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CONTENTS.

ERRATUM.

In the Map illustrating "Swallow Holes," published with the *R.E. Journal* for May, *for* "Scale: six inches," etc., etc., *read* "Scale: three inches," etc., etc.

CONTENTS.

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STAFF RIDES AND MANŒUVRES.

Car of a Dirigible Balloon.

Gun Limber used as Field Observatory.

Wireless Telegraphy.

Cavalry in Action Dismounted.

STAFF RIDES AND MANOEUVRES

STAFF RIDES AND MANŒUVRES.

A Lecture given at the S.M.E. on 7th January, 1909, *by* Lieut.-Colonel H. S. Jeudwine, R.A.

The regulations regarding staff rides and manœuvres which at present are to be found in Chapter VII. of *Combined Training* are undergoing revision, and will shortly be republished, with additions and amendments, in the shape of a separate manual, entitled *Training and Manœuvre Regulations*. In this volume the designation "Staff Ride" is altered to "Staff Tour," and "Regimental Tours" are called "Regimental Exercises." I propose therefore to refer to them under the new nomenclature.

Staff tours and manœuvres, as means of training officers, are complementary to each other. Each has its peculiar advantages and limitations. The opportunities which the one presents are not always to be found in the other, and at the same time different drawbacks attach to each.

In a staff tour it is possible to present exercises in strategy and in grand tactics, involving the handling of large forces and their movement and disposal over a wide area. The bulk of the administrative work which, in the case of actual forces, would be necessitated by this, can be practised in a manner approaching to the conditions of war, and untrammelled by the fictions which during manœuvres we are compelled to adopt by peace establishments of men, horses, and vehicles, and by the absence of arbitrary powers over means of communication, inhabitants, etc. For instance, in a staff tour we can, in imagination, assume control of a railway system, or of telegraphs, impress vehicles, requisition supplies, enforce billeting, etc., and the fact of our doing so will compel us to practise the systems of control by which such measures would in war require to be regulated.

But exercises in tactics, although possible to some extent with liberal aid from the imagination, are not always convincingly presented in staff tours. The necessity for mutual co-operation and the penalties which follow from its absence are not clearly demonstrated. Estimates of time and space are apt to be optimistic. There is a pleasant sense of irresponsibility, which is apt to result (on paper) in the execution of great feats of marching, in lightning entrainments, and in the magical evolution of impregnable defences in the absence

of tools, of materials, and even of men to use them Although the exercise of the imagination is to some extent a necessity at manœuvres also, they are attended by conditions of reality sufficient to exert a sobering influence on those responsible for the issue of orders. One hesitates to invite troops to undertake record marches or to do without sleep or food, even in the glorious cause of Redland or Blueland, when the order has to be conveyed to a materialized Red or Blue General or Commanding Officer, instead of to the accommodating and uncomplaining General X. or Colonel Y., who are such delightful comrades on a staff tour.

In addition to the advantage which manœuvres possess of curbing undue impetuosity on the part of the staff, they afford training in command and in initiative to regimental officers and non-commissioned officers, and in the physical labour of war to the rank and file.

I propose to refer first to staff tours, next to regimental exercises, and finally to manœuvres.

STAFF TOURS.

In dealing with staff tours and with regimental exercises I do not intend to attempt anything approaching a thorough treatment of the subject, but will try to confine myself mainly to new points and those which particularly touch officers attending them, rather than to those affecting the duties of the directing staff.

The object of staff tours is defined as being to train the higher commanders, staff officers, and those who may be appointed to command, or to the staff.

Schemes.—The first thing is the preparation of the scheme. The scheme is embodied in general and special ideas. The general idea contains information which in war would be within the knowledge of both combatants. When staff tours are double it is common to both sides. Special ideas contain information which would be in the possession of one combatant only. In the case of double tours there is a separate special idea for each side.

It is the function of the general idea to create, as it were, the atmosphere surrounding the imaginary operations, so that an officer who has thoroughly absorbed it may be imbued with the same knowledge and ideas as he would possess in similar actual circumstances, and may look at events in the same light. The mental attitude of anyone in similar circumstances in actual war is the result of an unconscious appreciation of hundreds of facts, each small in itself, which have presented themselves to him in succession during many months or even years which have preceded the actual events of the present moment. It is the result of what he has read, heard, or seen day by day. Of course all these facts cannot be recorded in any general idea, but it is worth attempting to produce the general effect of them,

or an approach to it. For this reason the general idea of a staff tour may be a document of some length. But length has no virtue in itself, and there is nothing gained by the addition of a single line if that line does not help to make the situation more vivid.

The special idea sets out the data for the immediate problem to be solved, the position and distribution of the troops under the commander's authority, and the circumstances of the moment at which operations commence. It contains intelligence such as the commander might possess in war concerning the strength, distribution, and recent action of his opponents. This intelligence need not be in the shape of exact information, since exact information on such points would as a rule be lacking in war. It may take the shape of supposed intelligence, obtained from inhabitants or from reconnoitring troops, which would naturally often be wanting in completeness. Or it may consist wholly or in part of reports, not necessarily entirely trustworthy, from which certain inferences may be drawn. When such reports form part of the intelligence contained in a special idea, they should not be intended by the composer of the special idea to carry more weight than it would be fair to attach to them in war; nor should the reader be led into attaching more value to them than he would be justified in doing in real life.

The scheme for a staff tour may be purely imaginary, or it may be based on a historical example. Whichever plan is followed, care must be taken that in its main features it is strategically and tactically sound, in order that there may be no danger of inculcating false principles or creating impossible situations. But it does not follow that all its details need be immaculate. The greatest commanders have made mistakes in war, and these may furnish episodes on which instructive schemes may be built up. One advantage of a historical basis for a scheme is that it stimulates interest in the campaign from which the scheme is taken, and often leads to the study of military history on the part of officers who might otherwise have neglected it.

One difficulty which is very generally met with in devising a sound scheme for a staff tour is that, owing to the limit which must be placed on the number of officers who can be employed, the forces actually dealt with must generally be a comparatively small part of the total forces which would be engaged in similar operations; that is the force actually dealt with must be of the nature of a "detachment." When this is the case, a sound strategical reason for the employment of a detachment must be apparent in the general idea.

Another difficulty is the adaptation of the scheme and the ground to each other; or when the scheme is based on history, the selection of ground, conveniently situated, which bears a sufficiently strong resemblance to that on which the historic operations took place. In the process of adapting scheme and ground to each other it may be

necessary to subject physical features to imaginary changes, but in this case alteration of features which are included in the area of tactical operations should be avoided, as such action robs the scheme of all reality, and alterations which are made should not bring too great a strain on the imagination, as is sometimes the case when continents are submerged, or large islands called up from the vasty deep, or oceans so located that rivers run out of instead of into them.

Among possible schemes are some of a more or less special nature, such as those dealing with the attack and defence of land or coast fortresses, with embarkations and disembarkations, with mountain or bush warfare.

The attack and defence of fortresses offer special opportunities for the practice of the co-operation between artillery and engineers, which would be a special necessity of such operations. The utilization of such schemes as a basis for staff tours is a somewhat recent development. The first staff tour of this kind, as far as I am aware, was that held in this command (Chatham) under General Scott as a preliminary to the siege operations of 1907. Others have been held at Shoeburyness and elsewhere. The problems arising in connection with such staff tours are in some respects peculiar, and are made more difficult by the fact that official literature dealing with the subject is rather scarce.

An important advantage of schemes into which both land and sea operations enter, such as those connected with the attack and defence of coast fortresses, or with embarkation or disembarkation, is that they offer the opportunity of practising co-operation with the Royal Navy in such undertakings. This is of particular value to the army of an insular power which cannot make itself felt in offence save by virtue of very complete co-operation of this kind. It is all the more important to practise this co-operation occasionally by means of staff rides, because to do so at manœuvres involves almost prohibitive expenditure, as in the case of even the small force disembarked on the Essex coast in 1904.

It is not everywhere that ground can be found suitable for schemes dealing with mountain warfare, but, at home, Wales and Scotland offer opportunities for solving realistic problems on the ground, and several successful mountain staff tours have been held in these districts. Opportunities for practising bush warfare are practically non-existent at home.

General and special ideas will generally be issued a fortnight or three weeks before the tour is to commence, in order to allow officers to study them and to become thoroughly conversant with the general situation. If the scheme is based on a historical example a longer time may be necessary, in order to give opportunity for a study of the campaign.

Appreciations.—Appreciations will be called for from all officers, or at all events from commanders of forces, to be handed in a few days before the tour commences.

The object of appreciating a situation is to arrive by consideration of all the factors at the best course to adopt. Although the term "appreciation" is generally applied to the document drawn up at a staff tour or on manœuvres for submission to a director, appreciations are far from being limited to such uses. Whenever a strategical or tactical decision has to be made, it is necessary first to *appreciate* the situation. The form of, and the time available for an appreciation vary with the situation. An appreciation is required before the commencement of a campaign with a view to deciding on the strategical action to be taken. Such an appreciation would be a document of considerable length, prepared in anticipation of the outbreak of war. An appreciation is however equally required whenever a company of infantry suddenly finds itself in touch with an enemy. But in this case the appreciation would be reasoned out almost instinctively in the head of the company commander, and his course of action would be selected in a few minutes or perhaps even a few seconds. The kind of appreciation that we generally have to deal with in a staff tour is intermediate between these two, and is valuable as training for both of them. It is intended to accustom us to look all round a situation, not only on one side of it; to seize on the salient points, and to come rapidly to a decision after weighing one point against another. Whether the arguments are committed to paper, or whether the process is a mental one—and in the latter case whether it is conscious, or unconscious and instinctive—the object of an appreciation is the same—to arrive at the best course of action.

It has been decided that it is undesirable to lay down hard-and-fast rules as to the form which an appreciation should take. A great deal must depend on the nature of the problem and of the factors governing it. At the same time most officers, until they have gained experience, require guidance in the arrangement of their ideas, so that the result may be a logical and intelligible document, and so that the course of reasoning which has led to the recommendations may be clearly stated.

In the *Training and Manœuvre Regulations* certain headings are given with the object of assisting officers who through inexperience are in want of guidance; but it is clearly stated that there is no intention of fettering those who are not in want of assistance.

The following headings will generally be found suitable :—

(*a*). The distribution and relative numbers of the opposing forces.

(*b*). The object to be attained.

(*c*). Other factors which influence the situation, *e.g.*, character of the opposing commander and *morale* of the troops on both sides; politics; topographical and climatic conditions (which influence time and space); supply and transport, railways and communications; bases and reinforcements.

(*d*). The courses of action open to the enemy and to our own forces, their relative advantages and disadvantages.

(*e*). The plan recommended for adoption.

The main object to aim at is to seize on the dominant factors of the situation, and to turn them to account so as to gain the initiative and force the enemy to subordinate his actions to your own. In exceptional cases the nature of the situation or the orders received may preclude taking the initiative, but a purely passive attitude is very exceptionally permissible, and when such an attitude is recommended it must be clearly justified in the appreciation. The style should be simple, concise, and direct, and care should be taken that the recommendations are justified by the arguments. The whole document should be as brief as is compatible with clearness.

Work of Officers attending Staff Tours.—The officer in each party who represents the commander of the force will usually allot to the officers under him their daily tasks. These tasks should consist of work required to enable him to form his plans and to maintain, protect, move, and fight his force. As a rule each officer will be supposed to be occupying a definite position in the force as a commander, a general or administrative staff officer, a departmental officer, or in command of a unit. The work he is required to perform should be related to the position he occupies. Administrative work is not less important than that connected with operations, and should be carried out with as near an approach to reality as the time and the number of officers available admit.

Out-of-door work may include reconnaissance of and reports on :—

Ground, with a view to security, attack, or defence; localities such as villages, bridges, posts, or depôts on lines of communication, with a view to defence; rivers, hilly or mountainous areas, etc., as to their value as military obstacles; roads, rivers, railways, telegraph lines, as means of communication; railway stations, as to their facilities for dealing with military traffic; streets and roads, with a view to the regulation of traffic at points where it is likely to become congested; harbours, docks, and coast lines, with a view to embarkations and disembarkations; billets, camps, bivouacs, and forming-up places; sites for and arrangements of depôts and hospitals; areas, with a view to accommodation and supplies.

The indoor work, if officers are detailed to certain appointments,

will naturally be that which those appointments would in each case provide for. If officers are not so detailed, work of a useful and relevant nature must be set by the assistant director.

The indoor work may consist of:—

Writing operation orders; drafting routine and standing orders; keeping staff diaries and intelligence reports; writing despatches; working out and drawing up time-tables for movements by rail; calculations of tonnage required for movements by sea; arrangements for entrainment, embarkation, or disembarkation; organization of a system of field intelligence; arrangements for the evacuation of sick and wounded; replenishment of ammunition and supplies; the organization of lines of communication; arrangements for the requisitioning of supplies, transport animals, vehicles, and stores; collection and distribution of requisitioned supplies, etc.; replacement of *personnel*; organization of civilian labour; disposal of military prisoners; military administration of conquered territory.

In writing orders officers should be restricted to approximately the same time as would be available in similar conditions on service. It is no use being able to write admirable orders unless they can be written quickly. Delay in writing orders means delay in issuing them, and the hour or half-hour lost at headquarters is never regained, and may mean a loss of that amount of time in getting a force into motion or commencing some important operation.

With regard to administrative problems, it is only somewhat recently that stress has been laid on the necessity for their consideration at staff tours. Formerly staff tours dealt almost exclusively with the work immediately connected with fighting, and, although bivouacs and moves by rail were studied to some extent, this was practically the case only with reference to the fighting troops. One of the causes of this was no doubt the absence of authoritative instructions. But *War Establishments* now contain much fuller tables than formerly, and the *Field Service Pocket Book* contains a great deal of administrative information, which, until it was published, was difficult of access. Part II., *Field Service Regulations*, when published, will, contain still fuller particulars. Attention has recently been directed by the Chief of the General Staff to the necessity for studying all problems connected with the maintenance of the Army.

One of the most difficult problems is undoubtedly that of billeting. In this country we have not the power to billet troops on the inhabitants generally, as Continental nations have, and consequently, although we should no doubt have to use this means of accommodation and supply largely if operating on the Continent, we have no means of actually practising it in peace. Unless we have practised ourselves in billeting, great confusion is likely to arise when we attempt such a thing in war, and it is therefore most necessary that we should endeavour to prepare ourselves for such a contin-

gency. The maintenance of a large force in billets is a very complicated business, but it is thoroughly understood on the Continent and carried out with the utmost smoothness at manœuvres.

Then, again, the magnitude of the organizations in the rear of an army is not always appreciated, or the tremendous influence which their efficiency or otherwise exerts on the offensive powers of the fighting troops. There are some excellent diagrams in the *Field Service Pocket Book* to illustrate these organizations, which show clearly how complicated the machinery in rear of an army unfortunately is. It is obvious from these diagrams how much administrative arrangement in connection with the supply of food, forage, and ammunition, and the treatment and evacuation of sick and wounded, there is scope for in a staff tour, even if we go no farther back than the advanced depôt. Except in a very large staff tour, or one held expressly for the purpose of dealing with lines of communication problems, we seldom have the opportunity of going into the work which is required in rear of the advanced depôt; but the existence of all the organizations and establishments which must be present in rear of the fighting troops, and of the lines which stretch away behind them, should never be lost sight of.

We now come to

REGIMENTAL EXERCISES.

The term "regimental exercise" is used in lieu of the term "regimental tour," which is the one used at present in *Combined Training*. The change in name emphasizes the fact that exercises of this nature may be carried out in close proximity to quarters, and do not necessarily involve a "tour."

Regimental exercises are defined as "Exercises in which regimental officers work out on the ground, under the guidance of a director, minor tactical and administrative problems, such as they may be called on to solve in war."

The director, who will be a field officer, will select the country, which must be within easy reach of the place at which the unit is quartered, and will prepare a scheme. The exercise will usually be limited to one day. It will, therefore, generally be on the lines of the exercises which are treated of in Chapter XX. of General Haking's book, under the heading of "One Day Exercises." In that book will be found excellent examples of two such exercises, fully worked out, which should be of the greatest use to anyone conducting or taking part in work of this kind.

Schemes and the nature of the work will vary according to the arm and to the rank of the officers to be instructed.

Infantry and field artillery and engineer officers may be exercised in schemes dealing with one or two battalions, from one battery to a brigade of artillery, and from a troop to a squadron of cavalry.

Cavalry and horse artillery officers may be given schemes dealing with from a squadron to a regiment, with a battery of horse artillery. To encourage co-operation and the exchange of views between officers of different arms, officers directing regimental exercises should secure the attendance of at least one officer of each of the other arms.

The director will go over the ground carefully, and will arrange a series of situations involving minor tactical operations varying from the handling of a troop, a section of artillery, or half a company up to that of a regiment of cavalry, a brigade of artillery, or a battalion, according to the rank and experience of the officers. Whether the operations of the whole, or only a part of the force be followed out on the ground, the action of those parts not actually handled will always be taken into account.

The director will prepare beforehand a written statement indicating the action of the enemy as far as it can be foreseen. Where this action depends on the measures taken by the officers under instruction, it must be improvised on the ground. The problems to be solved may be prepared beforehand ready for distribution to the officers, or they may be improvised on the ground as the outcome of developments brought about by the action of the officers themselves. To carry out a scheme successfully and to make it interesting the director should, if possible, be gifted with an imagination which will supply him with a mental picture of the battlefield, and fill it with minor but realistic detail. If he is weak in imagination he will do well to study the situation on the ground particularly carefully beforehand, and himself work step by step through the various operations that he intends to present to the officers, accounting to himself as he goes along for the action of each unit or body of the enemy—the actual fences their infantry will line, or buildings they will occupy, the position of their artillery and its line of retreat; where limbers and 1st line wagons will be placed; where machine guns will be posted; the action of their cavalry, and where their horses will be left if they act dismounted. In short, whatever cock-and-bull story his inspiration may present, he must ensure that it is "of convincing detail full," if it is to impress the officers with its reality.

The orders on which the force is to act, if not included in the special idea, will be issued the night before or on the way to the ground. The party will be divided into pairs or groups if necessary.

On arrival on the ground the first situation will be issued and officers directed to make any reconnaissances that may be necessary, make notes of the action they intend to take, and rejoin the director at a certain spot at a certain time. In making reconnaissances officers must confine themselves to ground which would be accessible in war, and must not traverse ground which is supposed to be under effective fire.

On re-assembling, each officer, or one from each group, will be called

on to report the action he has taken. The director will comment, and the situation will be discussed. The party will then proceed to the next situation. Each problem may occupy from one to one and a-half hours.

In discussing problems of this kind it may be as well sometimes to ask an officer what reports he has made to his superior commanders. Such reports are often of great importance. The art of making them tersely does not come easily to everybody, and it is worth reminding officers that they are required in war and must be practised.

MANŒUVRES AND TACTICAL EXERCISES.

The *Training and Manœuvre Regulations* will also present some new features in respect of manœuvres.

I do not propose to go thoroughly into the subject of manœuvres, which would absorb a great deal more time than you would care to allow me. I will however endeavour to indicate what are likely to be the salient points of the new regulations.

Manœuvres are defined as operations between opposing forces, or against a skeleton force, in which the commanders are allowed freedom of action within the limits of the scheme.

Tactical Exercises are operations against a skeleton force whose commander's action is limited so as to allow the exercise to be carried out in accordance with the wishes of the officer directing the operations.

Operations may be held, with a special eye to one of the following objects :—

(1). Inspection, *i.e.*, to judge of the standard of training of the troops.

(2). Higher training, with a special view to affording opportunities of experience to commanders and staffs.

(3). To test the value of some theory or principle, or to practise some particular form of operation.

These will be carried out as manœuvres or as tactical exercises, as may be most suitable to the end in view.

The following special exercises may be carried out as opportunities arise :—

(*a*). Combined naval and military manœuvres—landings, attacks on defended ports, etc.

(*b*). Siege manœuvres.

(*c*). Mobilization exercises, such as the mobilization of a division or of a coast defence command.

(*d*). Exercises to test the administrative services, such as medical or transport arrangements, or the supply of food or ammunition.

It is always desirable to approach as closely as we can to war conditions in manœuvres. At the same time it is as well to recognize that there is a limit beyond which it is not desirable to go, especially in matters of supply, transport, and accommodation. In war we are not wholly dependent on what is carried with the army. If rations are not available, food can be obtained on requisition; if wagons break down, others can be impressed; if the weather is inclement, troops can be billeted in any available buildings. This is not the case in peace in England, and if all ranks are hungry, cold, and wet for days together, tactical lessons will not be laid to heart as they might be in happier circumstances. Besides, black and uncomplimentary headlines will appear in the newspapers, which will be full of the soldier's hardships and of demands for exemplary treatment of the culprit responsible. A voluntary army cannot afford to neglect the result of such occurrences. Besides, the financial expenditure necessary to equip even a small force with transport on a war scale is comparatively large, and money can only be found for it by refusing other demands which may be more important from a training point of view.

There is a point which seems at present to be attracting particular attention in all armies in connection with endeavours to lend reality to operations, viz., the subject of umpires and umpiring. It is only natural that this should be so. Recent progress in methods and material of war have all acted in the direction of making the umpire's task more difficult. The combined result of large armies, wide extensions, neutral-tinted uniforms, smokeless powder, cover, and concealed positions has been to make it extremely difficult for an umpire to discover what is going on at any distance, or even where troops are, and in what strength.

In the French, the German, and the United States Armies, among others, new instructions for umpires were in force at last year's manœuvres. The general tendency has been towards increasing the number of umpires and giving them more independence. The French in their grand manœuvres last year had no less than twenty-one general officers on the umpire staff.

