPOGRAPHICAL SECTION OF THE BRITISH GENERAL STAFF.**

IN continental armies the Topographical Sections of the Staff are responsible for the work which in Great Britain is divided between the Ordnance Survey and the Topographical Section of the General Staff. Our Topographical Section may be regarded as derived from the Ordnance Survey, though it was not formed directly from it and in the first years of its existence had no connection with it. The military side of the Ordnance Survey is apt to be lost sight of to-day, placed as it is under a civil Department of State, and a major portion of its work being cadastral rather than military. Its establishment was due to the need felt for an accurate map of the country for purposes of defence; and for upwards of 70 years it remained under the War Department, at one period being actually combined with the Topographical Section.

EARLY HISTORY.

After the rebellion of 1745 had been finally crushed at Culloden, Lieutenant-General Watson, D.Q.M.G. in North Britain, recognizing the necessity of having a good map of a wild and rugged region, which had been the scene of military operations and might be so again, directed Major-General W. Roy, R.E., then D.A.Q.M.G., to undertake the task.

This survey, afterwards extended to the Lowlands of Scotland, was not based on any great triangulation; but was more of the nature of a "magnificent military sketch" to quote General Roy's own description. The map was never completed, or published, the outbreak of the Seven Years' War in 1756 necessitating the employment elsewhere of the officers engaged upon it.

Although never completed, this survey is important as being the first large military survey undertaken in Great Britain and the forerunner of the Ordnance Survey. In that it marked an official recognition of the necessity of preparing maps of possible theatres of military operations, it may be regarded as the germ of an idea which more than a century later developed into a Military Topographical Department.

On the conclusion of peace in 1763 the question of undertaking a Topographical Survey of the whole of Great Britain came for the first

* Extracted from an account written by Capt. G. R. Frith, R.E., Staff Captain, T.S.G.S., by order of the Director of Military Operations.

time under the consideration of the Government. Again war postponed the work, the outbreak of the American Revolution in 1776 turning the attention of the authorities in another direction.

With the advent of peace in 1783, General Roy thought the time favourable to bring forward once more the question of a national survey. Finding himself detained in London he conceived the idea of making a small trigonometrical survey of the immediate neighbourhood of the capital. As the foundation for his proposed survey he measured a base of 7,744·3 feet across the fields between the Jews Harp near Marylebone and Black Lane near Pancras.

General Roy's efforts were seconded from a totally unexpected quarter. In October, 1783, Comte d'Adhemar, then French Ambassador, transmitted to Mr. Fox, at that time Foreign Secretary, a memoir by M. Cassini de Thury, in which the latter showed the great benefit which would accrue to astronomy by carrying a series of triangles from London to Dover, and connecting them with those already executed in France, thus determining accurately the relative positions of the observatories of Greenwich and Paris. This proposal was communicated to the Royal Society, and, with the approval and financial assistance of the King, the task was entrusted to General Roy.

THE ORDNANCE SURVEY.

On the 16th of April, 1784, General Roy, accompanied by Sir Joseph Banks, President of the Royal Society, began operations for measuring a base on Hounslow Heath. The measurement of this base line may be called the commencement of the Ordnance Survey of Great Britain; though it was not till 1791 that, on the initiative of the Duke of Richmond, then Master General of the Ordnance, an order was given for a survey of the whole country for the purpose of producing a military map of the United Kingdom.

The establishment of a national survey having ensured the provision of accurate maps of the United Kingdom, an extension of the geographical service to include the colonies and foreign countries was the next requirement. In 1803 the value of a department which should collect information, both topographical and statistical, not only about Great Britain and her colonies but about foreign countries, appears to have been realized by the authorities.

THE DEPÔT OF MILITARY KNOWLEDGE.

The Department, which enjoyed the quaint title of Depôt (or Deposit) of Military Knowledge, was under the Q.M.G., but quite distinct. It appears that the office was divided into two branches, each under an "Officer of approved knowledge," one to have charge of the plans and maps and direct the drawing room, the other to have the direction of the manuscripts and library; in addition 2 D.A.Q.M.G.s were appointed to aid these officers, and there were 2 draftsmen and

2 clerks. The work was retarded by the re-commencement of the war, and also by the lack of office accommodation. There seems to have been no co-ordination between the Depôt of Military Knowledge and the Ordnance Survey.

The long peace which followed the campaign of 1815, and the general lack of interest in military affairs consequent upon the final defeat of Napoleon, was felt by this embryo Intelligence Branch in common with the other departments of the army; and the outbreak of the war with Russia found the army quite unprovided with maps of the theatre of operations. The department created in 1803 had become a mere appanage of the Q.M.G.'s department; and the necessity of forming an entirely separate branch was brought home to the authorities through the persistent efforts of Major T. B. Jervis, a retired officer of the Bombay Engineers, who had throughout his service in India been employed on survey work and was an enthusiast in everything pertaining to geography and topography. In 1846 he addressed to Lord Aberdeen, then Foreign Secretary, a letter, pointing out the acknowledged want of geographical information in many well-known and recent cases and the want of a geographer attached to the Government and a national depôt of maps and plans. This memo. was acknowledged with thanks, but the stress of war was necessary to bring home to the Government the importance of a properly organized topographical department.

In 1854, at the outbreak of the Crimean War, Major Jervis was fortunate enough to obtain in Belgium copies of the Russian General Staff Map of the Crimea and the Austrian Military Map of Turkey in Europe, both very rare maps as they were jealously guarded by the respective War Offices. He transliterated the former and pressed the Government to have it reproduced for use in the field, but his proposal was not entertained. Undismayed by this rebuff he reproduced the maps at his own expense. At first the Government purchased but few; the map, however, was found so invaluable at the seat of war that large numbers were eventually bought.

THE TOPOGRAPHICAL DEPARTMENT OF THE W.O.

Major Jervis continued to press on the Government the importance of instituting a Topographical Department, and at last, on the 2nd February, 1855, was rewarded by receiving a letter from Lord Panmure, Secretary-at-War, notifying the sanction of the Treasury for the creation of a Topographical and Statistical Department in connection with the War Office, and offering him its superintendence.

In a memorandum to the War Department in 1855, Major Jervis gave his ideas as to the work which the department should perform :—

1st. Compilation and printing of all maps required for military and political purposes. Collection of maps published at home and abroad, and of topographical and statistical information about the colonies and foreign countries.

2nd. To afford facilities for a limited number of officers from all arms of the service to become acquainted with the methods employed in making and reproducing maps, and to acquire information both topographical and statistical about other countries.

3rd. To carry on geographical and statistical researches in other countries.

To carry out this last he proposed to have attached to the department, and under the orders of its director, a small number of highly-trained officers and subordinates, who should be constantly employed, in parties not exceeding six, in making maps of, and collecting information about, countries of which it might be considered desirable to gain accurate knowledge.

In August, 1855, there were employed in the department 26 engravers, lithographers, and assistants, including one clerk. In 1856, when the department moved to Spring Gardens, the amount taken in the estimates for it was £5,000. In this year it was decided by Lord Panmure that the duties of the department should embrace the acquisition of plans of all the barracks and forts in the British Dominions.

On April 3rd, 1857, Major Jervis died, and shortly afterwards a Committee was appointed by Lord Panmure to "investigate and report on the Topographical and Statistical Department." Pending their report Capt. J. Cameron, R.E., Executive Officer, Ordnance Survey, was placed in temporary charge of the department.

The Committee's report stated that, notwithstanding the zeal and ability displayed by Major Jervis, the value of the work was not proportionate to the cost and the selection of work not always judicious; and pointed out that there were three separate and independent establishments in connection with the War Office engaged in Topographical work, viz. :—

1. The Topographical Depôt of the Q.M.G.'s Department.

2. The Survey Branch of the Inspector General of Fortifications' Department.

3. The Topographical Department.

They recommended that there should be a department of Government for procuring topographical and statistical information, in which these three offices should be amalgamated, and that the officers of the department should be selected from as wide a field as possible. They considered that the department should be an independent branch of the War Office, and that the Secretary of State should be empowered to employ officers and men from any branch of the British or Indian Armies or from civil life. Also that the Ordnance Survey should be under the immediate direction of the Assistant Director in the Topographical Department.

In consequence of this report Lord Panmure ordered the following arrangements to be carried out :—

(1). Lieut.-Colonel H. James, R.E., to be Director of the Topographical and Statistical Branch of the War Office, to include the Ordnance Survey.

(2). The existing Topographical Department, the Ordnance Survey, and the Topographical Depôt to be united.

(3). Appointment of four officers, additional to those of the Survey Department, to be selected from cavalry, artillery, engineers, and infantry.

(4). Pay to be £1,200 per annum for the Director, and for the other officers twice and one-half the regimental pay of their rank in lieu of all military pay and allowances.

(5). A quarterly return of progress to be rendered.

(6). Early attention to be paid to the study of colonial military resources.

Lord Panmure's instructions with regard to Colonial Surveys are of particular interest at the present time, when renewed efforts are being made to establish close relations with the Topographical Departments of the Self-Governing Colonies and to co-ordinate the various surveys of the Crown Colonies and Dependencies. In his letter of instructions to Colonel James, he said, " Lord Panmure is desirous that you direct an early attention to the subject of Colonial Surveys, ascertaining as far as possible what works of this nature are in progress at the expense of Colonial Legislatures, and reporting whether it may not be possible to establish a system under which your department, with the concurrence of the Secretary of State for the Colonies, may assist in their systematic prosecution, his Lordship being satisfied that, whether from a military, a scientific, or a national point of view, it is of much importance to bring all the topographical operations of the British Colonies into harmony with one another, and to collect all information respecting them at a central establishment accessible to government."

Subsequent to this report Major H. C. Elphinstone, V.C., R.E., was appointed to assist Colonel James as executive officer.

In April, 1858, the old Depôt of Military Knowledge, established in 1803 and latterly known as the Topographical Depôt of the Q.M.G.'s Department, was amalgamated with the Topographical and Statistical Branch.

In January, 1859, Major Elphinstone was succeeded by Major A. C. Cooke, R.E. ; and in March of the same year Capt. Petrie of the 14th Regiment was appointed to the department in pursuance of Lord Panmure's decision to have each branch of the service represented.

In 1865 the Department was again subjected to the scrutiny of a Committee, consisting of :—Sir Richard Airey, K.C.B., Q.M.G., Colonel

F. E. Chapman, C.B., D.A.G., R.E., Capt. D. Galton, R.E., Assistant Under Secretary of State for War. They were directed to enquire into the Topographical Department, especially with reference to the desirability of separating the Ordnance Survey from the Topographical Depôt. They recommended that no change should be made, but considered that there was a want of special supervision over the work done, and suggested :—

(1). That requisitions for military service should pass through the Q.M.G.

(2). That the sale of Ordnance maps should be transferred from the Topographical Depôt to two or four publishers in London.

The Secretary of State approved these conclusions, but reserved to himself the right of ordering any services he might think fit without reference to the Horse Guards.

In November, 1865, the necessity for extending the Topographical Department was discussed, and a project for its further development was laid before the War Office by Sir H. James, after approval had been given by H.R.H. the F.M. Commanding-in-Chief and by Sir John Burgoyne.

On the 1st April, 1870, the Ordnance Survey was transferred from the War Office to the Office of Works; and in May, 1870, Capt. C. W. Wilson, R.E., who had been Executive Officer under Colonel James, was appointed Director of the Topographical and Statistical Department. The reasons which led to the severance of the Ordnance Survey from the Topographical and Statistical Department appear to have been financial and not difficulties of organization; the military map of England and Wales being complete, it was not considered right that the cost of the cadastral survey should fall on the War Office vote.

During the directorship of Sir Henry James, a survey of Jerusalem and Sinai was carried out. This work was executed under the Ordnance Survey, and not, as would have been expected, by the Topographical Department.

It will thus be noted that for a period of 13 years (1857—1870) the two departments were under one director, an arrangement which enabled the Topographical Department to utilize the resources of the Ordnance Survey and thereby effect a reduction in its own staff of draftsmen and lithographers. During this period the Ordnance Survey printed for the Topographical Section 1,097 separate maps and plans, amounting in all to 237,519 impressions. A somewhat similar arrangement, so far as concerns utilizing the Ordnance Survey resources, still obtains, and tends greatly to relieve the strain on the Topographical Section under any sudden pressure of work.

When the Ordnance Survey was transferred from the War Office to the Office of Works, the Topographical Department consisted of but one officer (Lieutenant Baring, R.A., now Lord Cromer) in addition to the Executive Officer (Capt. Wilson, R.E.); the subordinate staff numbered 13 civil assistants and draftsmen, 4 labourers, and 1 military clerk.

The condition of the department at this time was not satisfactory. Besides the want of information about foreign armies the library and map collections were deficient. Reports from military attachés were seldom received. Officers were not sent officially to the Continent, and there was no information about the Colonies. The department was really in a transition stage; the statistical part was increasing in importance, and the whole branch needed re-organization.

THE INTELLIGENCE DEPARTMENT.

On the 30th April, 1870, Capt. Wilson submitted a memorandum on the state of the department and the duties it ought to perform. The topographical work was apparently hampered by insufficient funds being allotted for the purchase of maps. The recommendation of the committee of 1857 that "all maps now lying scattered throughout the offices of the I.G.F. and Q.M.G. should be added to the collection of the Topographical Depôt" had not been carried out; there were apparently some 4,000 maps in the Director of Works' Department alone, most of which were of a purely topographical character, embracing nearly every country in the world. The Statistical Branch of the Depôt also suffered from neglect. The whole department does not appear to have been taken seriously at this time, and would seem to have been regarded merely as an ornament which an army must have if it wished to be regarded as up-to-date. Capt. Wilson complained that when information on foreign statistics was required by the Secretaries of State or the heads of departments in the War Office, application was seldom made to the Topographical Depôt, the natural result being that officers gradually lost interest in their work. In the same report Capt. Wilson suggested that the War Office Library should be placed in charge of the Topographical Depôt.

When the war of 1870 broke out and the Government was in need of information about continental armies, it was apparent that a re-organization of the Department was urgently required, and Capt. Wilson prepared a scheme for this purpose in August, 1870. It is significant testimony to the practical value of such a department that its formation in 1855, its re-organization in 1871, and the large increase in its staff in 1904 should in each case have been brought about by war and the need, actually experienced, of information such as the department, properly organized and staffed, would supply.

Capt. Wilson's scheme, which was practically adopted in its entirety, was, briefly, for the department to be divided into two sections under one Director—a Topographical Section and a Statistical Section. The duties of these two Sections to be:—

Topographical Section.

I. Collection of maps.—A collection to be formed of :—

(*a*). The best maps extant of Great Britain and Ireland, the Colonies, and all foreign countries.

(*b*). Plans of foreign fortresses.

(*c*). Maps and plans illustrative of campaigns, battles, sieges, etc.

(*d*). Photographs to be procured by purchase, exchange, and by encouraging officers who travel to send photographs to the Department.

II. Production of Maps.

(*a*). Compilation of maps for military purposes, such as that of Abyssinia issued before the departure of the expedition to that country.

(*b*). Copying maps.

(*c*). Lithographing maps.

Statistical Section.

This Section to be divided into three sub-sections, each presided over by an officer. Each sub-section to have allotted to it a group of countries, about which it would collect information of military value.

Capt. Wilson also recommended the formation of a good military library, to be placed under the Topographical Department.

In 1872 Capt. Wilson, at the request of Mr. Cardwell, S.S. for War, proposed a scheme for an enlargement of the department. The chief features of his proposals were :—

1. That an officer of high rank and position be placed at the head of the department, and have no executive duties.

2. That all candidates for staff employment be passed through the department, and thus become personally known to its chief.

3. That the system of working by sections be retained, but the staff increased.

4. That additional sections be formed for Home and Colonial defence, railways and telegraphs, and military history.

5. That a military periodical, similar to those published by continental armies, be issued by the department.

On the 24th February, 1873, Mr. Cardwell, in his speech on the Army Estimates, announced his intention of enlarging the department by transforming it into an Intelligence Department with a General Officer at its head.

On the 1st April, 1873, the Intelligence Department was created, and the Topographical Department allied to it, Major-General Sir P. MacDougal being appointed D.A.G., in charge of the combined offices.

The general scope of the enlarged department was defined as :—

I. The collection of all statistical and topographical information which it would be useful to possess in the event of invasion or foreign war.

II. The application of such information, in respect to the measures, considered and determined on during peace, which should be adopted in war, so that no delay might arise from uncertainty and hesitation.

With the creation of the Intelligence Department, the separate existence of the Topographical Section ceased, and henceforth it constituted one of the branches of the department which had been evolved from it.

On the 2nd October, 1873, Major Wilson submitted to General MacDougal a scheme for a further enlargement of the Department, bringing the Ordnance Survey again under the chief of the Intelligence. The work of the suggested organization was to include the compilation of official accounts of wars and expeditions. The scheme was not adopted.

On the 22nd July, 1874, the Intelligence Branch was transferred to the Q.M.G.'s Department and Sir Patrick MacDougal was appointed D.Q.M.G.

In 1875 the following arrangement and distribution of duties was brought into force :—

D.Q.M.G.

A.Q.M.G.
(in direct charge of Topographical Section).

D.A.Q.M.G.	D.A.Q.M.G.	D.A.Q.M.G.	D.A.Q.M.G.	D.A.Q.M.G.
Section A.	Section B.	Section C.	Section D.	Section E.

In addition to directing the Topographical Section and exercising a general supervision over the five statistical sections, the A.Q.M.G. took Central Asia, China, and special subjects, as well as office routine work, registry, and general correspondence.

In March, 1876, Major Wilson's period of staff service expired and he left the department, being appointed head of the Ordnance Survey in Ireland. He was succeeded by Lieut.-Colonel R. Home, R.E.

THE TOPOGRAPHICAL SECTION.

In March, 1877, it was pointed out that the topographical work was so important that it was then executed under the immediate personal direction of the A.Q.M.G.; but that the many duties this officer was charged with did not permit him to give complete attention to this work. It was therefore considered advisable to form another section, and in October a new section, F, was added.

The duties of the officer in charge of Section F comprised:—

Charge of map room and library.
Superintendence of compilation of maps.
Superintendence of lithographic work.
Issue of maps, plans, books, etc.
Selection of books and maps to be purchased.
Examination of newspapers and periodicals.

The staff of the Section consisted of:—

1 officer (D.A.Q.M.G.), 1 assistant librarian, 2 assistants to librarian, 5 draftsmen, 3 lithographers.

In 1894 the Library was constituted a separate Section. Otherwise the above organization was maintained till 1900, with little change except a small increase of staff. At the end of 1900 the strength of the Section was:—1 D.A.Q.M.G., 1 Staff Captain, 1 Attached Officer, 2 clerks, 1 map mounter, 1 map curator, 1 assistant do., 15 draftsmen, 1 photographer, 3 printers, 1 stone grainer.

In 1901 the whole office was rearranged, and Section F further reduced by being deprived of the custody of maps.

PRESENT ORGANIZATION AND DUTIES.

In 1904 the Intelligence Department was again re-organized, its designation being changed to that of Directorate of Military Operations. Under the new system it forms one of the branches of the newly created Department of the Chief of the General Staff, its immediate head being a Major-General with the title of Director of Military Operations.

The Directorate is divided into four sections, of which the Topographical Section forms the fourth. Under the re-organization the custody of the collection of maps has reverted to the section.

The present staff of the Topographical Section consists of:—

1 D.A.Q.M.G. in charge of the Section.
1 D.A.Q.M.G.
7 Staff Captains.
1 Map curator (civilian).
1 Assistant map curator (civilian).
3 Clerks.
1 Map mounter.
21 Draftsmen }
1 Photographer }
4 Litho printers } civilians.
1 Stone grainer }
1 Boy }

The organization of the Section is as follows : —

D.A.Q.M.G. IN CHARGE OF T.S.G.S.

Collection of topographical information, compilation and preparation of all maps for military purposes. Organization of all geographical work for the army. All matters connected with International boundary delimitation and demarcation commissions. Selection of officers for survey and geographical work. Issue of maps for war. Selection of officers from the Section, or who have served in the Section, for duty as Staff Officers for Topography with an army in the field.

Staff Captain to D.A.Q.M.G.
3 Clerks.
1 Map mounter.
1 Photographer.
4 Litho printers.
1 Stone grainer.
1 Boy.

Sub-Sections A, B, C.

Compilation and preparation of maps. Study of the geography of the countries dealt with. Actual work in those countries as may be required.

(A)
1 D.A.Q.M.G.
2 Staff Captains.
7 Draftsmen.
Compilation and preparation of maps of Africa.

(B)
2 Staff Captains.
7 Draftsmen.
Compilation and preparation of maps of Asia, except that part dealt with by the Intelligence Branch, Simla.

(C)
2 Staff Captains.
7 Draftsmen.
Compilation and preparation of maps of N. and S. America and Europe. Maps for mobilization, and for manœuvres.

Sub-Section D, Map Room.
1 Map curator.
1 Assistant curator.
Reception, indexing, and storing of all published topographical maps in the world, also of all geographical material received. Index of geographical information and records of travellers' movements. Distance and area measurements.

Broadly, the functions and duties of the Section are as follows :—

1. The provision of maps for war. This not only includes the compilation, arrangement, printing, and publication of geographical material in various forms for use by British troops; it has been recently decided that officers of the Section should as far as possible have a personal knowledge of the countries with which they deal, and should themselves, as opportunities offer, take a part in the investigation of geographical problems on the spot.

2. The co-ordination as far as possible of the various survey organizations throughout the Empire. The Topographical Section of the General Staff is in fact the only co-ordinating element for geographical purposes in the Empire. The D.A.Q.M.G. in charge of the section is a member of the recently formed Colonial Survey Committee, which advises the Secretary of State for the Colonies on all matters connected with the surveys of the British Colonies and Protectorates in Tropical Africa.

3. All correspondence on technical matters between the War Office and the Ordnance Survey; and on geographical matters between the War Office and the Intelligence Branch, Simla, and (through the latter) between the War Office and the Survey of India.

4. The Section advises the Foreign Office and the Colonial Office on all geographical questions, especially those connected with International Boundaries.

5. All questions relating to the appointment of army officers to geographical duties, and to the control of the Colonial Survey Section.

6. In war it has been decided that officers from the Topographical Section, or who have served in it, will be appointed Staff Officers to

organize and direct the topographical work at the seat of war under the Chief of the Staff.

7. The drawing and printing of maps and charts for defence schemes.

8. Minor duties, such as the preparation of maps for handbooks and military reports.

THE ORDNANCE SURVEY.

At first sight the disproportion between the strength of the Topographical Branches of European War Offices and that of the Topographical Section of the British General Staff is very striking. A numerical comparison, however, is misleading, as much of the work done by the Topographical Departments of the French, German, Austrian, and Russian War Offices is in England carried out by the Ordnance Survey. In making any comparison therefore, the strength of the Ordnance Survey must be taken into consideration.