There have been two principal complaints against our system of umpiring in the past. One was that umpires interfered too much, and the other that they interfered too little. The fact that these two opposite complaints have been urged against our system shows that there is something wanting in the regulations, or that they have been wrongly interpreted.

The duties of umpires may be said to be twofold, viz.:—

(1). To give such information to troops as they would obtain in war from shells and bullets.

(2). To give decisions when troops come into actual collision.

In order that umpires may be prepared in advance to appreciate situations as they arise they must make themselves fully acquainted before action with the general and special ideas; with the narrative of preceding operations, if any; and with the intentions and orders of commanders if possible of both sides, but at all events of the side to which they are attached. During an engagement, although they must avoid giving away the position of troops to their opponents before contact is established, they must ascertain, directly touch is gained, the dispositions and strength of opposing troops, and must as far as possible obtain and keep communication with the umpires attached to the opposing side. For this purpose their position will generally be well forward, where they can be in frequent personal conference with these umpires.

In order to carry out the first duty, that of giving information to the troops, they must know how the enemy's firing line and artillery are posted, what are their numbers, and what is the objective of their fire. It will then be possible for an umpire to say, for instance, to a commander in the firing line, "You are under a superior musketry fire from the wood on your right front and flank, and under heavy artillery fire from behind the ridge to your left front." It will then rest with the commander to take steps to obtain reinforcements or support sufficient to place himself more on an equality with his opponents before attempting to advance.

Great difficulty is now felt by umpires in appreciating the effect of artillery fire and assigning to it a fair value. This is due to long ranges and concealed positions, and the difficulty will be accentuated when smokeless blank for artillery comes into use, as it probably will this year. All the information that an umpire with advanced troops in the early stage of a battle gets concerning the disposition and objective of the opposing artillery may perhaps be the sound of a few guns a long way in his front. If he is fortunate enough at this early stage to meet an umpire of the opposing force he may perhaps learn something of what they are shooting at, but the probability is that this fortune will not befall him, and he will then have to resort to his imagination. If he thinks it reasonable to suppose that the guns are firing at the troops he is with, he should so inform the latter, in order that they may be obliged to adopt suitable formations. He may give them this information with full confidence, well knowing that, if he himself is ignorant, the accompanying troops at all events have no grounds for contradicting him.

Unless umpires use their imagination in this way, the effect of artillery is apt to be underrated at manœuvres and the importance of artillery support entirely neglected. The artillery gets disheartened, seeing that its best efforts are credited with no result, and the infantry care nothing whether the artillery supports them or not. Eventually neither takes any interest in what the other is

doing, and each fights its own battle independently, which is bad teaching for all concerned.

With regard to the second duty of umpires, that of giving decisions when troops come into collision — as in the case of an assault on an enemy in position — this will generally fall to the senior umpires of each side or the umpire-in-chief, but where tactical operations are spread over a comparatively wide extent of country, and especially when that country is enclosed, broken, or wooded, there will probably be numerous instances even in the early stages of a battle where small bodies will come into close contact, and where the intervention of junior umpires will be necessary to prevent unreal situations being created, and their effect being allowed to influence the operations at large. In such cases junior umpires must act with decision, and while confining their action to the minimum of interference in the position or movements of the troops, they must endeavour to prevent the encounter having a false effect on the general course of the engagement.

For instance, suppose in the earlier stages of an attack on a position local opposition is encountered by some part of the attacking force from defenders' troops occupying an advanced post from which flanking fire can be brought to bear on portions of the attack. Possibly the defenders of the post may be forced to evacuate it by envelopment, but if they do not do so of their own will they must be given credit for the effect which they produce by hanging on, and if they decide to do so to the last nothing short of an actual local assault by a portion of the attacking force should force them to evacuate. It will be for the junior umpires on the spot to watch carefully the conduct of operations on both sides; to see that the approach and assault, if carried out perfunctorily, and in a way which could not have reasonable chances of success in war, are not allowed to succeed; and on the other hand to see that the local resistance of the defender is credited with no greater result than could be expected in view of his strength and preparation for defence, and is not prolonged in a way which would be impossible in war. A wrong decision in either of these directions, or the absence of a decision, may have a lasting false effect on the progress of the whole operations, either by allowing the general attack to be too quickly driven home, or by suffering weak local opposition to act unduly as an impediment to the advance of greatly superior forces. Similar instances of local collisions needing quick decisions are of frequent occurrence in encounter battles, in which the opposing sides meet without opportunities of complete reconnaissance, and each side is striving to obtain the initiative. A golden rule is that a prompt decision, even if it is faulty owing to want of full information, is better than a correct one long delayed.

The following points should receive consideration in judging of the conduct of an attack :—

(1). The choice of fire positions and the manner in which they are approached and occupied.
(2). The use made of the tactical features of the ground and of cover.
(3). The fire preparation previous to the assault.
(4). The co-operation of the artillery.
(5). Superiority of force.
(6). The frontal or enveloping nature of the attack.

In judging of the conduct of the defence the following are the chief points to pay attention to :—

(1). The distribution of the troops.
(2). Whether the position has been artificially strengthened.
(3). The field of fire.
(4). The co-operation of the artillery in the decisive stages of the fire fight.
(5). The use made of reserves for counter-attack.

In coming to a decision as to the success or failure of an attack, due credit should always be given to the moral influence of offensive action. It is desirable to impress on troops and commanders the advantages which are gained by initiative and the offensive spirit, and for this reason, unless the attackers are relatively very weak, or the attack has been misconducted, the attacking side, if there is any uncertainty as to the result, should always have the benefit of the doubt. There is one tendency—sometimes observable at manœuvres—which should be carefully guarded against, viz., the inclination to take into consideration the value of reserves which are not firing. Only the troops which are actually engaged have any tactical value. The presence of others must be neglected as far as the tactical situation is concerned.

When an assault has been delivered, effect will be given to the umpire's decision by ordering the defeated troops to retire behind the line of their nearest supports. If there are no supporting troops the losers will be ruled out of action for a definite period, and will be ordered to withdraw to a specified locality before re-commencing operations. But so that their instruction may not be too much interfered with the period should be as short as possible.

In cavalry encounters, where shock action is used, the *moral* of the defeated side would suffer severely, and in such cases it will generally be necessary to order them to retire from the field for a

considerable period of time in order that the winners may have the opportunity of reaping full advantage from their victory.

The distribution of umpires is a subject which deserves careful consideration. The director of the manœuvres is *ex-officio* umpire-in-chief, and under his authority a senior umpire and a staff of umpires will usually be allotted to each side. The umpires may be allotted to their various duties under the authority of the director, but they will usually be so allotted in large manœuvres by the senior umpire on each side. There are two systems of distributing umpires—they may be allotted to certain units or to certain areas of ground. The director will usually decide which of these two systems is to be followed, but sometimes a combination of the two systems may be convenient, or it may be found that in certain operations one system gives the best result, and in certain other operations the other system is most convenient. Both systems have been exemplified in our own operations and in foreign manœuvres.

When umpires are allotted to units, one will usually be required with each regiment of cavalry, brigade of artillery, and battalion of infantry. These would be divided into groups, each under the senior, and the natural grouping is by brigades in the case of cavalry and infantry, and by divisions in the case of artillery. If enough officers are available it will probably be of advantage to attach an extra umpire to the headquarters of each cavalry and infantry brigade, and to the divisional artillery. This umpire would be the senior of the group, and the control of the umpires in the group would be vested in him. Where units remained long in reserve, the senior umpire of the group would temporarily re-allot the umpires attached to them to other units which might be closely engaged, or to certain areas where the combat was hottest. This facility for local re-allotment of umpires is particularly useful in close country, where several distinct minor encounters may take place simultaneously. As the senior umpire of a group would be in a position to know the intentions of the brigade or other commander to whose staff he was attached directly they were formed, he should be able to provide for any contingency which might suddenly arise.

All reports from umpires with units should be made to the senior of the group, and should be collated by him and despatched either at stated intervals or on the termination of a day's operations to the senior umpire of the side. For this purpose he should be furnished with one or two bicycle orderlies. By this means the second possible disadvantage of the unit system can be obviated.

There will generally be a phase in the operations at the beginning of the manœuvres when the cavalry of the opposing forces are in contact, but the infantry are far apart. In this stage it will be necessary temporarily to withdraw umpires from the field artillery and infantry, and largely to increase the numbers with the cavalry, so as

to provide for the regulation of small affairs of squadrons and patrols, which may be of frequent occurrence in the early phases of the cavalry encounter.

I do not think I can conclude these observations on umpiring better than by quoting the remarks of Major March, of the United States Field Artillery, Director of the U.S. Camp of Exercise at Fort Riley in 1908, in his report on that camp.

He says: "There has been in former camps some complaint of the lack of rank of umpires. I am convinced that the main cause for complaint, if any appears, is not so much lack of rank as lack of fitness for such work, and that in this camp the rulings of officers met with respect according to whether they were deserved, regardless of the rank of the umpire. Duty as an umpire at a manœuvre camp is not appropriate for a man who is out for a jaunt. It requires hard work, and officers who do well should have credit for it in their efficiency reports."

A GRAPHIC METHOD FOR CALCULATING FIELD SUSPENSION BRIDGES.

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

The case of a field suspension bridge, where the piers on either side are the same height and where the cables are loaded throughout their entire length, is simple, and the calculations necessary to find the maximum tension in the cables and the lengths of the slings are fully explained in *Military Engineering*, Part III., para. 189, *et seq.*

The case in which the piers are of unequal height, but where the cables are still completely loaded, is almost as simple, and the modifications in the usual calculations are also explained in the paragraphs referred to above.

The problem however is not so easy when on one or both sides there are unloaded lengths of cable, strained over piers of possibly different heights, or attached to anchorages at possibly different levels. In such a case the simplest method of procedure appears to be a graphic one, whereby the data of the curve of the cable may be obtained and the necessary calculations then made as in the normal case.

Certain assumptions are made in the textbook, in order to simplify the considerations that govern the curve in which the cables of a suspension bridge hang. These assumptions are that the weight of the bridge is transmitted to the cables by an infinite number of slings, and that the weight of the cables themselves can be neglected in comparison with the weight to be carried by them ; in other words, as expressed in *Military Engineering*, Part III., para. 189, "that the load is uniformly distributed along a horizontal line."

It is obvious of course that the foregoing assumptions are not correct, but the inaccuracies involved are negligible in a field structure and the calculations are enormously simplified.

These assumptions will be adhered to in the following investigation. It is true that the errors introduced may appear to be larger in proportion than in the simple case, but even assuming them to become appreciable, their effect will only be to give the roadway a little greater camber than in the theoretical design, and they cannot therefore be regarded as harmful.

Imagine the solution of the problem to have been effected. *Fig.* 1 will then be a diagrammatic elevation of the bridge. A and B are the

anchorages on either side, or may represent the tops of piers over which the cables are strained. CD is the gap to be bridged. In accordance with the assumptions made above, the portion EF of the cable (E and F being vertically above C and D respectively) will be uniformly loaded horizontally, and will in consequence hang in a parabola whose axis OP is vertical. The unloaded portions of the cables AE and FB will be straight and will be tangential to the parabola at E and F. MN is the tangent at the vertex of the parabola, and is of course horizontal.

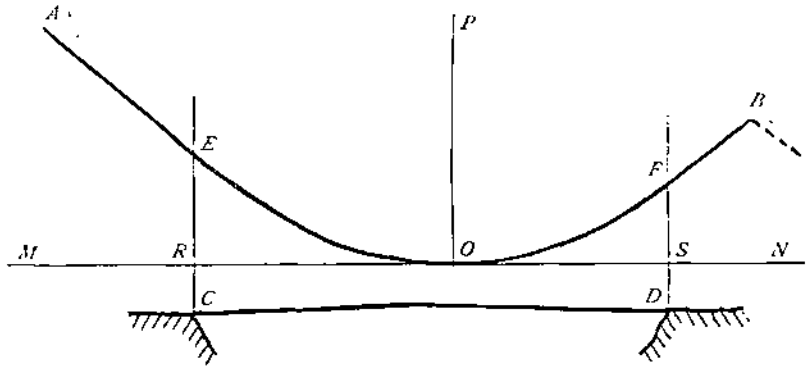

FIG. 1.

The problem to be solved is to find the heights of the points E and F and the position of the axis OP. Another point that might appear to require determination is the position of the tangent at the vertex. As however for any given span the maximum tension in the cables increases as the dip decreases, it is desirable to keep this tangent as low as possible, and its position for any case will be determined by the camber required in the roadway of the bridge, plus an amount required for the length of the shortest sling, due allowance being made for any difference in the level of the abutments.

Fig. 2 represents the parabola formed by the cable. The tangents AE and BF intersect in X, which by a well-known property of the parabola is half-way between the lines ER and FS, parallel to the axis, that is to say, Y, vertically above X, bisects RS, the portion of the tangent at the vertex vertically above the gap CD. Moreover the points T and V, in which the tangents at E and F intersect the tangent at the vertex, bisect RO and OS respectively. That is to say, TV, the portion of the tangent at the vertex intercepted between the lines AX and BX, is half RS.

Now the locus of a point that moves so that lines drawn to it from two fixed points intercept a constant length on a fixed straight line, is a hyperbola. However in most cases of the present problem the portion of the hyperbola involved does not differ materially from a straight line, and can be so considered in a graphic solution. If the

error thus introduced is appreciable, it can be practically eliminated by a second adjustment.

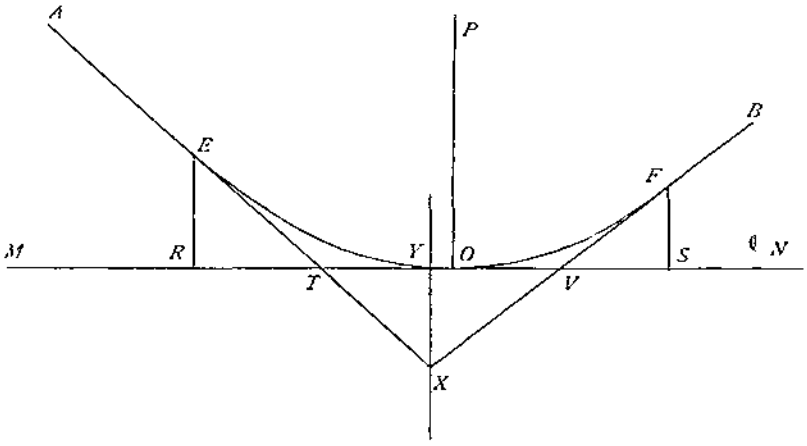

FIG. 2.

The construction then in any case will be as in *Fig.* 3. CD represents the gap, and A and B the position of the anchorages or tops of piers. Draw MN to represent the tangent at the vertex, its position being determined by the considerations mentioned above. Draw CR and DS vertically to meet MN and bisect RS in Y. Let lines AR and BY intersect in G, and let AY and BS intersect in H. Join GH, cutting a vertical line through Y in X. Join AX, BX, cutting MN in T and V. Measure TO along MN equal to RT, then O will be the vertex of the parabola. The accuracy of the construction can be checked by measuring OV, which should equal VS.

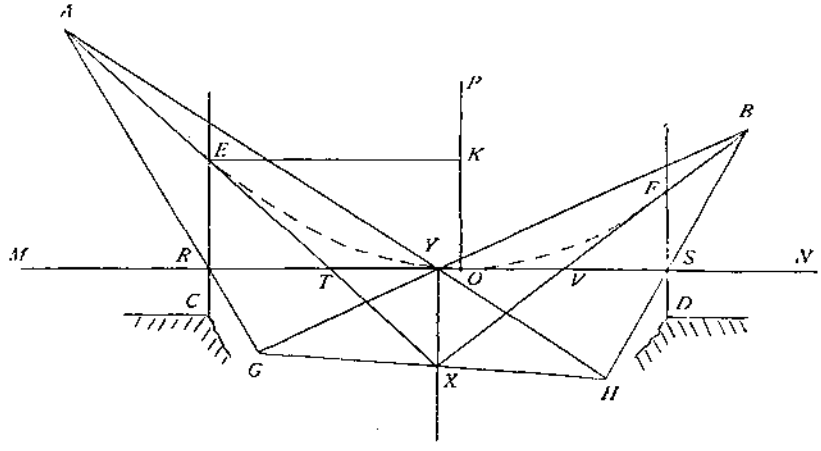

FIG. 3.

Should it be found that this is not true, the position of X can be adjusted, as in *Fig.* 4, by taking two pairs of points, tv and $t'v'$, near T and V, and such that $tv = t'v' = \frac{1}{2}$ RS, and by finding the intersections gh of the lines At, Bv, and At', Bv' respectively. The adjusted position of X will be where gh cuts the vertical line through Y.

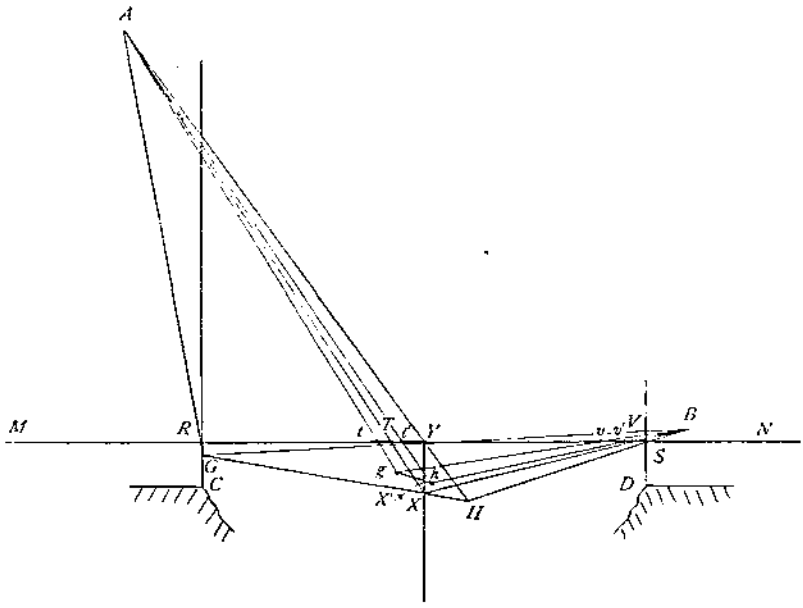

FIG. 4.

When the position of X has been finally settled, points E and F in AX and BX, vertically above C and D, will be the tangent points, and the parabola through EOF can now be completed.

If the tangent at the vertex is on the same level as B, X will coincide with Y, and O with S, and consequently these points can be immediately found.

To find the "dip" of the parabola a horizontal line EK can be drawn, cutting the axis OP in K. Then twice EK will be the equivalent span and KO will be the dip. The horizontal tension can now be calculated, and also the maximum tension which will occur at E or F, whichever is the higher. The length of the slings can also be calculated by the usual formula, or can be measured directly from the diagram. It may be noted that the points E and F are equivalent, as far as these calculations are concerned, to the tops of piers of corresponding heights, and the textbook formulæ can be immediately applied.

UNSTABLE TERRITORIALS OF IMPERIAL ROME, CIRCA 200 B.C.—100 A.D.

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

IN the May number of the *R.E. Journal* particulars in easily digestible, almost tabloid, form were quoted as to the gradual decadence attending the Roman Territorial movement, circa B.C. 200—A.D. 100. How the enthusiasm evinced in B.C. 224, when Italy alone raised 700,000 infantry and 50,000 cavalry, diminished in an inverse ratio as the years rolled on; and how, owing to various causes, compulsion and corporal punishment had a little reluctantly to be applied, and were even more than a little reluctantly accepted.

Further research enables us to probe more deeply into the true causes of this instability, and to diagnose the complaint by means of its carefully recorded symptoms.

Many changes in the social conditions of the times—such as the admission of conquered provinces to the rights formerly enjoyed by Roman citizens only, the cultivation of the land by slaves, the expansion of Empire on the aggressive-possessive system, which necessitated larger numbers and redistribution of troops, the arising of a mercenary spirit, the carping at and questioning of the nostrums and doctrines laid down by leading men, the extensive employment of foreigners in the Army—had necessarily altered the conditions during the period alluded to.

In lieu of the double free issue of corn,[1] formerly and willingly accepted by soldiers for acts of personal bravery, golden crowns were now expected, golden chains or torques, "corniculæ," or brightly polished horns for helmets, fancy clasps, buckles and golden bracelets;[2] neither were double pay (*duplex stipendium*) nor free extra garments looked at askance.[3]

It was also during this time that military decorations and ornamental trappings (*Phaleræ*) came into use as articles of wear by the Imperial Army Horse (*Equites*), such accessories being provided by and charged to a long-enduring public.[4] Moreover, the rigorous discipline and training exacted, at the very time when an inferior substratum of the population had to be tapped, owing to an increased number

[1] Livy, VI., 110, II., 59. [2] Tacit., Annal. II., 9, III., 53; Juvenal, XVI., 60; Livy, X., 44. [3] Cæsar, Bell. III., 53. [4] Virgil, Aen., V., 310; Livy, XXII., 22.

of troops being required for an extended Empire, militated against the popularity of partially voluntary service.

Amongst some of the pains and penalties for wrong-doing were the following minor punishments :—Deprivation of pay[1] (*stipendio privari*) ; to be placed on No. 2 diet of barley instead of on No. 1 scale of wheat (*hordeo pasci*) ;[2] to be bled, or letting out of blood (*sanguinem mittendi*) ;[3] to be expelled into the wilds from camp winter quarters (*a castris segregari*), and to be employed on heavy fatigue work.[4]

Some of the more severe punishments were :—

To be beaten with rods (*Vergis coedi*) ;[5] to be scourged and sold as a slave and to suffer the bastinado (*Fustuarium*), which was the usual punishment for theft, perjury, or desertion ;[6 7] to be overwhelmed with stones (*lapidibus cooperiri*), or by hurdles (*sub crato necari*) ;[8] to be beheaded[9] (*securi percuti*) ; to be crucified[10] and to be left unburied ;[11] to be stabbed by the swords of the brother soldiery ;[12] and, finally, in the days of Imperial Rome, to be exposed to wild beasts or to be burnt alive, etc., etc.