In 1905 the staff of the Ordnance Survey consisted of:—

23 Officers,
2 Warrant officers,
366 N.C. Officers and men,
1,630 Civil assistants,
535 Labourers.

A portion of the officers, N.C.O.s, and men, are organized into 3 Survey Companies, which form part of the Corps of Royal Engineers and are available as Fortress Companies in war. A considerable proportion of the civilians employed are men who have served in these Survey Companies.

Three complete Survey Sections, each composed of 2 officers and 12 N.C.O.s and men of the Royal Engineers, fully equipped both for survey work and for reproducing and printing maps, are held in readiness for service with an army in the field. Further, the whole plant, including 11 machine presses, of the large establishment of the Ordnance Survey at Southampton, is available for the production of military maps if required.

It will thus be seen that the survey staff available for service in the field during war, and the facilities at the command of the Topographical Section of the General Staff for reproducing and printing maps required for war, are very large, and should be sufficient to meet any probable demands.

PROGRESS OF SURVEYS IN BRITISH DEPENDENCIES.

Outside of Great Britain and Ireland and the Dependency of India, the survey work of the Empire is in a very backward state; but within the last two or three years steps have been taken which should ensure the eventual provision of good maps, sufficient to meet all military requirements, of Canada and of most of the African colonies.

In Canada a Topographical Section forms part of the recently created Intelligence Branch at the Militia Headquarters. This section is now engaged in executing a survey on a scale of 1 inch to

1 mile. While the output of maps is at present small, owing to the limited amount of money available annually, no doubt as the value of the work becomes recognized, not only for military but also for civil purposes, the present small section will be developed.

In Australia nothing is being done towards executing a topographical survey of the country. In view of the vast extent of Australia and the small population, the commencement of such a survey can hardly be expected for some years.

The surveys and explorations of the British Colonies and Protectorates in Tropical Africa have developed very largely within the last few years. Briefly the state of the work is as follows:—

Gambia.—With the work of the various Boundary Commissions, and material collected by officials of the Colony, very fair maps are now available.

Sierra Leone.—An accurate survey of the vicinity of Freetown, on a scale of 1 inch to 1 mile, has been executed. Maps of the remainder of the Colony have been compiled from the work of Boundary Commissions and from route sketches.

Gold Coast.—An organized Survey Department has now been working for about five years. Accurate surveys of the mining area have been made, and a network of rigorous traverses run throughout the south of the Colony and Ashanti. Of the Northern Territories the only maps available are compilations from boundary maps and sketches.

Southern Nigeria.—In this Protectorate, which now embraces Lagos, regular surveys have been in progress for nearly five years, and fair maps of a considerable portion now exist. Under the new administration an amalgamated Survey Department is being formed, which will carry on a methodical survey of the country.

Northern Nigeria.—No attempt has been made to start a rigorous survey, and it is unlikely that any such survey will be commenced for many years. During the last year a small party, formed by agreement between the Colonial Office and the War Office, has accurately fixed by latitudes and telegraphic longitudes the position of fifteen points distributed over the Protectorate; with the control furnished by these it will be possible to compile from route sketches and other material maps of sufficient accuracy to meet present requirements.

British Central Africa.—No systematic survey has been undertaken. In the South some rough plane table sketching is available, and in the North work executed by Boundary Commissions.

British East Africa.—A well-organized Survey Department has been formed and a systematic survey of the Protectorate is in progress, chiefly confined for the present to trigonometrical and cadastral work.

Uganda.—A Survey Department exists, which has made some progress with a network of secondary triangles. As a result of three Boundary Commissions a fair chain of triangles now extends from the Indian Ocean round the north of Lake Victoria to Lake Albert Edward.

Somaliland.—The only maps of Somaliland are those compiled from surveys executed during military expeditions in the country and from the work of Boundary Commissions.

Egyptian Sudan.—An organized Survey Department has been in existence for several years, and excellent work is being done, but owing to the limited resources of the department and the vast area to be surveyed progress must necessarily be slow. At present cadastral surveys occupy most of the energies of the department.

South Africa.—The five South African Colonies form the area of British Africa of which it is most important to have good maps. In Cape Colony, Natal, the Orange River Colony, and the Transvaal, the geodetic framework has been completed, and arrangements have been concluded for completing the meridional chain of triangles already run through the greater part of Rhodesia.

In Cape Colony a staff of twelve officers is now engaged in executing reconnaissance surveys on a scale of 4 miles to 1 inch. This survey, while not of rigorous accuracy, should just fulfil the military requirements and can only be regarded as a temporary expedient.

In the Orange River Colony a Survey Section consisting of 2 officers and 4 N.C.O.s is engaged in carrying out a topographical survey.

In Natal, the Transvaal, and Rhodesia no topographical survey work has ever been carried out, and of these Colonies the only maps available are the untrustworthy ones compiled from farm surveys which proved of so little value during the Boer war.

Egypt.—In view of the preponderance of British influence in Egypt, and its geographical situation, that country may be considered with British Africa. A highly organized Survey Department forms part of the Egyptian Administration, and rigorous surveys of the country have been executed. Within the next year the Department expects to publish 140 sheets of the $\frac{1}{50000}$ map. A beginning is also being made with the geodetic lines along the Nile.

Other Colonies.—Of the remaining parts of the Empire few accurate maps exist. St. Helena, Bermuda, Mauritius, and Hong Kong have been accurately surveyed; but of the other colonies and dependencies only compilations from very rough material are available.

Until the last year no central body to co-ordinate and advise upon the survey work in progress in the various Crown Colonies existed. Recently an advisory committee termed the Colonial Survey Committee has been formed. This committee, which meets from time to time at the Colonial Office, deals with all questions of survey work, in the Colonies administered by the Crown, which may be referred to it by the Secretary of State for Colonies; it consists of a representative of the Colonial Office, the Director General of the Ordnance Survey, and the D.A.Q.M.G. in charge of the Topographical Section of the General Staff. Questions affecting surveys in Self-Governing Colonies do not, of course, come within the province of the committee.

FERRO-CONCRETE COAL WHARF AT ROCHESTER.

By Lieut. P. O. G. Usborne, R.E.

A general description of the work now in progress for Messrs. Cory & Son, Coal Merchants, Rochester, appeared in *Engineering* (November 16th, 1906). It is hoped that the following details will be of interest to readers of this Journal.

The general design of the Wharf is by Mr. H. Shoosmith, M. INST. C.E.; and the reinforced concrete details have been worked out by Mr. L. G. Mouchel, M.S.C.E., agent for England of the Hennebique system. The contractors are Messrs. Playfair and Toole.

The site for the proposed Wharf is on the right bank of the Medway, in the immediate vicinity of Rochester Station (late S.E. Ry.). At this part the bank of the river is unused and unrevetted in any way; mud and grass flats form the foreshores. The rise and fall of the tide varies from 15 to 18 feet.

In order to cheapen the freight of coal, which is all sea-borne, Messrs. Cory & Son decided to construct a wharf on to which sidings from the S.E. & C. Ry. could bring rolling stock: this is the only reason for returning the ends of the Wharf (*vide* plan in *Fig.* 1). They also intended, by dredging the river bed immediately in front of the Wharf, to enable steamers to lie alongside.

The mud at this part is very soft and deep, and masonry, concrete blocks, or mass concrete were thereby put out of court as possible means of construction. Piling was obviously essential, and reinforced concrete makes the only permanent pile; its adoption was therefore decided upon.

Having decided on these preliminary details, trial holes were sunk on the site in order to determine the length of pile required and the nature of foundation to be got. It is believed that only two such borings were made, and their insufficiency has since been apparent.

About 30′ below Low Water Mark a hard bottom was found—supposed to be chalk, although at present no certainty of this exists. The piles were therefore designed of lengths varying from 37 to 41 feet. They have to be driven between half ebb and half flood tide; and must have 2′ 6″ at their upper ends left exposed for stripping and jointing to other members, both uprights and horizontals, *i.e.*, their heads should project about 6′ above Low Water Line.

Along the front of the Wharf sheet piling is driven between the main piles, which are $16'' \times 20''$, up to the level of the waling. Behind this come two further rows of smaller piles. They are all connected together by horizontal waling at about 6′ above L.W.L. They are produced upwards by ferro-concrete verticals to the required deck level, viz. about 8′ above H.W.L., and their tops are connected together by cross beams, railbearers, and slab floor. The top is finished with 8″ of filling and 4″ of tarred limestone.

Diagonal bracing is introduced between piles all along the main front of the Wharf, where the shock of a ship bumping may be felt, but only occasionally along the returned ends.

The features of the work which appear most useful to the Royal Engineer may be summarized under the following two heads :—

(1). Reinforced concrete piling.
(2). Practical methods of construction.

EXCAVATION.

Now, in any particular work the length of the piles must be governed by the depth required in order to get a hard bottom. This has to be decided on, before moulding the piles, with sufficient accuracy to avoid much cutting away or jointing on afterwards.

For economy in handling, pitching, and driving piles should naturally be as short as possible. In this respect the tidal nature of the Medway is of great use, allowing short piles to be driven at low water, which can afterwards be lengthened as required. To make use of this advantage to the full it is necessary to clear away mud, soil, etc., from the proposed site almost down to L.W.L. The piles are then driven to a hard foundation during low water; and if their length has been properly estimated, they should then project high enough above L.W.L. to allow of their heads being stripped of concrete and the reinforcement exposed, thus enabling the period between low and high water to be utilized for joining on the horizontal waling and producing the piles upwards as verticals.

For the Rochester Wharf no excavation was required along the front face, as the Wharf is being built well out into the river; a little dredging (done at high water) has accomplished all that was required.

But at the returned ends, where the structure runs back into the bank, excavation had to be undertaken. *Fig. 2* shows a rough plan of the works as they are at present, with stacks of cast piles ready for driving: on the right hand is shown the approximate amount of digging that had to be done.

When this excavation was started, the contractors thought that they could cut straight down, 20 to 30 feet, leaving a vertical face of mud only 4 feet behind the inner row of piles. The earth excavated was thrown back on the top of this vertical mud bank. They did revet the face with light timber sheeting; but when their pile driving was well in progress the mud slipped, burying all their gear and necessitating fresh excavation.

As is well known, once slips have started they require drastic treatment to stop them. An expert in these matters from similar works at Southampton came to inspect the place, and advocated cutting the mud back from a vertical face to a flat slope of 1 in 2. Naturally the contractors were very loth to do this; but after another slip it became obviously necessary, and was done. Accidents of this kind, easily avoidable in themselves, cannot be considered as creditable; nor do they pay.

It is worth while noting that excavations on tidal foreshores should be accomplished by dredgers or grabs at High Water. At Low Water the soft wet mud offers no footings or facilities for mechanical navvying; and usually the spoil thrown out has to be loaded into lighters or barges, either by hand or by grab, involving two handlings.

STAGING.

When the above excavation was complete, staging formed on timber piles had to be erected. At the Rochester site some remains of old wharves existed: one of these was set aside for landing timber, ballast, cement, etc., which all come by water; the other served as staging for pile drivers. But a good deal of additional staging on timber piles was required, and these piles were driven from lighters floated in at high water.

The positions of all angles and also all alignments were fixed by transit lines, these lines being laid out by erecting accurate marks in line on shore.

PILE DRIVING.

When piling began, a start was made on both the inshore ends of the Wharf; and as these piles were driven the temporary staging, with the pile drivers, was moved further out by the help of the lighters.

The ferro-concrete piles were brought out on the staging on rollers by hand. They were pitched in the usual manner, and driven with a dolly or cap placed over their heads. At Southampton a sawdust cushion was used between the head of the pile and the dolly; but this has not been considered necessary here.

After all the piles had been cast, and piling was well in swing, the mistake of too few trial holes was discovered. The underlying hard foundation (chalk) was found to be at very variable depths. Some piles would go through the mud very rapidly, and strike the chalk when 10′ was still projecting above L.W.L. To drive them much further was useless; and the only remedy was to strip some 10′ of concrete off their tops, exposing the steel. This was necessary to enable the horizontal waling to be joined in at the proper level: cutting with a cold chisel and hammer is the only way to do this, and it is a very tedious and lengthy process if the pile has been well made.

Other piles were driven out of sight without touching the hard. The remedy for this is to join on an extra length. *Fig.* 3 illustrates the method of doing this. The reinforcement of the pile is bared for 2′ 6″. A cylindrical ferrule, 10″ long, is slipped over the top end of each steel rod and held in place by steel wire. The lower ends of the steel rods for the extra length are similarly inserted in the ferrule from above. Then short steel splicing rods, 5′ long and of the same diameter as the reinforcement, are used to fish the joint, being laced by steel wire to the rods of the reinforcement. Sheeting is then fixed, and concrete is packed in to the height required, being formed into a driving head at the top. This concrete has to set for six weeks before driving may be continued.

It is therefore clear that a small number of trial bore holes is not always an economy.

On going through mud the point of a pile may strike an obstruction, such as a sunken baulk of timber, which will deflect it. In such a case it is usually best to draw the pile at once. It is rarely that exact alignment will be obtained by slewing the head of the pile over, and trying to drive it back into its correct position. If circumstances permit, float a lighter alongside the pile and make fast to it at Low Water; the rising tide will then do the work.

One pile has been broken on the Rochester works, apparently about 10′ below the mud surface; it has not yet been drawn, and so further information is not available.

There are four pile drivers on the works, two heavy and two light. A sketch of the heavier one is given in *Fig.* 4.

The frame of such a pile driver took four carpenters fourteen days to make, or about 448 man-hours, costing in England £15. This does not include any material or the fixing of machinery.

PILE CONSTRUCTION.

The main piles and sheet piling in this Wharf are all of ferro-concrete.

The sheet piles are 30′ long, being shod with the usual splayed cast-iron piling shoe. They have a semi-circular rebate down both sides. When in position, the cylindrical hole formed by two adjacent rebates is filled up with cement, put down in a long canvas bag. It seems doubtful whether a watertight joint could ever be obtained by this means; it would appear to be better to pour a strong mortar, made with quick-setting cement, in fairly liquid form down the hole, ensuring that the whole joint was filled by lightly ramming with a long pole.

The main piles are of various sizes. The largest are 16″ × 20″. These are used along the front of the Wharf and are 41′ long, being cast with a hollow in the centre (*Fig.* 5). The armouring consists of four bars of $1\frac{3}{8}$″ round steel. At the toe these terminate in four holes in a pointed cast-iron shoe, which has four wrought-iron straps, turning inwards into the concrete, to hold it in position.

The four steel bars are kept apart by cast-iron distance pieces, spaced 4′ apart (*Fig.* 5), and are held together by links of steel wire, about No. 3 gauge ($\frac{3}{16}$″ diameter). These links are placed 6″ apart along the middle of the pile, closing up to 3″ and 2″ spacing at the bottom and top respectively.

The hollow in the middle of the pile is formed with thin sheet iron cylinders, 4′ long and 8″ in diameter, placed between the cast-iron distance pieces.

Fig. 6 shows a section through the casing for a pile. The sides are held together by wood cleats nailed to them on top, and the reinforcement is held up by clips over these cleats. The tops of the clips can be knocked outwards or inwards, thus raising or lowering the reinforcement, which must be adjusted very carefully to the casing.

Other sizes of piles in use are :—16″ × 16″, with $1\frac{3}{8}$″ reinforcement, averaging 37′ long; and 14″ × 14″ with $1\frac{1}{4}$″ steel, also about 37′ long. These are all solid, the 16″ × 20″ piles along the front being the only hollow ones.

The amount of steel in piles varies from $2\frac{1}{2}$ to 5 per cent. The 16″ × 20″ hollow piles and the 16″ × 16″ solid ones in the Rochester Wharf have about $2\frac{1}{2}$ per cent. of steel only.

This can in no sense be considered as anything more than a general guide. Mr. Mouchel says that he never designs piles with any reference to percentage, but simply as if they were beams, assuming that they have to be handled very roughly and will be placed in various unexpected positions. In short, formulæ for the accurate design of piles are still the property of experts, and for important structures experts should be consulted. For ordinary piles the $2\frac{1}{2}$ to 5 per cent. rule is a good guide, provided that the length does not exceed 30 times the least breadth of the pile (16″ × 16″ piles are used up to 40′ long).

The gauging of the concrete for the piles is the most important part of their construction. The ballast used at Rochester is Thames ballast, and is carefully screened to separate out the sand. Rounded sand and ballast is preferred, as it is easier to gauge the interstices and prevent porosity. The screened ballast is broken to a $\frac{7}{8}$″ gauge, and then 1 yard of ballast and ½ a yard of sand (by volume) are mixed with 7 cwt. (by weight) of cement. Water is added as considered desirable by the contractor—with this one proviso, that the whole of the above mixture must ram into 31 cub. ft.

This becomes impossible if too much water is used. The practical manner of checking this is to cast five or six piles at one time. The quantities for the concrete are roughly worked out beforehand, and if more than a barrow full of concrete remains over at the end, the mixture is too wet. Of course it is then too late to alter these piles, but the representative of the firm of reinforced concrete specialists, whoever he may be, can tell fairly well by experience how the mixing is being performed.

The piles are cast in a horizontal position. Until recently it was considered necessary to mould piles in a vertical sheeting; but now this is never done, as experience has shown that there no material advantage is gained thereby. Enough men and material must, however, be got together to enable a pile to be finished in one operation.

The concrete must be very carefully mixed, by hand, close to the work. It is carried to the casing in small buckets or cans, and there deposited in position. It has to be very carefully rammed or packed, so as to make it properly fill the casing underneath the reinforcement; to ensure this in the case of hollow piles, which are particularly difficult to pack, the first lot of concrete put in may be slightly wetter than the rest. The ramming is done with light pieces of timber, and is really better described as "poking" or "packing" into position.

For solid piles, or waling, etc., the filling is begun from one end and carried on towards the other, the face of the concrete at any instant being the natural slope of repose of wet concrete.

All piles are specified to set for six weeks before being driven.

The top of a pile, when ready for driving, has 3″ of plain concrete above the reinforcement.

In the foundations of a new warehouse at Victoria Docks, ferro-concrete piles cost about 4s. 6d. per cubic foot to make and drive.

Major E. Stokes-Roberts, R.E., in a "Report on the Application of Reinforced Concrete," published in India, says that he has seen a 35′ ferro-concrete pile, 15″ × 15″, driven through a 12″ slab of concrete, which it was not thought worth while to go to the expense of removing.

WALING, DIAGONALS, AND SUPERSTRUCTURE.

In the design of a Wharf or of any other structure carrying rails and rolling stock, the first thing is to locate the permanent way on the plan, remembering that curves may be sharp since the speed will always be slow. When this is done, place reinforced concrete beams or rail bearers under the rails. These will in turn be supported by cross girders running from pile to pile, transversely to the direction of railway line. The whole surface is closed in by a slab floor.

In the Rochester Wharf there are two railway tracks and a crane track to be allowed for, and the test loads are specified as follows.

Crane Track (main wharf).

Outer rail—100 tons on 3 wheels, base 22′ 6″.
Inner rail— 50 tons ,, ,, 22′ 6″.

Railway Tracks.

All tracks— 30 tons on 6 wheels, base 9′ 0″.
,, ,, or 20 tons on 4 wheels, ,, 6′ 0″.
,, ,, or 25 ,, ,, 9′ 9″.

The calculations for a rail bearer and cross girder are given at the end of this article.

Fig. 7 shows a section of the rail bearers, and *Fig.* 11 shows the cross girders, as designed by Mr. Mouchel.

The rails are laid on longitudinal sleepers, placed immediately above the bearers and sunk flush with the deck surface. There is 6″ of stone packing between the sleepers and the bearers; this helps to distribute the wheel loads over some 2′ or 3′ of the bearers, giving a slight reduction of bending moment.

The slab floor is 6″ thick, with ½″ armour placed as shown in *Fig.* 7. There is also $\frac{5}{16}$″ transverse armour along the top, about 3 bars per foot.

At the water face, it will be noticed (*Fig.* 8) that the main horizontal beam is placed immediately under the outer crane track, while the front edge of the floor is finished with another and lighter beam.

Down the front of all uprights along the face of the front wall of the Wharf are secured timber rubbing pieces. These are 8″ × 11″ green-heart, protected with a segmental wrot-iron strap, 5″ × ¾″.

The construction of the superstructure of the Wharf is not a matter of much difficulty.

After the piles have been driven to their required depth, the concrete is stripped from their heads, exposing at least 2′ 6″ of reinforcement; if the pile has not been driven deep enough, and over-much is projecting above proposed level of waling, more cutting away is required.

The sheeting for the waling, which is 14″ × 14″, is then fixed in position; it is left open at the top and the reinforcement is laid in it. The waling is not subject to any serious cross-breaking strain; its purpose really is to brace the whole structure, and to take direct tension or thrust when vessels come alongside the wharf and bump into it. The reinforcement is therefore laid longitudinally and straight. It is kept apart by short cloven iron bars (shown in *Fig.* 9), placed diagonally, and held together by links of $\frac{3}{16}''$ steel, just as for the piles but spaced 6″ apart. The reinforcement in the waling and diagonals consists of four 1″ bars.

At the same time as this sheeting is being placed, the vertical casing for the upright prolongations of the piles must be fixed. For purposes of filling and ramming, it must be left open on one side. Three sides are therefore formed of boards running vertically; and the fourth is closed up by short horizontal boards, 2′ at a time, as the work of filling and ramming progresses upwards. The reinforcement is fixed in position in the usual manner. The number of twisted ties or links required is not so large as in the case of the pile proper; where the shock of driving has not to be contended with, 6″ to 8″ spacing is therefore sufficient for these.

At their lower ends the vertical steels are attached to the bars of the pile with ferrules, just as for lengthening a pile, the only difference being that the 5′ splicing rods are not required.

The horizontal walling is joined to the pile by passing its reinforcement bars from both sides through the reinforcement of the pile, so that the bars overlap each other about 2′. The detail of the joint is shown in *Fig.* 10. It will be noticed that the joint is not made plain square; but that additional adhesion is obtained by splaying out the concrete joint, and also a considerable amount of increased stiffness by introducing short $\frac{1}{2}''$ diagonal steel bars. This treatment of joints is adopted throughout the whole structure.

The concrete for the waling has to be laid during half tides.

When the water recedes it leaves all old work covered with a film of mud. This is cleared away with a hose pipe, and the surface of the existing concrete is chipped and roughened with cold chisels before any more laying can be done. The concrete is mixed close to the work and is carried down in small buckets, being carefully placed in position and rammed, as for the piles. All the aggregate is gauged to $\frac{7}{8}''$ throughout. The top of the waling is smoothed off by hand with a straight edge, and covered with sacks to prevent detrition when the tide rises again.

When the uprights have been made and setting is complete, the casing is removed; and then there remains only the floor to put in.