Although the pay of the soldier had steadily, if not rapidly, increased from the sum of 2½d. (B.C. 216) up to A.D. 100, when it stood at 7½d., discipline does not appear to have benefited thereby, for it is recorded in *Tacitus*, Annal. I., 17, that on occasions the extra emoluments received by the men were used in bribing their Centurions, with a view to obtaining certain restrictions from digging, forage, water, and wood fatigues on arriving late in camp after a heavy day's march.[13]

Another source of discontent was due to a difficulty in having to wait before obtaining the "Missio Honesta," or ordinary discharge after 20 years' service with the eagles. To obviate this trouble, Augustus introduced a new kind of discharge termed the "Exauctoratio,"[14] by which all those male adults, who had served throughout 16 campaigns, were exempted from all military duties except that of fighting, their services being retained in a special reserve as "Veterani," until they should receive the full discharge and the rewards for their services (*Præmia vel commoda militiæ*) either in lands or in money, or in both. Sometimes however this final settling up of accounts, as is most carefully recorded, was never completely accomplished.[15]

[1] Livy, XL., 41. [2] Livy, XXVII., 13. [3] A. Gellius, X., 8. [4] Vegetius, III., 4. [5] Val. Max., II., 7, 4 ; Juvenal, VIII., 247. [6] Livy, Epit. 55. [7] Livy, V., 6 ; Cic. Phil., III., 6 ; Polyb., VI. [8] Livy, IV., 50. [9] Livy, Epit. XV., XXVIII., 29. [10] Livy, XXX., 43. [11] Val. Max., II., 7, 15. [12] Tacit., Annal. I., 44. [13] Tacit., Hist. I., 70. [14] Pliny, Ep. VI., 31. [15] Suet., Aug., Cal., Cic., Phil., Virg., Horat., Sat., Tacit., Annal. I., 17 ; Tiber, 48 ; Dio., LIV., 25, etc.

PROGRESS IN THE MANUFACTURE, TESTING, AND EMPLOYMENT OF PORTLAND CEMENT.

By J. G. BAXTER, F.C.S.

Lecture delivered at Chatham, February 18th, 1909.

I WILL not trouble you with ancient history further than to say that Portland Cement was the name given to a material manufactured from a mixture of chalk and clay as long ago as 1824, the patentee of the material being Joseph Aspdin. The name Portland Cement, I think, arose from the resemblance of this material when set to the well-known Portland building stone. Of course, at this early stage and for many years afterwards, the manufacture of Portland Cement was conducted on an extremely small scale, and in a very haphazard fashion; indeed, a great quantity of this material was never even calcined to incipient vitrification, as is necessary for the production of what is now called Portland Cement. From a variety of causes, for a long time very little notice was taken of this new material, but its obvious advantages gradually brought recognition, and we find that about 1850 it was being manufactured in Kent, at Northfleet, by Messrs. J. B. White & Sons, from chalk on their own premises and clay from the saltings at the mouth of the Medway, and also at one or two other very small factories. The majority of the records previous to this date are those of Major-General Pasley, who appears to have devoted considerable time and attention to the whole matter.

After 1850 however the manufacture of Portland Cement began to go ahead, possibly due to some extent to the interest the material excited during the Great Exhibition of 1851, and also began to get on more or less general lines. Several factories in and about Northfleet, on the Thames, and Rochester, on the Medway, came into being. This was of course only natural on account of the proximity of practically inexhaustible supplies of what is perhaps the best, and certainly the most easily worked, raw material for the manufacture, namely, chalk and Medway clay.

The general method of manufacture about this time was as follows:—The chalk was dug then, as now, from the cliffs near the works and the clay brought from the Medway saltings in barges. These two materials were put down somewhere near an arrangement called a washmill, consisting of a kind of pan about 12′ or 14′ in diameter and about 4′ deep, in which revolved harrows with tines on much the same principle as those one sees in the fields. The materials were shot

into the washmill in the proportions of practically 3 parts of chalk to 1 part of clay, together with a very considerable amount of water, some 70 per cent. in fact, and produced 2 parts of cement. The action of the mill naturally broke up the chalk very fine and mixed it with the clay and water into what was called "slurry." This "slurry" was pumped into large tanks called "backs," some 4′ deep and about 1,000 square feet in area, in which it was allowed to settle. When, after a long period, by drainage and evaporation the mixture had become fairly stiff, it was dug out and wheeled away to "floors." The "floors" consisted of iron plates, covering flues, along which the products of combustion from numerous furnaces travelled, on which it was heated until dry. The dry material, called "slip," was then taken and placed in a kiln much the same as a lime kiln, in layers of some 8″ or 9″ thick, each layer of slip having between it a layer of coke some 3″ or so thick. The material was lighted at the bottom of the kiln, and in the course of four or five days, according to the size of the kiln, had burned out, and there remained some 20 tons or so of a semi-fuzed mass called "clinker." This was then wheeled away to crushing machines. (In very early days the clinker was broken by hand, but this was soon given up owing to the cost). After passing through the crushing machines it was put through millstones about 4′ 6″ diameter made of French burr, a peculiarly hard and tough stone. The product of this grinding was the Portland Cement of commerce.

This describes in brief the method of manufacture about 1850 and for some very long time afterwards, indeed, even to-day in one or two of the very old factories this same method is in use with some slight modifications. The first improvement of any real moment was the transition from what is called the "wet" process to the "semi-wet," that is to say, instead of breaking up the chalk and clay with about 70 per cent. of water, this was done with 40 to 45 per cent., and the product of the washmill was in this case passed through millstones to obtain the particles of chalk in a finer state than had previously been the case. The raw product was now in the state of a thick kind of mud, and this, instead of being pumped to the backs or ponds, was pumped direct to the drying floors. This stage marks a real advance, both from the point of view of cost and of quality, as it showed a recognition of the advantages of the finer grinding and better intermingling of the particles of the two ingredients in producing a better quality of clinker. About the time this semi-wet process was introduced a few of the better class manufacturers began to recognize the influence of a more regular proportion of chalk and clay in the slurry upon the regularity of their cement, and an instrument called the calcimeter was introduced. This instrument was used for testing the proportion of chalk in the slurry, and thus indirectly the amount of lime in the finished cement. Previously the regulation of the proportions of chalk and clay had

been done in a very rule-of-thumb way. Some manufacturers burned a small portion of the mixture in a sample kiln, which was a practical way, but others judged the composition by tasting the slurry or by looking for crystals of lime as they were called in the clinker, others again in other ways equally ridiculous.

The next advance was of more use in reducing the cost of manufacture than in improving the quality of the product. It was the addition of a drying chamber to the bottle kilns, whereby the waste heat from the burning of one charge dried the slip for the next charge; this method is still in use to some extent.

About 1880 a Mr. Ransome conceived the idea of calcining the raw mixture in a rotary cylinder and thus doing away with the large amount of labour employed in the loading of the intermittent kiln, as it is called. This process was tried at two or three works in England, at Arlesey, near Cambridge, and at Gibbs' Works, at Grays, Essex. Producer gas was used for firing and the kiln was about 30′ long by about 3′ diameter. The process however proved a failure owing to several causes, the principal one being the difficulty of generating sufficient heat to calcine the raw materials. During all this time, as may be imagined, the demand for cement had been increasing enormously, and this district had become the centre of the industry, cement being shipped to all parts of the world from here. This state of things, of course, could not continue indefinitely, and people in other countries and other parts of our own country began to cast around for raw materials, and naturally found them, although not in the same form as chalk and clay. For a long time it had been thought that these two materials were absolutely necessary for the production of cement, but with better knowledge of the constituents it became obvious that any materials or combination of materials having the right composition, without any deleterious admixture, could be used successfully.

During the whole of this time Portland Cement had been essentially a British production, and all advances and improvements had been made in this country. The next real advance however was made in America. It was found there that although there was no chalk available there was an abundant supply of limestone, and shale instead of clay. These materials however on account of their characteristics did not lend themselves to the same treatment as in England. They could not be ground sufficiently fine unless they were dried, and as they contained only a comparatively small amount of moisture, this was easily done. Now after they had been ground together, it was on the face of it foolish to add a lot of water which would have to be evaporated to the material, merely to get it into a condition to load into intermittent kilns, which themselves would have meant a lot of expensive labour; so here was the opportunity for the rotary kiln. The Americans however did not bother with gas

firing; they started with oil and with kilns 60′ long, and after some little time were successful with this method of manufacture. Oil firing however was somewhat expensive, and ground coal was tried with success.

The Germans had during this time been faced with somewhat the same difficulty as the Americans, but as labour with them was cheap and fuel comparatively dear, they struck out a new line by the introduction of the continuous chimney kiln, in which the least possible amount of fuel is used. The dry materials, after being ground together, were pressed into bricks and burned in a very tall, narrow kiln, with alternate layers of fuel and slip or bricks, being continually loaded at the top and drawn at the bottom. This system, although much cheaper in fuel consumption than the rotary kiln system, was somewhat costly in labour. During this time, both in England, America, and on the Continent, it had been recognized that the more finely ground the clinker the better the resultant cement, and it soon became apparent that something better than millstones were required for this purpose. Very many different mills were invented and tried, but the most successful machine, and the one which made the great advance in grinding possible, was the tube mill. This consists of a cylinder 30′ × 5′, supported at both ends and revolving at about 27 r.p.m., lined with steel plates and about half-full of pebbles (*Fig.* 1). Practically every manufacturer got one of these mills and put it on to the end of the mills he was then using, in the great number of cases millstones. After this came the ball mill, which is now almost universal in place of millstones as a preliminary grinder for a tube mill.

This consists of a drum 6′ × 5′ long, revolving about 25 r.p.m., with steps inside, and having inside a charge of about 2 tons of steel balls from 5″ diameter downwards (*Fig.* 2). These, by their action of rubbing against one another and falling over the steps, break up the clinker fairly fine, and from here it passes to a tube mill to be finished.

It will be obvious that, by the infinitely increased fineness of grinding, the chemical action of the water when added to the cement was enormously increased, and quick-setting cements resulted, and, owing to the better results obtained from a comparatively slow-setting cement, some method of regulating the setting time became necessary. Many things were tried, but until a few years ago the only one which was of any practical use was the addition of from ·5 per cent. to 2·5 per cent. of gypsum. Since then however Mr. Bamber has invented what is called the hydration process for this purpose. This consists of blowing a certain amount of steam, depending on the setting time required, into the tube mill (*Fig.* 3).

This process has much simplified the setting time question, as well as improved the quality of the cement, owing to the effect of the steam in making stable the less stable compounds in the cement.

We will now turn to the question of burning clinker in England

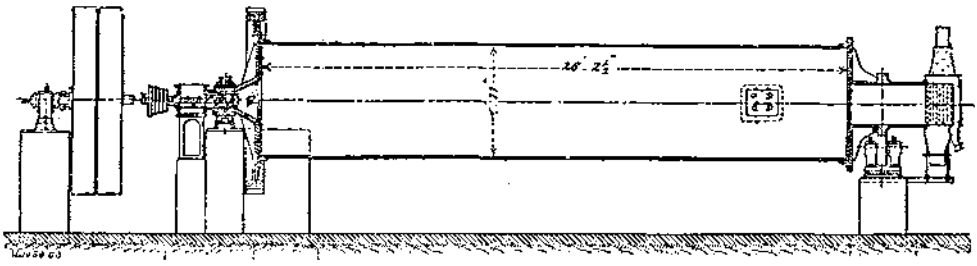

FIG. 1.—Longitudinal Section of Tube Mill.

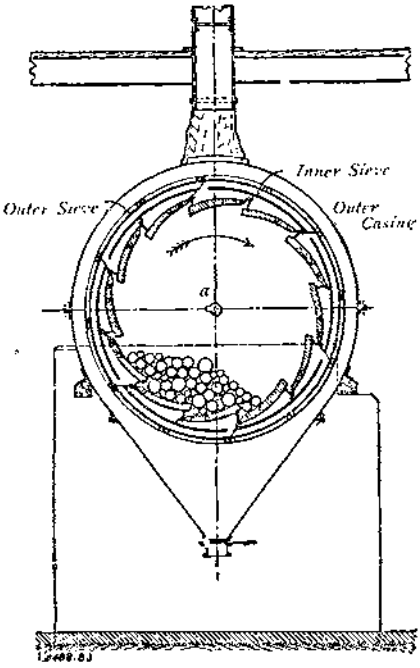

FIG. 2.—Section of Ball Mill.

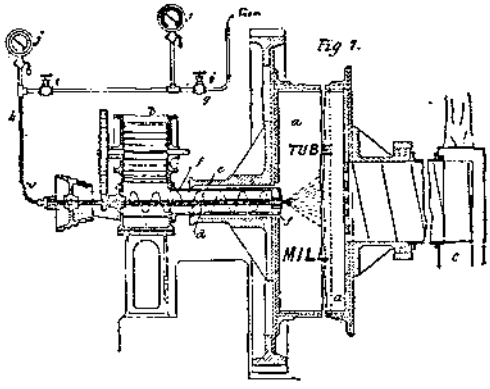

FIG. 3.—Hydration Apparatus applied to Tube Mill.

(British Patent No. 22735/02).

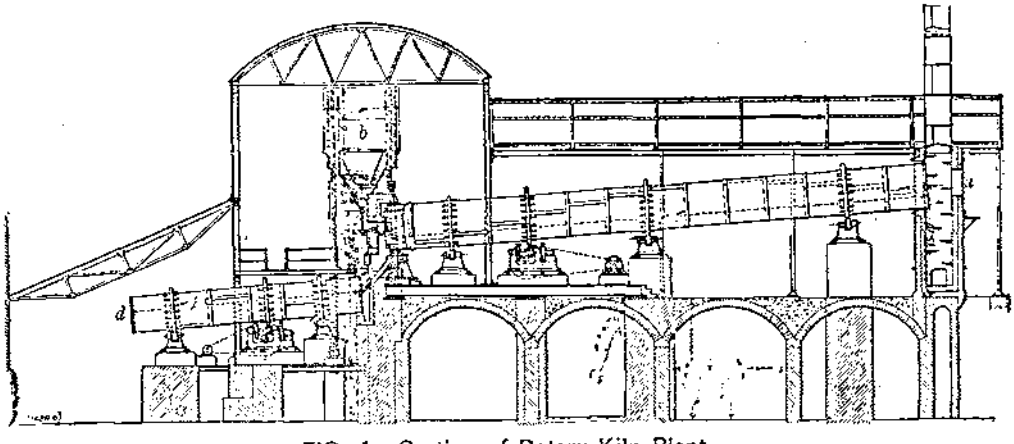

FIG. 4.—Section of Rotary Kiln Plant.

a Slurry Feed End of Kiln. *b* Powdered Coal Hopper. *c* Jet Burner. *d* Cooler.

again. When it was seen that the rotary kiln with powdered coal was successful in America, the English manufacturer began to recognize that he would benefit by it, and a battery of 16 was erected at the J. B. White works of the Associated Portland Cement Manufacturers about 1900. These were 70′ long by 6′ diameter, but have been improved out of recognition by lengthening and in other details, until, whereas they produced in 1900 about 1,500 tons per week, they are now producing some 7,000 tons. The limit has not however been reached, as there are now being erected kilns 160′ long by 10′ diameter.

I will now give a description of a modern cement works.

In the wet process, with soft wet raw materials such as chalk and clay, the chalk is dug by steam diggers in some places and by hand in others, the clay being dug by grab dredger. Both of the materials are brought to the washmills in wagons holding a definite amount, the contents of the wagons being shot into washmills of a larger and stronger type than that previously described. The washmills are in batteries of about six, the materials and water passing on from one mill to the other through a screen, each mill having on a finer screen than the previous one, until, after passing the sixth mill, the whole of the slurry has passed through perforated plates with holes only $\frac{1}{40}$″ diameter, and is practically an impalpable powder mixed with water.

The proportions of chalk and clay are regulated by a chemist, who takes a sample from the washmills every half-hour and tests the proportions of the ingredients by means of a calcimeter, and also the percentage of water present, which should be about 40 per cent.

The product of these mills is so fine that only some 3 per cent. of the material is too coarse to pass through a 32,400-mesh sieve.

The slurry, as it is called, is then pumped to large storage cisterns about 70′ diameter by 10′ deep, each holding sufficient for 500 tons of cement. In them the slurry is kept in constant agitation night and day. Just before a cistern is full the chemist takes a sample and tests it. If the composition is not exactly right, it is made so by the addition of slurry rich in chalk or in clay, as the case may require. After thorough mixing in the cistern, the slurry is pumped away to the rotary kilns.

In the dry process, with hard, comparatively dry materials, such as limestone and shale, after crushing, each is shot into its own dryer, consisting of a revolving cylinder about 5′ diameter by about 50′ long, with a furnace at one end; this drum being inclined, the material passes along through it, meeting a current of hot air from the furnace and losing the whole of its moisture. The two materials are then elevated into hoppers, each with an automatic weighing machine set to deliver a certain amount of each material, according to the proportion determined by the chemist in charge, who is constantly taking samples for testing and altering proportions when necessary. After being weighed the materials come together and go into a mill, in the

majority of cases a ball and tube mill combination, where they are ground to an extreme fineness and then elevated to large storage hoppers, from which the mixture is fed to the rotary kilns.

From this stage onwards the dry and wet processes are alike, and are as follows :—

The rotary kiln is a long cylinder about 150′ × 7′, inclined to the horizontal about $\frac{1}{2}$″ to the foot. This cylinder is mounted on several sets of roller bearings at suitable intervals, and is rotated through gearing by a motor, the speed of which can be varied. This cylinder revolves about 1 r.p.m., and is lined about three-quarters of the way along from the lower end by fire-resisting blocks ; the remainder of its length is sometimes not lined, sometimes lined with concrete. The upper end projects into a housing connected with a large flue with dust-catcher arrangements, this flue ending in a large chimney some 250′ to 300′ high (*Fig.* 4).

The raw materials enter the upper end of the kiln and soon lose whatever moisture they may contain by meeting the heat travelling up the kiln. The next stage, as they get nearer the intense heat, is the loss by the chalk, or limestone, of its carbon dioxide. This occurs when the temperature is some 700° C. The material is now in the form of small balls about the size of a walnut, and next coming into the hottest part of the flame, about 1,400° C., these are cintered, and combination takes place between the lime as it now is and the clay, forming, when cold, a dense hard black nodule. The whole of this operation is under the control of a skilled attendant, who watches everything through smoked glasses and has control by levers just to his hand of the coal supply, and consequently the heat, the speed of rotation of the kiln, and the speed of supply of raw material. It is here where the great difference will be noticed between the new and the old process. In the old, when a kiln was loaded it was left to itself, and good, bad, or indifferent product was to a great extent a matter of luck. Here it is a definite and controllable operation. The white-hot clinker then falls into a cooler, which is a cylinder inclined like the kiln, about 50′ long by 6′ diameter, fitted with shelves, which, as the cooler rotates, picks up the clinker and drops it through the current of cold air rushing up through it to supply the necessary oxygen for the combustion of the coal in the kiln.

The clinker now issues quite cold and is taken to hoppers over the grinding mills, which are almost invariably of the ball and tube variety already described. In the tube mill the nearly finished cement is subjected, as has already been described, to a steam-saturated atmosphere, the degree of saturation of which can be controlled. From this mill it goes straight to the warehouses, where it lies in heaps until tested by the customer and despatched.

It will now be seen how from a very rough-and-ready hope-it-will-be-all-right way the manufacture of cement is now in all the stages

under the most perfect control, with the resultant most satisfactory product.

Some work has been done in America by actually fuzing the raw material to clinker in a kind of blast furnace to save the preliminary grinding and mixing, but has come to nothing.

We will now compare the cement of 50 years ago with that of to-day, and you will see the enormous advance that has taken place in the quality.

Setting Time.

Was whatever it happened to be.	It is now almost anything one asks for.

Fineness.

Was 20 per cent. residue on 2,500-mesh sieve.	It now is commonly 5 per cent. on 32,400, and sometimes as low as 2 per cent., although only 18 per cent. is guaranteed.

Tensile Strength.

Was about 400 lbs. on a $1\frac{1}{2} \times 1\frac{1}{2}$ brick at 7 days, that is 177 lbs. per square inch.	It now requires 600 to 700 lbs. on $1'' \times 1''$ briquettes at 7 days to break it.

Soundness.

No comparison whatever, as no tests were made until comparatively recent years.

We now come to the question of testing, which is, as you know, very important, and the source of almost all the dissatisfaction between manufacturer and user.

From the very first some attempt has been made to test the strength of the cement supplied, and naturally these attempts took the form of tensile tests as being the most easily carried out. The early experimenters in this direction chose the very practical way of sticking two bricks together with the cement and seeing how much pulling apart they required. Various forms of this test were in vogue until the briquette mould was introduced. The cement after gauging was put in this mould, allowed to set for a certain period, sometimes under water and sometimes not, and at given dates the briquette was put into a machine and weight applied until the briquette broke. The early briquettes had a breaking section of $1\frac{1}{2}'' \times 1\frac{1}{2}''$. This size was customary for some time, but the unwieldy nature of the briquette, together with the fact that the quality of the cement was constantly improving, necessitated the making of a smaller briquette, and the $1''$ section was adopted, which to-day is the standard in English-speaking countries. The shape of the mould has undergone certain modifications, but through the efforts of the British Engineering Standards Committee one particular shape has

now been agreed upon, at least so far as this country is concerned. The shape adopted by other nations differs but little from our own. About the time of the advent of finer grinding it was noticed that the tensile strength of the neat briquettes did not show the increase in strength which it was thought finer grinding would give; and as cement was seldom used without an aggregate, sand briquettes began to be made. At first of course this was done in a very rough way, but later, as the value of this test was recognized, a standard sand was adopted and also a standard proportion; the standard sand comes from Leighton Buzzard and must all pass through a 20-mesh sieve and all be retained on a 30-mesh; and the standard proportion is 3 of sand to 1 of cement, by weight.

The first tests for soundness were made many years ago by simply making up a block of cement and noticing whether after a certain time it fell to pieces or not. Then small pats were made up, sometimes on glass, and after having set were immersed in water. After different periods they were examined to see if they had cracked.

The first real attempt to get a satisfactory soundness test quickly was made by the late Mr. Henry Faija, who instituted the test which bears his name; this was the placing of a pat of cement, gauged with about 25 per cent. of water, in moist air for four or five hours, and then in water at 115° F. for 17 or 18 hours. If the pat did not then show any cracks, the cement was considered sound and fit for use.

The advances on this particular test came as follows:—First the Deval pat, which was similar but the temperature was increased to 170° F. After this came the boiling test; in this case the pat, after being allowed to set in air for 24 hours, was subjected to immersion in water, which was then brought to boiling point and maintained there for six hours. M. Deval, in addition to the pat test as described, instituted another on somewhat similar lines, namely the Deval briquette test. This test consists of making up briquettes of 1″ section both neat and with sand, allowing them to remain in air 24 hours, and then placing them in water at 170° F. for six days, after which time if the cement is sound it is supposed to show a strength equal to that to which a similar briquette treated in the usual way would attain in 28 days. This is a fairly good test, as if there is anything radically wrong with the cement no strength will be obtained.

Several other tests of more or less value have been invented, but have now dropped out of use, such as making a ball to just pass through a certain ring, boiling it, and then seeing if it still passed this same ring; also making up pats and subjecting them to a high temperature in an oven and noting their behaviour. A very elaborate machine was also devised in Germany for measuring the expansion of small bars of cement; numerous other tests of less note have been also devised.

The accelerated test however, which has been adopted by the

British Standard Specification Committee, is that known as the Le Chatelier expansion test, a test which has the merit of being simple and one whereby the degree of merit, so to speak, of the cement can be measured, and withal it is fairly severe. This test consists of gauging up the sample of cement (after it has been laid out in a thin layer some $\frac{1}{4}''$ thick for 24 hours) with about 23 per cent. of water and placing it in a split cylinder, packing it fairly tightly to remove air bubbles. Over each end is placed a small piece of glass or metal, and the mould is then placed under water. After 24 hours it is taken out and placed in boiling water for six hours, preferably being placed in cold water and brought up to the boil. The distance between the ends of the forks attached to the cylinder is measured just before boiling and again after boiling, the difference between the two readings representing the expansion of the cement under test. This, according to the standard specification, must not exceed 10 millimètres after 24 hours aeration. But if it does the cement need not be condemned, but is left spread out for a further period of six days, with occasional turning over, and again tested as before; if this time it does not exceed 5 millimètres, it may be assumed to be quite satisfactory. Something even more stringent than this is called for at times; thus considerable amounts of cement are supplied to a specification which only allows 1 millimètre expansion after 24 hours' aeration, and such are modern methods of manufacture that it is quite possible to do this, although at a somewhat increased cost. Should anyone be in a hurry to get this test over and not want to wait the whole six hours for the result, I may say that an expansion of under 10 seldom goes any further after one hour's boiling.

The analysis of cement is a somewhat long process, and although to some extent necessary, it has only come into vogue in the last few years, although a few of the more advanced users of cement have been in the habit of specifying a certain limit to the amount of calcium oxide a cement should contain, for some considerable time. Then it was recognized that some limit should be placed on those manufacturers who did not scruple to add cheaper inert material to their product, obviously for their own benefit. Thus the insoluble residue is limited to $1\frac{1}{2}$ per cent., which prevents such things as broken bricks, silica, etc., being ground with the clinker. The percentage of magnesia also received attention, chiefly owing to a very considerable failure of work in the Aberdeen Harbour. A limit has been put to this, namely 3 per cent. Sulphuric anhydride is also another ingredient which it is as well to keep within reasonable limits, this being set at 2·75 per cent. Sulphides should be excluded, although with the modern cement manufactured from the usual materials it is not likely that much of these compounds will be present, as they disappear during calcination, especially in the rotary kiln. The proportion of calcium oxide to that of alumina and silica

should also be within certain limits represented by $\frac{CaO}{SiO_2 \& Al_2O_3}$, calculated in chemical equivalents, not being greater than 2·85. Thus slag cements, or additions of slag cements, or the dangerous Belgian natural cements are detected.

The chemical analysis however should never be carried out except by one very experienced in this class of work; any amateur attempt is sure to lead to trouble.

Now as to the weight of cement. A heavy cement has from the very earliest times been looked upon as a proof of a good cement, and thus among the first tests was the old one of weight per bushel; the heavier a bushel of cement the better was thought to be the quality. In course of time a regulation hopper was designed for filling, as there was scarcely any limit to the weight of cement which would be packed into a bushel measure by shaking and such dodges. As fine grinding came in however it was recognized that whatever use this test might have been formerly, it was no longer of any value, as the more finely ground the cement the lighter it weighed, independently of the kind of clinker it had been made from. This test gave way a few years ago, although then only very gradually, to the more rational and scientific one of specific gravity, which is not affected by the fineness of grinding. The minimum specific gravity has been fixed by the Engineering Standards Committee at 3·15 for freshly ground cement and 3·10 for cement which has been ground four weeks. This test is of use chiefly for the detection of adulterations by natural and slag cements, as well as of limestone and other such material, and is fairly simply carried out. It is however a test in which care should be exercised; it is very easy to carry out, but equally easy to get a wrong result.

We now take the fineness of the cement. You will recognize that only certain portions of the cement are of any use as cementitious agents, the coarse nibs simply behaving like so much sand, at least for a very considerable period after use. Roughly speaking, the cementitious particles are those which will pass a 200 × 200 mesh to the square inch sieve, that is a sieve containing 40,000 meshes to the square inch. There has been only one way of carrying this test out all along, that is by sieving the product. The start was made with a 50-mesh sieve, that is one with 2,500 holes to the square inch. When this test was first introduced 25 per cent. was the usual residue on this sieve; as competition grew stronger and the value of fine grinding was recognized, this figure was reduced, usually by one manufacturer going one better than his rival, until about 12 years ago 5 per cent. on this sieve was the practice.

Since the advent of better machinery the 50 sieve has disappeared, and the 180, that is one with 32,400 meshes to the square inch, takes its place, which you will see is a very considerable advance. Well,

the start on this 180 sieve was 25 per cent., then three years ago 22½ per cent., two years ago 18 per cent., and to-day many firms, notably the Associated Portland Cement Manufacturers, who are the pioneers of fine grinding in this and all other countries, are supplying quite as an ordinary thing cement leaving only 5 to 6 per cent. of residue on a 180-mesh sieve, or 10 per cent. residue on a 200 sieve (40,000 meshes to the square inch). This is at present, and is likely to remain for some time, the limit. I may say that in testing with these very fine sieves it is not sufficient merely to roll the cement about in the sieve; it must be very vigorously shaken and knocked on a bench or something, or the wires will get clogged and it will be impossible to get the quantity of stuff which should go through to pass. There have been some attempts made at different times to get a machine which would separate the flour from the useless material. The only one however which has had any measure of success is that known as the Goreham Flourometer. This is an apparatus by which a certain amount of air at a certain pressure is blown through the cement and carries with it the finer particles of cement; the residue is weighed, and by difference the amount of flour is obtained. This is a cumbersome machine and is of very doubtful value indeed. Recently an attempt has been made to supply the elutriation method with turpentine instead of water to this purpose, but this again appears to be an attempt to supercede a simple and sufficient test, at least for practical purposes, by something much less reliable.

Setting time. This test is one of considerable importance. In the early days when any test was made of this property a mass of about 14 lbs. was mixed up with whatever amount of water the operator considered necessary and put on a piece of board or stone, or even left on the ground independently of whether it was cold or hot; the gentleman testing then promptly forgot all about it for about six hours, when he came back and usually found it set, which was of course all right. Gradually this gave place to more exact methods, commencing with gauging up a comparatively small amount and making a pat, considering it set when the thumb nail applied more or less lightly to the surface made no impression; here one can recognize almost unlimited possibilities for mistakes. This however gave place to a pat made up with an amount of water usually 22·5 per cent., but even now, left in the British Standard Specification, somewhat ambiguous, and a so-called needle of a particular pattern placed on the pat at suitable intervals. This needle weighs 2½ lbs. and has a point $\frac{1}{16}''$ square. When this needle fails to make an appreciable impression the cement is considered set. Incidentally, the initial set is supposed to have commenced when the needle fails to completely penetrate the pat. Neither of these give an absolutely accurate result. I personally consider the needle used on the Continent known as the Vicat Needle gives more accurate results, but is

much more troublesome to work than our standard needle. In the first place, with the Continental, or Vicat, Needle a definite amount of water is used and the thickness of the pat, or in this case block, is prescribed, also the final mark is more easily placed. The easiest way to take the final set with the British needle is to take the mark just before all four sides of the point of the needle are not clearly shown after lightly applying it, and only allowing it to remain just long enough to get the weight of the needle. This final mark has become somewhat more difficult to detect since the advent of cement made in rotary kilns, as such cement, being practically pure, has the peculiar property of setting and still remaining just impressionable on the surface to the British needle for considerable periods after it has really set. Thus, although the setting time of a given cement may be only one hour, it is quite possible to get this peculiar impression up to some four hours afterwards, and this of course may easily give rise to disputes. In addition to this point it should be stated that the setting time of cement is the point over which mistakes in testing are most likely to be made. Care should always be taken to keep the temperature as near 60° F. as possible; always make sure that the cement is cold; always put the pat of gauged material on non-porous stuff, glass preferably; keep the pat away from direct heat from any source, especially sun; keep out draughts as far as possible; also gauge up with as near 23 per cent. of water as possible, but in any case the pat must show wet when finished, but not be at all sloppy.

An attempt has been made to record the setting time by recording the rise in temperature by means of an apparatus consisting of a kind of camera, which photographs the height of a column of mercury in a thermometer placed in a block of gauged cement. Needless to say, this is another of those things which are interesting scientifically, but of very little practical value.

Now to return to the tests for tensile strength. I have told you how matters are now practically settled down to the 1″ section briquette of the well-known shape, both for sand and neat briquettes. In addition to the cement having a certain tensile strength at seven days, it has been recognized, more especially of late years, that this strain should show a certain increase as time goes on; naturally not so great when the starting point is high, but still some. Thus it has been settled that from 7 to 28 days the increase should be from 25 to 5 per cent., varying according to the seven days' result in the case of the neat briquettes, and 20 per cent. in any case for the sand briquettes.

Now a great deal of care is necessary in making up briquettes. It is about as easy a thing as possible to fill a briquette mould with a mixture of cement and water, or cement, sand, and water, but as in the case of many other things there is considerably more in it than appears on the surface. Thus most of the gauging done now is what

is called dry gauging. That is to say the neat cement is mixed with only about 18 or 19 per cent. of water and the sand briquettes with about 8 per cent. Whether this method of gauging, or that with about 22½ per cent. of water, is used, it is absolutely necessary that the water and the cement be very thoroughly worked together for some little time before being placed in the mould. Also the mould should not be filled in one lump, but a small piece must be pressed into place with a piece of wood; another portion is then placed in the mould and this lot is pressed into the other, and so on until the mould is full, and in fact more than full, so that a thoroughly sound, close briquette, free from air bubbles, is produced. The whole of this operation, after the addition of the water, must be carried out as expeditiously as possible, preferably gauging only sufficient to fill one mould at a time. The top should be smoothed off and the mould allowed to stand in air 24 hours; preferably the moulds with the briquettes in should then be covered over with a piece of sack (not a cement sack, by the way—they are valuable) saturated with water.

In making a sand briquette the sand and cement should be very thoroughly mixed before water is added, and even more care should be taken in compacting these briquettes than the neat ones; also they should be very carefully handled when being removed from the moulds, as they are easily damaged. When breaking briquettes they should be placed in the clips very carefully and squarely, or a bad break will result. When briquettes which have been boiled or placed in the Deval bath are to be broken, they should be allowed to get cold before breaking, or a much lower strength will be shown.

One further test for cement, I may mention, is now coming to the fore, the compression test. This is really a more useful test than the tensile one, but is far more difficult to carry out, the necessary apparatus being more cumbersome and the results not quite so regular. Although concrete is practically always used in compression, the carrying out of this test is not perhaps so important as it might appear to be, because the more easily obtained tensile strength bears a fairly constant ratio to the compressive strength, namely, 1 to about 9. However when carrying out this test the largest sized blocks should be made that it is possible to deal with in one's machine, a hydraulic machine should if possible be used when crushing, and great care must be taken in placing the blocks fairly in the machine. The pressure really should be applied, especially on smaller sized cubes, through leather or felt or something which will take up the irregularities of the surface; also the cubes should be crushed the way they are made. If carelessly made they may be laminated, in which case if crushed sideways a poor and unrepresentative result will be obtained.

I should like to add that if on testing a cement anything is found to which exception is taken, the point should be very carefully looked

into before blaming the manufacturer, and in nine cases out of ten, especially if the cement be the product of a reputable English maker and guaranteed to comply with the requirements of the British Standard Specification (and no cement used, at least by any of our countrymen, should be anything else), it will be found that it is not the cement at all, but some little thing in the testing. Thus one example :—A cement may have been ordered of a slow-setting kind. It is sent out to, say, India and tested on a fearfully hot day by someone who wants to get away from the job. Well, he may make it a medium or even a quick setter, according to the heat or the length of time he has at his disposal, and the manufacturer is blamed. It is not much use, for example, if you have an hour to spare to start to make a setting time test of a slow-setting cement; something is going to be wrong. I could give you dozens of examples such as these which have come to my notice, where the manufacturer is blamed quite without cause.

Now, as to the progress in the use of Portland Cement. From the very earliest days of the industry the use of this material was simply as a substitute for the lime, hydraulic and other, and for the various Roman cements in use prior to its introduction. During the first half of last century Portland Cement had a very hard fight to demonstrate its superiority over the articles just mentioned, some of which had been in use since the earliest times; indeed it was not until the latter half of the 19th century that Portland Cement by its constantly improving quality and inherent advantages really began to seriously displace these materials. During this period however we find an ever-increasing quantity of large works carried out in Portland Cement concrete, until to-day there is comparatively little demand for lime or the other kinds of cement, except perhaps natural cements, which mostly come from Belgium, and even for these the demand is very properly dying.

In the early days of its use, and even later when it was becoming more widely known, there were several failures of works carried out with this material, and this naturally had the effect of to some extent retarding its progress. These failures were practically all due to the fearfully bad quality of the product, owing mainly to the very crude methods of manufacture then in use. The really intelligent use of Portland Cement may be said to have begun about the time the system of construction known as reinforced concrete was invented. This is commonly attributed to M. Monier about 1876. It must not be thought that the use of iron in concrete was not known before this, as I have seen concrete made many years before that date which had bars, old rails, and so on embedded in it. The iron which was put in however was placed, one might say, indiscriminately; no reliance was placed on it, the sole idea being that while it did no harm, it might make the concrete stronger. About this time how-

ever the price of cement had become much lower, and larger works were being carried out in concrete, more attention was being given to the subject in this country, in Europe, and in America, and the larger users began to recognize that concrete was something more than an indiscriminate mixture of stones, cement, and water. It was found, for instance, where any notice was taken of the strength, that less cement need be used to obtain a certain strength than had previously been the case. Also the different kinds of aggregate used began to be studied as to their nature, etc., the results of mixing certain sands in certain proportions, and so on, and an immense amount of very profitable experimental work was done in this direction, the more so as reinforced concrete with its definite formulæ came more and more to the front. The history of the more intelligent use of Portland Cement is simply a record of steady progress, to which an extra fillip was given by the introduction of reinforced concrete. Although throughout all the latter half of the 19th century there were daring spirits who attempted to use concrete for many different purposes such as house building, etc., these attempts, from an economical point of view, were mostly, I might almost say invariably, failures. It was not until the present century that a thorough knowledge of the material showed its marvellous adaptability, now so well known and so highly appreciated. Where one building was being erected in concrete in 1900 we find now dozens, where it was being used for one purpose then we now have scores, and practically the whole of them economically successful. It is impossible to enumerate the whole of the various uses to which concrete plain and reinforced is being put, but some of the most interesting are fence-posts, railway sleepers, linings for colliery shafts, props for coalpits, stopping holes in ships, building barges, electric-light standards, telegraph poles, and innumerable other purposes. The last one which has come to my notice was a suggestion made by Mr. Guttman, the expert on explosives, to construct magazines of reinforced concrete, with the idea that should an explosion occur there would be infinitely less possibility of the results of the explosion of one magazine being communicated to the contents of another, as owing to the embedded steel work there would not be such a tendency for masses of constructional matter to fly about. Indeed, he stated that in the event of a bad explosion the concrete would practically go to powder or at any rate very small particles. I am not prepared to say whether this would be the case or not, as I am not an expert on explosives; but the fact remains that magazines are being put up in Germany in reinforced concrete. Now as to the present-day use of Portland Cement in the manufacture of concrete for various purposes. I can best put this by saying what should be done and what should not be done. In the first place, and most important, see that you get pure Portland Cement complying in all respects with the requirements of

the British Standard Specification. All natural and slag cements should be absolutely barred; there is not sufficient difference in the price to warrant the risk. In the next place, get cement with a right setting time, and the slower the setting time in reason you can manage with, the better results you will get. In this connection I may say that the difference in strength of concrete made with quick and slow-setting cement is inappreciable after less than 48 hours. Choose the cleanest possible aggregate and sand, and don't use anything which cannot be described as clean without making considerable experiments before doing so. Also be careful as to the water you use for mixing the concrete. Special care must be taken with the aggregate when intended for reinforced work, in order that nothing injurious to the steel be included. Proportion the cement, aggregate, and water carefully and see that the proportion is strictly adhered to. Also mix the cement and aggregate well before adding the water. If the work in hand warrants its use, have a concrete-mixing machine and see that it is used intelligently. Also be absolutely certain that any reinforcement is in the position it is intended to occupy.

Now as to some of the things which should not be done. Don't aerate the cement; present-day cement does not require this. Satisfy yourself that it is to British Standard Specification; if it is, use it as soon as you can; if it is not, don't have it. Don't store it in a damp place and expect it to keep indefinitely—it won't. Don't waste any time in getting the concrete into its place after water has been added—especially in hot weather; and if you are not able to get the whole batch in position before it begins to set, don't use what is left—it may be all right, but possibly it won't be. Don't mix very wet aggregate with cement and then allow it to stand for a long time before gauging. Don't take down the moulds or forms sooner than is absolutely necessary. Don't use a dry concrete for reinforced work and a wet concrete for concrete block work—the reverse is proper practice. Don't do any concrete work when it is freezing if it can possibly be avoided—but if not get the work done as quickly as possible and use warm water for gauging, and if the aggregate can be slightly warmed, so much the better.

Finally, don't, if the cement has complied with the requirements of the British Standard Specification, blame it if anything goes wrong—in 99 cases out of a 100 it is something else.

There are innumerable other questions connected with the subject of cement and concrete, but they scarcely come within the scope of this paper, and I will conclude by saying that there are few articles of commerce more useful to mankind in general than Portland Cement in its present state of, well, practically perfection, and that this is recognized is shown by the recent formation and flourishing condition of the Concrete Institute for the consideration of all subjects relating to cement and concrete.

THE R.E. HEADQUARTER MESS.

(Continued).

By LIEUT.-COLONEL B. R. WARD, R.E.

Nearly all the plate in the Mess has been collected during the last 50 years. Two pieces only date from the period when the Mess was joint R.A. and R.E. One is a small silver snuff-box bearing the monogram R.A. surmounted by a crown, and the other is a ram's horn snuff-box bearing the inscription :—

BROMPTON BARRACKS
R.A. AND E. MESS
FROM GEORGE SIM
BENGAL ENGRS.
AN HONY. MEMBER
XMAS 1844.

Since its establishment as a purely R.E. Mess in 1846, every campaign of any importance has been commemorated by a presentation of plate on the part of the officers who took part in it, and owing to this custom, fifteen of the principal campaigns of the last half-century are now commemorated.

The first of these is the Crimean Campaign, which is commemorated by a handsome silver vase mounted on an ebony pedestal, on the sides of which are three silver plaques embossed with views of places made famous by the campaign. On projecting corners of the pedestal stand silver figures of a R.E. officer, a sapper in field-service dress, and a sapper in working kit.

A beautifully designed representation of an elephant resting under a palm tree commemorates the Indian Mutiny, whilst the China Campaign of 1862 is marked by a handsome silver vase of Chinese design and workmanship, supported on silver dragons.

Silver vases mark both the Abyssinian and Ashanti Campaigns, and the Zulu War plate is a handsome silver trophy composed of Zulu assegais and shields, resting upon a silver pedestal embossed with representations of Rorke's Drift, Ulundi, and the Tugela. Round the base of the pedestal are kneeling figures of three different types of natives.

Afghanistan is commemorated by a chased silver vase, 24″ in height, and a circular basis. The vase is described on p. 215 of the *R.E. Journal* of 1884, and is richly carved with Indian engraved

work, interspersed with figures of R.E. and Sappers either engaged in action, on the line of march, or on work. The circular basis is engraved with representations of Kandahar, Kabul, Ali Musjid, and other places in Afghanistan.