The sheeting for cross girders, railbearers, and floor is all made in one. The reinforcement and stirrups are carefully placed, and the whole is laid as a monolith. The vertical bars of the uprights are flattened or bent over, and terminate about 3″ below the finished floor surface. The reinforcement of the floor is shown in *Fig.* 7; it consists of $\frac{1}{2}''$ bars, straight and bent alternately, spaced 4 to the foot, while $\frac{5}{16}''$ bars, spaced 3 to the foot, are laid transversely at the top of the slab. The floor slabs are considered as continuous across the railbearers.

In all works of this description one of the most expensive items is always the timber sheeting. In this respect a good foreman is invaluable, as he can save an enormous amount of cutting to waste, and can so make up his sheeting as to readily admit of using it over and over again. $1\frac{1}{2}''$ to $2''$ deal boards are used throughout at Rochester.

At the land face of the Wharf, a little extra deck space is obtained by giving a cantilever overhang. This is shown in *Fig.* 8 and needs no explanation.

LABOUR AND SUPERVISION.

While tide work is in progress the men are paid time and a quarter, whether they work night or day. They are also supplied with sea boots for working in the mud.

The supervision seems to be insufficient. It has actually occurred on this work that some of the reinforcement specified has not been put in; this may be due to many causes, but it is manifestly impossible to expect uneducated workmen, or even foremen, to understand the somewhat complicated drawings of reinforced work. The method resorted to for ensuring accuracy is to lay out the reinforcement for any member all together on the ground beforehand and label it. This tends to eliminate mistakes.

It was found to be a very difficult and tedious job to cut away all the concrete from those members in which part of the reinforcement had been left out, and the only remedy is constant supervision. If it is permissible to criticise these works further, it appears that the piles have all been cast unnecessarily far from their eventual site, involving much labour in shifting (see *Fig.* 2), and that some sort of workmen's club or shelter might have been provided with advantage.

It is noteworthy, too, that, as the piles have got to be set for six weeks, and the rate of driving is necessarily slow, there is nothing to be gained by manufacturing piles faster than they can be driven. The first stages of the work must therefore necessarily be slow, and the number of men employed should not be large.

The lighting for night work is done by three Wells lights, a special man being kept on the works for their superintendence.

PATENT RIGHTS.

In considering the practical methods of construction, the primary question of interest is—How far do patent rights affect us?

In civil practice in England, some engineer designs the general plan of the work, and then goes to a specialist, such as Mr. L. G. Mouchel, to design the reinforcement details, both of these receiving a fee for their work.

The contract is then let, and the accepted contractor must pay a license of £500 to the particular firm on whose reinforced system the structure is being built. Sometimes, also, he has to pay a certain commission on the total cost of the work.

When work commences, the firm of reinforced concrete specialists are bound to oversee the work, standing practically in the position of an architect so far as the reinforced portion is concerned.

But no patent rights can prevent any individual or collection of individuals from using any device whatsoever for their own work.

Government is therefore entirely at liberty to use the Hennibique or any other system of reinforced construction in England, provided that War Department labour is employed. If, however, a contractor be employed, complications arise, and it is difficult to say what the final legal decision might be in such a case if the Patentees protested. In practice it would be simpler and better to call in the firm of specialists and pay their fee.

But the matter is different abroad. In India or S. Africa, for instance, few, if any, reinforced concrete systems are protected, and we have an absolutely free hand.

It is the first business instinct of all civil firms to create a mystery enshrouding their particular work; and while pretending that they possess information of very far-reaching importance, to veil it with the utmost care. At the same time a little thought and some experience will convince anyone that there is a very large proportion of bluff. Such firms of specialists have experience galore; but drawings of every existing reinforced structure can be got for reference, and one or two simple formulæ will supply us with all that economical practice demands.

CALCULATIONS FOR RAIL BEARERS.

The span of the bearer is 10′.

A careful inspection of the three test loads given on page 86 shows that the largest bending moment is produced by the 25-ton engine on 4 wheels with a base of 9′ 9″, when one axle is right over the centre of the bearer, and

$$\text{this Moment} = \tfrac{125}{8} \text{ ft. tons} = 35{,}000 \text{ ft. lbs.}$$

The weight of the bearer itself is negligible, also that of the superincumbent load due to people, etc.; but the weight of the floor must be considered.

The thickness of concrete is 6″, weighing 112 lbs. per ft. cube, or 56 lbs. per ft. super. The weight of ballast and limestone, 12″ deep, may be taken at 130 lbs. per ft. cube, or 130 lbs. per ft. super. Total 186 lbs., or say 200 lbs. per ft. super.

Each bearer (*Fig.* 7) appears to support a slab of floor

$$10' \text{ long by } \frac{5'\ 2\tfrac{1}{2}''}{2} + \frac{4'\ 11''}{2} \text{ wide} = 50 \text{ sq. ft. nearly.}$$

Therefore the total dead load $=50\times 200$ lbs. $=10{,}000$ lbs.
Then for this uniform load

$$M_f=\frac{Wl}{10}\text{ (since the bearer is continuous)}=\frac{10{,}000\times 10}{10}\text{ ft. lbs.}$$
$$=10{,}000\text{ ft. lbs.}$$

Therefore total $M_f=45{,}000$ ft. lbs. $=540{,}000$ inch lbs.

And $$M_f=M_r=\tfrac{1}{6}r_c\ bd^2=540{,}000$$
$$\therefore\ \tfrac{1}{6}\times 600\ bd^2=540{,}000$$
$$\therefore\ bd^2=\quad 5{,}400.$$

(Safe resistance to crushing of concrete may be taken as 600 lbs.).

Now by ordinary rules for T beams B, the effective breadth of the top of the tee, may be taken as half the spacing of the beams (*Fig.* 12).

Therefore
$$B=\frac{5'\ 2\tfrac{1}{2}''+4'\ 11''}{2}\div 2=30''\text{ nearly.}$$

The compression portion of the tee is represented by the rectangle *wxyz* and the pressure is assumed to be uniform throughout it;

and the effective depth of the section is $d^1+\frac{g}{2}$.

Therefore in the above formula, where it was found that $bd^2=5{,}400$, we can substitute B, or 30″, for b.

$$\therefore\ d^2=\frac{5400''}{30}=180''$$
$$\therefore\ d=13\tfrac{1}{2}''.$$

But $$d=d^1+\frac{g}{2}=d^1+3''\text{ (since }g=6'')$$
$$\therefore\ d^1=10\tfrac{1}{2}''.$$

Allowing $1\frac{1}{2}''$ for covering the reinforcement, the final depth of the rail bearer below the floor slab becomes 12″; or, adding in the thickness of the floor slab, the total depth of the rail bearer is 18″.

1 per cent. of steel may be used for such beams, the percentage being based on the area of the tee head. 1 % of $30''\times 6''=1{\cdot}8$ sq. ins. Two bars $1\frac{1}{16}''$ diameter will therefore suffice.

On referring to *Fig.* 7, it will be seen that Mr. Mouchel has used a beam only 16″ deep and having two 1″ bars as reinforcement. Our formula errs therefore very slightly on the safe side.

The thickness of the T beam at its stem (*b* in *Fig.* 12) is usually made $\frac{1}{6}$th of B. This thickness is governed solely by the tendency of the tee head to shear off from the stem, and is based on practical experience. In this case 5″ would suffice, but 6″ is used.

CALCULATIONS FOR CROSS GIRDERS.

The cross girders (*Fig.* 11) are 10′ apart, and their span is 13′ 10″ or 14′, centre to centre. They are continuous over a central support, and may be considered as fixed at their ends.

All dead load may be treated as concentrated at the junctions of the rail bearers to the cross girders.

The dead load on one span, due to the 6″ floor,

$$=14' \times 10' \times \tfrac{1}{2} \times \frac{112}{2240} = 3{\cdot}5 \text{ tons.}$$

That due to the bearers, at each point of application,

$$=\frac{16'' \times 6''}{144} \times 10' \times \frac{112}{2240} = {\cdot}35 \text{ tons.}$$

That due to the cross girder itself

$$=14' \times 1' \times 2' \times \frac{112}{2240} = 1{\cdot}4 \text{ tons.}$$

Therefore the total dead load at each point where the junction with rail bearers occurs may be taken as

$$=\frac{3{\cdot}5}{2} + {\cdot}35 + \frac{1{\cdot}4}{2} \text{ tons} = 2{\cdot}8 \text{ tons.}$$

In addition to this there is the live load of an engine on each track.

Consideration will show that the first engine quoted in the test loads, namely 30 tons on 6 wheels with base 9′, will produce the greatest stress in the cross girder when standing with its centre axle immediately over the cross girder and its leading and trailing wheels resting on the adjacent rail bearers. When in this position it brings a load of 10·5 tons on to the cross girder at each junction with the rail bearers, partly direct and partly transmitted by these bearers.

Therefore the total load on the cross girder is $10{\cdot}5 + 2{\cdot}8 = 13{\cdot}3$ tons under each rail, as shown in *Fig.* 13.

In this figure the diagram of bending moments is drawn to scale. When measured it shows the maximum M_f to be about the support and equal to 500 inch tons, and also that the maximum downward M_f in the central portion of the beam is only 270 inch tons.

It will be noticed that the load due to the outer crane track has been ignored; its effect on the cross girder is practically *nil*, since it falls immediately above a splayed joint and a diagonal brace, and only 10″ from the pile head itself.

Having found the M_f all that remains is to design the girder. The usual formula for beams can be used, taking the safe resistance of concrete to compression as 600 lbs.

(1) First for the middle portion of the beam.

From diagram,

$$M_f = 270 \text{ inch tons} = M_r$$

$$= \frac{1}{6} r_c bd^2$$

$$= \frac{1}{6} \times 600\ bd^2 \div 2240$$

$$\therefore\ bd^2 = \frac{270}{600} \times 6 \times 2240 = 6048.$$

Assume $b = 12''$. Then

$$d^2 = 504$$

$$\therefore\ d = 22\tfrac{1}{2}''.$$

Allowing $1\frac{1}{2}''$ for covering reinforcement, the total depth ot beam $= 24''$.

The usual allowance of steel is 2 % for beams.

The cross section of concrete $= 24 \times 12$ sq. ins. $= 288$ sq. ins.

$\therefore$ area of reinforcement $= 5{\cdot}76$ sq. ins.

Assume 4 bars. Then section of each $= 1{\cdot}44''$.

$\therefore$ four $1\frac{3}{8}''$ bars will do. Mr. Mouchel uses four $1\frac{1}{2}''$ bars.

Where the M_f changes from sagging to bogging, two of these bars are bent up in the usual manner.

(2) Over the central support, or pile, the $M_f = 500$ inch tons.

Here again

$$500 = M_f = M_r = \frac{1}{6} r_c bd^2 = \frac{1}{6} \times 600\ bd^2 \div 2240\ ;$$

$$\therefore\ bd^2 = 11200.$$

Again assume $b = 12''$. Then

$$d^2 = 933$$

$$\therefore\ d = 30\tfrac{1}{2}''.$$

Allowing $1\frac{1}{2}''$ for covering the reinforcement, total $d = 32''$.

This large depth required is met by shouldering out the head of the pile as shown in *Fig.* 8. The shoulder in this case is made 12″ deep, giving a total beam section of $12'' \times 36''$.

Reference to *Fig.* 13 will show that the M_f falls very rapidly as we get further from the point of support, and reaches the value of 270 inch tons at 14″ from the centre of the support. The shoulder must therefore extend at least 14″ from the pile centre; but, since the pile is 16″ × 16″, the shoulder need only project 6″ beyond the pile.

In this case (*Fig.* 7) it is made to project 12″; and it is reinforced on the compression edge against shear and other stresses with two ½″ bars similar to those in *Fig.* 10.

It must be remembered that the 1½″ steel bars, which remain at the bottom of the beam all the way over the point of support, help to resist compression, though no account has here been taken of them.

Also that, when one span of the cross girder is loaded and the other not, the whole of one girder may be under an upward bending stress, while the other is much more severely strained in a downward direction than *Fig.* 13 shows.

For this reason two 1″ bars are introduced along the top of the cross girder, in order either to take tension or to assist with the compression.

The steel allowed at the top of the beam above the point of support is just 2%.

NOTE.—The author regrets that space has not allowed a fuller investigation of the methods of calculating continuous beams of this description. The whole subject is a very lengthy and difficult one.

MEMOIRS.

LIEUT. F. H. BUSHELL, R.E.

THE past year has been a disastrous one for the Corps in India. Amongst the names of the comrades, whose loss we have to deplore, occurs that of Frederick Harley Bushell, a keen and energetic soldier, a thorough sportsman, and an all-round favourite, who died of enteric at Bangalore on October 31st.

Born in 1878, Bushell was educated at Harrow, entering "The Shop" (where he obtained his "Colours" for Association Football and Revolver Shooting) in January, 1896, and gaining his commission in December, 1897.

Soon after arrival in India in 1900, he was posted, as he wished, to the Sappers and Miners, and fell to the 2nd "Queen's Own." After undergoing an 18 months' course in the Civil Telegraph Department, and serving a year in Chitral with the 14th Company, he was selected for the command of C Company, which embraces the Telegraph, Printing, and Photo-Litho Sections of the Corps.

His selection was amply justified by the manner in which he threw himself heart and soul into his job, with that sturdy self-reliance which was his main characteristic, raising the efficiency of the various Sections and making for himself a name as an Army Telegraph expert, of no mean order, whose word carried much weight. At the Bangalore Manœuvres the Tactical Telegraphs, of which he made a special study, formed, under him, a marked feature; while in November, 1905, he took a Telegraph Section to the Rawal-Pindi Manœuvres, where his work was such as to receive universal approbation.

In the realm of sport and play it need only be mentioned that Bushell was a fine all-round sportsman, a keen polo player, a good cricketer, a brilliant racquet player, a tower of strength in our hockey team, and a good shikari.

Socially he was beloved by all who knew him, and his untimely death cast a gloom not only over the Corps, but over the whole station, which turned out "en masse" to attend his funeral, while letters of condolence arrived from all parts of India.

The Native Officers of the Corps asked, of their own accord, to be allowed to wear mourning for him, a small but significant sign of the respectful love which the Native ranks bore "Bushell doray." Had he lived there can be no doubt that his splendid qualities would have ensured him a brilliant career in the Service.

F. J. ANDERSON.
E. K. MOLESWORTH.

THE REV. J. J. CURLING, M.A., LATE LIEUT., R.E.

THERE has recently passed from amongst us an old R.E., who in his younger days was liked by his contemporaries, and in his after life was esteemed and honoured by everyone who knew him, and why? Because, being a man of means he unselfishly devoted not only those means, but also his life, to promote the best interests of his fellow men. He had an unobtrusive, gentle, and charming manner, and no one who came in contact with him for a moment doubted the sincerity and genuineness of his motives and character; but behind the gentleness of manner there was a strong fixity of purpose, and plenty of energy to carry his purpose to useful maturity. The most casual observer could not fail to see that "Self" never entered his head. He had set himself a noble task, and his whole mind and energies were devoted to carrying that task to a successful issue. Such an unselfish and admirable character deserves notice in the Corps Journal. The record of a fine character insensibly produces a beneficial effect and tends to raise the tone of mind of those who read it, who begin to think, "Well, after all, there is some good in this wicked world."

Curling was educated at Harrow, and entered the Royal Military Academy at Woolwich direct from that school. There he did well, obtained his commission in the Royal Engineers, and received the "Sword of merit" on leaving in 1865. His contemporaries speak of him as rather reserved in character, taking little part in ordinary games except racquets at which he was a proficient, and never joining in the somewhat riotous amusements which were not uncommon at the Academy in those days, but bright and cheery and full of quiet energy.

His tastes were decidedly nautical, and when at Chatham he was generally one of the crew of the *Violet*, on board of which there was no better hand in an emergency. Sometimes his energy found vent in venturesome, not to say foolhardy, expeditions. As examples it may be mentioned that on one occasion, whilst quartered at Dover, he paddled and sailed across the Channel in a canoe—not as a sensational expedition, but at night—by himself, and unknown to anyone until he returned with his canoe in the steamer. On another occasion he started one evening to row in a light sculling skiff from Gravesend round by Sheerness to Chatham, and after meeting with some adventures, as was not surprising in the dark, reached his destination safely. When at Gravesend as Assistant Musketry Instructor, soon after leaving Chatham, he owned the *Lavrock*, a yawl, 72 tons. In a little "brochure" the late General Drake, R.E., always an amusing writer, speaks of the *Skylark* (*Lavrock*) as Curling's first love and the joy of his heart. Being an old yachtsman myself I can quite imagine that Drake was not far astray. The "brochure" is an amusing account of a trip in the *Skylark* across the Channel to Havre and back, in October, 1868. In that year Curling was elected a member of the Royal Yacht Squadron, and continued a member until his death.

In April, 1869, he went to Bermuda as A.D.C. to General Sir Fredrick Chapman, R.E., the Governor; this suited him well, as he had there every opportunity of enjoying his favourite sport.

When at Bermuda he met the Bishop of Newfoundland and had much conversation with him as to the circumstances of his Diocese and his visitation voyages to distant places in it. After his return to England in 1870, when still holding the appointment of A.D.C. to Sir Fredrick Chapman, who had become Inspector General of Fortifications, Curling heard of the wreck of the Bishop's "Church Ship" and promptly offered his yacht the *Lavrock* to replace her, a most generous gift, illustrating both his liberality and the tendency of his mind. The offer being accepted he had her thoroughly overhauled and, having obtained leave, navigated her across the Atlantic to Newfoundland, where he handed her over in 1872 as the new "Church Ship."

In 1873 he retired from the Corps, and took Holy Orders the same year, as he had then determined to devote himself to active missionary work in Newfoundland. It is impossible to look into the hidden springs of his mind which induced him so completely to change his career in life, but his resolution once formed was carried vigorously into effect. He went to Newfoundland, and worked hard as a missionary for nearly 20 years amongst the fishermen and others. Being a good seaman and fond of everything connected with the sea, he was singularly fitted for the work to which he had devoted himself. During this period he took his degree at Oxford, coming over from St. John's to keep the College terms.

About the year 1880 he was appointed Rural Dean of the Straits of Belle Isle and in that capacity had spiritual charge along some 600 miles of coast. To enable him to visit the far apart places in his District he designed and built *The Sapper*, a small schooner of about 57 tons Thames measurement, and in 1882 passed the necessary Board of Trade examination and obtained a "Master's Certificate."

Whilst at St. John's, Newfoundland, he married a daughter of Sir Bryan Robinson, Judge of the Supreme Court, by whom he had four children, three sons and a daughter.

In 1892 he found it desirable to give up his work in Newfoundland and to return to England for the education and placing of his sons. As there was no longer need for *The Sapper* in Newfoundland after his departure, he sailed her home across the Atlantic, meeting some heavy weather on the voyage; and soon after his arrival he gave her to the St. Andrew's Waterside Church Mission.

He took up his residence at Hamble, near the entrance to Southampton Water, where he had purchased a house. The living of

Hamble becoming vacant, he applied for it at the suggestion of some of his neighbours, was appointed, and remained there as Vicar for nine years.

In 1901 he retired from active work, and came for a short time to London before deciding where he would settle down. Returning from a ride one afternoon, early in 1902, his horse fell and threw him heavily, his head striking against the curbstone. He never really recovered from the injury he then sustained, but gradually failed, and passed away on the 18th of November last.

His three sons are all in the army, two in the Royal Artillery and one in the King's Royal Rifles.

He never ceased to take a deep interest in his old Corps, and when within reach he generally attended the Annual Corps Dinners for the purpose of meeting old comrades.—*Requiescat in pace.*

G. A. LEACH.

COLONEL ROBERT HAWTHORN, LATE R.E.

ROBERT HAWTHORN joined the Royal Military Academy at Woolwich on the 1st May, 1847, at the age of 14; and obtained his commission in the Royal Engineers on the 19th June, 1850, passing out at the head of his batch and receiving the 1st prizes for mathematics and fortification.

After the usual course of instruction at the School of Military Engineering at Chatham, followed by two years at Woolwich, he was ordered, in December, 1854, to Bermuda. Returning home in March, 1858, he served a year at Chatham and two years at Weymouth, where he married a daughter of Capt. Wm. Dow, Royal Navy, and thence proceeded to Gibraltar. In October, 1864, he came home again, and after nearly two years at Sheerness he once more went abroad, this time to Ceylon, where he remained until August, 1871.

His station on arriving home was Pembroke, and his five years there saw him promoted major (5. 7. 72) and lieut.-colonel (1. 4. 76). From November, 1876, to June, 1880, he was in command of the R.E. Companies at Portsmouth, where he interested himself greatly in the Sappers under him, becoming a total abstainer to help the temperance movement in the garrison.

In June, 1880, he embarked for South Africa. On the outbreak of the Boer war he was detailed to the Communications, and appointed Commandant at Pietermaritzburg, and it was not until after Majuba that he was able to go to the front.

Having become brevet colonel on 1st April, 1881, he returned home in July, 1884, and served for nearly a year at Woolwich. On 2nd July, 1885, he was promoted substantive colonel, and appointed

Commanding Royal Engineer of the Thames District. Hawthorn was always devoted to the interests and well-being of the Sappers; and during his time at Chatham he took the greatest interest in the success of the R.E. Temperance Society, of which he was president.

In January, 1888, when the appointment of C.R.E. at Chatham was temporarily amalgamated with that of Commandant of the School of Military Engineering, he was sent as C.R.E. to Jersey. He completed his service there in July, 1890; and on 28th October of that year he was placed on the retired list after nearly 40½ years' service.

After his retirement Hawthorn settled in London. In the summer of 1899 he moved to Wimbledon, and early in the following year to Bath, returning to London again in the spring of 1903. In the winter of 1905–06 he went to Florence, where he died of pneumonia on the 18th December last.

TRANSCRIPT.

THE POSITION OF THE 3RD MANCHURIAN ARMY AT MUKDEN.*

WHEN General Baron Kaulbars arrived to take over the command of the newly-formed 3rd Manchurian Army on the 16th December, 1904, he found the troops already on the ground. As the senior members of his staff had not arrived, various acting appointments were made, and among these the post of Inspector of Engineers to the 3rd Army fell to the writer of this article.

Composition of the 3rd Manchurian Army.

The 3rd Army consisted of the 17th Army Corps (General Baron Bilderling), the 6th Siberian Corps (General Soboden), at first the 1st Army Corps (General Meyendorf), and subsequently the 5th Siberian Corps (Lieut.-General Dembovski). The troops occupied the irregular line which they retained at the end of the unsuccessful autumn battles. Their positions were consequently not selected, but fell to them quite accidentally, and contained many essential defects, towards modifying the prejudicial influence of which engineering skill was called into use.

Description of the Position.

The 3rd Army occupied the centre of the Mukden position with the 1st Army on its east side and the 2nd Army on the west. Its front line was shaped like a bow, concave towards the south, the most northerly point being the works opposite the railway bridge near Linshinpu, which itself was in the hands of the Japanese. The river Shaho ran past the eastern part of the position; its upper waters, as far as the village of S. Wandikudyaza, were in the Russian territory; below this the Japanese held both banks as far as the railway bridge, beyond which the Russians held the north bank as far as Linshinpu, where the river turned south and passed entirely into Japanese territory.