A silver statuette of Cleopatra by Mr. H. H. Armstead, R.A., and exhibited in the Royal Academy in 1884, is a fitting souvenir of the Egyptian Campaign, and figures of Arabs resting under a group of date palms recall the Soudan Campaign of 1884.

The trophy for the Burma Campaign of 1885–87, is described on p. 261 of the *R.E. Journal* of 1889, as a silver vase "resembling a pepper pot with a pagoda top." The vase itself is 2′ 6″ high and is splendidly embossed with mythological and Burmese figures. It rests on a handsomely carved ebonized wood stand which is 2′ 3″ square.

The 1895 Chitral Campaign is commemorated by a cup which, with its base, stands 3′ high. On p. 259 of the *R.E. Journal* of 1895 it is recorded that the cup was made in Poona under the direction of Major (afterwards Colonel) O'Sullivan, R.E.

The long and severe campaign on the North-West Frontier of India during the years 1897–98, is marked by a handsome silver cup of Indian design, which is described on p. 110 of the *R.E. Journal* of 1901. It stands on an ebony pedestal, bearing shields inscribed "Mohmand," "Malakand-Buner," "Tochi," and "Tirah." Round the base of the pedestal is a silver scroll on which are engraved the names of the officers who served in the campaign, and at the four corners are silver figures representing a R.E. officer of the Queen's Own Sappers and Miners, a sapper of the Bengal Sappers and Miners, a sapper of the Q.O. Madras Sappers and Miners, and a havildar of the Bombay Sappers and Miners.

The three last campaigns to be commemorated are the Expedition to Pekin (1900–01), the South African War (1899—1902), and the Thibet Expedition (1903–04). Descriptions of these pieces of plate are given in the *R.E. Journals* of 1903 (p. 3), 1904 (p. 75), and the *Supplement to the R.E. Journal* of 1905 (p. 75), and are shortly as follows:—

The Pekin Expedition trophy is a silver model, 15″ long, of one of the two dragons which stand at the entrance of the Emperor's Hall of Audience at the Summer Palace, Pekin. It rests on a carved ebony base, the whole on an ebony pedestal, on the two long sides of which are the names of the officers who took part in the expedition, whilst at the ends are a record of the presentation and a description of the dragon.

The South African bowl is 13″ in diameter and 14″ high. The upper portion is surrounded by a design in relief of a veldt wagon drawn by 18 oxen. Standing at the four projecting corners of the plinth are four silver statuettes representing a sapper in field-service dress, a sapper engaged in entrenching, a young Boer, and an old

Boer. The ends of the plinth bear silver plates, on which the names of the principal battles in Cape Colony, Natal, the Orange Free State, and the Transvaal are engraved. In the curves of the plinth are silver panels typifying the work of the Corps, viz.:—(1), A pontoon bridge with oxen drawing a naval 4·7″ gun, escorted by mounted infantry, in the background a captive balloon; (2), a broken railway bridge of five spans; (3), a "Rice" pattern circular corrugated-iron blockhouse and a rectangular two-story masonry blockhouse, on either side of a river in hilly country; and (4), Sappers making a masonry and sandbag breastwork round a camp, in the foreground an armoured ox wagon and also an air-line.

The last of the pieces of "campaign" Mess plate commemorates the Thibet Expedition. It is a silver model of a "chorten" and was copied from a miniature in brass inlaid with turquoises which was presented to Sir J. Macdonald on his departure from Lhassa. It is worthy of note that the various portions of a "chorten" are said to represent the five elements as known to the Thibetans, viz., earth, air, fire, water, and ether.

In addition to these pieces of plate, commemorative of the various campaigns, are numerous pieces which have from time to time been presented either by officers on their retirement, or by units which have been associated with the Corps.

The principal of these pieces are the Burgoyne statuette, the piece commemorating the amalgamation of the Indian and Royal Engineers in 1862; Prince Arthur's Cup, presented in 1868; the silver pickaxe and stand, presented by Major W. Merriman in 1875; the Wilson Cup; General Grant's bowl; the Lindsay Cup and Casket; and a set of three fruit stands, originally presented to General Scott-Waugh. In addition to these may be mentioned a bowl of classical design presented in 1874 by the following Volunteer Engineer Corps:—1st Middlesex, 2nd Tower Hamlets, 1st London, 1st Hants, and 1st Northamptonshire; also a ram's head snuff-box presented by the officers of the 1st Lanarkshire R.E. Volunteers in July, 1900, and a cigarette case presented by the officers of the Special Service Sections R.E. proceeding to South Africa in April, 1901.

The Burgoyne statuette is a replica in silver of the statue by Boehm in Waterloo Place, which was unveiled on the 1st August, 1877. The statuette is 23″ in height, and stands on a pedestal 7″ high. The general effect is far better proportioned than is the case with the original statue in Waterloo Place.

The statue in Waterloo Place is lost under the shadow of the Duke of York's Column, and the pedestal dwarfs the figure. The statuette, on the other hand, rests on a pedestal of more artistic proportions and the figure is on a level with the eye instead of being too far above it.

A shield festooned with oak and olive leaves on the front of the pedestal bears the following inscription :—

JOHN FOX BURGOYNE,
FIELD MARSHAL, G.C.B.
BORN 1782—DIED 1871.
Erected by his Brother Officers of
Royal Engineers.
"How youngly he began to serve his country,
How long continued."
Coriolanus.

The back of the pedestal bears the Burgoyne arms and crest, the arms being surrounded by a circle bearing the motto of the Order of the Bath, "Tria juncta in uno," underneath it being a scroll bearing the motto "Ich dien." A shield on the right side of the pedestal bears the following inscription :—

WAR SERVICES.

Malta.	Badajos.
Alexandria.	Salamanca.
Rosetta.	Burgos.
Passage of Douro.	Vittoria.
Salamonde.	St. Sebastian.
Busaco.	Bidassoa.
Elboden.	Nivelle
Ciudad Rodrigo.	Nive.

Bayonne.
New Orleans.
Fort Bowyer.
Alma.
Balaklava.
Inkerman.

On the left side of the pedestal is a shield inscribed as follows :—

This statuette
copied from the
Memorial Statue
Erected in
Waterloo Place
is presented to the
Royal Engineers Mess
By the subscribers to the
BURGOYNE
Memorial Fund.

The words J. E. Boehm, A.R.A., Sculptor, and A. Hubert, Chaser, are engraved on the right upper portion of the pedestal.

The enumeration of his war services give but a faint idea of Burgoyne's claim to especial distinction in the Corps.

First of all Engineer officers to gain a Field Marshal's bâton—a rank to which he was gazetted on the 1st January, 1868—it was due to him more than to any other single man, that the Corps, after a period of comparative neglect when honours were few and military command unattainable, rose to a proud position of prestige which might well be the envy of foreign military engineers.

In the opinion of many of his contemporaries he occupied a place second only to the Duke of Wellington among the many distinguished officers who rose to fame during the most glorious period in the annals of the British Army. Sir William Gomm, for instance, writes to congratulate him on the 6th January, 1868: "I should have been better satisfied if I found the Government adding the Peerage to the Marshalship, as your just desert beyond that of any who have attained it from our ranks, save one, since the opening of the great French Revolutionary War."*

Lord Hatherton, a prominent Parliamentary figure during the earlier decades of the 19th century, who occupied the position of Secretary for Ireland when Burgoyne was Chairman of the Board of Public Works in that country, once remarked that he considered Sir John Burgoyne and Lieut. Drummond to be, without exception, the two ablest public servants he had ever met.†

A certain diffidence of manner and even of character appears to have militated against his personal advancement to the full height of reputation to which his great powers undoubtedly entitled him.

"If Burgoyne only knew his own value, no one would equal him,"‡ was said of him by the Duke of Wellington; but this in no way detracts from the value of his work for the Corps, nor can it lessen by one iota the honour in which his name and fame will always be held by his brother officers.

On his retirement from the War Office he wrote a farewell order to the Corps, which by permission of the Duke of Cambridge, Field Marshal Commanding-in-Chief, was read as a "General Order" at a full-dress parade of the Corps at Chatham, and which is sufficiently characteristic to merit reproduction *in extenso*.

"War Office, 17th January, 1868.

"Field Marshal Sir John Burgoyne cannot relinquish the post he now holds, without thanking the officers and men of the Corps of Royal Engineers for the cordial and efficient co-operation and support which he has always received from them, during the twenty-two years that he has held his present office, and at the same time expressing the great regret with which he bids farewell to the active superintendence of a Corps in which he will never cease to feel the deepest pride and interest.

* Wrottesley's *Life and Correspondence of Sir John Burgoyne*, Vol. II., p. 431.
† *Ibid*, p. 461.
‡ *Ibid*, p. 462.

"On such an occasion he cannot refrain from calling to mind the great changes that have taken place in the Corps since he first entered the Service.

"In the midst of the greatest war in which this country has ever been engaged, the Corps was held in such little consideration that it was without a single Sapper, had no recognized field equipment, and during prolonged campaigns with armies in the field, possessed only a few individual officers to carry on arduous sieges, entrench camps of magnitude, and perform all the varied and important duties of the Engineer Service.

"Nor were the duties in garrison or military stations better provided for, although the effects were of less importance.

"Those days are happily at an end; and the Corps now possesses a fine body of well-trained Engineer soldiers, fully instructed in every field duty, and is thoroughly competent to undertake any of the active services of war.

"As regards its ordinary peace duties, it has given proof of its efficiency in the control and management of the great works of defence considered to be necessary at home and abroad, and of which the design and execution are acknowledged to be at least equal to those of a similar character in any other country.

"An additional proof of the estimation in which the Corps is held, may be noted in the large proportion of its officers and men selected for extraneous positions of an arduous and responsible character under other branches of the Government.

"Much of the improved condition of the Engineer Service may be attributed to the spirit and exertions of its individual officers, but it is due in a still greater degree to the increased value which the progress of science has given to the special branches of the army, and to the higher appreciation with which the profession is regarded by the military authorities and country at large.

"After an association extending over seventy years, and comprising many periods of difficulties and hardships, Sir John Burgoyne takes leave of his comrades of all ranks, with the strongest sentiments of esteem, and with the fullest confidence in their future prosperity and distinction."

As senior officer of the R.E. in Spain at the close of the Peninsular War, and again as oldest officer of the three armies—Russian, French, and British—in the Crimea, he holds a unique position.

In addition to this, his record of service of over 70 years, commencing as a Second Lieutenant and ending as Field Marshal, Colonel Commandant, R.E., and Inspector-General of Fortifications, can never again be repeated. It is for this reason that his memory was specially honoured for many years after his death by his statuette being placed on the Mess table facing the President on guest nights. Subsequently this was discontinued and the latest campaign plate was given the place of honour. But the old custom has lately been revived, and the special honour is once more accorded to the man to whom the Corps owes so much, and whose position in it can never be usurped by any future Engineer, however famous.

The late Lieut.-Gen. Sir Richard Hieram Sankey, K.C.B.

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The Late Lieut-Gen Sir Richard Herman Sankey KCB

MEMOIRS.

LIEUT.-GEN. SIR RICHARD HIERAM SANKEY, K.C.B.

By 'H.M.V.'

LIEUT.-GENERAL SIR RICHARD HIERAM SANKEY, K.C.B., who died suddenly on 11th November, 1908, in his 80th year, was the fourth son of Matthew Sankey, of Bawnmore, Co. Cork, and Modeshil, Co. Tipperary, and Eleanor, his wife, daughter of Colonel O'Hara, J.P., of O'Harabrook, Co. Antrim.

Originally the Sankeys were an old Lancashire family, where the first known ancestor in King John's time was given a carucate of land in Sankey, near Prescott, to hold by military service, the line being unbroken to the present heir of Fort Frederic and Coolmore, near Clonmel.

In 1646 Sir Hyrome Sankey went to Ireland as one of Cromwell's generals and commander of the Parliamentary Cavalry, and for his services there obtained a large grant of land in the counties of Kerry and Tipperary. Under these circumstances it is scarcely surprising that Sir Richard Sankey, like his two elder brothers, chose the profession of arms.

He was born on 22nd March, 1829, at Rockwell Castle, Co. Tipperary, and was first educated by the Rev. D. Flynn in Harcourt Street, Dublin, and remained with him till he left for Addiscombe in 1845. From his earliest days he evinced a great talent for drawing, sketching everything that attracted his fancy, particularly animals, and his first silver medal was presented to him by the Dublin Society for the sketch of a cow which was in the show in 1845. He entered Addiscombe, February, 1845, and left with a commission in the Engineers, December, 1846, before he was 18. He carried off the first prize for painting. The head of his term was Duncan Home, who blew up the Cashmere Gate at Delhi, September, 1857; and another of his contemporaries was Geo. D. Willoughby, who blew up the magazine at Delhi on the outbreak of the Mutiny, May, 1857. His great talents as an artist were well known, everybody tried to get some specimen of his work to carry away, and there was a

current rumour that on his leaving the college, Fielding, the professor at Addiscombe, had offered him a handsome salary if he would give up his profession and join him as a teacher. He passed the usual time at Chatham, and did not reach Madras, to which Presidency he was posted, till November, 1848.

He was at once sent to the Sappers at Mercara, then commanded by Capt. J. W. Rundall, M.E.; but in 1850 he took up the officiating post of Superintending Engineer, Nagpore Subsidiary Force. This appointment he retained for three years, when he became very ill and went home for three years, not returning to Madras till 1856. During this time he resided a great deal abroad, in Germany and Switzerland.

He was now appointed Superintendent of the East Coast Canal, but in May, 1857, was sent up to Calcutta as Under Secretary, P.W.D., under Colonel Sir William Baker. On the breaking out of the Mutiny he was commissioned as Captain of the Calcutta Cavalry Volunteers, but in September following he was despatched to Allahabad for general field duties.

In addition to the completion of the defensive works along the Jumna, he had some heavy work in levelling the whole of the Allygunge quarter of the city (on which some 6,000 workmen were engaged), to clear the front of the entrenchments, and in addition to this he had to construct a causeway across the muddy bed of the Ganges some 1,000 yards wide, and to establish a bridge of boats for the crossing of the troops then expected from home. He was also specially charged with providing shelter for the bodies of advancing troops all along the Grand Trunk Road in N.W. Provinces, and while so engaged arrived at Cawnpore the day before that place was attacked by the Gwallior Force, under Tantia Topee. He acted as Assistant Field Engineer under General Windham, the C.R.E. being Lieut.-Colonel N. C. McLeod, B.E.

When the British force was driven back to its entrenchments he had of course the usual duties in the defence, and at this time he connected an outpost some 600 yards to the north by a simple screen of mats fixed during one night, and though the whole place was swept by fire, hardly a life was lost after the mats were put up.

The siege coming to an end with the defeat of the Gwallior Force on 6th December, 1857, Lord Canning appointed him Field Engineer to the Goorkha Force, under Jung Bahadur, to which General G. (afterwards Sir George) MacGregor, C.B., acted as Commissioner and Agent for the Governor-General. Only one other Engineer officer, Lieut. Garnault, B.E. (date of commission, December, 1855), lately arrived from England, was with the force, and between them they had to organize an Engineer Park at Gornekpore as best they could with scant materials and with the whole country disaffected. To provide means for the passage of the Gogra and the Goomtee on

the line of march to Lucknow required the collection of 120 large grain boats, which were towed up the first-named river under protection of Colonel Rowcroft's force, some 3,000 strong (consisting of the Naval Brigade and Goorkhas), and manufacturing a pontoon train from jheel boats (dug-outs) collected from all sorts of places, 100 miles off, and carried on carts to the Gogra with the main Goorkha force.

Sankey (quite alone) reconnoitred the river Gogra at Tandah, in view of effecting the crossing into Oude. On 19th February, 1858, the Gogra was crossed opposite Nowrance and the fort seized. The next day the action of Phoolpore took place, which caused the enemy to retreat. Owing to darkness, the success was not so great as it otherwise would have been.

At Phoolpore Sankey constructed the bridge of boats in $2\frac{1}{2}$ days. The bridge was 960′ long and 3 miles of road had to be made.

The next day the Goorkha Army, 20,000 strong, with 24 guns and 5,000 carts, crossed into Oude, and Sankey received the thanks of the Commander, as well as of the Government, for his "great and successful exertions on that occasion."

On 26th February, while on the march from Mobarakpore to Akbarpore, they were informed that at a small fort called Jumalpore there was a small party of rebels; troops were at once sent to attack it. The fort proved a very "hedgehog" of fortification, and very great difficulty was encountered in forcing an entrance. After a long time a gun was forced, with great labour, through the outer fence of bamboos into a position within 10 or 12 yards of the wall; another (a 12-pr.) and a third were placed at right angles to the first, and the cross fire thus produced was attended with the happiest results. "Lieut. Sankey, of the Engineers, who had been on the ground the whole day, discovered a small breach made by the first gun; it ceased firing. He enlarged the opening with his hands until it was sufficiently large to admit his head and shoulders, forced himself through it, and was the first man inside. The gallantry of this act, which I was an eyewitness of, I venture to bring particularly to the notice of the Brigadier-General."—Capt. Edmonstone's report. The Military Commander in his despatch to Government remarked: "The conspicuous gallantry of Lieut. Sankey was the admiration of every one; it was by his advice the gun was brought up which breached the wall, and he was the first man in the fort."

General MacGregor strongly recommended Sankey for the V.C. Lord Canning warmly supported the recommendation and forwarded it to England. This was considered informal, and it was referred back to India. Meanwhile Lord Canning had died. Sir Hugh Rose (then Commander-in-Chief) referred the case to a committee of officers, and they reported that "while considering the action a gallant one, yet from the circumstance of Major Sankey having been

made a Brevet Major while a subaltern, they could not support it." General MacGregor (brilliant services in Afghanistan from 1838 to 1842, and was granted C.B. and rank of Major for his services on these occasions) thus wrote: "The fact of Major Sankey having been made a Brevet Major one month earlier than he had a right to expect can hardly be looked upon as weighing in the balance against a decoration which in many respects is deservedly considered the proudest honour in the gift of the Crown. No man, in my opinion, ever better earned the V.C. than did Major Sankey. In the performance of his duty he exposed himself to almost certain death, setting a brilliant example of courage to the men who were engaged with him at the fort; and I may add with much truth that his services on this occasion contributed greatly to the capture of the place; and while it would be a mere act of justice on the part of Her Most Gracious Majesty to confer the V.C. on Major Sankey, it would be at the same time a delicate compliment to the memory of the lamented Earl Canning, who recommended Major Sankey for this honourable distinction." The authorities would not however move in this affair. As a matter of fact, Sankey was first made a Brevet Major on 20th July, 1858, but after some time it was discovered that being a subaltern at the time he had no right to it; it was changed to 28th August, 1858, the day after he attained the rank of Captain in the Madras Engineers.

How the date of a Brevet Majority could affect the question of a V.C. it is utterly impossible to understand, as Sankey would have obtained that, even had he not been present at Jumalpore. His services in bridging the Gogra and Goomtee, etc., would have sufficed to gain him the Brevet.

Sankey was present at the action of Kandooah Nulla on 4th March (mentioned), shortly after they had crossed the Goomtee, constructed the bridge for our passage at Sultanpore and received the thanks of the Government:—"Lieut. Sankey's exertions were as conspicuous as they were successful, and they merit the best thanks of the Government."

A few days after this the Goorkha force reached Lucknow and took possession, on the left of Sir Colin Campbell's force, of a suburb south-east of the Charbagh.

On the evening of 12th March they made an attack on the Charbagh. Next day a battery, under Sankey's advice, was established near the Hussain Gunge Bridge to enfilade the enemy's entrenchments with 12 guns. After two hours' heavy fire, the Goorkhas rushed over the entrenchment in their front and carried all before them to a point in the city ¾ mile south of the Kaiser Bagh. Lieut. Sankey was engaged with the Goorkhas in this attack, and while waiting with Lieut. Robertson at the point they had reached, they heard that Generals Franks and Napier had then carried the Kaiser Bagh, and at once

pushed on through the city with 80 Goorkhas, while the enemy was on the run (magazines exploding on all sides), to the gate of the Kaiser Bagh, where they reported themselves to General Franks. At night they returned by Banks' house and rejoined the Goorkha force.

On 15th Sankey was present with the Goorkhas in the attack on the enemy, who were threatening the Charbagh, and on the 18th and 19th the Goorkhas attacked the southern suburbs, this resulting in the final capture of the city. Lieut. Sankey made immediate arrangements for establishing the bridge over the canal near the Charbagh.

The bridge was made on 18th and 19th under difficult circumstances. The gap was 70′ wide and 38′ to 40′ deep, while the ripped-up roofs of houses only afforded baulks of 16′. After the 19th the Goorkhas had no more fighting; they encamped at Nawabgunge and soon marched back to Nepaul. Sankey, shortly after the siege, returned to Calcutta ill, and saw no further service. On 2nd July, 1858, he went on six months' leave to the Neilgherries, and before the close of the year married Sophia, daughter* of W. H. Benson, Esq., I.C.S. In 1859–60 he was Executive Engineer and Superintendent of Convict Jail at Moulmein, Burmah, for the management of which he received the thanks of the Government of India. In 1860–61 he became Garrison Engineer, Fort William, Calcutta, and in 1861–64 he was Assistant to the Chief Engineer, Mysore, Colonel E. Lawford, M.E. In this capacity his services were eulogized in the very highest terms by his chief, Colonel Lawford.

In 1864 he succeeded to the post of Chief Engineer and Secretary to the Chief Commissioner, Mysore. During the next 13 years he managed the Public Works of that Province in a most able and masterly manner.