The accompanying plan shows details of the position, with the fortified villages and the works constructed in the intervals between them.

5th Siberian Corps.

Starting from the west flank the 5th Siberian Corps held the front line from Kandzyatai to the Dalantun group. In this section the ground was practically level. As regards the defences it is noted that the intervals between the various works were not so completely obstructed by trenches and approaches as in other parts of the line. The second line of this section extended from Tuyp-pu to Sifantai (exclusive).

17th Army Corps.

The section of the 17th Army Corps extended from Dalantun to N. Wandikudyaza (exclusive). Here the ground continued practically

* *Précis* of an article by Colonel G. P. Chornik, Russian Engineers, in the May, 1906, number of the *Eenzhenernee Zhoornal.*

level, but was commanded by high ground on the left bank of the river. In this section was included the village of Linshinpu, the northern edge of which, including a fort named after the Resurrection, was held by the Russians, the rest of the village being in the hands of the Japanese. Here also were some brick-kilns, from the cover of which a mountain battery enfiladed the lower reaches of the river. In the space between the hostile lines immediately east of the railway were two groves of trees, called the Aspen Grove and the Black or Fir Grove, of which the former frequently changed hands between the combatants but the latter was always in the possession of the Japanese. The second line of the 17th Army Corps extended from Sifantai (inclusive) to Guantun (exclusive).

6th Siberian Corps.

The front line of the 6th Siberian Corps extended from the villages N. and S. Wandikudyaza to Khousandachanza (exclusive). The ground near the river was much intersected by nullahs; and there was some higher ground to the south, which however was completely commanded by the hills named Kho-utkhai and Slyusarenki within the Japanese lines. This section included the Mandarin road and the important bridge-head at Sakhepu, consisting chiefly of the fortified temple enclosure, the rest of the village being demolished; this point gave support to a large system of trenches forming the salient angle of the line in this part. The second line extended from Guantun (inclusive) to Podavyaza.

1st Army Corps.

The front line of the 1st Army Corps extended from Khousandachanza to Liudzyatun. The ground was hilly, intersected with ravines, and included the Putiloff and Novgorod hills, which were commanded by the hills already mentioned in the Japanese lines. In this section there were rather too many redoubts, which was due to the extreme tactical importance attached to this part of the position.

Difficulties Encountered.

The Russians found considerable difficulty in defilading their works and approaches from the high ground held by the Japanese. It was also a great inconvenience that their works faced towards the south, as they not only had to fight with the sun in their eyes but their works were not easily concealed, while the Japanese works, being generally in shadow, were well hidden.

A difficulty, common to both antagonists, was that of making earthworks when the water-logged ground was frozen to a great depth. It was soon found that ordinary entrenching tools were useless, and that tasks averaged $\frac{1}{4}$ to $\frac{1}{2}$ cub. ft. per hour. The Japanese tried lighting fires to thaw the ground; but the Russians soon decided to use explosives, and the question arose as to which kind of explosive was the most convenient. Gunpowder required too bulky a charge; pyroxiline was not procurable in sufficient quantities; dynamite was available, but was unsafe in its frozen state; and finally the choice fell upon rak a rock, an American explosive consisting of two parts, a butter and an absorbent, which are mixed just before fixing the charge. This proved satisfactory, but was somewhat less powerful than pyroxiline.

The Sapper boring tools were rejected in favour of machine drills, with which 3 or 4 men could make a hole 3 ft. to $3\frac{1}{2}$ ft. deep in 3 to 5 minutes. In such a hole a $\frac{3}{4}$ lb. charge of rakarock would produce a kamouflet, breaking up the ground into fragments which could be got out with crowbars or entrenching tools or even with the hands. In this way the rate of progress of the work was much increased and there was also a great reduction in the number of tools broken on the works.

The Fortifications.

As to the fortifications themselves, where possible there was little or no parapet, and where not formed like a glacis the parapets were made not less than 12 ft. in thickness. In trenches not exposed to enfilade fire, as a protection against splinters, traverses were placed not further apart than 25 paces; and portions of the trenches skirting parapets and traverses were covered with light splinter-proof shelters as a protection against shrapnel. The frozen earth allowed the sides of excavations to be vertical.

Field casemates were placed in small trenches somewhat in rear of the firing line and were covered with beams taken from the Chinese tombs. These beams were 14 in. to 28 in. thick, and by themselves or with only a thin layer of earth gave sufficient protection against anything but direct hits from large shells; owing to the difficulty of excavating, the risk of such shells was generally taken. In addition to these casemates the troops excavated for themselves in the trenches niches for individual men, sometimes under the parapet, but more often under the rear side of the trench; the former was forbidden, more as a matter of principle than from any real danger of weakening the parapets in the frozen ground.

Communication Trenches.

In the various works communication trenches were made to connect the faces with the gorges; these trenches were given a breadth of 1 pace, or, if required for machine guns, of 3 paces. It was intended to make them from 6 ft. to 8 ft. deep; but time rarely permitted them to be completed, and it remained with the enthusiasm of the commander of each redoubt whether or no the communications were improved after it was occupied by its garrison.

In the same way the communications between these works and the ground in rear were seldom at first brought up to their full profile, and improvements were carried on gradually when men could be spared from more pressing work. In the section of the 6th Siberian Corps, which had been previously occupied by the 10th Army Corps, the latter troops had begun a great number of communication trenches, some of which remained in places not more than $4\frac{1}{2}$ ft. deep, while others were so narrow that not only was it inconvenient to carry wounded along them but even individual men found it difficult to pass one another. Many of these approaches remained unfinished to the end; and though a great deal of labour was spent on them, the writer acknowledges that not a little of it was useless.

Observation Posts.

In every work there was an observation post, but opinions differed as to the best place to put it. Some posts were placed in the salients of the firing line, where they could find cover in the angle of a traverse; while others were placed in the rear parts of the works, in specially constructed casemates raised above the level of the firing line.

Machine Gun Emplacements

Machine gun emplacements were constructed in the various works, generally in salient angles, the guns being kept in blindages until they were wanted.

Rifle Trenches. In profile the trenches were kept as low as was permitted by the time available, the underground water, and especially the facilities for firing. They were made 1 pace wide at the bottom and, if possible, not less than 6 ft. below the ground level, the sides being very steep and in places vertical.

Loopholes. The works and trenches were constructed without any form of loopholes, but the troops occupying them made these for themselves with sandbags or any other available material. Sometimes in salient angles the engineers, by special request, made loopholes in the form of continuous slots with light head cover; and when carefully masked these were very effective.

Exterior Ditches. All the works made before the frosts began were given exterior ditches, either triangular or rectangular in section and in depth approximating to 9 ft. In those of four-sided section it was usual to put wire entanglements, but the writer preferred to put these obstacles by themselves some distance to the front.

Obstacles. For obstacles it was at first the custom to make deep military pits and shallow pits with stakes, the former strengthened with wire entanglements; but after the beginning of the frosts the only obstacles used were wire entanglements and *chevaux-de-frise* or abattis, both of the latter being entangled with wire.

The entanglements were made not less than 14 ft. in breadth. There was great difficulty in driving the stakes into the frozen ground, and considerable use was made of a Chinese implement, probably a sledge pole, which had a sharp point and could be driven into the ground or frozen into holes in the ice. These were also largely used for anchoring *chevaux-de-frise*.

Chevaux-de-frise. Various forms of *chevaux-de-frise* were used as substitutes for the stakes of wire entanglements, either when the latter had to be constructed under fire or on ice or frozen ground. Two kinds are described, (1) one consisting of a series of equal-armed wooden crosses joined to a common shaft, and (2) the other of three stakes of equal length joined at their centres at right angles to one another, with all the ends sharpened. They were lashed together with wire, anchored down, and then entangled with wire.

Other Wire Obstacles. In places tree-trunks, shrubs, and bushes were entangled with barbed wire. Fences were also made of barbed wire, but these were used only as temporary obstacles during the construction of entanglements in rear of them, after which they were removed. Empty tins, bells, etc., were occasionally hung on these fences, but this was less popular with the Russians than with the Japanese.

Military Pits. In the snowless wind storms of the Manchurian winter it was found that military pits soon became silted up with sand and ice, and the task of clearing them at night was not a popular one with the troops. If the pits were reinforced with wire entanglements this operation became more difficult. The obstacle formed of pits and wire was necessarily high and consequently difficult to conceal.

Abattis. Abattis were not much employed. They were used as obstacles on the ice when material suitable for making *chevaux-de-frise* was not available.

They ran the risk of being stolen for firewood, and for this reason it was advisable to entangle them well with barbed wire.

Fougasses.

The writer regrets that the number of fougasses was limited by the small number of exploders to be found in the equipments of the Sapper companies. Shortly after the setting-in of winter one fougasse, exploded prematurely during a false alarm, revealed the fact that the charges at a depth of 6 ft. were too weak in the frozen ground; consequently all the others had to be recalculated and increased.

General Notes on Obstacles.

The Mukden position showed a great tendency towards the excessive use of obstacles, leaving little room for *active* defence.

The distance of obstacles from works did not exceed from 50 to 100 paces, and in places in close proximity to the enemy they were much nearer. At Linshinpu for instance they were only a few paces away.

The obstacles suffered little from the enemy's fire, but they were all inspected each night by Sappers and, where necessary, repaired. But they often suffered severely from the Russian fire, especially by night, and when there had been much night firing a second inspection was always necessary.

Great care was taken in masking all obstacles; and high standing ones were placed in shallow broad trenches with glacis in front, which were in their turn carefully disguised.

Field Artillery.

The quick-firing artillery with the 3rd Manchurian Army numbered 31 eight-gun batteries, or 248 guns. The following are the numbers of these batteries in the accompanying plan of the position:—13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 25, 31, 32, 33, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, 45, 47, 48, 49, 52, 53, 54. There were also 5 eight-gun batteries (or 40 guns) of ordinary field guns (Nos. 12, 18, 46, 50 and 51), and one battery (No. 19) of 8 heavy field guns. In all, 296 field guns.*

The quick-firing batteries were placed in special trenches, and used indirect fire. Where possible the guns were placed at intervals of 25 paces, and in the intervals there were trenches for the detachments, niches for ammunition, and field casemates.

These batteries were at first all placed in the second line of defence, but later they were moved to between 1,800 and 2,800 yards distance from the enemy's works.

Owing to the nearly continuous lines of the front trenches, the guns were almost always firing over the heads of their own infantry; and consequently, when opposing an attack, they had to discontinue their fire when the enemy arrived within 800 paces of the Russian works. As in some places the hostile lines were not further than this distance apart (*e.g.* at Linshinpu and Vujhanin), some of these most important points were thus entirely bereft of artillery support. The writer recommends the Japanese method of keeping a few guns concealed in pits in the trenches themselves, from which they can be brought into action at the moment of necessity and returned under cover when no longer required.

It was a serious defect that the quick-firing guns were not provided

* Batteries Nos 1, 2, 3, 7, 8, 9, 10, and V were composed of 6″ guns; Nos. 4, 5, 6, 11, A, and B, of 4·2 m.m. guns; Nos. 26, 27, 28, 29, 30, 39, 55, 56, 57, of 6″ howitzers. Nos. 58 and 59 were intended for 8″ howitzers. See below and also Table on Map.

with common shell, as their shrapnel was powerless against troops taking shelter in villages or in any form of cover. For this reason the ordinary field guns, which fired common shell, were allotted to the army; but they were not adapted for indirect laying and were consequently difficult to conceal. The writer considers that the Japanese had a great advantage over the Russians in having shimoze shells for their field guns; although these shells did little harm in the frozen ground and could not be called satisfactory, they nevertheless had a strong moral effect and were considerably better than shrapnel when employed against troops under cover.

Siege Artillery.

In view of the strength of the Japanese defences, and also partly to create a diversion in favour of General Grippenburg's attack with the right wing, it was subsequently decided to introduce siege artillery into the lines. But though many of the batteries were ready armed when this attack took place, towards the end of January, they were not allowed to open fire; and after the defeat some of the guns were transferred to the 2nd Army for use at Sandepu and elsewhere.

The following table gives the original scheme for the distribution of the siege-train in Manchuria; it was afterwards considerably altered:—

Description of Gun.	Kharbin.	Allotted to Army. 1st.	2nd.	3rd.	Total.
6" steel guns of 4,366 lbs	6	8	—	40	54
4 2 m.m. guns	—	8	—	20	28
8" howitzers	16	—	—	—	16
6" field howitzers not horsed	—	10	—	30	40
6" field howitzers horsed	—	—	8	—	8
Light field guns not horsed	—	8	—	32	40
Rocket tubes	26	—	—	—	26
15-pr. S.B. mortars	20	—	—	—	20
Machine guns	—	—	8	—	8

The siege guns eventually allotted to the 3rd Army were as follows:—

6" *guns of* 4,366 *lbs.*, 34. (Batteries Nos. 1, 2, and 3 had 5 guns each; No. 9, 6 guns; Nos. 7, 8, and 10, 4 guns each, and V 1 gun).

4·2 *m.m. guns*, 20. (Batteries Nos. 4 and 5 had 5 guns each; Nos. 6 and 11, 4 guns each, and A and B 1 each).

6" *field howitzers* (*horsed*), 24. (Batteries 26, 30, 39, and 55 each had 6 of these howitzers).

6" *field howitzers* (*not horsed*), 30. (Batteries 27, 28, 29, 56, and 57 each had 6 of these howitzers).

8" *howitzers*, 8. (Batteries 58 and 59 were each built for 4 of these howitzers, but were never armed).

Batteries Nos. 9 and 30 were subsequently disarmed and their guns sent to the 2nd Army.

Further details of these batteries are given in the accompanying table. The most effective gun batteries were Nos. 5, 6, and 7 and the most effective howitzer batteries Nos. 27 and 39.

The author criticises the tendency to place the siege guns at too great a distance from the enemy, thereby losing the full advantage of their ballistic qualities and resulting in an unproductive expenditure of ammunition.

All the siege guns used indirect fire and were thoroughly concealed. The guns were placed at intervals of 21 yards, and were sunk in pits, except where the dampness of the subsoil did not allow of this. In the traverses were casemates for the garrisons, and in their rear slopes niches for ammunition. On one flank there was generally a strongly roofed reserve magazine, and on the other flank a casemate for officers. The melinite shells were stored separate from the other shells.

Japanese 11" Howitzers.

The Japanese brought up some 11" howitzers from Port Arthur and mounted them opposite this position. The Russians could not understand the object of this, but assumed that the enemy trusted in the demoralising effect of the huge shells; the Russian troops, however, soon got used to them, when they found that they did comparatively little damage.

General Criticism of the Position.

In studying the defences at Mukden, the fact must not be lost sight of that the troops did not select their defensive lines, but entrenched themselves where they stood at the end of the October battles. Much unnecessary loss would have been saved, and the troops would have been less harassed, if they had been drawn somewhat back to enable them to entrench themselves under normal conditions.

The writer's idea of a strongly entrenched position consists of a line of powerful redoubts or similar works, reinforced by obstacles and provided with wing trenches or "whiskers" (which increase the development of rifle fire and afford cover to the garrisons during a bombardment), with no connection between the works except a strong bond of fire.

Owing to the rapid fire of modern artillery, it is better to keep only a few men in the firing line, and to hold the reserves under cover, ready when required to occupy all works at the rate of one man to every two or three paces of the firing line. Machine guns should also be kept at hand under cover, ready to be brought into action at a moment's notice; these are useful in the works themselves, but are better placed in the intervals, drawn somewhat back.

Parapets.

There are two points to be considered with reference to the custom of reducing the parapets of works and trenches, (i.) the difficulty of disposing of the earth, and (ii.) the risk of insufficiently commanding the ground in front; against such skilful individual skirmishers as the Japanese this last was a serious consideration.

Villages.

In defending a village the trenches were thrown out to the front, enabling the troops to remain in them safely during the bombardment of the village. Villages gave good cover against shrapnel; against shimose and other high-explosive shell, the keeps should not be in temple yards or suchlike enclosures, but must be specially constructed earthworks.

Screens. For concealing works rough earthen screens were extraordinarily successful. In one instance the ruins of a brick house, which lay behind a howitzer battery and were covered with a little earth as a protection against splinters, were successful in drawing the enemy's fire; and in another case a deserted village which matched in colour another lying in front of it, behind which was placed a battery of quick-firing guns, also became an accidental screen. The Japanese frequently screened their batteries with smoke, the prevailing south wind favouring them in this. They also made frequent use of flashes and dummy guns.

In masking works with millet stalks care was taken to continue the existing rows of the plants over the earthworks, and this was also done with the furrows of ploughed fields. The top earth was also put aside to be spread over the lighter yellow soil of the lower excavations.

Batteries. In selecting sites of batteries care was taken to enable fire to be brought on as large a number of targets as possible, allowing the guns to be concentrated on each target in turn. The large supply of observation posts, connected by telephone with the batteries, aided considerably the good shooting of the artillery.

Japanese Obstacles. As far as could be ascertained the Japanese used the following obstacles in their defences:—Abattis, both of the ordinary kind and strengthened with wire and cable; deep military pits, usually combined with wire entanglements; fougasses; *chevaux-de-frise* made like the Russian ones; on a few occasions palisades; and finally wire entanglements. The latter were made very high in the middle, the centre line of stakes standing about 6 ft. out of the ground. They generally had two cables run through each entanglement, one about 18 in. above the ground in the rear part of the obstacle, and the other carried in an irregular line along the high central stakes.

Shields. Many proposals were made of various kinds of shields for covering the approach of individual men towards the enemy's works; these were made up by the Sappers in Mukden and sent to the various sections for trial, but none were reported on favourably. One of these so-called mantlets is described as follows:—A drum was made of planks, in diameter about 4½ ft., and of such length that two men could take cover and shoot from behind it; inside, there were radial partitions, meeting at the wooden axis, made of planks covered with iron, the partitions being so placed that as the drum was rolled along some of them would always be in a position to stop a bullet. When tried these mantlets proved clumsy and inconvenient.

Devices for Crossing over Obstacles. A contrivance for crossing entanglements is also described,—a huge mat of millet stalks, rolled up and bound to a sledge, the shafts of which were to be run up to the obstacle and the mat then unwound over it to form a passage for climbing over: this device was found to be extraordinarily bulky, heavy, and clumsy.

Small carpets made by sewing Chinese mats together in two or three thicknesses were more popular with the troops; in use they were placed on light poles thrown on to the entanglement. Ladders of split bamboo were also popular. But the best methods of getting through entanglements were by means of bags filled with hay, straw, tow, etc.; or by cutting the wires with pyroxiline charges on poles or with cutting pliers.

Reconnaissance.

In each section reconnoitring parties were constantly employed in studying the enemy's works, and from their reports charts were drawn up and corrected daily as fresh information arrived.

Balloons.

For verifying these charts, during January, 1905, a company of the 1st E. Siberian Balloon Battalion was temporarily attached to the 3rd Army. They worked constantly between the 10th January and 9th February with a captive balloon from the following villages:—Pendianza (3½ miles from the nearest Japanese batteries), Lanshanpu (3½ miles), Uenchenpu (3½ miles), Tacsun (4 miles), and Tuyp-pu (4½ miles). The Japanese fire did not allow them nearer than this.

The weather was bright and sunny but there was almost always a slight mist, which concealed distant objects, and a strong breeze, which made the use of telescopes and field-glasses, necessary for observing against the sun, very difficult; and it was only on one or two clear days that any useful information was obtained. The company returned to Mukden when it was most wanted, having used up all the material for making gas.

The balloon envelopes proved very unsatisfactory in the extreme cold, possibly through the lacquer with which they were impregnated becoming brittle, and frequent failures occurred.

Kites.

The writer has not a high opinion of the utility of balloons, and considers the idea of taking photographs or observing artillery fire from them as utopian. He is more in favour of kites, both those fitted with photographic apparatus, without an observer, and those carrying an observer. At his instigation a specialist in kites was telegraphed for, and set to work; but he had not got beyond the experimental stage, with (it was said) good results, when the battle of Tsu-Shima and proposals of peace caused his work to be stopped by command.

F. E. G. SKEY.

REVIEWS.

THE RUSSO-JAPANESE WAR.

Compiled by the GENERAL STAFF, WAR OFFICE. PART I.—(1s. 6d. Wyman).

IT is understood that this work will be completed in eight parts. The first part, 75 pages and appendices, deals with the events leading to the war, the strength of the belligerents, the theatre of war, and the operations up to and including the battle of the Ya-lu. It contains five maps, three of which illustrate this battle.

The work does not claim to be complete and accurate in every respect; but all available information, with the exception of such matter as it has been considered necessary to withhold, has been utilized. Criticism has been excluded.

A very clear account of the operations is given; and as the book is likely to be the only authoritative one in English for some years to come, it is recommended to the notice of officers, especially those who have promotion examinations before them.

'E.'

THE RUSSO-JAPANESE WAR ON LAND.

By CAPT. F. R. SEDGWICK.—(3s. 6d. Forster Groome & Co.).

As this is, at present, the only book in English which attempts to give a complete account of the operations on land, it is much to be regretted that the author has not based it on the good authorities now available:—the Austrian account published by Seidel, the articles in the *Russki Invalid*, and the *Einzelschriften* of the German General Staff, etc. Amongst the errors in the first few pages are the statements that the whole of General Kuroki's army was landed at Chemulpo and occupied Seoul (only 1 division was disembarked there and only a small portion of this went to Seoul); that the Russian position at the battle of the Ya-lu "was cut in half by the Aiho River" (it was behind the Ai River and not divided by it); and that 3 divisions under General Oku and 2 divisions under General Nogi commenced disembarking, the former "opposite Elliot Island" (*sic*) and the latter "about Pitzevo," on the 5th May (it was General Oku who landed near Pi-tzu-wo, and the 9th and 11th

Divisions, given as Nogi's army, did not commence landing till the end of July and May respectively).

The author's difficulties with the spelling of place names are perhaps excusable, but there seems no reason he should spell Manchuria as Mandchurija, Ta-shih-chiao as Daschitza, Ussuri as Ursari, etc., etc.

'E.'

ACHTZEHN MONATE MIT RUSSLANDS HEEREN IN DER MANDSCHUREI. VOL. I.

By MAJOR FREIHERR VON TETTAU.—(8s. 6d. Mittler, Berlin).

This is a work that should be read by every officer. The author, a well-known authority and writer on the Russian Army, was one of the German attachés with the Russian forces during 18 months of the war in Manchuria. Proficient in the language, and having made the acquaintance of many Russian officers during visits to Russia, he enjoyed exceptional facilities for learning the events of the campaign as they were taking place; and his training on the Great General Staff enabled him to take full advantage of the opportunities thus afforded.

His first volume, which has just been published, contains the story of the war up to the retreat from Liao-yang. As Freiherr von Tettau was attached first to Count Keller's detachment and afterwards to the X. Army Corps, which opposed the advance of General Kuroki, he relates the same events as Lieut.-General Sir Ian Hamilton did in *A Staff Officer's Scrapbook*, but from the other side.