The following account of his work there has been obtained from Colonel W. Chrystie, R.E., who was his assistant there for many years :—

"Sir Richard Sankey, being a man of unusual ability, original ideas, and untiring energy, left his mark on the country. Convincing the Government of India of the soundness of his views, he originated, in opposition to the views of the then Chief Commissioner, an Irrigation Department to deal scientifically with the old Native Works. Before his time the repair of the tanks was carried out as if each tank was independent of others in the same basin, but under Sankey's Tank Department the catchment area of each valley was surveyed, the area draining into each tank was determined, as also the discharge from the weirs of any tanks above. On these details, the length of weirs required for the tanks and height of tank were fixed. If water and

* Mrs. Sankey died 1882 at Ootacamund.

land were available, the capacity of the tank was increased. When the chain of tanks was very large (in one instance there were 700 tanks above the terminal one), what were called stop tanks were made where the conditions were favourable, *i.e.*, good rock available and the ground above flat, so as to give a good impound of water. The weir was then contracted in length, and the bank raised many feet above it, thus delaying the discharge of a large body of water and enabling the weirs of the tanks below to run off in exceptional rain-falls before the upper water came down. Of course, all the tanks in each chain were repaired at one time, and as each chain was completed the work was carried on to the next chain in the series. The other branch of the Irrigation Department dealt with the old native channels, which were very defective. Headworks were built, masonry distributories substituted for the pottery pipes, drainage carried over or under the channels instead of being allowed to fall into them, whilst the channels were surveyed, their defects of levels corrected, and the cross sections and falls made to carry the quantity of water required for the cultivation."

"The designs for the Great Maurai Kanvai work (since completed) were prepared by the late Capt. Pole, R.E., under Sankey's instructions. This work has a drainage basin of 1,250 square miles. Then as regards roads, the old ones were improved and new ones opened in all directions. Colonel Sankey's attention was especially directed to opening up the Mulnaad or Western Districts of Mysore, where previously almost all traffic had been carried on by bullocks."

"He caused to be constructed the Hyder Ghur Ghât, connecting the former city of Bednore with the coast. This place, the seat of a dynasty ruling all the low country at the foot of the ghâts, was sacked by Hyder Ali in 1763, when Wilks says a reasonable estimate of the spoil was £12,000,000. The capital, Bednore, never recovered this disaster and was called "hidden"; only one European, Capt. Le Hardy (who was Superintendent of Coorg in 1835), is said to have entered it between 1783, when General Mathews' force surrendered to Tippoo, and Colonel Sankey's first visit in 1866, when it was a hamlet of about 100 huts."

"Other ghâts were greatly improved, and roads running north, south, east, and west constructed, so that the whole tract of country was thoroughly opened out to wheeled traffic."

"Of buildings constructed in Colonel Sankey's time, the fine pile of Government offices at Bangalore is the most noticeable; the beautiful park which now surrounds it, was a piece of waste ground, cut up by nullahs so deep and steep that the troops practised escalading in them; these were sloped away, partly filled in, and further erosion stopped by numerous stone dams and paved drains. Colonel Sankey also greatly improved the quality of the water in the Ulsoor Tank, which at that time was the principal source of the water supply to

that part of the city. He collected the drainage of the native town above the tank into stone drains and conveyed it by a culvert under the Ulsoor into the Dumloor Tank."

"He also interested himself in the preservation of the ancient Dravidian temples, which are among the finest in Southern India."

In fact, he interested himself in everything which he considered would improve the condition of the country, and being most talented and an able administrator, he was most thoroughly successful in improving the Province in many ways, and the Mysoreans owe him a heavy debt of gratitude for what he did for them.

In 1870, while holding the post of Chief Engineer, at the request of the Government of Victoria, he was nominated by the Viceroy, Lord Mayo, to proceed on special duty to that colony. He went to Melbourne and made a full enquiry into the subject of the large reservoirs and distributary channels intended mainly for the supply of water for washing down the gold-bearing alluvium of several valleys. This duty, which was mainly that of an arbitrator, occupied him seven months, when he returned to Mysore. On the completion of the duty he received the thanks of the Government.

In 1877 Colonel Sankey was transferred to Simla as Under Secretary to Government of India, and in September, 1878, when war with the Ameer of Afghanistan appeared imminent owing to the rebuff of Sir Neville Chamberlain's Mission, Colonel Sankey was nominated C.R.E. of the force ordered to concentrate at Multan under Lieut.-General (afterwards Sir Donald) Stewart. From the first day of his appointment his energy and clear thinking were remarkable. General Stewart had not returned to India from furlough, and as Colonel Sankey was at Simla when preliminary arrangements for the campaign were being discussed, his opinion and assistance were sought at the Headquarter Offices, and he was daily in consultation with the Adjutant-General, Sir Peter Lumsden, and the Deputy Quartermaster-General (Sir Chas. MacGregor) as to the movement of General Stewart's force across the Indus, should an immediate advance into Afghanistan be ordered. On the 9th October, Sankey, with his personal assistant, Lieut. Childers, left Simla and reached Mooltan a few days later. Colonel Sankey set out immediately to find a suitable place for the division to cross the Indus, in the event of its being decided to make the advance through the low hills which lie between that river and Dadur, at the mouth of the Bolan Pass. From the 17th to 27th October he was up and down the river between Kashmore and Mithenkote, examining all the likely landing places, and riding inland on either side. He and his assistant had to follow country paths, which seldom failed to take them through some swamps. The Indus, always unmanageable in flood, was this autumn worse than usual. In making their way after dark from the river bank to Nowshera Station, on the Indus Valley Railway, they found

no track and had to pick up local guides to lead them from village to village through the muddy swamp, and with no moon this was not exactly a cheerful task; but Colonel Sankey was always cheery and his extraordinary energy carried all before it. On his return to Mooltan on 27th October, Sankey found General Stewart arrived from England, and learned moreover that the reply of the Amir was decidedly unsatisfactory; the pontoon and telegraph companies of the Sappers and Miners had arrived from Roorkee and the two siege batteries were coming in.

It may here be remarked that General Stewart's Division was equipped originally to proceed to Herat. General Stewart at once held a council, and after receiving Colonel Sankey's report and advice, it was decided to give up the idea of crossing the Indus near Mithenkote, but to push on all stores and material and to arrange for the transport of troops by Sukkur and Jacobabad—the old route of the Army of the Indus in 1839.

During the following three weeks Sankey, with the rest of General Stewart's Staff, were working hard at the organization of their various branches. A Field Engineer Park was created, and placed under Lieut. (now Colonel) Call; the Sapper companies were sent off in advance by rail to Sukkur, whither the rest of the division were gradually following, and on the 18th General Stewart, with Sankey and the rest of his Staff, crossed the Indus at Sukkur, and moved with his division across the Scinde Desert from Jacobabad to Dadur, reaching Quetta (through the Bolan Pass) on 12th December. Long before this the Amir had rejected the ultimatum, Ali Musjid had been captured, and General Stewart was now anxious to surmount with his division the only remaining barrier (the Khwaja Amram Range) between him and Candahar.

Colonel Sankey accordingly was again sent forward to examine and report, and as a result of his energetic explorations, was able to recommend an entirely new and hitherto little known line of advance by the Khwaja Pass, a route which was at once adopted by General Stewart, and which enabled him to move his 1st Division with the heavy guns speedily and easily, leaving the Khojak available for the use of the 2nd Division, under General Biddulph. It did not take General Stewart long to realize the value of Sankey's ability, and the influence of the Commanding Engineer in the counsels of the General was very marked throughout the whole of this campaign. Power was given to Sankey to go ahead and work in his own way, in preparing the roads for the advance of the army. A brigade of native infantry, with a British infantry detachment, as well as the Sappers and field park, were placed under his immediate orders, with a view to push on all works as he should think best for the general advance of the army towards Candahar.

"The plan of giving Colonel Sankey power to go ahead and work

his own way with the regiments at command for work is a sound one," wrote Colonel Le Messurier, "and will settle many misunderstandings as to the position of the Commanding Engineer and his officers."

The Candahar Field Force was fortunate in having a Commanding Engineer who possessed the entire confidence of his General, and of a General who was able to appreciate so accurately the valuable qualities of his Engineer Adviser.

On the 3rd January, 1879, Sankey, with his advance force, came up to the cavalry under General Chas. Palliser at a place called Hauz (General Palliser received a sabre cut at the Battle of Sobraon, and highly distinguished himself during the Mutiny; was afterwards a G.C.B.), about two marches from Candahar, and next morning advanced with General Palliser to reconnoitre the front; a body of Afghan cavalry came out to oppose this advance, and near a village called Takt-i-Pul a cavalry fight took place, the only action of this theatre of the war.

Candahar was immediately afterwards occupied, and after a ten days' halt, General Stewart continued his advance towards Cabul, but got no further than Kelat-i-Ghilzai, as the flight of Shere Ali put an end for a brief period to the war in Afghanistan. General Stewart returned with his 1st Division to Candahar, where he and his Staff were soon deep in consultation settling the arrangements for the hutting of the troops during the coming hot weather. Surveys were ordered to be made, questions of water supply discussed, and committees sat daily, over which the powerful and active mind of Sankey exerted a preponderating influence. In the midst of this arduous work Sankey received a telegram offering him the appointment of Secretary to Government of Madras in the Public Works Department, and to the regret of the whole Staff he left Candahar and returned to India.

Although he was able to carry out during this campaign a great amount of valuable work, in which his time must have been constantly employed, he yet found leisure to make many valuable sketches of the country, and two of his sketches of Kelat-i-Ghilzai are published in the *Life of Sir James Browne, K.C.S.I.*, by Major-General J. McLeod Innes, V.C., C.B.

Colonel Sankey received the medal for the campaign and was appointed Companion of the Bath.

On 8th April, 1879, he reached Madras and took up the post of Chief Engineer and Secretary to Government. Here he again evinced his remarkable talents and energy. The following tribute to Sir Richard Sankey's work as Chief Engineer at Madras has been sent to me by Colonel J. Pennycuick, C.S.I., R.E., who was his Under Secretary during most of the time he served as Chief Engineer :—

"I was Under Secretary during three years of the time he was

Chief Engineer, and was in unusually close personal and official relations with him.

"I had the highest admiration for his administrative powers, and especially for his capacity of managing and judging men. He entered office under the serious disadvantage of having been absent from the Madras Presidency for about 20 years, and consequently knew but little of the personal affairs of the Department. A very short time however served to remove this difficulty.

"It so happened that during his tenure of office the Madras Public Works Department had to be completely reorganized twice over. In 1879–80 the Government of India, in one of their periodical attacks of economy, insisted on a reduction of the Superior Staff to an extent that rendered efficient administration a physical impossibility, with the natural result that in less than two years they were obliged to consent to an expansion of the same Staff to somewhat more than its former strength. The masterly manner in which Colonel Sankey dealt with the re-distribution of duties and charges rendered necessary by this double change, and the way in which he managed the long and highly controversial correspondence which preceded it, can only be appreciated by one who, like myself, was intimately acquainted with every detail of the business.

"Of his more personal characteristics, of his unfailing kindness and courtesy, his loyal support and ungrudging encouragement of every man who worked under him, I cannot even now think of without emotion; my own feeling towards him was one of little less than adoration."

While Colonel Sankey was at Madras he was elected Fellow of the Madras University and appointed a Member of the Legislative Council, and not content with all his onerous duties, he interested himself in the improvement of Madras, and was most active in forming the Marina and beautifying Government House grounds and the Botanical Gardens.*

Towards the close of 1883 he went to England, and on the 1st January, 1884, was appointed Chairman, Board of Works, in Ireland, and here in an entirely new field he again showed his talent, versatility, and energy, and his great powers as an administrator.

The title of that body conveys little idea of the variety and extent of the duties attached to it. It discharges all the functions in Ireland discharged in Great Britain by the Office of Works as regards the building, maintenance, and providing with supplies of all civil offices, with the addition in Ireland of some military, all Coastguard and Naval Reserve buildings, and the maintenance of the Royal

* Sir Richard Sankey received the reward given to officers for distinguished services.

University, Queen's Colleges, and all National Schools, numbering 935, vested in the Commissioners of National Education. As successor to the Shannon Commission it controls the whole of the non-tidal portion of that river for drainage and navigation purposes. It is the central authority for allowing the carrying out of arterial drainage schemes by local drainage boards and securing their maintenance. It has charge of the five Royal Harbours of Kingstown, Howth, Ardglass, Donaghadee, and Dunmore, and builds fishery piers and harbours for transfer to local authorities.

The management of the Phœnix Park and St. Stephen's Green Park, Dublin, and other open spaces is in its hands, and under the Irish Church and Ancient Monuments Acts it has to maintain some hundreds of ancient and national monuments. Its functions as regards works are sufficiently wide, but in addition it was, prior to recent land purchase legislation, the chief Government lending authority in Ireland, with functions much wider than those of the corresponding body in England, covering not only loans to local authorities for public health purposes, and to railway companies, but loans to landlords for the improvement of their estates and to tenants for the improvement of their separate holdings, so that the Board may on the same day be dealing with a loan of £50 to a tenant farmer in Connemara and a loan of a quarter of a million to the Corporation of Dublin. General Sankey was appointed to the supervision of this heterogeneous collection of duties at a critical time. The country was in a very disturbed condition and the Department was exposed to searching and often very unfair criticism. Fresh duties were imposed by the Irish Land Act in 1881, by the Tramways and Public Companies Act in 1883, and by the Sea Fisheries Act for construction of piers and harbours with the Irish Church Fund of £250,000.

Amidst this pressure, caused by the creation of these Acts, the ability, energy, and professional skill of the Chairman made themselves felt in the acceleration and improvement of the work of the Department, where every officer felt that, while his chief demanded much from him, he was unsparing of his own exertions, and could be trusted to stand by his Department, if unfairly attacked, through thick and thin.

Before April, 1886, the engineering merits of nearly 60 tramway schemes had been reported on, of which 30, covering 428 miles, received the approval of the Grand Juries, and baronial guarantees.

Every year saw more fishery piers in construction, and by 1890 57 had been built and four more nearly completed, at a cost of £253,000, often on the most out-of-the-way parts of the coast.

Arterial drainage is a matter of immense importance and interest to Ireland, and the general supervision of it is one of the chief branches of the duties of the Irish Board of Works.

With regard to the Lough Erne Drainage Scheme, it fell to General Sankey to defend the part played by the Board, and in another, the river Suck, he was actively concerned in the negociations of the arrangements which enabled it ultimately to be carried through.

The most important river in Ireland, the Shannon, is in actual charge of the Board of Works for canal navigation and drainage purposes. A Parliamentary Grant was made for improving the control of floods by means of sluices, and General Sankey took an active part in carrying them to a successful conclusion. His interest in the river never flagged, and a few years later he was largely concerned in the obtaining of a grant for additional works at Killaloe and Lough Allen, by which the control of the river was still further improved.

In 1889 the Government passed the Light Railways Act. As a result of this there was a great crop of schemes, and it was the duty of the Board to report on their relative merits. Prolonged and difficult enquiries were carried out under great pressure of time. The most important of these enquiries covered the counties of Donegal, Mayo, Galway, and Kerry. Agreements were necessary in each case between the Treasury and the promoting company. In their preparation General Sankey took a principal part. It is sufficient proof of the excellence of the work then done that in 1896, when further assistance was given by Government for railway extensions, scarcely any changes were required to be made in the provisions of the agreements.

General Sankey's interest in art and his skill as a painter both in oils and water colours were evidenced long before he came to the Board of Works. His work with buildings did not afford wide scope for his artistic sympathies, but in one field the work of the Board was highly congenial to him. The Irish Church Act had handed over a large number of ecclesiastical buildings to the Board for preservation as national monuments. General Sankey had the principal part in the administration of these Acts, and he devoted himself to the work with energy and enthusiasm.

The credit belongs to him of proposing and inducing the two principal Antiquarian Societies in Ireland to fall in with the proposal that the work of the Board should be carried out with the aid of a consultative committee, on which both societies should be represented. The happiest results have followed from this arrangement.

There is one other branch of the Board's business to which General Sankey was attracted by his love of nature and art, and that is the care of the two parks—St. Stephen's Green Park in Dublin and the Phœnix Park on its outskirts. Looking after these parks was an occupation he never wearied of, and he made a practice of visiting

them nearly every week and studying on the ground with the bailiff in charge every proposed new work.

Under his fostering care the park retained its true park-like character, without interfering with which there was developed in the park nearest to the city a garden, in which at every season of the year those interested in horticulture are delighted by landscape gardening in its highest developments. It only remains to speak of General Sankey as a member of the Board and the head of a large staff of officers. His ability, energy, his sincerity of purpose, and the absolute absence in him of self-seeking won the admiration and respect alike of his official and political chiefs, and of his colleagues and his subordinates, and these feelings deepened into personal liking and even affection in those who were brought into close relation with him. Many of those associated with him passed away before his death, but to those who survive his kindly personality is a cherished remembrance.

Sir John Barton writes that although his official duties as Chairman of the Board of Works were so important and onerous, General Sankey, owing to his gift of organization, was able to find time to devote to other interests which would benefit his fellow men. One of these was the Royal Zoological Society of Ireland.

His knowledge of zoology and interest in the well-being of the animals, especially the birds, combined with the fact that he was an experienced engineer, was of great value to the Society, both in the purchase and care of the specimens and in the building of new houses.

General Sankey held the post of Chairman of Board of Works for 12 years, his period of service having been extended two years beyond what is customary, owing to the great value of his services. On the occasion of Her Majesty's birthday (24th May), 1892, he was gazetted a civil K.C.B., being already a military C.B. He retired from the post of Chairman in 1896 and went to reside in London. His active mind did not permit him to remain without taking the very greatest interest in many matters with which his career had been connected, such as irrigation in India, improvement of Ireland, Navy League, etc., and he paid a visit to Mexico, and after had much correspondence with reference to that country with the celebrated President, General Diaz.

I have received a considerable number of letters from officers who knew him intimately, and they all unite in eulogizing General Sir Richard Sankey's ability and character. It will suffice to give two of these, which to my mind sum up the active, versatile, and brilliant character to which I hope this compilation does sufficient justice.

Sir Harry Prendergast, V.C., G.C.B., writes: "I think Sankey was the most brilliant officer of the Madras Engineers during the last half-century.

"As a military officer he was eminently distinguished by his skill and extraordinary bravery. His services as a Civil Engineer were very conspicuous. He was a born leader of men, whatever his hand found to do he did it with his might; he deserved and obtained the confidence and affection of the officers and men who worked under him, and thus secured their best and most enthusiastic support and reverence. He was an accomplished painter in oils and water colours, enjoyed a run with the hounds at Ooty and a game of polo at Bangalore, he was a deep thinker and a diligent reader, a charming companion, beloved by men and women."

Colonel W. Chrystie, R.E., who served under him for many years, writes: "In person he was of fine physique, absolutely untiring. He was a fine artist, an excellent companion, a very desirable friend, and a very undesirable opponent."

Sir Richard Sankey married, in 1890, Henrietta, daughter of P. Creagh, Esq., and widow of Ed. Browne, Esq., J.P. Lady Sankey survives him.

MAJOR PERCY BRAYBROOK MOLESWORTH, R.E.

By Capt. P. Robinson-Embury, late R.E.

Major Percy Braybrook Molesworth passed away at the Naval Commissioner's house at Trincomalee, Ceylon, on Christmas Day, 1908. His death was a great shock to many, and a personal loss to his friends, for not only was he one of the best hearted of men, but his character was an example to all in its fearless honesty and uprightness.

He was born at Colombo in 1867, his father—Sir Guilford Molesworth—being then the Engineer-in-Chief of the railway in course of construction to Kandy. He was educated at Winchester College, and obtained his commission in the Corps of Royal Engineers in February, 1886.

After passing through the S.M.E., Chatham, he specialized in submarine mining, and was stationed at Fort Camden, Queenstown Harbour, until 1891, when he was ordered to Hong Kong for three years. After his return, finding he could not stand the English climate, he volunteered for service in Ceylon, and was sent out there to perfect the defences of Trincomalee Harbour.

In 1898 he joined the B.A.A. Solar Eclipse Expedition to India, and towards the end of that year he was temporarily seconded in order to act as Secretary to Sir Guilford Molesworth, and to visit and report on the Uganda Railway on behalf of the Foreign Office, returning to Trincomalee about the middle of 1899.

He obtained his majority in 1904, and retired in 1906, after 20 years of service.

During the time that Major Molesworth was in the Royal Engineers he was very keen on his regimental duties and trained his men to a high state of efficiency, and was greatly beloved by them. On his retirement the non-commissioned officers and men of his company wrote to Lady Molesworth, expressing their great appreciation and enclosing a picture of him and of the whole company. On his death, three years later, it was the desire of the native sappers of his company that they should bear his remains to their last resting place, and accordingly his coffin was carried by six of his native sappers.

Inheriting a large share of his father's well-known talents, he ever associated himself with matters of scientific bearing, and from his youth up made a special study of astronomy—particularly connected

with the planets Jupiter and Mars. On these he made some very important and valuable memoirs, many of which have been published in the B.A.A. Papers. He was the first to detect, in February, 1901, the beginning of what has since become one of the most important and interesting features of the planet Jupiter, the great disturbance on the South Tropical Zone.

He was a wonderful draftsman, and the amount of care and trouble expended on his work can only be fully realized by those who have had an opportunity of studying his original entries and drawings.

Trincomalee, with its wonderfully clear atmosphere, is an ideal spot for astronomical observations, and this, together with the fact that the climate suited Molesworth's constitution, were the main factors which induced him to purchase estates in the neighbourhood on retiring from the Service. Here he settled down with his brother Guy, developed the land and cultivated various products, including cocoanuts, rubber, tobacco, and cotton. The hard work entailed in starting the estates prevented him, unfortunately, from continuing his astronomical observations. His death is doubly sad as it occurred just as he had brought the estates to paying condition, which would have allowed him sufficient leisure to continue his well-beloved study.