In his preface the author says :—"I cannot report any successes of the Army whose comradeship I enjoyed for a year and a-half. The guest who chatters unpleasant things outside the house in which he has been received with hospitality may be counted as ungrateful. And yet the depicting of the events of a war is of value only when the author speaks his mind openly and freely. Only in this way will those be served who wish to draw lessons from the war. Every Army has had to go through times of misfortune like the Russian in this campaign. When, however, the causes of the ill success are freely recognised, and efforts made to remove them, then the pendulum will quickly swing the other way."

Writing in an objective spirit, free from personalities, the author has given a very vivid picture of the Russian Army in war and a most excellent study of the methods of its commanders. Since he was often initiated into the thoughts of the generals with whom he served, and was given copies of orders (which are printed at length in the appendices), his account will probably be the most complete that we shall have from the Russian side for many years to come.

One thought seems to have had the mastery in the mind of every Russian leader, and is accountable for many a lamentable failure; this was "position." The word appears on nearly every page. Not content with selecting a "main position" there were also always "advanced positions," "rear positions," and "intermediate positions" to be considered. The first officer the author met was going not "to the front" but to the "position" of his regiment. When it was discovered that the 1st Japanese Army was endeavouring to cross the Tai-tzu Ho at the battle of Liao-yang, the 35th Division, instead of advancing and attacking the enemy during the crossing, took up a "defensive position." One Army Corps Commander, when the Japanese took the offensive after a delay had prevented one of his own divisions from advancing, remarked to Major von Tettau, "How lucky Vassiliev had not marched off; otherwise he would have run into the Japanese when we had no 'position.'"

Owing to the Japanese having drawn first blood, at the battle of the Ya-lu, there was terrible confusion in the Russian Army; and new units, as they arrived, were rushed off to fill a gap anywhere, to the dislocation of all the higher commands. The same thing occurred in the early part of our war in South Africa, and is generally the case with an army unready for war.

When the X. Army Corps arrived at Liao-yang, one infantry brigade, with artillery, was at once pushed into the mountains to support Count Keller; another brigade with artillery was sent up the Tai-tzu Ho; the third brigade was sent south to General Stakelberg; the fourth brigade with 6 batteries was retained at Liao-yang at the disposal of the Commander-in-Chief; the rifle regiment was sent to Count Keller; and a cavalry regiment, with the mountain battery, was attached to General Rennenkampf's Cavalry Division. This left 2 squadrons of a second cavalry regiment; one of these was sent to protect the Army Pontoon Park, and half of the other was detailed as escort to the Grand Duke Boris, leaving the Army Corps Commander with half a squadron. "Apart from this he controlled not a single man." "There was not at the time (8th July, 1903) one higher Russian leader who had the whole of the troops belonging to him under his command."

The specimens of "operation orders" which are given show that the higher commanders constantly interfered in the provinces of their subordinates, legislated with regard to the smallest details, and often prescribed courses in the event of contingencies. General Count Keller appears to have been killed because he considered his place in action as commander of a detachment was in front, with his orderly bearing his flag close behind him.

General Kuropatkin, when present during fighting, does not seem to have assumed command himself, but to have told off a subordinate not necessarily the senior to take charge; with the result that, on the 2nd September, 1903, at Liao-yang, opposite the 1st Japanese Army, a junior, thus temporarily in command, ordered a senior general to carry out a certain attack with his troops, with the remark—"But for the execution of this task I place myself under your excellency."

The volume contains 400 pages, 8 excellent maps, and numerous photographs.

'E.'

FIELD FORTIFICATION AND MODERN ARMAMENTS.

By LT.-COL. DU GÉNIE CLERGERIE.

The first part of this book is devoted to the fire effect of modern field artillery. The angle of descent of the projectile, the cone of dispersion of the fragments, and the maximum angle of impact that will cause a shell to ricochet are taken as the data from which various types of fire trench are deduced. None of these present any novel or interesting features.

The trenches are not provided with either head or over-head cover, and the writer admits that the troops using them could not show their heads above the parapet in the face of artillery fire. He intends that the garrison of the trenches should crouch under cover until the hostile artillery has prolonged its range to permit the attacking infantry to advance to the assault. The possibility of the trenches being enfiladed by the enemy's artillery does not appear to have been considered.

It is stated that the rear cutting edge of a trench is very conspicuous to an observer in a balloon, and to obviate this it is suggested that the parapet should be made high enough to cover it from view.

The second part of the book, which deals with obstacles, consists of two pages only.

In the third part the author discusses the tactical employment of field fortifications. He considers that the infantry of the defence should not open fire until the enemy are within 400 yards of the trenches. By reserving their fire they will expose themselves as little as possible to the hostile artillery, and will probably be able to surprise and crush the enemy's infantry by an overwhelming fire at short range. A field of fire of from 400 to 250 yards in length should therefore be ample. If the defence works have a total length of crest line equal to from a third to a half of the front of the position, the attacking infantry should not be able to establish a superiority of fire. The possibility of enfilade fire is not apparently taken into consideration. The writer evidently intends that the defence works should be placed in groups forming *points d'appui* along the front, but he does not actually say this.

Several pages are devoted to the siting of works, but no very definite conclusions are arrived at. The dominant factor in the author's mind is evidently the artillery fire of the attacking force, and to escape this he is in favour of placing the main line of defence on the rear crest of a hill. In order to prevent the enemy from massing on the lower slopes of the hill, he proposes to place some well-concealed advanced works on the front crest. The idea is that the enemy should exhaust their troops and ammunition in capturing the advanced works, only to find themselves confronted at short range by a new and intact position on which they cannot bring artillery fire to bear.* The object to be kept in view in arranging defence works is to bring the heaviest possible combined

* This system finds much favour with modern French writers. It has already been fully described in this *Journal* (September, 1906) in Capt. Swinton's "Defence of a Position upon Open Ground."—J.E.E.C.

infantry and artillery fire to bear on the enemy's infantry at the moment when they advance to the assault.

In fortifying a locality the defences must be made to suit the *rôle* that the garrison are intended to play. Particular attention must be paid to communications, especially to those that will be used for counter-attacks. The organization of communications is the special *rôle* of the Sappers. Lines of communication should not pass through villages, as they are very liable to be blocked by an outbreak of fire, or by fallen houses, etc. If a village is to be held, positions should be taken up on each flank, the village itself remaining unoccupied, and serving merely as an obstacle to the enemy's advance and as a screen to cover the reserves. In clearing the field of fire trees should be left standing unless they can be removed altogether; the lower branches should be cut off. Haystacks should be removed, and must not be set on fire, as they burn very slowly and make an enormous amount of smoke.

The last section of the book professes to deal with the employment of fortification during an engagement, but it is chiefly devoted to the tactics that should be adopted by a force acting on the defensive. It is suggested that the cavalry screen should be reinforced by strong detachments of infantry and artillery, which would occupy a series of defensive positions in front of the true position of the main body. These advanced detachments would fight a number of rear-guard actions, until they were finally driven back on the main position. The author believes that by this method the attackers might be subjected to heavy losses before coming in contact with the defenders' main body.

In conclusion he insists on the necessity for providing every soldier with a portable entrenching tool.

J. E. E. CRASTER.

MITTEILUNGEN DES INGENIEUR-KOMITEES.

PART 43.

This important publication of the German Engineer Committee is so closely packed with information that a summary of it would practically be a translation. As there is nothing of the kind like it in English it is much to be hoped that a translation will be undertaken.

It consists of 170 royal octavo pages, and is entirely devoted to a survey of recent literature on the subject of fortresses, fortress warfare, and field engineering.

The preface makes its object clear:—"The study of technical literature undoubtedly forms a material means to the scientific, and indirectly to the practical, improvement (*Weiterbildung*) of our officers. Unfortunately their time is so fully taken up by their onerous duties that often they are unable to keep close touch of it. The Engineer Committee intends therefore to issue compilations, which will at least make the readers generally acquainted with the most important new literature on fortress and field engineer matters, will incite them to study some special question, and indicate to them the best sources for theoretical and practical information."

The work is divided into 5 sections, with two appendices :—

(1). Land Defences and Fortresses.
(2). Permanent Fortification.
(3). Semi-permanent and Field Fortification and Engineer Material.
(4). Coast Defence.
(5). Fortress Warfare. Attack and Defence of Fortified Positions and River Lines.

Appendix 1. Literature of the Russo-Japanese War.
" 2. Organization of Engineer Troops.

Each of the sections is divided into a number of sub-sections; thus No. 3 Section contains :—

General.
Semi-permanent Fortification. Definition and purpose.
" Materials and general organization.
" Details.
Field Fortification. Value, purpose and materials.
" General organization.
" Details.
Passage of rivers.
Explosives and mine warfare.
Railways, balloons, telegraphs, etc.
Landings.
Fortress warfare.
Semi-permanent and Field Fortification abroad :—
General.
France.
England.
Italy.
Austro-Hungary.
Roumania.
Russia.
Switzerland.
Japan.
U.S.A.
Semi-permanent and Field Fortification in military history.

A translation of the sub-section dealing with "Explosives and Mine Warfare" is given below and will serve to show the nature of the book :—

"Electrical mine firing is exhaustively discussed by Stavenhagen in the *M.G.A.E.*,* 1905.

* *Mitteilungen über Gegenstände des Artillerie-und Geniewesens.*

"In the 'Attack of Fortresses' (*Jahrbücher für Armee und Marine*, 1898) Frobenius thinks it probable that in fortress warfare a number of the defensive arrangements—*e.g.* the iron fencing on the counterscarp and counterscarp galleries, etc.—can only be destroyed by mining, and deduces therefrom the necessity for a miner corps. In 'Retrospect of the historical development of Mine Warfare' (*M.G.A.E.*, 1899) Stavenhagen comes to the same conclusion, and demands the utilization of the present wonderful condition of technical material and machinery for perfecting mining apparatus. He draws attention *inter alia* to the rapid gallery driving proposed by the Belgian engineer officer Gillet, which in its latest form is described in 'L'Art Militaire à l'exposition universelle de Liége en 1905: Regiment du Génie' (*Revue de l'Armée Belge*, 1905).

"The essays 'Construction rapide des Mines' and addenda ('Recueil des travaux techniques des officiers du génie de l'armée Belge, 1897, 1900, and 1902') are instructive as regards the development of Gillet's system.

"In connection with Stavenhagen's 'Retrospect' mentioned above, Kutzlnigg (*M.G.A.E.*, 1899) discusses in detail the views of various military writers on mine warfare of the future, and various methods of driving galleries.

"In 'Mine Warfare' (*Kriegstechnische Zeitschrift*, 1902) Scharr considers this method of attack and defence with reference to the views expressed by Brialmont in 'Organisation et Composition des Troupes du Génie et de l'État Major de cette Arme.'

"The question of the most suitable section for galleries is, *inter alia*, discussed in 'Galleries for shelters and depôts' by Nerad (*M.G.A.E.*, 1900), in 'Fougasses in field and fortress warfare' (*Streffleur*, 1905, but extracted from the *Russki Invalid* and based on the experiences of Port Arthur), and in 'A new Mine System' by Op Ten Noort (*Kriegstechnische Zeitschrift*, 1906).

"Finally must be quoted 'Saragosse, Sébastopol, Paris, et Port Arthur' (*Internationale Revue*, 1905; *Supplement* 72), in which von Boguslawski *inter alia* refers to the importance of mining in fortress warfare, and 'Subterranean warfare' (*Schweizerische Zeitschrift für Artillerie und Genie*, 1905) by Stavenhagen, in which the necessity of still practising mine warfare is insisted on.

"Submarine mining is dealt with in Section 4."

It will be of interest to readers of the *R.E. Journal* that in Appendix 2, "Organization of Engineer Troops," reference is made to the articles on "Royal Engineer Duties in the German Army" by Major Edmonds, R.E. (*R.E. Professional Papers*, 1900), and "The Engineers of the German Army" by Colonel Ferrier (*R.E. Journal*, 1906); as they are recommended to German officers by a German official publication the articles may be taken as substantially correct.

There is a notice that "the Engineer Committee is preparing a work on Engineer matters in the Russo-Japanese War of 1904–05."

'E.'

ENGLAND AND HER ARMY.

By H. V. BASEDOW, Lt.-Col. on the Staff of the 4th West Prussian Infantry Regiment, No. 140.—(Supplement of the *Militär Wochenblatt*).

A journey to England, says the writer of this lucid, and for the German reader, most illuminating brochure on the British Army, enabled him to study our system after a manner impossible for the ordinary home-abiding soldier of the Fatherland.

In well-nigh his first sentence we are glad to read an intentional friendliness towards us in the statement that, in spite of the much-advertised *Invasion of 1910*, by an English author, and of other essays by German writers dealing with the practicability of a descent upon our shores, the *average* German officer is more concerned with the progress and development of the military forces to east and west of him, than with the 'wild-cat' schemes of foreign and other "Jingoes" to steal a march upon the fleets and armies of Britain. And whereas we are not invited to criticise, but rather to summarise the contents of the pamphlet before us, we will accept the gallant author's critiques in the spirit in which he enters upon his task.

The author shows, on the strength of the preamble to the Army Act, that we *still* stand in awe of the shadow of Oliver Cromwell and the dangers of a "standing army," while up to the time of the campaign in the Crimea our military forces were nearer akin to an Imperial Police Force than a striking force modelled on up-to-date lines; and further that the Cardwell school of thought, of whom is Lord Wolseley, produced to a very great measure the army which fought in the South African war. *We* should perhaps read into the author's statement, though he does not connote the fact, that the logic, which sends half our army to serve beyond the seas in India and the Colonies, and trusts to a moiety and to the Fleet to protect our shores, is perhaps justified by the marvellous adaptability of the British soldier to his environment and the character of each fresh campaign, in respect of which he is perhaps only second to the Japanese warrior of the reformed army of our allies in the far east.

The system of two battalions, which, though serving under one county or other title, rarely meet, if ever, *as* battalions, is approved in normal times, as also the custom of exchanging horses when cavalry regiments take their turn on the roster for foreign service. The faults in the system are however summarised as follows, when the author records the modifications forced upon the War Office by the lessons of the last campaign.

(1). The Cardwell system made practically no allowance for expansion in time of great stress, in respect of the organisation of an adequate "striking force"; and thus (2) the reserves fell short of requirements; while (3) in the third place, the actual worth of the Militia and the Volunteers in warfare was left to be proved and evolved in the grim earnest of a campaign for which we were unprepared.

Next Mr. Brodrick's six Army Corps are mentioned and dismissed with the remark that, while one was a mere paper unit, the scheme came to an end with the transfer of Mr. Brodrick to the India Office, to be replaced by a system of seven supreme Commands, which have so far held together and may survive the Haldane administration and the (possible) introduction of the nationalised army of the future, a question with which, however, our author does not attempt to deal.

Nor does our author express a definite opinion on the proposal made, and now formulated, to provide a "striking force" or "general service force" of 90 battalions and other details with a service of 9 years with the colours and 3 in the reserve, and a "home service army" of 48 battalions, including the Guards, with a time limit of only 2 years with the colours and 6 in the reserve. For this is a question, which *should*, one might have thought, suggest some interesting remarks from a soldier, who is visibly stirred and impressed by the recruiting "posters," which mainly purport to fill the ranks of our voluntary army, from the point of view of the foreign critic.

The high wages which form the bait held out to the doubting recruit do not, according to our present authority, attract the very best of our manhood to the colours. Surely, however, the author is in fault in the statement that the social status of "Tommy Atkins" (the term is the author's, *not* ours) is to be appraised by the fact (?) that from many public places non-commissioned officers and soldiers in uniform are rigidly excluded? Moreover, stress is laid upon the easy life of the first few months in the army, the prohibition of long marches during the first half year's service, and the whilom all-night passes once served out to all and sundry with a view to popularising the service to the potential recruit. And then, last but *not least*, the very praiseworthy attempts of Lord Roberts and others to find and provide a trade for the soldier, when he merges again in civil life, as the State takes no cognisance of the soldier as a private citizen. But all these inducements, from a German point of view, are useless: the lack of recruits still continues and is like to continue.

The reserve therefore is insufficient, and is consequently dependent upon the Yeomanry, Militia, and Volunteers for a stiffening, which the writer in question obviously does not rate very highly. Is it not however a heresy to antedate the consolidation of the Militia forces so far back *only* as the middle of the 19th century on the alarm of a French landing in force upon our coasts? But this being a collation of facts, rather than a critique, we are bound to pass on, after noting this rather crude conversion of the old Constitutional Force, which was the germ and origin of the army of to-day, into a hypothetical body of "francs-tireurs" contemporary of the Volunteer forces, with which a more experienced soldier than our author might well have confused it.

It would however be tedious to follow the writer into details of the constitution and organisation of the Auxiliary Forces, which, though accurately defined, are too well known to our readers to merit recapitulation; and so we shall prefer to follow him in his very guarded *hints* at, rather than actual appraisement of, the military forces of the Crown.

Thus we can only guess from the italics used that the word "efficient," as used by the Volunteers, is regarded by the author as a certificate of good-will on the part of the Volunteer, rather than a clearly defined estimate of the man's competence as a soldier of to-day with to-day's requirements. The Volunteer Corps, we are told, leans upon its adjutant, who is the soul of the whole thing, while the selection of a "regular" officer as commandant of the regiment or corps would be an infringement of the rights and privileges of the officers of Volunteers. But the principal shortcoming in the system of training would seem to be that Volunteers as a mass are not regularly exercised with the regular forces. We might add that, if they did *so* exercise themselves, they would no longer be Volunteers, in the sense that what would make an "efficient" in point of time in the case of the Line would be a sheer impossibility in the case of the Volunteer.

It is however cheering to learn that fourteen days in camp *must* tend to partly justify the over-appreciation in which the Volunteers of a past day were held by the British nation, and to discount the dispraise with which foreign critics have regarded a movement, which, we now learn to our surprise, could have had but little influence upon strategists, who *should* have been deterred from attempted invasion by reason of our burgher army and its associated Militia.

Passing to the education of officers, we are told that they pass many examinations, which however are by no means difficult (from a German point of view). But difficult or not, the result is that the officer who leads our soldiery is warmly appreciated by a German critic, who in this instance speaks out, and in his favour, though regarding with a doubtful eye the Briton's love of sport and the extravagant glory of the "red coat." In this connection Lord Wolseley is held up as a type of the full development of the British officer, who has his opportunity and knows how to make the best of it, though incidentally we may remark that the writer does not include the great Field Marshal in the ranks of the perfervid sportsmen, who, to German eyes, form so marked a type in our much-criticised army.

Next in order our author treats some idiosyncrasies (as he regards them) in our national character, which produced the occasional "ragging" scandals and the like, and elicited (*pace* the writer) many objections on the part of officers on the active and retired lists to the drastic action taken by the authorities to protect the person of the commissioned officer.

And so in conclusion, for our space is limited, the writer covers much ground in descriptions of forms of training very familiar to us, of picturesque ceremonies in London (as for instance the Trooping of Colours and Relieving Guard), and impresses us with the accurate and attentive eye with which he has taken stock of our uniforms and of the methods we have adopted for assimilating our training to the teachings of modern warfare.

In fact, the author in the course of some fifteen pages has touched a great many questions, but has to a very great extent denied us the pleasure and interest with which we should have read his well-meant and no doubt able criticisms. Thus we should like to know what he really thought of the state of our army under the genial autocracy (modified and tempered by political interference) of him whom men are now beginning to remember as the *great* Duke of Cambridge; and whether he considers the oligarchy (tempered by supervision of the Secretary of State) known as the Army Council, more in keeping with our traditions; or in fine *what* is really the best form of government for our unique and peculiar armed forces, organised upon the principle of a voluntary army.

This and other such questions would, from the pen of an outside critic, have been even more interesting than the anomalies detected by our author in the supersession of officers in the field by others holding "local rank," or the descriptions of Aldershot and the Duke's monument, which, however, regarding the fact that the brochure in question was written for his compatriots rather than to benefit British readers by means of a critique from outside our ranks, lends local colour to a description of England and he rarmy which should be widely read by those for whom it has been so laboriously and carefully prepared.

F. C. ORMSBY-JOHNSON.

NOTICES OF MAGAZINES.

JOURNAL OF THE SOCIETY OF ARTS.

Vol. LV. No. 2820. *December 7th*, 1906.

THE METRIC SYSTEM: SOME OBJECTIONS TO ITS COMPULSORY INTRODUCTION.—A Paper read by Colonel Sir Chas. Watson, K.C.M.G., C.B., late R.E.—The author commenced by reminding his hearers that both the British and the metric systems of weights and measures were legal in this country, the only compulsion being to accord with the standards kept by the Board of Trade; and that, since those who use the British measures are quite content with them, the public hears much of the arguments for the metric system but little against it.

The arguments usually brought forward in favour of the French measures may be summarised as follows:—

1. That the metric measures are thoroughly scientific, while the British measures are antiquated and unscientific.

2. That the metric measures are better suited both for ordinary and scientific use than the British, and that the decimal system of division is superior to the binary or to the duodecimal.

3. That the metric system has been fully adopted by most nations, and, therefore, its use would be very advantageous for British commerce.

As regards the first argument Sir Chas. Watson contributed a very interesting *résumé* of the history of the metric system.

Its original design and its present actual form are as follows:—

Original Metric System.	*Actual Metric System.*
1. The circle to be divided into 400°; each degree into 100′; each minute into 100″.	1. The ancient division of the circle into 360° remains; each degree being divided into 60′, and each minute into 60″.
2. The Mètre, the standard of length, was to be exactly $\frac{1}{10,000,000}$th of a quadrant of the earth's surface, measured from the North Pole to the Equator—*i.e.*, 1-10th of a new second of arc.	2. The Standard Mètre is slightly less than $\frac{1}{10,000,000}$th of the quadrant, and is, therefore, an arbitrary measure.
3. The Litre, the standard of capacity, was to be exactly equal to the cube of the tenth part of the Mètre.	3. The actual Litre is the volume occupied by the quantity of pure water which weighs exactly 1,000 Grammes. It is slightly larger than a cubic decimètre.
4. The Gramme, the standard of weight, was to be exactly equal to the weight of a volume of pure water, contained in the cube of the hundredth part of the Mètre. The kilogramme, or 1,000 grammes, was consequently to be the weight of the volume of pure water contained in the litre.	4. The Kilogramme, the actual standard of weight, is a platinum weight which was deposited in the Archives in 1799. It is slightly larger than the theoretical kilogramme, and is consequently an arbitrary measure. The actual gramme is the thousandth part of a kilogramme.
5. The Are, or standard of surface, was to be the square of ten mètres.	5. As the actual Mètre is slightly shorter than the true Mètre, so the Are is slightly smaller than the true theoretical Are.