In addition to the estates, the two brothers established a motor-boat service from the mouth of the Mahavelli Ganga, where their estates were situated, across the harbour to Trincomalee, and this did a great deal in opening out that part of the country.

Retiring and somewhat shy, but unassuming to a fault, Major Molesworth yet possessed a charm of manner and personality peculiarly his own. His quickness of brain, added to his naturally scientific bias, made his views not only deeply interesting in his exposition of them, but far sighted.

His death in the prime of life is a great loss to the Corps, and has taken from those who knew him personally a good and true friend, of a lovable and sterling character.

TRANSCRIPT.

THE TRAINING OF THE 7TH ENGINEER REGIMENT OF THE FRENCH ARMY.

Translated from an article by Capt. D. Honorato Manera Ladico,* in the *Memorial de Ingenieros* for September, 1908.

THE 7th Regiment is composed of four battalions, one engineer transport company, and one fortress company. Each battalion is divided into three companies. The battalions are numbered 12, 13, 15, and 19, the numbers indicating the army corps to which each is attached in case of mobilization or manœuvres. In each battalion the 1st Company belongs to the 1st Division of the army corps, the 2nd Company to the 2nd Division, and the 3rd Company to the corps troops. In peace time the four battalions and the engineer transport company are stationed at Avignon. The fortress company, which has a special organization (not dealt with in this article), is at Nice and in the forts in its neighbourhood. The regiment is commanded by a colonel, assisted by a lieutenant-colonel and a major, and each battalion is commanded by a major.

Attached to the regiment, and under the orders of its commanding officer, is the "Ecole du Génie d'Avignon," which is in charge of the engineer parks and stores and of all the equipment of the school of instruction, and which has a major in command.

In the French Army all the recruits join the colours during the first ten days of October. This is to allow of the recruits being trained by the spring, as spring and summer are considered the most likely seasons for a campaign.

The recruits are allotted to the engineers in accordance with their height, trade, degree of education, etc. On arrival at the barracks they are classified in two groups—combatants and auxiliaries. The latter receive only a limited amount of training, and after one month are drafted to fill vacancies as clerks, orderlies, tailors, shoemakers, etc. In 1907 some 75 recruits were posted to each company (60 combatants and 15 auxiliaries). The two classes are trained separately.

The French soldier is drilled every day, commencing at 5.30 a.m. in summer and 6.45 a.m. in winter. Drill lasts until 9.30 a.m., at which hour the troops breakfast. Work is continued in the afternoon from 1 p.m. to 4.30 p.m. Dinners are at 5 p.m. The men are given coffee before the early morning drill.

During the first fortnight of their service the combatants of each company of the four battalions are instructed in infantry drill and gymnastics

* Capt. Ladico was attached to the 7th Engineer Regiment at Avignon for nine months.

only. Commencing in the third week, half the day is devoted to drill, and the other half to technical instruction. The recruits' training continues until March, after which it is combined with that of the old soldiers. At the end of the first week a rifle and knapsack are issued to the recruits, and these they always take with them when marching from barracks to the drill ground, when at drill, or when practising—as they frequently do—the passage of obstacles whilst in marching order. When technical work is to be done, arms are piled and knapsacks taken off, that is to say the French soldier puts on his equipment, including his portable entrenching tool, four times a day (twice in the morning on going to and returning from the drill ground, and twice in the afternoon). This produces excellent results, because the soldier is so accustomed to his equipment that it becomes quite natural to him to carry it. After the first few weeks of instruction, all tactical movements are always executed in marching order.

The various branches of the technical instruction are combined in such a way that all are learnt simultaneously. For example, a company will devote Mondays to earthworks, Tuesdays to demolitions, Wednesdays and Fridays to pontoon bridging, and Thursdays to spar bridging. There is no drill on Saturday afternoons, which are devoted to inspection by the subaltern in charge of the section. Almost every Saturday morning is spent in battalion drill, and during the last hour all the battalions are united under the command of the lieutenant-colonel, and march past before the colonel of the regiment. As soon as the recruits are able to march and to carry their rifles correctly, they join the old soldiers for battalion drill, but they do not take part with them in other drills and exercises.

Technical instruction is carried out relatively slowly, each subject being thoroughly mastered. On arrival at the fieldwork ground, arms and equipment are taken off, and the men are divided into small squads under a N.C.O. or old soldier, who first gives an explanation, then questions the men about it, and finally sees it practically carried out. For instance, during the instruction in demolitions, when mélinite bombs are being dealt with, the N.C.O. first describes them in detail, and then questions each recruit on the subject. The latter handle them and make themselves thoroughly familiar with them. The detonators, fuzes, method of making joints, etc., are then explained. The officer of the week supervises the instruction of each group, and frequently takes one of them himself. The captain is responsible for the instruction of his company, and is present whenever he thinks it necessary. Both the field officers and captains attend very frequently at the fieldwork ground.

In teaching fieldworks, a commencement is made by giving the recruit a succinct account of the different kinds of earthworks which have already been made on the fieldwork ground; after that they are set to make trenches, gabions, etc. Instruction in these subjects is alternated with practice in crossing obstacles, first without arms, and afterwards in marching order. No attempt will be made to give a full description of the courses of instruction, but a few points of interest will be noted. It should be stated that six to seven hours daily are devoted to the work.

In mining the various kind of mines are first explained, and afterwards galleries, shafts, etc., are constructed.

In demolitions the men are thoroughly instructed in the use of mélinite, detonators, fuzes, jointing, use of the exploder, etc.

In pontooning the recruits are first made acquainted with the two types of pontoon which are employed—namely, the wooden and iron pontoons—with the mode of loading and unloading, method of launching and taking out of the water, rowing, poling, formation of bridge, mooring, etc.

In the month of April the recruits join the old soldiers and practice *elementary instruction*, drill and technical work being taken in turn.

A fortnight before the arrival of the recruits a squad is formed of aspirants to non-commissioned rank. Men to join this squad are selected from every company in accordance with their educational and other qualifications. Only one such squad is formed for the whole regiment, and it is placed under the command of a captain, assisted by two subalterns. The squad formed during the time that Capt. Ladico was attached to the regiment numbered at first 180, but little by little those men were eliminated who proved themselves unsuitable. Thus in some years it is difficult to obtain promotion to the rank of corporal. This squad is put through the same course of instruction as the recruit squads, but as it is formed of picked men it progresses much more rapidly.

In April, when the recruits join the old soldiers, the *elementary instruction* consists in the execution of various types of earthworks, all kinds of hasty bridges, and small demolitions. Water work receives special attention; rafts, sections of bridge, and bridges across the Rhône are made. During this period drill is only carried out once a week, namely, on Saturday mornings, the first hour being devoted to section and company drill, and then battalion drill. On the other days of the week the men are on the works both in the mornings and afternoons.

Each battalion carries out a route march once a week, dinners being cooked in the field. Each route march is executed in accordance with a previously issued scheme, and technical engineer works are carried out on the ground during the march. These exercises are considered to be of great importance, and will be described on another occasion. Field firing is frequently practised, generally once a week.

Every battalion goes under canvas for a fortnight, during which period mining is practised.

At the end of May battalion technical manœuvres take place. One divisional company is formed from all the men available, and carries out a definite scheme in which the company forms part of a column engaged in some tactical operation. These manœuvres usually last four days, during which the engineer works required for accomplishing the tactical conditions are executed. The officers also prepare sketches, reconnaissances, and projects, and perform other military and technical duties. The battalion is billeted in the villages.

As soon as all the battalions have finished their technical manœuvres, they are united in order to carry out regimental technical manœuvres (1,000 men took part in them in 1907). In these only a few engineer works are undertaken, attention being specially directed to purely military

operations; thus of the four battalions three act as infantry, and only throw up such entrenchments as would be made by that arm. Open order drill and the infantry combat are practised, and the regiment is billeted in one or more villages.

During July each battalion has its pontooning manœuvres, which last four days. All the men (in the battalion mentioned there were 250 pontoniers) are engaged on bridging duties on the Rhône. At the end of these manœuvres the men of each company are divided into two groups for higher training, some being detailed as sappers and miners, and others as pontoniers. They all remain in the same company, and in it receive higher training in the group of subjects in which they specialize. Thus all the men receive the same complete elementary training, and afterwards higher training either in fieldworks or in pontooning. The pontoniers go down to the Rhône every day, both morning and afternoon, and practice nothing but pontooning. The sappers and miners go to the camp of Villeneuve-les-Avignon, where they continue the instruction in mining commenced by all during the first period of training, assisting at explosions and mining exercises which take place in August.

During the same month the pontoniers of the regiment under a major and other officers, carry out special manœuvres on the Rhône—in 1907 they lasted four days, and 280 pontoniers were trained—make numerous bridges, and are billeted in the villages.

At the end of August competitions are held for N.C.O.'s and men. In 1907 the subjects were earthworks, four-legged trestles, water work, and pontooning. The winner is the man who executes his task in the best manner and in the shortest time. The company which gains most prizes is honoured by being detailed as escort to the colours.

Afterwards the inspection of the Chief Engineer is held. In 1907 it lasted six days, during which he witnessed all kinds of technical and military exercises, inspected the barracks, fieldwork and training grounds, and distributed prizes to the winners of the competitions.

Each divisional company takes part in the evolutions of its own division. That to which the writer was attached trained with the 23rd Division at the camp of Courtine (department of la Creuse) at the end of June and beginning of July. Six thousand men were present, of whom 110 were engineers.

The grand manœuvres of 1907 took place in the first fortnight of September in the departments of Dordogne and Charente. The writer's battalion was attached to the 12th Army Corps. It and the 18th Corps numbered together 35,000 men, of whom 750 were engineers. Leave was given at the end of the manœuvres.

In the divisional companies there are more sappers and miners than pontoniers; the opposite is the case in the corps troops company. The companies attached to the Alpine divisions practise a great deal with the Yarron and Eiffel bridges (without intermediate supports), so as to be able to use them in the ravines of the Alps.

The recruits told off to the engineer transport company receive a special training in riding, harness, vehicles, and all kinds of transport duties.

'M.'

REVIEWS.

THE LIFE OF MAJOR-GENERAL SIR JOHN ARDAGH.

By Susan, Countess of Malmesbury (Lady Ardagh).—(Published by Mr. J. Murray, 1909).

Lady Malmesbury deserves the thanks of the Officers of the Royal Engineers for having written this interesting memoir of their distinguished brother officer, Sir John Ardagh, who had the advantage of being closely connected with several important episodes in the history of Great Britain during his military career. With great discretion she has included much of what Ardagh wrote himself, and his observations on the events of which he was an eyewitness show him to have been a shrewd judge of men and matters.

At a comparatively early age he had an opportunity of proving his resourcefulness under difficulties when, as a subaltern of two years' standing, he was ordered to Canada in command of a detachment of Royal Engineers, at the time that relations with the United States had become strained in consequence of the high-handed action of the Federal Government regarding the arrest of Messrs. Slidell and Mason. Ardagh and his men embarked in the s.s. *Victoria*, a vessel which had been hired as a transport, although totally unfit for an Atlantic voyage, as the rigging was in bad order and the engines weak and defective. Meeting with heavy weather, the ship lost her sails and sprung a leak; then, to make matters worse, the engines broke down and the pumps refused to work. Had it not been for the energy of Ardagh and his sappers, all on board would probably have been lost, but he succeeded in tinkering up the engines, rigging jury pumps, and at last the *Victoria* was brought back to England in safety, after having been three months at sea. Ardagh's services were so conspicuous on this occasion that on his return to Chatham he was publicly thanked on parade by order of the Commander-in-Chief.

During the time that Ardagh was having his perilous voyage in the Atlantic the war cloud had blown over, as the United States Government had yielded to the British demand for the surrender of Slidell and Mason; his orders to proceed to Canada were therefore countermanded, and he was sent to the Southern District for duty on the fortifications, which were then in course of construction at Portsmouth and at Newhaven under the Defence Loan of 1860. He was principally responsible for the design and construction of the works erected for the protection of

Newhaven Harbour, and showed such ability in all matters connected with fortifications that in 1868, when a Commission was appointed to inspect and report on the works that were in course of construction under the Defence Loan, he was selected to act as Secretary, and accompanied them on their tour of inspection round the United Kingdom. He was next chosen to go with Sir William Jervois on a visit to the defences of Halifax and Bermuda, and on his return was appointed Secretary of the Committee on Coast Defences. In these different positions Ardagh had the opportunity of becoming thoroughly acquainted with British defences, knowledge which proved of great use to him later, when he joined the Intelligence Department.

But his studies were not confined to the fortifications of the United Kingdom, as in 1869 he was sent to Holland and Belgium to report on the defences of those countries; and in the spring of 1871, having obtained leave to travel in France, he arrived in Paris just after the armistice was concluded between the French and Germans, and as soon as peace was concluded he took the opportunity to visit the forts round Paris. From Paris, Ardagh went on to Besançon, Belfort, and Strasburg, and returned to England by way of Germany after a very instructive tour.

After a short period of service at Malta, where he was struck down by the much-dreaded Maltese fever, now fortunately a disease of the past, he was invalided home, and in 1872 passed the entrance examination to the Staff College, and when his course of instruction there was completed was selected for employment at the Intelligence Department of the War Office, of which General Sir P. Macdougall was then the head. He spent a little more than a year at the War Office, and in 1876 was chosen for special service under the Foreign Office in connection with the affairs of the Near East.

It was a period of great excitement in Turkey and in the Balkan Peninsula. Insurrections in Herzegovina, Bosnia, and Bulgaria led to the deposition and death of the Sultan, Abdul Aziz, and to his succession by the Sultan Murad, who in his turn was deposed and succeeded by the late Sultan, Abdul Hamid. In July, 1876, Servia declared war against Turkey, and in the following month, after some severe fighting, the Turkish Army entered Servia, when the latter State appealed to the European Powers to interfere on its behalf, and an armistice was arranged, so as to allow of the question being settled at Constantinople.

General Sir Arnold Kemball was British Military Attaché with the Turkish Army which had entered Servia, and Capt. Ardagh was ordered to join him at Nisch, where the Turkish headquarters were then established. Leaving London at the end of August, he proceeded to Vienna, and by steamer down the Danube to Belgrade and Widin, whence he had a rough journey across the Western Balkans to Nisch. Here he found the Turkish Army extended along the left bank of the Morava River and facing the Servian position in front of Deligrad-Alexinatz on the right bank, and notwithstanding the armistice, the Servians were frequently firing at the Turks, who had instructions not to reply. At length a deliberately planned attack compelled the

Turks to drive off their treacherous enemy, which they succeeded in doing without much difficulty.

On the conclusion of the armistice the Turkish Army advanced, completely defeated their opponents, and made themselves masters of Servia, when Russia interfered, and a further armistice was agreed to.

Ardagh however did not see the conclusion of the struggle, as he was summoned to Constantinople to assist Colonel Home, R.E., in preparing a scheme for the defence of the Turkish capital by a line of fortifications from Buzuk-Tchekmedji, on the Sea of Marmora, to the Black Sea, and in making other surveys in connection with the defences of the Bosphorus and the Dardanelles. After the completion of this duty he was sent to Bulgaria to report on the state of the country, which was in a very disturbed condition. A few months later Russia declared war against Turkey, and the Russian Army crossed the Danube and advanced towards Constantinople. The war continued until March, 1878, when a treaty of peace between the two conflicting Powers was signed at San Stephano; then the other European countries intervened, and a Congress was assembled at Berlin in June, to settle the boundaries of the different states in the Balkan Peninsula.

Lord Beaconsfield and Lord Salisbury were sent as the British representatives to the Congress, and General Sir Lintorn Simmons and Capt. Ardagh accompanied them as technical advisers. The knowledge which the latter had gained during the time that he had previously spent in the Balkan States proved of the greatest value, and much of the work in connection with the settlement of the boundaries fell to his share; on his return to London he was recommended by Lord Beaconsfield for the civil C.B., an unusual distinction for so young an officer. But his work in the Balkan States was by no means at an end, as in September, 1878, he was selected as assistant to Colonel Home, R.E., who had been appointed British representative on the International Commission for delimiting the boundaries of Bulgaria.

Ardagh's journals, many extracts from which have been included in the Memoir by Lady Malmesbury, give a most interesting account of the difficulties met with by the Commission in the prosecution of their task. Poor Home was attacked by typhoid fever, brought on by exposure and hard work, and returned to England to die; and when the Commission re-assembled in the spring of 1879 he was succeeded as British Commissioner by Sir Edward Hamley. Great difficulties were raised by the Bulgarians and Russians, and the former actually fired at Ardagh and his party when engaged on survey work; it was not until September that the work was completed and the convention describing the boundary signed at Constantinople.

In June, 1880, an International Conference was assembled at Berlin to consider the question of the Turko-Greek frontier, and once more Sir Lintorn Simmons and Ardagh (who had been given a brevet majority for his work in Bulgaria) were ordered to attend as the British military advisers. The negociations were continued at Constantinople in the following year, and a Commission was then appointed, on which Ardagh

was the senior British representative, for the actual marking out of the boundary, and on his shoulders fell the brunt of the work. Lord Dufferin, in his report to the Foreign Office, spoke enthusiastically of the manner in which he had fulfilled his duties.

In February, 1882, Ardagh was appointed Instructor in Military History at Chatham, but only held the appointment for a few months, as in the following July he was ordered to proceed to Egypt, and was one of the first of the British expeditionary force to land at Alexandria, a few days after the bombardment. As at that time only a small force had arrived, and as an attack by the Egyptian troops under Arabi was possible, steps had at once to be taken for putting the place in a state of defence, and the duty of so doing was entrusted to Ardagh, who was ably assisted by Capt. E. Wood and other Engineer officers. He was summoned by Lord Wolseley to Ismailieh at the end of August, and was present at the Battle of Tel-el-Kebir. A very good reproduction of his panoramic sketch of the battle is included in the Memoir, which shows in a graphic manner the position of the British troops at the time when the Highland Brigade and the brigade commanded by Sir Gerald Graham were approaching the Egyptian works. As Ardagh remained at Tel-el-Kebir for a week after the fight, he had the opportunity of making himself thoroughly acquainted with the position, and took much pains to make his sketch an accurate record of what had happened.

After the conclusion of the campaign Ardagh was appointed D.A.A.G. on the Staff of General Sir A. Alison, who was placed in command of the British Army of Occupation in Egypt, and was present during the severe cholera epidemic in 1883. His next experience of active service was in February, 1884, when Sir G. Graham was sent in command of a British force to Suakin, and Ardagh was attached to his Staff as Commanding Royal Engineer and Chief of the Intelligence Department. Lady Malmesbury has given some interesting extracts from his diary descriptive of the campaign, and a sketch by him, showing the disposition of the troops at the Battle of Tamai just after the left-hand square, to which he was attached, was broken by the Arabs and re-formed with some difficulty. The defeat of the Dervishes at Tamai was followed by an advance along the Suakin-Berber road to Tambuk, when Graham might have gone on to the assistance of Gordon had he not been recalled by the British Government. Ardagh, who studied the question with his usual attention, was always in favour of the Suakin-Berber, as opposed to the Nile route, for operations in the Sudan. For his services in the Suakin Campaign he was given the military C.B., so that he was thus in the unusual position of wearing both the military and civil decoration.

In August, 1884, it was decided to send an expedition up the Nile, under the command of Lord Wolseley, for the relief of Khartoum, and Ardagh naturally hoped to have accompanied it; but he was ordered to remain in Cairo, and was appointed Commandant of the Base, a position which gave him an enormous amount of work—work that he carried out in an admirable way, as will be remembered by those who were serving with him in Cairo at the time.

But after the fall of Khartoum and the withdrawal of the Nile expeditionary force, when the Dervishes advanced into the province of Dongola, he had his chance, as he accompanied General Sir L. Stephenson as Senior Staff Officer with the force which was sent to drive back the Dervishes, and took a leading part in the short but brilliant campaign which ended with the Battle of Ginnis, when the Arabs were completely defeated. Ardagh was strongly in favour of going on to Dongola, but orders came from London to retreat, and the operations were naturally reported at Khartoum as a victory for the Dervishes.

After the conclusion of the Nile Campaign, Ardagh was employed on the question of the adjustment of the Anglo-Egyptian finances, a very complicated matter, which engaged his attention until the beginning of 1887, when he returned to the War Office to fulfil the duties of A.A.G. for Mobilization at the Intelligence Department, a post which he held until October, 1888, when the Marquess of Lansdowne, who had been appointed Viceroy, asked him to accompany him to India as Private Secretary. He held the appointment during the whole period that Lord Lansdowne was Viceroy, and remaining for a short time with the Earl of Elgin, his successor, returned to England in 1894.

Ardagh was next appointed Commandant of the School of Military Engineering at Chatham, and was then selected for the important post of Director of Military Intelligence at the War Office in succession to Sir E. Chapman.

While he was in charge of the office the war in South Africa broke out, and considerable blame was given him at the time, on the ground that he had not kept the Commander-in-Chief and the Government fully informed as to the strength of the Boer forces. But the evidence given before the Commission on the South African War showed how absolutely unjustifiable was the attack on Ardagh, and that he had done everything that was required in obtaining and supplying the Government with all the required information. This part of the Memoir is very interesting and deserves careful perusal.

Ardagh's later services at the Hague Conference, on the South African Deportation and Compensation Commissions, the Chili-Argentine Boundary Commission, the Suez Canal Commission, and the meeting of the Red Cross Convention at Geneva are all fully treated.