It will be seen from the above that all the metric measures differ from their true theoretical values, and depend upon two arbitrary measures, the standard mètre and the standard kilogramme, exactly in the same way as the British measures depend upon two arbitrary measures, the standard yard and the standard pound. It is clear, therefore, that the metric standards cannot be regarded as perfectly scientific or as superior, in this respect, to the British standards.

When these facts are pointed out to an advocate for the compulsory introduction of the metric system into England, the usual reply is, that the standards are nearly what they profess to be, and that the measures in themselves are better than the British, and that the decimal system of division is very superior to the binary or duodecimal. These points deserve careful consideration.

The British measures are founded on natural units, and have descended to us from a remote antiquity. The yard is the direct representative of what was probably the oldest measure in the world, *i.e.*, the cubit, which is the length of the forearm of a man of average stature, measured from the elbow to the top of the middle finger. A yard is two cubits. It is rather remarkable that, while in the case of the yard the derivation from the cubit is almost forgotten, the Indian "gaz," which is equal to the yard, is still divided into two "haths" or cubits. The foot is also a very ancient measure, and though it varied considerably in different countries it was usually about two-thirds of a cubit. The British yard is divided into 3 feet, or 36 inches. This number is divisible by 2, 3, 4, 6, 9, 12, and 18. The mètre on the contrary is divided into ten decimètres, each decimètre into ten centimètres, the latter being the nearest unit to the inch. There is no division of the mètre corresponding to the foot. The decimètre is too small to take the place of the foot as a unit, and it is little used. The absence of a unit of about the length of a foot is a blot on the metric system. Similarly, the inch is a better unit for ordinary purposes than the centimètre, which is too short, about $\frac{4}{10}$ths of an inch. The $\frac{1}{100}$th inch is better than the millimètre, as it is the smallest measure that can be seen conveniently with the naked eye, while the millimètre is too long.

As regards the decimal system of division, this is not a monopoly of French measures, and the British measures can be so divided by anyone who chooses to do so. But whereas in the French system, the decimal division only can be employed, in the British other fractional divisions are also applicable. For example, a carpenter prefers to use the inch divided into $\frac{1}{8}$ths and $\frac{1}{16}$ths; whereas for scientific and other accurate measurements it is better to divide the inch into $\frac{1}{10}$ths, $\frac{1}{100}$ths, and $\frac{1}{1000}$ths.

Similar reasoning is given to show that the metric system has no great advantage in the measures for weight and capacity; and the author deals with the fallacy that we now make difficulties for ourselves in relation to foreign trade with metric countries, many of which still retain some of their ancient measures. In the case of money, however, there is much to be said in favour of the decimal system.

Sir David Gill, Lord Kelvin, and others spoke more or less in favour of the metric system; and Major E. H. Hills, late R.E., aptly summed up the whole situation by saying, "The advocates of the metric system in the course of their arguments lapsed almost insensibly into an argument in favour of the decimal system. The author had quite rightly pointed out that the two should be most rigorously distinguished. Almost all the arguments, which had been used in the course of the discussion in favour of the metric system, were equally capable of being applied in favour of the introduction of a decimal system based on the English weights and measures. The only argument which remained was that of uniformity with the rest of the world. The present free system, where everybody was allowed to use those weights and divisions which most suited their particular trade, was the best for a free country. For scientific purposes, there was no doubt that the decimal metric systems presented very great advantages."

MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

December, 1906.

THE RUSSIAN ENGINEER EQUIPMENT FOR FIRING MINES ELECTRICALLY.

I. *Detonators.*

There are three types of detonators:—

(i.). A high resistance detonator.
(ii.). A cork detonator.
(iii.). A platinum detonator.

(i.). The High Resistance detonator (*Fig.* 1) has a resistance of 10,000 to 30,000 ohms. The priming composition consists of 52% potassium chlorate, 42% sulphate of antimony, and 6% powdered carbon. The electrodes are from ·04 to ·06 inches apart.

(ii.). The Cork detonator (*Fig.* 2), which was originally used as a makeshift, has a wire bridge, with a resistance of 500 ohms. The priming composition consists of mealed powder; this is kept in contact with the bridge by collodium, a solution of which is poured drop by drop over the powder. The length of the bridge is from ·12 to ·16 inches.

(iii.). The Platinum detonator (*Fig.* 3) has a resistance of about 1 ohm. Apparently this detonator is not definitely approved for the Russian Army, as there does not seem to be any type of exploder suitable for firing it. The bridge consists of a platinum wire with 15% of iridium in it. The priming composition consists of 50% of chlorate of potash, and 50% of yellow prussiate of potash. To fire this detonator a current of 1 ampère is required.

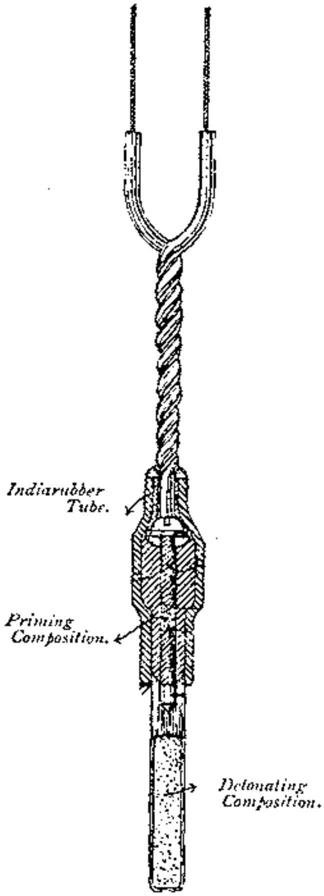


FIG. 1.—*High Resistance Detonator.*

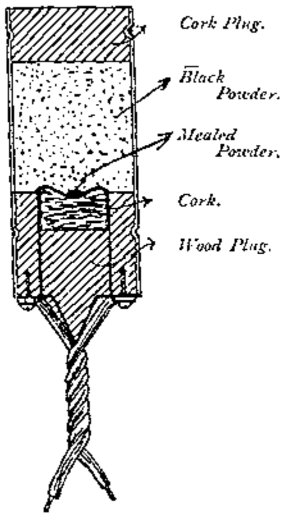


FIG. 2.—*Cork Detonator.*

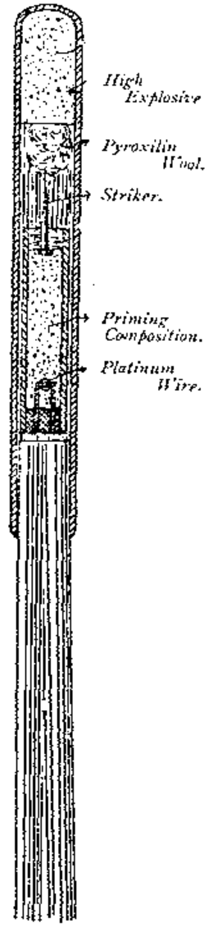


FIG. 3.—*Platinum Detonator.*

II. *Firing Apparatus.*

These consist of:—

(i.). Siemens' Exploder.
(ii.). An Inductor.
(iii.). A Volta's Pile.

(i.). The Siemens' Exploder needs no description.

(ii.). The Inductor (*Fig.* 4) is a magnetic induction apparatus. A, A, A are horse-shoe magnets made of hardened steel, between the poles of which an armature can be rotated. By means of cog-wheel gearing this armature can be rotated at a rate of 24 revolutions to the second.

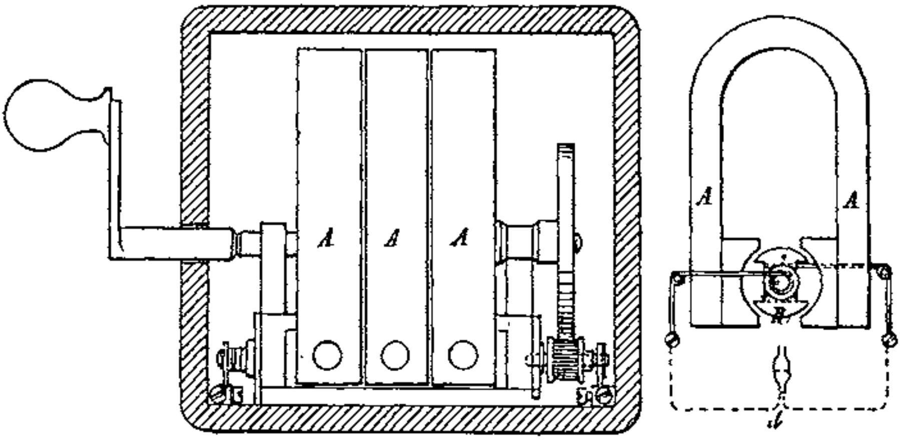
The coils of the armature have a resistance of about 500 ohms; and the current excited flows continuously through the outer coils; consequently, owing to the gradual increase of the current, a premature explosion of the more sensitive detonators may easily take place. The apparatus is therefore not reliable for firing detonators in series.

The E.M.F. developed by the Inductor depends on the external resistance. Experience shows that, if the armature is making 24 revolutions a second, the following E.M.F. is produced:—

External Resistance.		E.M.F.
1,000 ohms	....	70 volts.
500 ohms	....	45 volts.
250 ohms	....	30 volts.

As the High Resistance detonator requires at least 45 volts to explode it, the resistance of the circuit when using the Inductor must amount to at least 500 ohms

One advantage of the Inductor is that it weighs only $4\frac{1}{2}$ kilogrammes.



AAA Magnets. *Detonator.*

FIG. 4.—*Inductor.*

(iii.). The Volta's Pile (*Fig.* 5) is useful as a reserve apparatus. It consists of 100 pairs of zinc and copper plates, between each of which is placed a piece of cardboard soaked in sal-ammoniac solution. The plates are put into a wooden frame and pressed together with a wood screw. When freshly charged they have an E.M.F. of 80 volts and a current of $\frac{1}{4}$ ampère. The weight is about 74 kilogrammes.

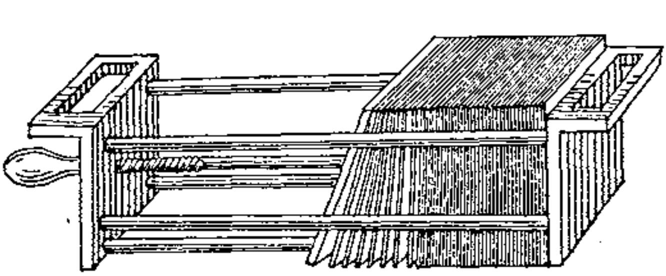


FIG. 5.—*Volta's Pile.*

With this apparatus single detonators of high resistance and also cork detonators can be fired. Both E.M.F. and current soon fall off after the apparatus is brought into use.

III. *Leads.*

There are two kinds of leads, known as

(i.). Sapper leads.
(ii.). Single Strand leads.

The Sapper leads have a core consisting of seven strands of copper wire soldered together. The insulation consists of 3 layers of indiarubber; the layer next to the core is simple indiarubber, the second layer is a mixture of gum arabic and zinc oxide, and the outer is vulcanised indiarubber; over this last is wrapped linen tape. Twisted flax threads are plaited over the tape, after being heated with beeswax mixed with tar.

The external diameter is about ¼". The resistance of 1 verst (about 1,200 yards) must not exceed 14 ohms.

(ii.). The Single Strand lead, as its name implies, has a core of a single strand of copper wire. The insulation consists of a layer of indiarubber, round which waterproof tape is wrapped. These leads are made up in coils of about 120 yards.

The resistance of 1 verst must not exceed 17 ohms.

To facilitate connecting up charges in divided, six-way connecting pieces are supplied, in which the ordinary lead branches out in to six leads, and these can be joined to the main lead at any point.

IV. *Test Cell and Apparatus for Measuring Resistances.*

The apparatus for measuring resistances (*Figs.* 6 and 7) consists of a galvanometer (g), a box of resistance coils (W, W_1), two terminals k and k_1 to connect up with the test cell, two terminals K K_1 for connecting up to the object of which it is desired to discover the resistance, and lastly the switches U and U_1. The internal connections of the different parts is shown in *Fig.* 6.

The coils of the galvanometer, which is in a revolving brass case, have a resistance of about 100 ohms. The magnet M (*Fig.* 7) is bell shaped, and is connected with an aluminium needle which shows the deflection obtained. The lever H, which is operated on by closing the lid of the case, keeps the needle in a fixed position when not in use. The resistance box has 6 coils, the resistances of which are 500, 1,000, 2,000, 5,000, 10,000, and 30,000 ohms, any or all of which can be put into circuit. The test cell is very similar to the Leclanché dry cell; and has an E.M.F. of 1·4 volts and a resistance of 2 ohms.

Use of Apparatus.—The apparatus when used must be placed on a flat base, and the brass case of the galvanometer revolved till the needle points at 0. The test cell and the resistance to be measured are then connected up in the circuit.

The resistance can be measured in two ways:—

(*a*). By comparing it with the resistance coils. For this purpose the current is first switched to the object whose resistance is to be found, and the deflection on the galvanometer noted. Then the current is passed through the resistance coils, the deflection on the galvanometer for the various resistances being noted. From a comparison of these the resistance to be found is estimated.

(*b*). By calculation from the number of degrees of deflection on the galvanometer, for which purpose a special table is supplied.

This method gives a result correct within 5%.

Test Cell and Resistance Measure.

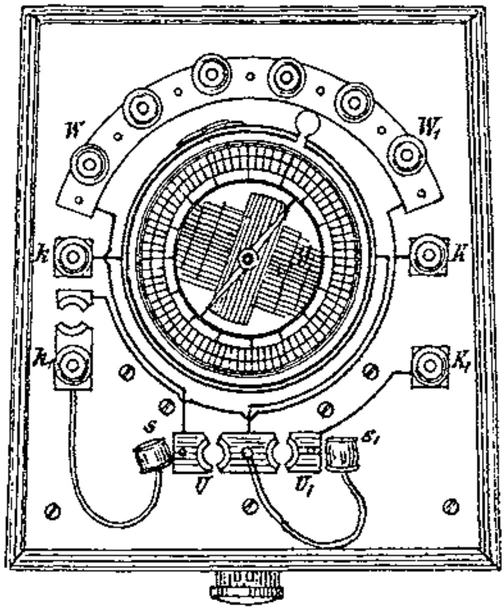


FIG. 6.

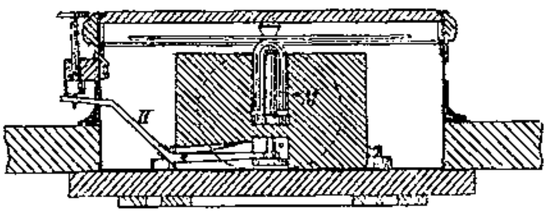


FIG. 7.

V. *Equipment of a Sapper Company.*

The equipment for each Engineer Company consists of:—1 inductor, 1 exploder, 1 galvanometer and box of resistance coils, 1 test cell, about ¾ mile of sapper leads on 3 drums, 220 yards of single strand leads in 2 coils, 4 six-way junction pieces, 220 detonators.

C. OTLEY PLACE.

NATURE.

December, 1906.

WIRELESS TELEGRAPHY (*p.* 134).—Experiments, carried out between Landi Kotal and Peshawur, have demonstrated the fact that the interposition of higher mountains does not interfere with free communication between two places in a mountainous country.

THE MICROPHONE PRINCIPLE (*p.* 153).—An ingenious application of the microphone for the detection of fire-damp has been made in France. If the sound waves of two pipes of equal pitch impinge on microphones connected in series with a telephone, a clear note is heard; but if one of the pipes emits a but slightly different note, there will be beats heard in the telephone. Now if one pipe is on the bank and the other underground, the latter, if there be fire-damp, will be blown with air of a different density and emit a different note. The telephone will then, by sounding beats, give warning of the presence of fire-damp. The apparatus, when tested with coal gas, showed great sensitiveness. An admixture of but 0·1 per cent. gave three beats in twenty seconds, and an admixture of 1 per cent. gave thirty beats in twenty seconds.

"ARTILLERY AND EXPLOSIVES" (*p.* 174).—By Sir A. Noble.—When the author first joined the Royal Artillery, the heaviest gun in use was a cast-iron weapon weighing 95 cwt. and firing a 68-lb. round shot with a muzzle velocity of 1,600 feet per second. When, later, officers of the R.A. were pressing for the introduction of a naval gun weighing seven tons, the naval officers "doubted whether so heavy a gun could be carried on board ship," and a compromise was effected by introducing a gun of 6½ tons. Yet we have had vessels, the *Sans Pareil* and *Benbow* (both long since obsolete), carrying two 110-ton guns!

When Noble and his colleague Sir F. Abel first took up the examination of gunpowder, the knowledge on the subject was simply chaotic; the most diverse ideas, as to the pressure and temperature developed on firing, were held; charges occupying but a small portion of the space in the experimental vessel had been employed; and it was not until they succeeded in retaining all the products of combustion in a space which the charge completely filled, that knowledge on the changes commenced to have any claim to scientific accuracy. Charges so large as 23 lbs. of gunpowder and 5 lbs. of guncotton have been fired in the author's explosion vessels, illustrations of which are given. The result of these researches was that velocities in guns were advanced to 2,100 feet per second.

The advantages of a smokeless powder are so great that as soon as the difficulty of "taming" gunpowder had been overcome, its adoption, either gelatinised alone or mixed with nitro-glycerine, quickly followed. Again Noble and Abel were pioneers in our knowledge of the conditions attending the use of smokeless powders; changes involved during their combustion are less complicated than those with ordinary gunpowder. The influence of increasing amounts of nitro-glycerine to nitro-cellulose in cordites was first fully worked out by Noble, who showed that erosion in guns is due to two causes—(*a*) high temperature of the products, (*b*) the motion of these hot gases—and that increase of temperature went hand-in-hand with increase of nitro-glycerine and consequently also the erosion.

The new M.D. cordite contains only 30 per cent. of nitro-glycerine instead of 58 per cent. as in the earlier form. Powder of this composition will, for the same charge and size of cord, give less energy in the gun, but this may be overcome by suitable modification of the charge and size of cord.

ANTI-MALARIAL MEASURES (*p.* 204) were commenced at Ismailia in 1903, since which no fresh cases of malaria have occurred; before the anti-malarial campaign there had been from 1,500 to 2,500 cases per annum.

At Port Swetenham, Malay States, anti-malarial measures were commenced in 1901–2. Among the Government employés in 1901, 236 sick certificates were issued and 1,026 days of leave were granted on account of malaria. In 1905 the figures were respectively four and thirty. Comment is needless.

W. E. WARRAND.

PROCEEDINGS OF THE SOCIETY OF ANTIQUARIES OF SCOTLAND.

Vol. XL., pp. 136—150.

ON VITRIFIED FORTS: With Results of Experiments as to the Probable Manner in which their Vitrification may have been Produced, by Lieut.-Colonel A. B. McHardy, C.B., late R.E., Vice-President.—Scattered along the Caledonian Valley, along the great line of Lochs between Inverness and Fort William, and beside the margins of the broad arm of the sea known as the Sound of Arisaig, are many curious rudely-built Forts constructed of native stones.

These Forts are considered to have been built by the hands and after the designs of a long vanished and primitive people. Amongst the stones forming their somewhat massive ramparts may be seen varying numbers of similar local stones which are cemented together in places by a lava-like substance, thus assuming the appearance of vitrified conglomerates.

Colonel McHardy has set himself the arduous task of endeavouring to account for this peculiarity in ancient Fort building, to unravel the origin of the works and the purpose or purposes which they served, and to discover if possible the inner meaning of the Vitrified Stones and their uses. This he has signally achieved by the aid of sound military constructional and scientific knowledge. He has devoted his leisure time during a space of 5 years to this object, and right well has he accomplished his unremunerative, self-imposed task.

The theories hitherto advanced to account for the existence of these stones in the Forts well show the mysteries which have surrounded them; by some, the vitrification has been considered to have incidentally arisen as the result of Beacon Fires, or great fires for Religious or other purposes; by others, of fairly equal authority, the vitrification is believed to be the intended result of a structural strengthening of the parapet walls by fusing its component stones into an interdependent mass. Colonel McHardy, calling science to his aid, has taken the pains to verify, by actual experiments and chemical analyses, what kind of process applied to the various natures of stones in the vicinity of the Forts is capable of producing the particular form of vitrification observed.

The importance of the subject is evidenced by the fact that vitrified materials used in Forts have been discovered in Ireland, Germany, Austria, and France, the matter, therefore, being one of cosmopolitan interest to all, and not limited to those to whom the History of the Scottish Race is somewhat more than a mere phase of passing fancy.

By a series of carefully-conducted experiments in stone burning, utilising such varied fuel as grass, straw, wood, bracken, peat, brushwood, sea-weed, etc., afterwards analysing the residual slag and observing fluxes, much valuable information has been obtained on the subject of vitrification.

The net deductions are that vitrification of the stone to the extent required does not result from a too rapid conflagration fanned by an active draught of air. But by placing wood fuel below the stones, heaping on wood and stones alternately in a smouldering smothered fire of great intensity, whilst checking the consumption of fuel as much as possible, after some 18 hours, the hot pile having meanwhile risen to a height of 4 feet, a vitrified block weighing 8 lbs. was artificially evolved. The probability is that the vitrification of Fort materials was originally brought about by their primitive constructors in much the same fashion, the rate of combustion being reduced, whilst the heat was conserved.

The author likewise suggests that in these isolated Forts a long-continued smouldering fire, capable of being stirred up at any time, would be a matter of necessity, being available for signalling purposes as well as in constant use for cooking food. Such an arrangement is now said to be in vogue in some of the Pacific Islands, and appears also to have been a common custom in Prehistoric Kentish and Surrey defended village oppida settlements.

Incidentally he deduces the facts that the Fort defenders were not in the habit of assuming that they had undeniable Command of the Sea, and that their visual lines of communications between the scattered Forts were admirably adapted to give early information as to the movements of a probably hostile sea rover appearing on the scene at an inopportune moment.

The whole Paper can justly be said to be a masterly exposition of a very probable solution of a much vexed, complex question; the subject is treated with great scientific insight, and the Paper seems likely to become the standard record for all time on the mysterious art of vitrification as applied to ancient Fort construction.

O. E. RUCK.

REVUE DU GÉNIE MILITAIRE.

November, 1906.

DIRIGIBLE BALLOONS.—A continuation of the article published in the previous numbers. The discussion on propeller designs is concluded. Petrol motors are the only form of engine now used in dirigible balloons. They can be constructed to weigh from 6½ lbs. per horse-power. The latter part of the article is devoted to the history of dirigible balloons.

DEDUCTIONS FROM THE SIEGE OF PORT ARTHUR.*—These are derived from the articles published by Capt. von Schwarz of the Russian Engineers in the *Eenzhenernee Zhoornal.*

The position at Nanshan is described in detail, and a large scale plan of it is given. Twelve batteries and two infantry redoubts were constructed on this position by the Russians in 1900. Just before the outbreak of war, it was decided to add a number of infantry trenches and two more batteries, and to provide bombproof shelters. In the end the hill was surrounded by two, and in some places three, tiers of trenches, supported by 15 batteries, 4 redoubts, and 5 lunettes. In front of the trenches was an almost unbroken line of wire entanglements. The gaps in the line were filled with fougasses. The walled town of Kinchow, which lies in front of Nanshan, was occupied by a small garrison, which did not exceed 400.

The Japanese attacked the town on the 21st, 23rd, and 25th May, and were on each occasion repulsed with heavy loss. On the night of the 25th they surrounded and captured the town, after some severe fighting.

On the morning of the 25th the Japanese artillery opened fire on Nanshan; and though they inflicted no loss, they drew the fire of the Russian guns. On the 26th the Russian trenches were occupied by 8 companies of the 5th Regiment, with 3½ companies and 2 detachments of skirmishers in support. The general reserve consisted of 4 regiments, one being on the right flank, one in the centre, and one on the left, with the fourth near the railway station of Nangalin. There were also 6 batteries in reserve. The Japanese had 230 field and 20 siege guns, nearly all quick firers, against a total of 60 Russian guns, of which only 12 were Q.F.; the Russians had only 150 rounds per gun. The Japanese guns opened fire at 4.30 a.m., and very soon established their superiority. By 9.30 a.m. most of the Russian guns had finished their ammunition, and at 11 a.m. the last battery ceased fire. The Japanese infantry, supported by their artillery and by the fire of their gun-boats, were then able to advance against the Russian left flank. They gradually pushed it back, and at about 5 p.m. their advance was facilitated by the retirement, owing to a mistaken order, of some of the Russian infantry from the trenches on the left centre. By 8 p.m. the whole position had been captured.

* A *précis* of Capt. von Schwartz's article, by Major F. E. G. Skey, R.E., was published in the *R.E. Journal* of July, 1906.—ED.

The Russian defeat was due to the following causes:—(1) They had only 2,400 men to hold 7,500 yards of entrenchments; (2) their general reserve was unnecessarily large, and the greater part of it was never engaged; their guns had only 150 rounds each; (4) the defences on the left flank were completely destroyed by the fire of the Japanese gun-boats.

As regards field entrenchments in general, Capt. von Schwarz lays down the following conditions which should be satisfied:—(1) The soldier should be able to fire comfortably; (2) he should be protected from rifle and shrapnel fire; (3) he should be secure against enfilade fire; (4) the works should be invisible; (5) the trenches should be wide enough to allow troops to pass along them without disturbing the firing line; (6) there should be covered communications with the neighbouring trenches and with the reserve.

The type of trench which the Russians found most satisfactory was about 3 feet wide, with the rear half 18 inches deeper than the front, thus providing covered communication behind the firing line. The parapet was furnished with embrasures for two or more rifles; and overhead cover for the firing line was provided by means of thick planks laid on pickets driven into the inner face of the parapet and projecting about 18 inches over the trench. If possible every trench should be 4 ft. 6 in. deep, and should have no parapet; but if more command is required to obviate dead ground, a parapet must be used. In permanent fortifications, which are likely to be subjected to the fire of heavy siege guns, raised parapets must be dispensed with.

Dead ground must be filled in, or must be under the effective fire of some other work.

Fire trenches should not be continuous, especially if the garrison is weak. A separate trench or group of trenches should be provided for each unit, with a covered trench leading to a main communication trench in rear, the latter being roughly parallel to the front of the position. A space of 150 to 250 yards of front may be left between the groups of fire trenches. The main communication trench should be from 350 to 400 yards behind the fire trenches, so that shrapnel fire aimed at the latter shall not sweep the former.

The reserves should be posted under cover in rear of the main communication trench.

Short lengths of mine gallery form the best bombproof shelters.

As regards the arrangement of redoubts and trenches, the writer considers that strong lunettes should be placed a little in front of the fire trenches, so that they can flank the latter. The enemy will then be forced to capture the lunettes before they can gain a footing in the trenches. As far as possible the interior of each work and trench should be exposed to the fire of works in rear, so that they may be rendered untenable by the enemy. Closed works should only be allowed in the rearmost line of defences. All parapets or trenches exposed to enfilade fire should be recessed.

In calculating the size of works, the author deducts one third of the whole garrison to form a reserve, and then allows a length of parapet of 7 ft. 6 in. per man on the front and flanks for the remainder.

A type of battery, which was found very useful at Port Arthur, consisted of two or more emplacements, excavated to the full depth. These were placed some distance apart, and were connected by a mine gallery, which served as an ammunition store and shelter. The excavated earth was painted—presumably with some sort of colour wash—to match the surroundings. Batteries should be protected by infantry entrenchments, situated at least 350 yards away on the front and flanks.

Wire entanglements proved to be the most efficient obstacles. They should be concealed from the enemy in ditches or low ground. The enemy should not be able to locate the position of any gaps which may have been left in the entanglement for a counter-attack. Planks studded with spikes were placed on the parapets of some of the works at Port Arthur, and proved a very efficient obstacle. Fougasses in a single line are useless; they should be placed in several rows, one behind the other, near the entrenchments, so that the defenders may counter-attack before the enemy has recovered from the effects of the explosion.

In conclusion Capt. von Schwarz states that defence works designed and executed in haste are of little use. When time is short, only a few works should be undertaken; but these should be completed in every detail.

J. E. E. CRASTER.

RECENT PUBLICATIONS.

The Battle on the Scha Ho. Authorized translation by Karl von Donat of the August, 1906, Supplement to the *Militär Wochenblatt*, with "Comments on the Battle" by Lieut.-General von Caemmerer. ($8\frac{1}{2} \times 5\frac{1}{2}$. Rees).

Achtzehn Monate mit Russlands Heeren in der Mandschurei. Band I. Vom Beginn des Krieges bis zum Rückzuge nach Mukden. Von Major F. v. Tettau. (8.50 mks. Mittler, Berlin).

Critique Stratégique de la Guerre Franco-Allemande. Les Armées en Présence, par Lieut.-Colonel A. Grouard. (8vo. Paris).

Die Schlacht der Zukunft, von Major v. Hoppenstedt. (3.60 mks. Mittler, Berlin).

Die Feldverschanzung. I. Teil. Grundzüge der Führung. Aus den Kriegslehren grosser Feldherren. Von Oberstleut. Julius Mener, Instruktor der Genietruppen. (3.50 frs. Bern).

The Nation in Arms, by Baron C. von der Goltz. Translated from the 5th German edition by P. A. Ashworth. ($8\frac{1}{2} \times 5\frac{1}{2}$. Rees).

Commerce in War, by L. A. Atherley-Jones, K.C., M.P., assisted by H. H. L. Bellot. (10 x 6. 21s. Methuen).

Geschichte des preussischen Ingenieur-und Pionierkorps von der Mitte des 19. Jahrhunderts bis zum Jahre 1886. Band II. Die Zeit von 1870 bis 1886. Bearbeitet von Oberstleut. H. Frobenius. (6 mks. Remier, Berlin).

Der ferne Osten. Seine Geschichte, seine Entwicklung in der neuesten Zeit, und seine Lage nach dem russisch-japanischen Kriege, von Generalmajor C. v. Zepelin. I. Teil. (6.50 mks. Zuckschwerdt, Berlin).

Official Crests of the British Army now in daily use, and *Official Medals and Ribbons of the British Army, 1800 to the Present Day.* (1s. each. Gale & Polden).

Reinforced-Concrete Construction, by A. W. Buel and C. S. Hill. 2nd edition. (21s. Constable).

Reinforced Concrete, by C. F. Marsh and W. Dunn. 3rd edition. (31s. 6d. Constable).

Sanitary Engineering with respect to Water Supply and Sewage Disposal, by L. F. Vernon-Harcourt. (9 x 6. 14s. Longmans, Green).

Garbage Crematoria, by W. M. Venable. (8s. 6d. Chapman, Hall).

Mechanics of Materials, by Mansfield Merriman, Professor of Civil Engineering, Lehigh University. 10th edition. (21s. Chapman, Hall).

Hints on Horses, with short Notes on Camels and Pack Animals, by Major H. P. Young. (7 x 5. Courier Printing Works, Leamington).

FERRO-CONCRETE COAL WHARF AT ROCHESTER.

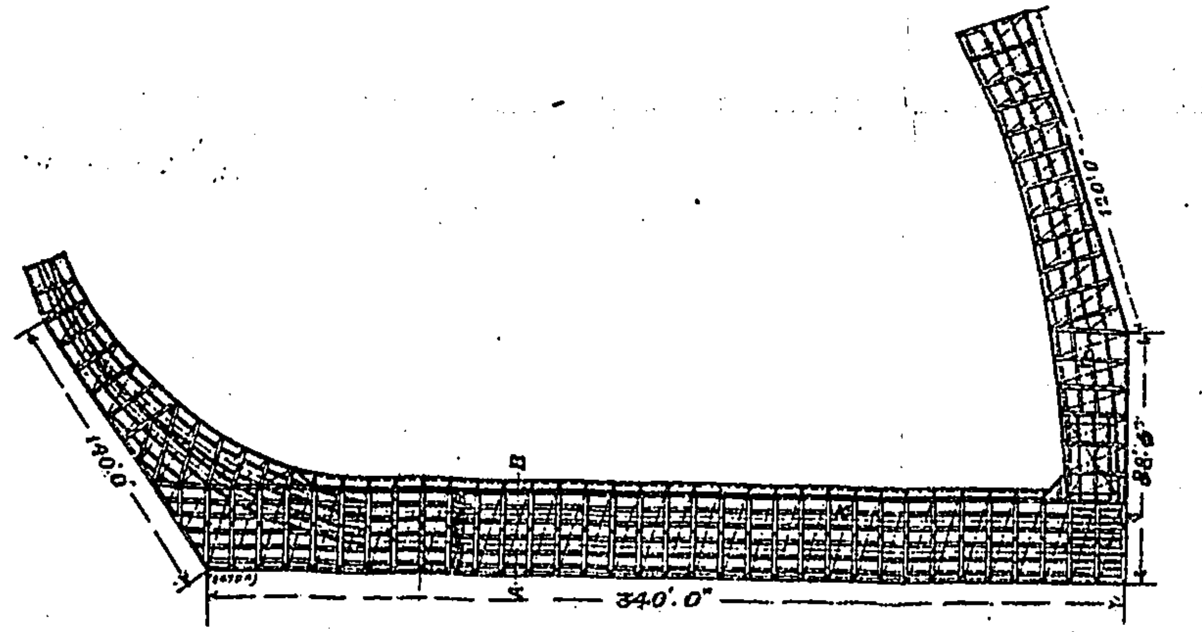


Fig. 1. General Plan of Wharf.

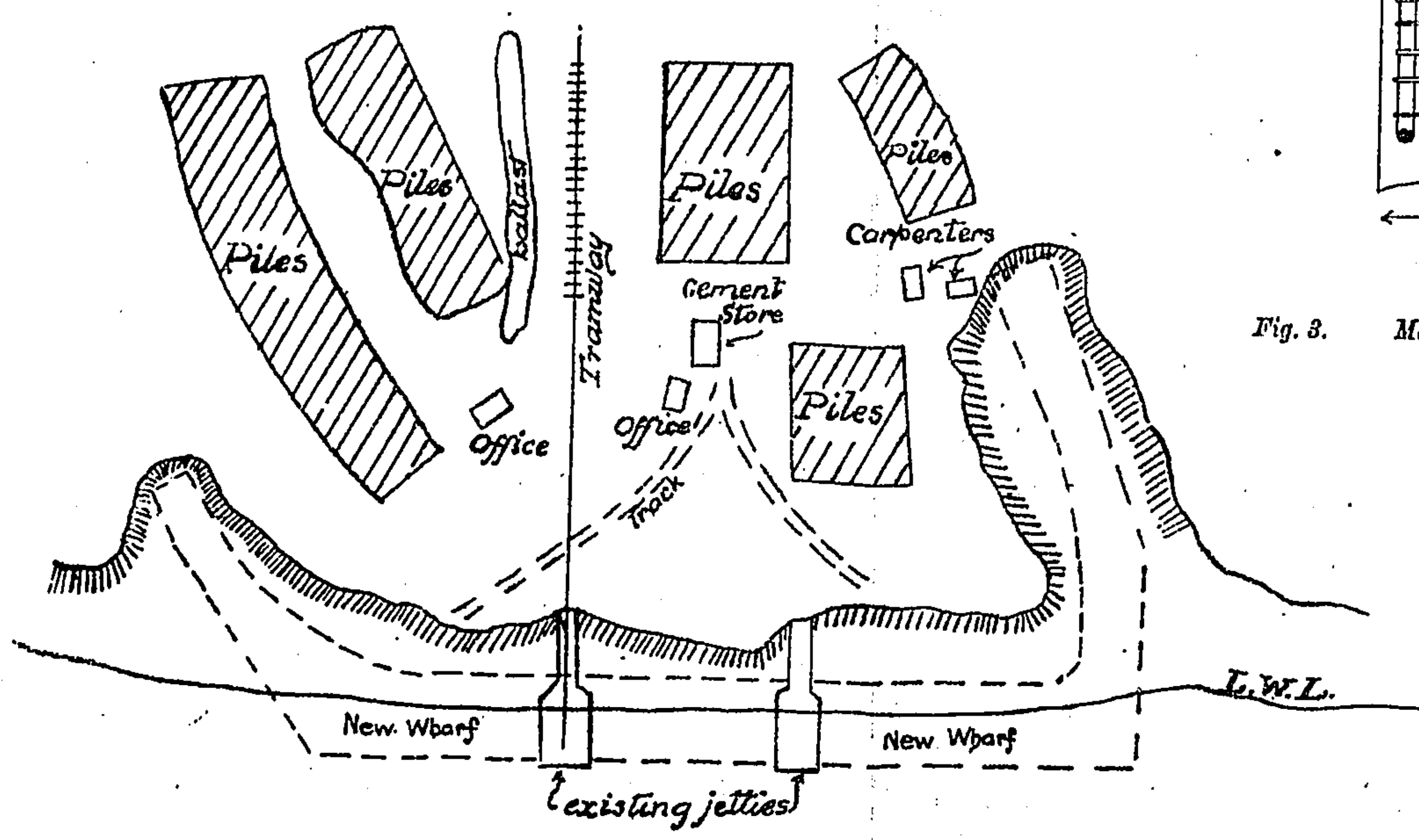


Fig. 2. Plan of Site.

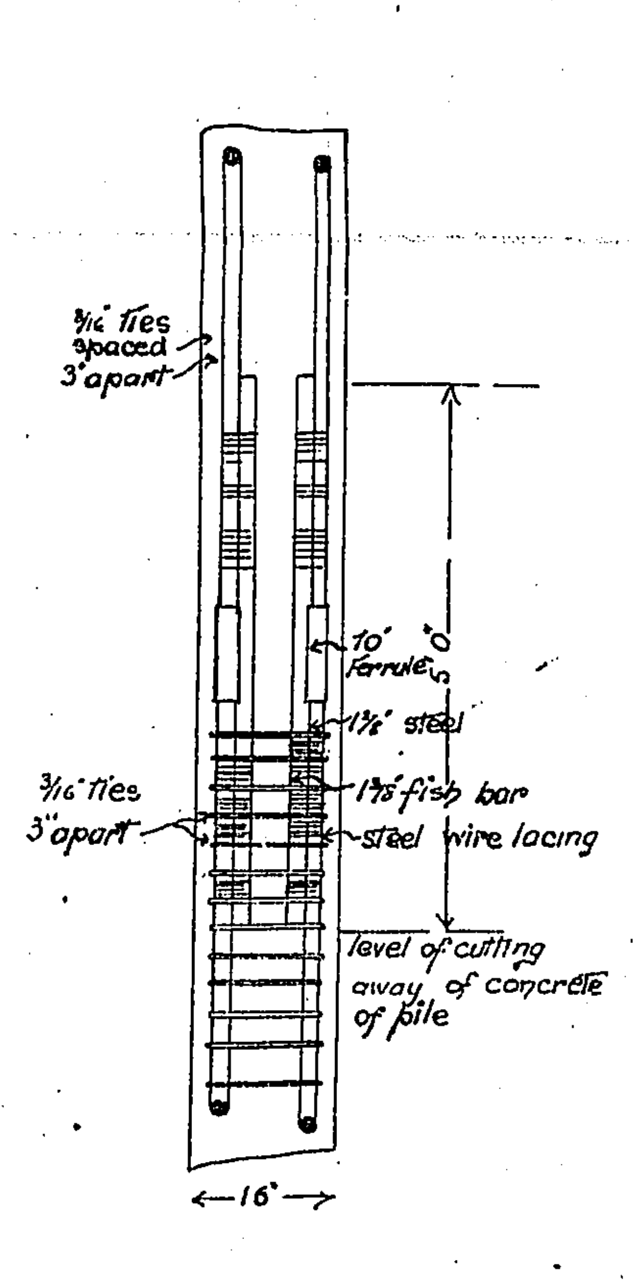


Fig. 3. Method of Lengthening Pile.

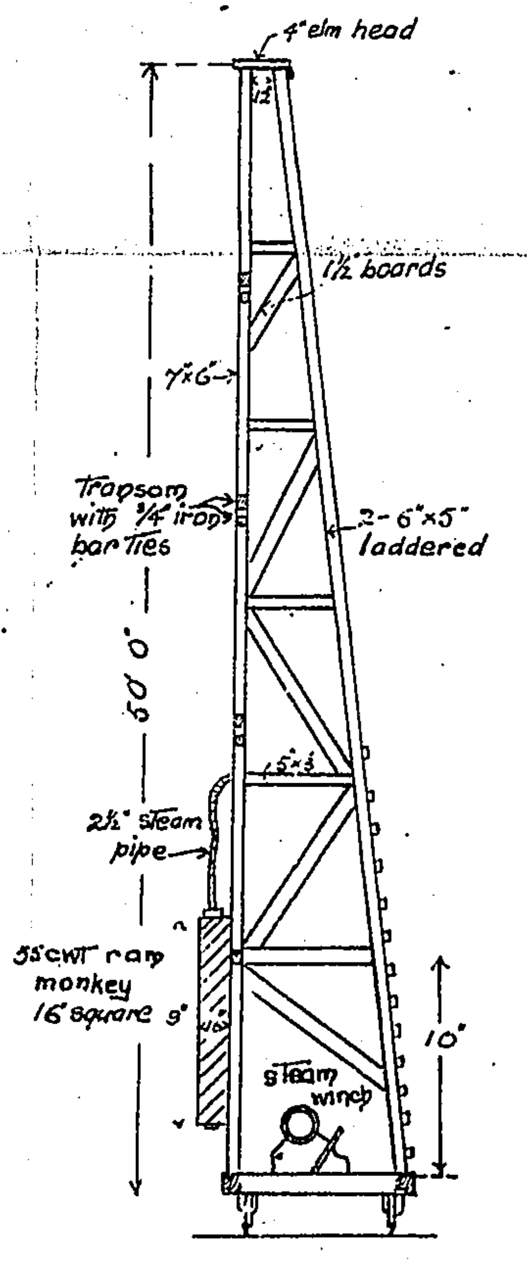


Fig. 4a. Elevation of Pile Driver.

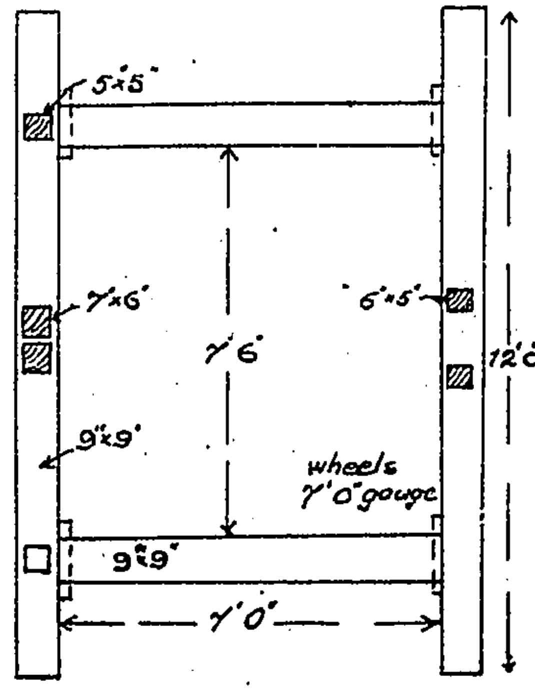


Fig. 4b. Plan of Pile Driver.

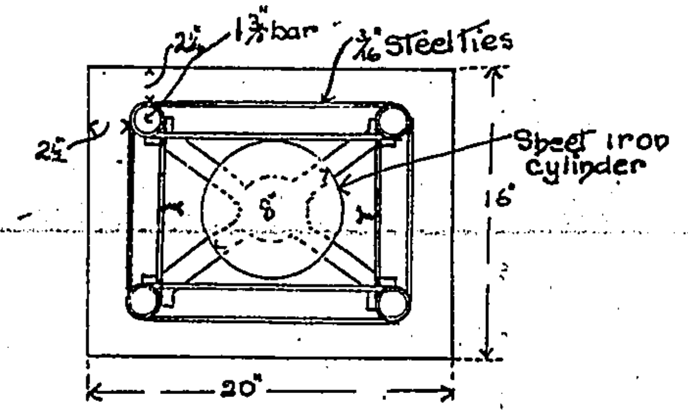


Fig. 5. Cross Section of Hollow Pile.

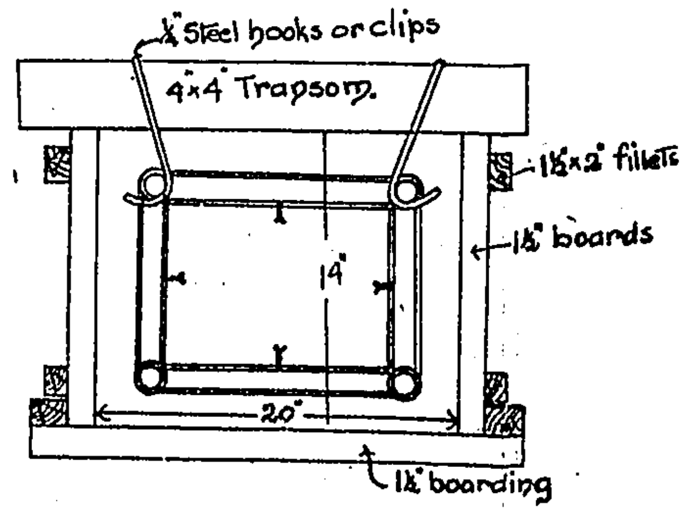


Fig. 6. Casing for Pile.