Ardagh was fortunate in having had a most interesting and active career, and the thorough manner in which he carried out the very varied duties committed to his charge gives an example that may well be followed by other Royal Engineer officers.

The work is admirably illustrated with a selection of his own sketches, and there is a good map to explain his work in the Balkan Peninsula. In conclusion, we would like to congratulate Lady Malmesbury on the able manner in which she has completed her difficult task, and would recommend the handsome volume to all the officers of the Corps.

THE HISTORICAL RECORDS OF THE FIFTH (ROYAL IRISH) LANCERS.

By MAJOR W. T. WILLCOX, 3RD HUSSARS, LATE CAPTAIN, 5TH LANCERS.—(London: Arthur Doubleday & Co., Ltd., 1908. 42s.).

Much has been done in recent years towards the development of *esprit de corps* both by means of regimental monthly and annual publications and by regimental histories. The *Rifle Brigade Chronicle* probably represents the high-water mark hitherto attained by an annual regimental publication, and the history under review is probably the most elaborate and best got-up general record of any regiment or corps in the Army.

Capt. Willcox served for 13 years in the 5th Lancers, and was then promoted to a majority in the 3rd Hussars. During the last three years of his service in the former regiment he occupied himself in collecting its historical records. It is not too much to say that he has raised the standard of regimental histories to a point higher than any reached hitherto.

The letterpress, plates, and maps are alike excellent, the appendices containing biographies of distinguished officers of the regiment, and an alphabetical list of officers of the regiment from the date of its first formation as Wynne's Inniskilling Dragoons, in 1689, to the present day. The history embraces the campaigns in Flanders under the Duke of Marlborough, the Irish Rebellion of 1798, the Nile Expedition of 1885, and the South African War, 1899 to 1902.

One of the most striking figures in the history of the regiment is that of Colonel J. J. Scott Chisholme—popularly known as "Jabber" Chisholme—whose portrait is given opposite p. 208.

His five years' tenure of the command of the regiment expired on the 12th August, 1899, and exactly two months afterwards the following extract from Ladysmith garrison orders was published as a Regimental Order in the 5th Lancers:—

> "WAR.
> The Secretary of State for War telegraphs from London that war has been declared by the South African Republic, and the British Agent at Pretoria has been instructed to ask for his credentials and withdraw to British territory."

Meanwhile Scott Chisholme had been engaged in organizing a local mounted corps, known as the Imperial Light Horse.

On the 21st October he led his newly-raised regiment into action at Elandslaagte, and had the satisfaction of knowing that "his boys were doing well" before his brilliant career was ended by a bullet in the brain.

The author comments as follows:—"'Killed in action'—a soldier's death, as he himself used to say; but surely no officer was ever more sincerely mourned on the battlefield by his men than was 'Jabber' by those who had served him so well in India and South Africa. And the hard luck of it all was that fate had decreed he was not to lead the men

he had trained so well into their first fight, but at the last moment, and on the eve of war, had severed his connection with the regiment."

The book is a new illustration of the Hesiodic maxim that in military history, as in so many other subjects, "the half is more than the whole." By eliminating as far as possible all the history of the war except in so far as the 5th Lancers were concerned, the interest to members of the regiment is increased fourfold. Many a man who would never study a general military history unless he were obliged to would eagerly devour the smallest details referring to his own regiment.

In a Corps like the Royal Engineers this surely points to the desirability of keeping up company histories and developing company *esprit de corps*. Its unit is the company, and many who would eagerly read a company history would hesitate before tackling a general account of the doings of the Corps in a long-drawn-out campaign such as that fought in South Africa from 1899 to 1902.

B. R. WARD.

SANITARY ENGINEERING.

By MOORE & SILCOCK.—(Published by B. T. Batsford, London. 2 vols. £2 2s.).

Eight years ago a notice of Colonel E. C. S. Moore's colossal work on Sanitary Engineering appeared in these columns, and it was then stated that a book of reference had been produced which could fairly claim to be the standard work in this branch of engineering science. The talented author, who was one of the first to investigate and to recognize the possibilities of the new methods of purification of that day, spared no pains to bring within the compass of one volume the most recent results of the remarkable development in that particular direction which characterized the close of the last century, and the book was received by engineers as a most valuable compendium of all that was ascertainable on the subject. Shortly after its publication Colonel Moore was called to his rest, his loss being deeply felt not only by a large circle of his personal friends, but by a still wider circle, to whom he was known by his writings.

During the intervening years great strides have been made in the further development of those methods of bacterial purification which were introduced in the nineties, and—the second edition of the book being exhausted—the eminent authority on all matters of sanitary engineering, Mr. E. J. Silcock, M. INST. C.E., F.S.I., F.G.S., was asked to bring out a third edition, and this has now been published.

In this he has preserved all the features which made the original work so valuable, wisely omitting that which the march of time had rendered obsolete, and he has brought thoroughly up to date the information concerning the most successful solutions, which experience has approved, of the problems which confront the engineer.

Principles are discussed and practical methods are described illustrating the success which has attended the combined efforts of the chemist and the engineer, with a wealth of detail which cannot fail to be of the greatest assistance to all those who may be called upon to grapple with problems similar to those which are so lucidly explained. The most recent Reports of the Royal Commission are dealt with and the gist of them recorded, and side by side with these the requirements of the Local Government Board (revised up to this present year) are detailed and discussed.

The publishers have wisely divided the 900 pages and over 90 most beautifully produced plates, into two volumes, as otherwise the work would have been too cumbersome to handle conveniently, and they are to be congratulated on the style, combining clear type with excellent paper, in which they have published the valuable materials of the author.

Speaking broadly, the first volume deals with the details of Construction, and the second with the principles and practice of Sanitation, and reference is facilitated by a well-arranged and comprehensive index.

J. WINN.

PRACTICAL ARABIC GRAMMAR.

The Clarendon Press has recently published the fourth edition of Part II. of Green's *Practical Arabic Grammar*, to supplement the fourth edition of Part I., which was published apparently in 1901.

The grammar generally follows the lines of the earlier editions, but has been both enlarged and thoroughly revised, and in the Preface to Part I. Colonel Green points out that, at the request of the delegates of the Oxford University Press, he has entirely recast the system of transliteration previously made use of. This is in order to bring the work into conformity with the system adopted by the Geneva Congress of Orientalists in 1894.

Another improvement is that colloquial Arabic only is used in the body of the book, although the various grammatical inflexions and diacritical marks are given in the Syntax and Tables as an exercise in classical Arabic.

Finally a transliteration of many of the Arabic and reading exercises has been given, so as to enable the beginner to master the pronunciation and to help him with the reading of Arabic writing, and a few extracts from newspapers and manuscript letters are added for the more advanced students.

Part II. has also been revised so as to conform to the system of transliteration adopted now in Part I.

NOTICES OF MAGAZINES.

JOURNAL DES SCIENCES MILITAIRES.

April 1st, 1909.

The instalment of "Instruction of an Infantry Regiment" in this number considers the decisive attack. Everybody agrees as to the necessity for such a manœuvre, but there is considerable difference of opinion as to the way in which it should be carried out. Some authorities consider that the commander should be able to reconnoitre and pick out the weak point of the enemy's position and attack it, whether it is the front or the flank. Others think that frontal attacks are so dangerous that wide turning movements should be made instead. A flank attack is of the nature of a surprise, and is consequently more effective.

The Russo-Japanese War has shown that a frontal attack may succeed in spite of all its difficulties; but its results can never be anything but small, even in the most favourable cases. As modern civilization renders it imperative to cut down a campaign to the shortest possible time, frontal attacks giving small results are not sound measures. We must remember that what has been done once, with one armament and army, is not necessarily possible again with other armaments and armies.

According to General Langlois, Skobeleff's attacks on Plevna did not advance more than 1 kilomètre an hour; at Liao-Yang the final Japanese advance covered 900 mètres in an hour and ten minutes. The present tendency is for the distance covered by the final rush to grow shorter and shorter. In the French Regulations the initiative in making this rush is taken by the commander of the attack; but Germans and Japanese consider that the firing line may, in some circumstances, take this decision into its own hands.

The German cavalry is about to receive a bayonet for use when fighting dismounted, and an article in this number suggests fitting a bayonet to the French cavalry carbine in such a way that, when not in use, it may be folded back into a groove in the woodwork. Opinions are divided in France as regards the *rôle* of cavalry. Some are in favour of the cavalry doing most of its fighting on foot; the others declare that by doing so they will throw away their great moral advantage, viz., speed of movement. Some again declare it impossible for the French two-year men to face the German three and four-year men if on horseback. Others reply that it will be impossible to check by fire alone the German cavalry, which is trained to attack hostile cavalry at sight. The conclusion drawn is that, since in peace it is impossible to prove the superiority or otherwise of shock over fire action, the cavalry must be trained in both. Consequently, as it may have to fight on foot, it should be better armed for that purpose.

At present a dismounted cavalryman has nothing but his carbine. A bayonet of some sort is essential. It should be very light, so as not to alter the ballistics of the carbine; it should be adaptable to the present carbine, and if possible it should be permanently attached to it, since it gets in the way if worn in a scabbard attached to the waistbelt. In addition, the weapon should be of such a nature that the cavalry will never forget or distrust mounted action from too great love of dismounted action, and so become mere mounted infantry.

H. L. WOODHOUSE.

LE BULLETIN.

February 15th, 1909.

GERMAN FIELD SERVICE REGULATIONS.—This number treats of the use of outposts in siege warfare, and shows the influence of the late war in the East. The strength of siege outposts is placed at a high figure, one-third of the infantry allotted to each sector. Under the head of "Marches" it is noted that the passing of troops over military bridges should be under the control of the engineers.

THE MODERN MILITARY INSTRUCTOR.—*Marceau.*—The subject is continued. The author gives various hints to aid the company officer in forming an opinion on the merits of his men, and advises that a notebook should be kept to record against each man's name any points which come to his notice, as giving an indication of character. Stress is laid on the importance of eliminating any instruction which is not preparation for war.

ATTACK AND DEFENCE OF FIELD FORTIFICATIONS.—The value of villages, farms, and woods in a defensive position is discussed, that of the latter depending on the nature of the trees—large trees being better than saplings and undergrowth. Protection from fire in woods and villages is usually obtained 50—100 yards from the front edge. The quantity of ammunition needed to cause much damage, generally precludes an attempt being made to drive out by shell-fire, troops sheltered in them. For troops occupying woods, while the front edge is only held weakly, internal defence must be strongly organized. The author lays down that woods should always be occupied, when they exist in the defensive line, unless no field of fire is obtainable, in which case a position in advance of them must be taken up.

In dealing with advanced posts, the author is careful to distinguish between them and the outpost positions, the object of the latter being attained as soon as the troops in the main position are ready to repel an attack. The former should, on the other hand, never be abandoned before attack, and must be so chosen as to permit both of a flanking fire from the main position, and also of artillery support. The garrison of advanced posts should not usually exceed two infantry companies, and defensive works should be made with open gorges, so that they cannot be utilized by the enemy when captured. Considering the best means of

counter-attack, the author comes to the conclusion that it can only be successfully delivered from a flank, unless the enemy is completely shaken, or unless it is absolutely necessary to dislodge him from a foothold close to the defensive line.

February 28th, 1909.

Attack and Defence of Field Fortifications.—Continuing the subject of the counter-attack, it is suggested that it should generally be delivered as soon as the enemy has deployed his reserves and committed himself to a frontal attack.

In a frontal attack on a fortified position, the preparatory deployment would take place at 2 to 3 miles from the position, but up to the moment of assault, reserves in close order must be available. When the advance troops arrive within 300 yards they must make a careful reconnaissance of the favourable points of attack; this will be carried out by officers' patrols of engineers and infantry, aided possibly in the future by dirigibles.

The formation of assaulting columns depends on the number and size of the breaches in obstacles. They are usually preceded by pioneers. For the assault, a preparatory deployment under cover is necessary, and this would usually be made by night. The sharpshooters of each company take up a position to cover deployment, and the remaining troops are formed into assaulting columns. The latter advance in close order and in silence behind the pioneers and sharpshooters. When the sharpshooters reach the obstacles, or at any rate when 50 yards from the enemy's line, they throw themselves down and open fire on the enemy to distract their attention from the assaulting columns. The latter cross the line of obstacles, deploy, and rush the trenches. The most favourable moment for an assault is at daybreak, as the night affords time to make preparations.

Foreign Military Intelligence.—The French infantry are to be trained in the use of hand grenades. The present grenade is a hollow cast-iron shell, 3" diameter, weighing 2 lbs. empty, 2½ lbs. full. It contains a powder charge, and a quickmatch which lights a slow combustion composition, which burns for 5 seconds. The grenade is thrown by hand and the quickmatch lighted by means of a friction tube, the igniter of which is pulled by a hook attached to a leather wristlet worn by the man. The distance to which it can be thrown is 20 yards.

March 15th, 1909.

Contains nothing of special interest.

'E.R.'

Militärische Presse.

May, 1909.

In the *Militärische Presse* of the 16th January, an article appears out of the *Artilleristisches Blatt*, of which the following is a *précis*:—

Illumination of Foreground by Electric Light.—Every modern army has Search-light Sections now included in its organization. As a

rule, in the past their use has been limited to siege warfare or coast defence. They have without doubt their uses too in field operations, but, because they are unknown to the majority of the field army, they are seldom included in night operations. Every military student knows what an important *rôle* they played in the Russo-Japanese War, especially during the Siege of Port Arthur, and it behoves all modern leaders of to-day to employ every aid, however technical, to bring his operations to a successful termination. Attention is drawn to a publication by an artillery captain, commander of a search-light detachment in Pola, Austria. This pamphlet has especially been written as an aid and guide for officers of all arms.

Each S.L. detachment is similar in its organization to an infantry company, and is divided into "Züge":—

(1). The observation group.
(2). The projector group.
(3). The engine group.
(4). A reserve group.
(5). A telephone group.

The whole "service" is under (1). The details of the projector and lamp are then described. The 35-cm. size is fitted with "legs"; the 90-cm. size, as a rule, is carried in a 4-wheeled wagon. The 150-cm. size is used for coast work only. The reflector is a speciality of the Siemens Schukert Werke, made of glass and paraboloid in form. The projector body is closed by a plain glass door or fitted with a double dispersing lens. This latter however absorbs a very great quantity of light. The accessories are the controller and the dousing arrangement. As regards the control, when using motors the observer himself moves the projector, but with hand traversing all movements must be done by the man at the projector. Signalling by means of the dark shutter is referred to. The range of the light depends on the intensity of the beam and the state of the atmosphere and is very variable, but roughly we may say that for the 35-cm. size, it is 1,000 mètres, for 90-cm., up to 3,000 mètres, and for 150-cm., up to 5,000 mètres.

Direct current dynamos are used for supplying the current, the 35-cm. being sometimes run off accumulators. The dynamo is run by a steam or benzine engine. The latter must be used where portable sets are required. The reserve group supplies the relief numbers, and is in charge of all stores and repair materials. The horse teams are attached to this group when the lights have been started up.

The instructions point out that to get the best use out of the S.L.'s, the S.L. officer should be given a free hand by the higher C.O.'s, in the same way that battery C.O.'s carry out all their own preparations. The article finishes by urging that S.L.'s should be taken out on all big manœuvres, so that all arms and higher commanders should get to know something of their uses and possibilities in all night operations.

R. WALKER.

Revue du Génie Militaire.

January, 1909.

The Campaigns in China, 1858—1862.—This is an extract from the diary of the late General Gallimard, who served in Tonkin and North China as a captain of engineers. It is an account of the writer's personal experiences rather than a history of the operations.

The Fourth Arm in Conjunction with the Others.—An appreciation of a previous article on the same subject. The writer's remarks are chiefly quotations from military books and essays. They shed no new light on the subject.

February, 1909.

The Defence of Bou-Denib.—The Moors were defeated by the French in May, 1908, near the small town of Bou-Denib. The French then held this point as an advanced post. The town is walled, but it stands in a valley and is surrounded by palm trees, and is not therefore suitable for defence. The French constructed a line of works across the valley. The principal work was a redoubt for a garrison of 1,500 men, situated on a hill to the north-west of the town. On the opposite side of the valley a blockhouse for 60 men was constructed. A Moorish town in the centre of the valley was also held as a connecting point between the other two works.

The defences of the works consisted of loopholed mud walls 2′ thick. These were quite bullet-proof. The walls were built partly with puddled clay rammed into a mould, and partly with sundried bricks. The town itself was defended by occupying houses that overlooked the two gates, and a few flanking towers on the wall.

The Moors attacked the position on the 1st September, and were repulsed with heavy loss.

The Engineers in China.—An account of the organization and distribution of the French Engineers in North China from 1901 to 1906.

Military Kites.—An account of the apparatus used in the Russian Navy and the British Army. The Russians employ a team of six or seven box kites. The car is fixed to the cable just below the lowest kite. The apparatus oscillates a good deal while the cable is being paid out. Apparently the British system is more efficient.

March, 1909.

The Engineers in China.—The continuation of an article commenced in the February number.

Military Kites.—A continuation of a previous article. The author discusses the theoretical part of the subject. Calculations for determining the centre of pressure and angle of equilibrium are given.

J. E. E. Craster.

CORRESPONDENCE.

RAILWAY SIGNALLING.

SIR,

In the March number of the *R.E. Journal*, Capt. A. Gardiner criticized our article on the electro-pneumatic signalling installation on the low-pressure air system adopted by the London and South Western Railway, and we should therefore like to add a few remarks in reply.

With regard to the general article, we intended it only as a description of what we actually found on the London and South Western Railway, and not as the latest verdict. The installation has been in operation for some considerable time, has been extended in the course of the last few years from the experimental portion between Andover and Greatley to the parts of the line enumerated in our article, and is at present being laid down for use on the most important portion of the line near London.

We will deal with the objections raised by Capt. Gardiner in the order he has taken them.

Switch and Lock Movement.—There is no electric check in use, and it has been found that the pneumatic indication is sufficient. As all parts of the operating mechanism are made of steel, it is unlikely that both the switch rod and the lock rod would be disconnected from the motion plate at the same time either by accident or by neglect. In case of any "trailing through," the motion plate itself or some of the other connections would be bent, twisted, or otherwise disarranged, but not absolutely disconnected, thus preventing a complete movement of the motion plate, and this would consequently indicate to the signalman that something was wrong. If *Figs.* 5 and 6 of the article are studied, it will be seen that to trail through any points on the main line the engine driver would have to pass two signals at danger, in addition to the warning of the preceding distant signal.

Replacement of Signals by Air Pressure.—In all systems of railway signalling some method has to be adopted to place the signals at danger, and this replacement by air pressure seems very satisfactory when it is considered that the *total* air pressure on the piston tending to replace the signal at danger is 286 lbs. The magnitude of this seems to have been overlooked. All signals are replaced to danger on the *failure* of motive power by gravity, thus ensuring an additional safety precaution, in exactly the same way as a signal returns to danger by the action of gravity on the failure of a current on the "all electric." In ordinary working the cessation of pressure below the piston acts

simultaneously with the application of pressure on the top of the piston, and this makes the return to the danger position positive and rapid. The replacement of signals to danger is also clearly indicated to the signalman by the completion of the movement of the lever in his box.

Electric Signal "Replacement."—The time taken for the cycle of operations is about one second, with the advantage that the signalman is certain that his signal has been replaced to danger by the return of his lever. In addition, this replacement is used as a lock on the signal lever, which cannot be pulled off for the signal to be again lowered while a train is in the section in advance.

With regard to the criticism of the characteristics of this system:—

(1). It is hard to regard the first item as anything but a quibble. When we mention "all electric" systems, we do not go into the means of generating and otherwise obtaining an electric current, and we can hardly agree that air-compressing machinery is not less complicated than a dynamo, as it runs at a much slower speed, and is far more easily adaptable to its varying load.

(2). The distributing mains require practically no attention, and have to be maintained at that pressure, so as to always have a sufficient supply of air to supply the operating pipes.

(3). The extra precaution of being independent of gravity for ordinary operations, and of having that force in reserve in case of failure, does not require any further remarks.

(4), (5), and (6). The whole purport of these objections seems to be an idea that the operating of a signal or points takes a considerable time. As we have pointed out above, the whole time occupied is at the most a second, and is in fact no longer than the switch and motor operating the points at the electric signal box at Derby.

Advantages over the "All Electric."—The great advantage of a weak electric current is that the percentage of leakage is less, and, in addition to this, the battery power to generate it is simple. All the electric cells for the relay and cut-out valves are of the same pattern as those for track circuits, and can be recharged when run down, by an individual of ordinary intelligence. They do not require a skilled electrician to look after them, and it has not been found necessary to use the 50 per cent., or in fact any increase of air pressure, for five or six years on the London and South Western Railway.

The greatest drawback to an "all electric" system on one of the main trunk lines seems to be the means of obtaining the electric power required. Either one must provide generating plant accumulators, etc., at each signal box, with large primary cost and a large staff to maintain and attend to them, or, failing this, generating plant at certain centres to supply the power, and this entails large cost of distributing it to the signal boxes.

With regard to primary cost, the installation on the London and South Western Railway seems to be the only section of line of considerable length on any of the out-of-London railways to give reliable data, and a comparison of primary cost and also maintenance charges would be misleading. The greatest argument in favour of this system seems to be

that it is being extended, while the "all electric," which is being taken up by the Midland Railway, is not proving a saving, and is only being installed to work experimentally a set of automatic signals between Keighley and Steeton. We are informed that it is costing more than a mechanical box, including the capital value of the signalman's wages who would be required to work it.

Finally, "fineness of detection" seems rather out of place on a railway track, and as the lock rods are adjusted to within $\frac{1}{50}$ of an inch for each position of a switch, this seems to be fine enough for all practical purposes.

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