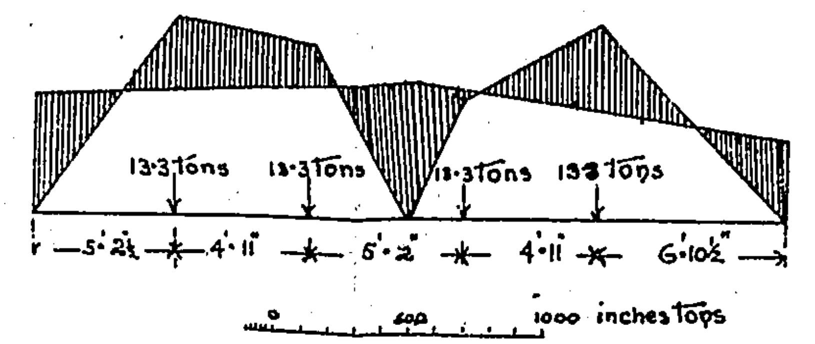


Fig. 13.

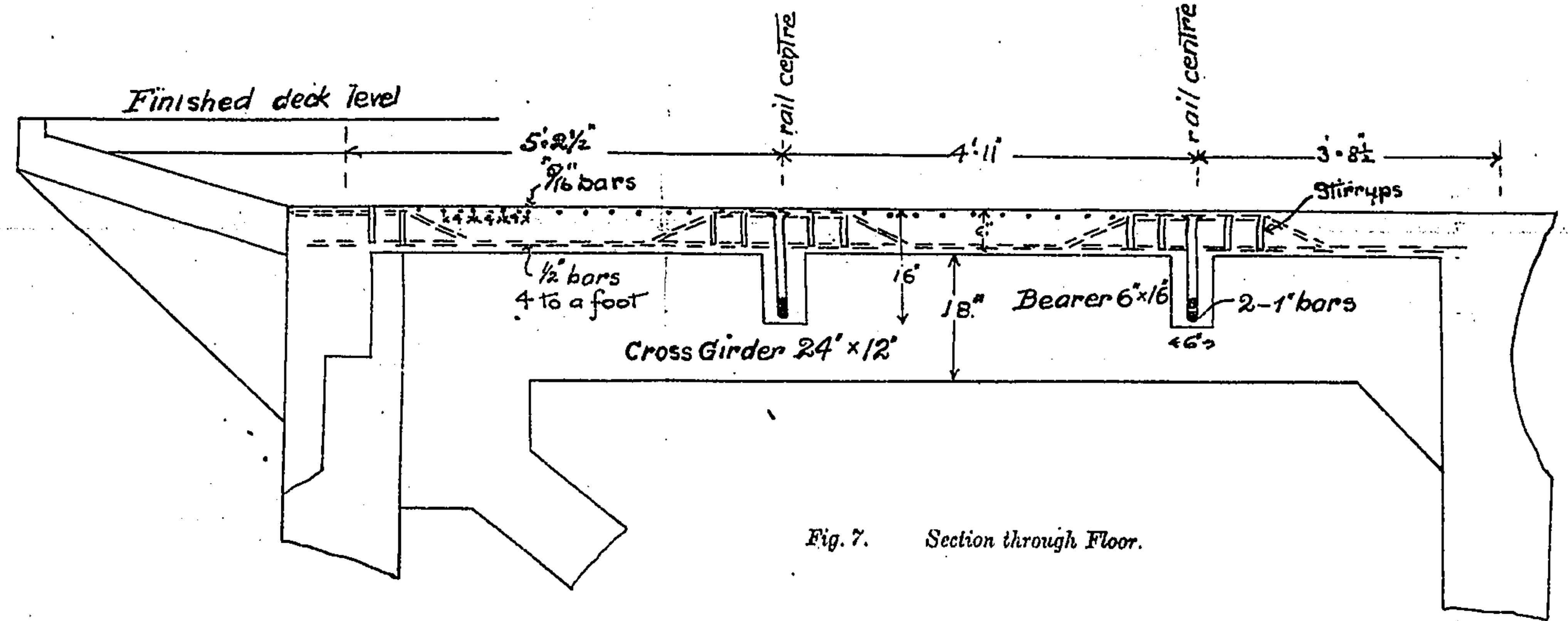


Fig. 7. Section through Floor.

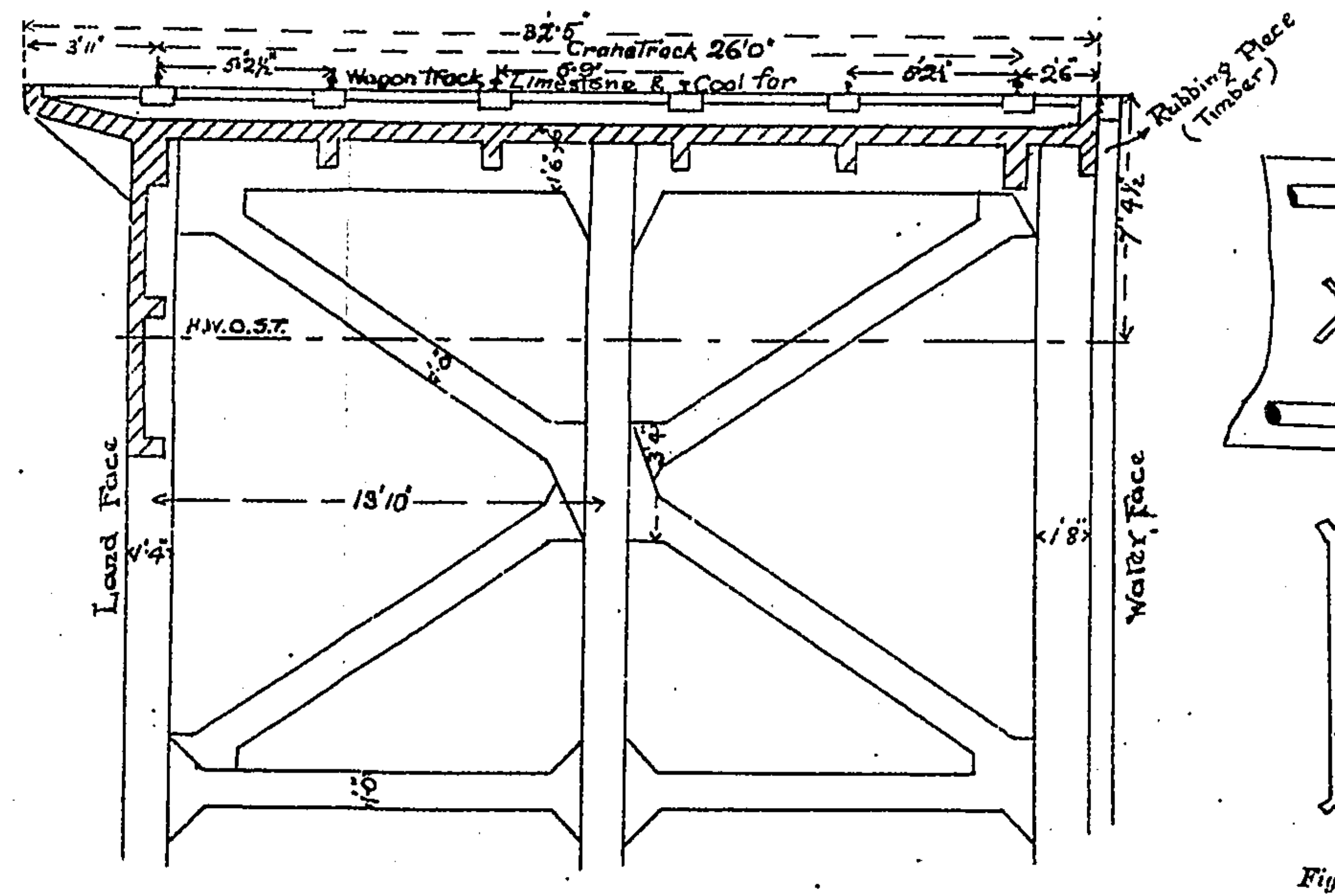


Fig. 8. Cross Section of Wharf.

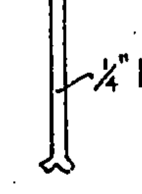


Fig. 9.

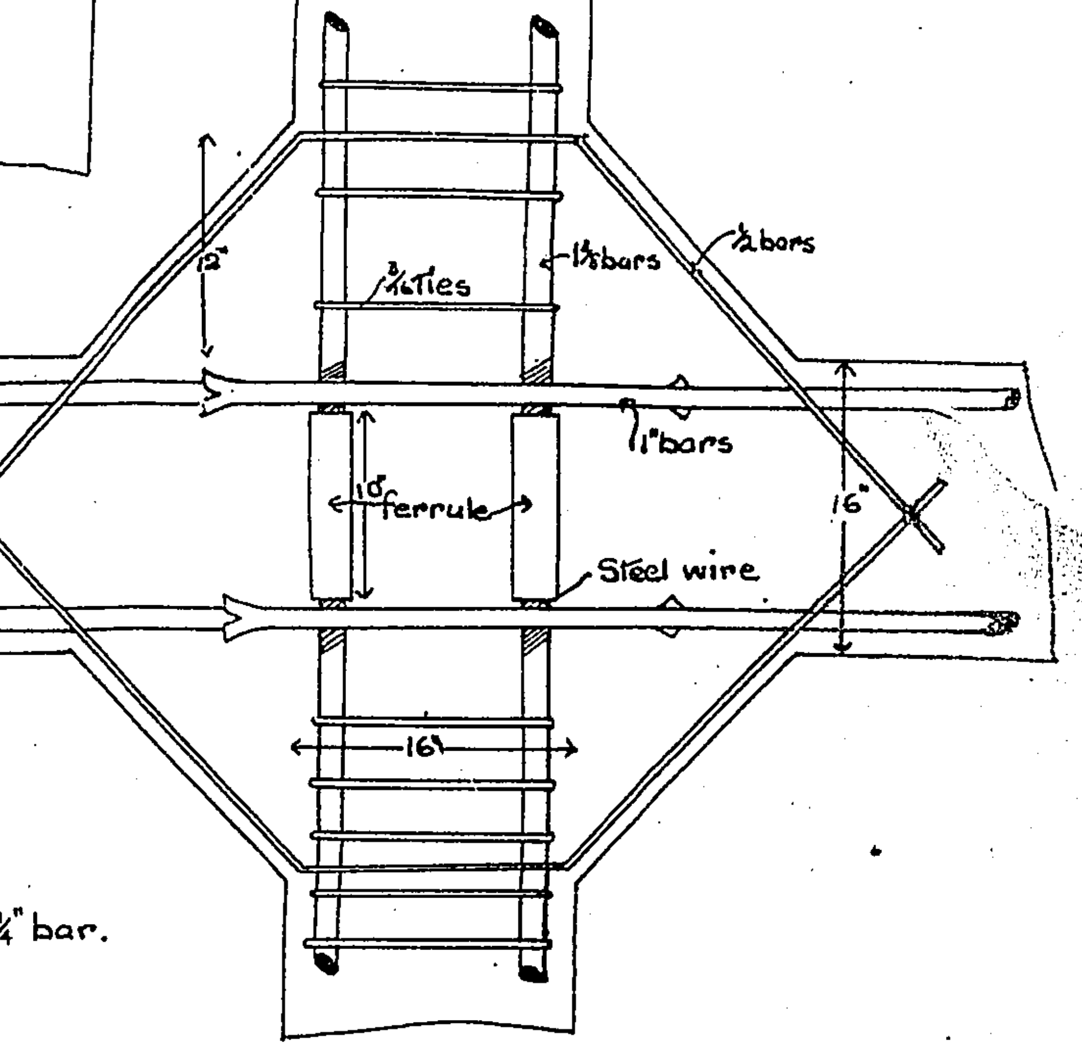


Fig. 10. Detail of Joint of Pile and Waling.

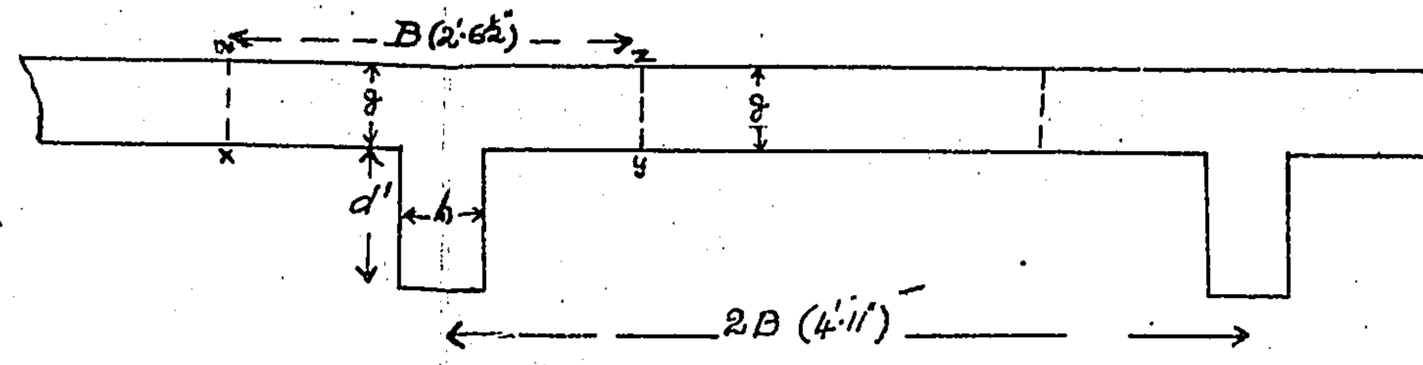


Fig. 12.

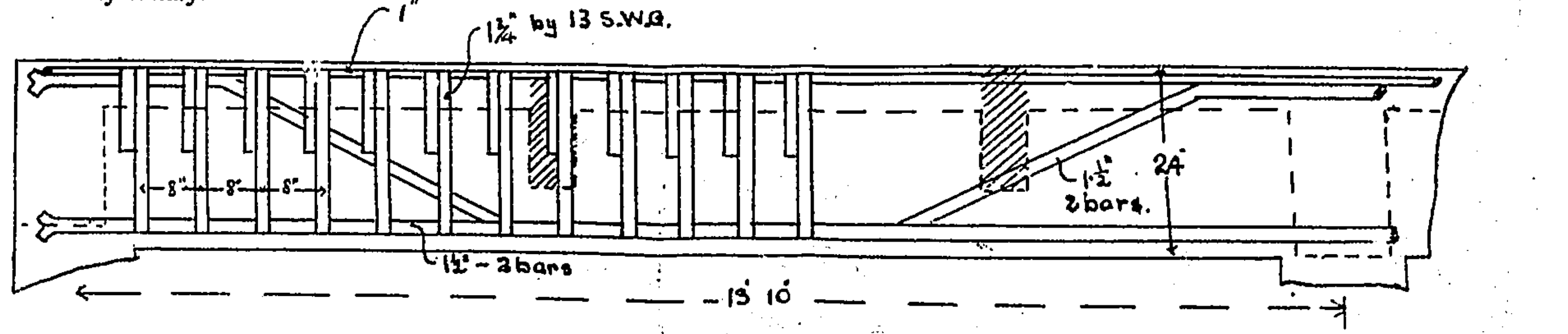


Fig. 11. Longitudinal Section of Cross Girder.

THE POSITION OF THE 3RD MANCHURIAN ARMY AT MUKDEN.

SHOWING THE BATTERIES AND OTHER WORKS AT THE TIME OF THE OCCUPATION OF THE POSITIONS ON THE RIVER SHAHO.

SCALE: 1 INCH = 1 VERST (·663 MILE).

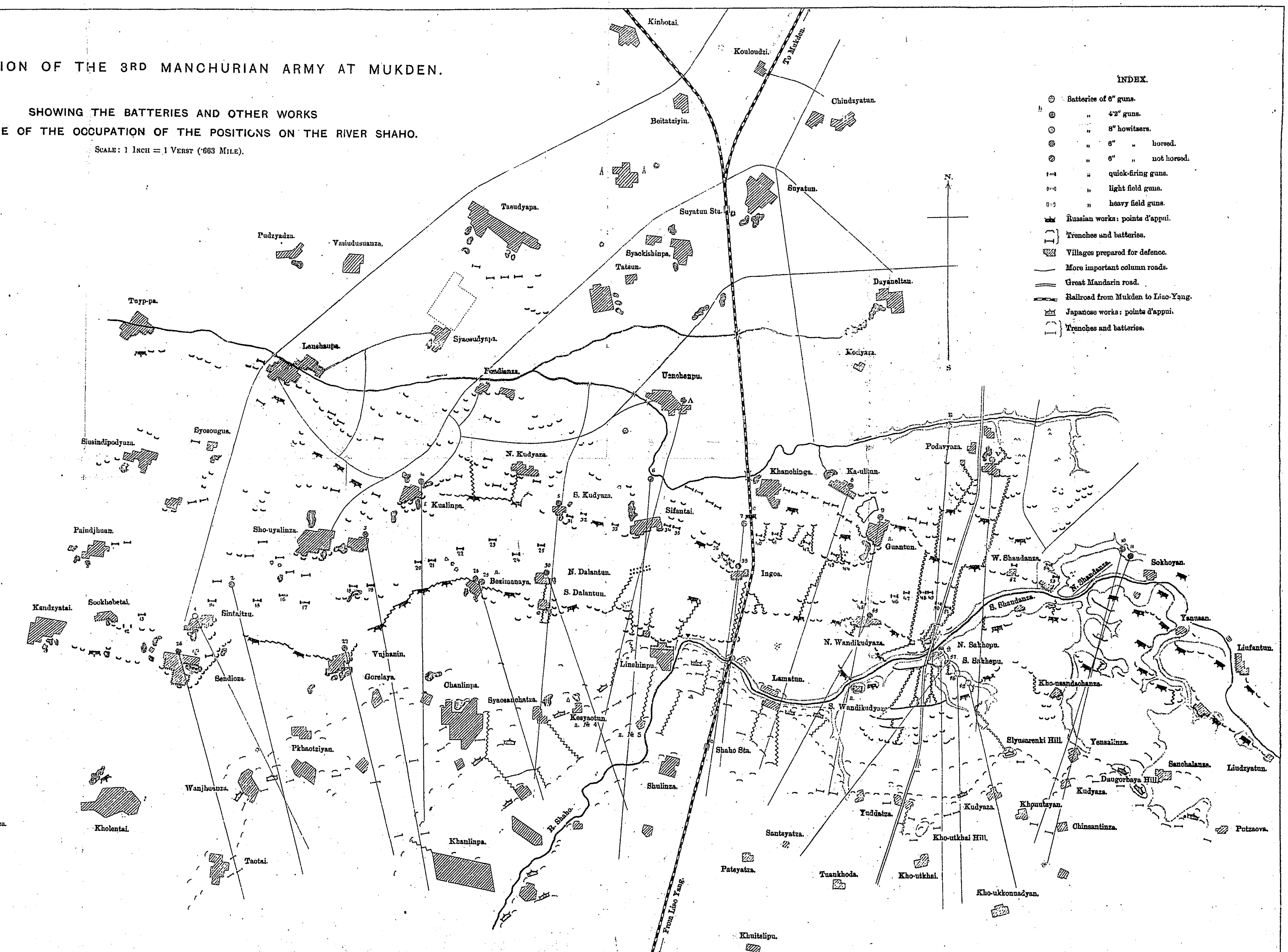


TABLE SHOWING DETAILS OF THE SIEGE BATTERIES.

Number of Battery.	Azimuth of Directing Line.	Distance to Enemy in yards.	Positions of the enemy within effective range of the batteries. (For 6" guns of 4,333lbs. this may be taken as 4,500 yds.; for 4·2 m.m. guns, 5,830 yds.; and for 6" howitzers, 2,100 yds.).
1 (6" guns, 5) ...	332°	2,566	Taotai—Wanjhuanza—Chanlinpu.
2 (do., 5) ...	334°	2,566	Ditto.
3 (do., 5) ...	348½°	2,916	Wanjhuanza — Chanlinpu — Syaosanchatza. Distant enfilade Wanjhuanza—Taotai and Linshinpu—Lamatun.
4 (4·2 m.m. guns, 5)...	358°	3,500	Pkhaotziyan—Chanlinpu—Linshinpu. Distant enfilade the same as the preceding.
5 (do., 5) ...	4½°	2,033	Gorelaya — Chanlinpu — Shulinza; Shaho Station — Lamatun. Effective enfilade Linshinpu — Lamatun; distant enfilade Gorelaya—Wanjhuanza—Taotai.
6 (do., 5) ...	4°	2,033	Chanlinpu — Shulinza — Lamatun. Effective enfilade Lamatun—Kho-utkhai Hill; less effective enfilade Gorelaya—Pkhaotziyan.
A (4·2 m.m. gun, 1)...	13°	4,500	Village No. 5—Linshinpu—Lamatun.
7 (6" guns, 4) ...	5°	2,250	Village No. 4—Shulinza, Shaho Station—Lamatun, and half interval towards Kho-utkhai Hill. Enfilade Linshinpu—Syaosanchatza.
8 (do., 4) ...	17°	3,966	Linshinpu—Lamatun and part of interval towards Kho-utkhai Hill. Distant enfilade Linshinpu—Syaosanchatza.
9 (do., 6) ...	10°	3,500	Linshinpu — Lamatun — Yudelatza. Distant enfilade Linshinpu—Syaosanchatza.
10 (do., 4) ...	13°	3,733	Works in neighbourhood of Slyusarenki Hill. Enfilade Chesandaganza—Daugorbaya Hill.
11 (4·2 m.m. guns, 4)...	18½°	3,733	Kho-utkhai Hill—Daugorbaya Hill. Enfilade the same as the preceding.
B (4·2 m.m. gun, 1)...	3½°	5,600	Works to east of Lamatun.
V (6" gun, 1)	3°	5,366	Very distant ground.
26 (6" howitzers, 6) ...	343°	2,100	Wanjhuanza—Pkhaotziyan.
27 (do., 6) ...	345°	933	Pkhaotziyan—Chanlinpu.
28 (do., 6) ...	342°	1,633	Chanlinpu, and part of the interval towards Linshinpu.
29 (do., 6) ...	342°	1,633	Ditto.
30 (do., 6) ...	339½°	1,633	Chanlinpu—Linshinpu.
39 (do., 6) ...	6½°	1,633	Linshinpu—Lamatun.
55 (do., 6) ..	28°	1,633	Works in neighbourhood of Lamatun.
56 (do., 6) ...	259°	2,100	Works to east of Lamatun and near to Yudelatza; foot of Kho-utkhai Hill.
57 (do., 6) ...	36½°	2,100	Works in neighbourhood of Yudelatza, and at foot of Kho-utkhai Hill.
*58 (8" howitzers, 4) ...	359°	1,866	Yudelatza—Kho-utkhai Hill, and Slyusarenki Hill.
*59 (do., 4) ...	345°	1,633	West slope of Kho-utkhai Hill; Kho-utkhai Hill to Chesandaganza.

* These batteries were never actually armed.

Observation.—The angle of fire can be taken as follows:—For guns 125° and for howitzers up to 90°.

Note.—No. 19 battery was composed of heavy field guns; Nos. 12, 18, 46, 50, 51 each had 8 ordinary field guns; the remaining batteries shown on map had 8 Q.F. field guns.