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THE ROYAL CHARTER.

AN announcement has already appeared in the March *Supplement* to this Journal that H.M. The King had been graciously pleased to approve the grant of a Royal Charter of Incorporation to the Institution of Royal Engineers; the bestowal on the Institution of this mark of royal favour is obviously an event of importance and calls for a special note in the pages of this Journal.

It is now some 47 years ago that the Institution was founded under its original title of the Royal Engineers Institute; during this period it has unquestionably served a most useful purpose, and its success has been so marked that to-day its members own much valuable property, a part of which has hitherto been vested in trustees. But something further was required to be done, in order adequately to protect the whole of the property of the members and properly to safeguard the future interests of the Institution. Both these ends have been secured by the grant to the Institution of a Royal Charter, which has had the effect of endowing the Institution with a legal existence distinct from and independent of its members. The Institution has, in consequence, become a "Body Politic and Corporate," and will, in its own name, be henceforth "for ever able and capable in law, notwithstanding the statutes of mortmain, to acquire, have, take and hold all the real estates, chattels, real and personal estate, belonging to or held in trust for the Institution." The Institution having acquired the status of a Corporation, it may not be out of place to say a few words here on the distinguishing characteristics conferred upon it, and their origin.

A Corporation is, needless to say, an artificial or fictitious person, and unites and personifies the group of transitory individuals who, for the time being, make up its membership; further, it enjoys a "kind of legal immortality"; that is to say, the Corporation possesses the attributes of unity and of perpetual succession. It is to Roman jurisprudence that belongs the merit of having invented the device of incorporation, which, it has been said, is a refined conception that has contributed more than any other human artifice to the civilization of Europe and the freedom of the States, since it was the Roman doctrine of Corporations that was brought in aid as the apt lever for the forces utilized in transforming the mediæval nation into the modern State. As the rights of natural persons may be said to die with them, the Romans conceived the

idea that something should be done in order to preserve the particular rights of an Association of natural persons, when formed for some praiseworthy purpose, entire for an indefinite period, instead of allowing them to fall with the lives of the members who might, at any time, compose such an Association. Consequently, the establishment of Corporations for the advancement of religion, learning and commerce, and, indeed, even for social and convivial purposes, was permitted, when their existence was thought to be to the public advantage. Such Corporations, though consisting of numerous individuals, were treated by Roman law as forming a unity, with rights and liabilities distinct from those of its members individually, and were constituted either by a law, or by a decree of the Senate, or by an Imperial constitution; and Associations, the existence of which was not so authorized, were deemed to be illicit and illegal.

A juristic conception which endowed an Association of natural persons with the characteristics of the Roman Corporation proved so convenient that it was duly transplanted in these northern regions and became firmly rooted in our own Common Law, which, from very early times, has for a multitude of purposes treated the Corporation very much in the same way that it has treated the man. It is quite natural, also, that, in the days before the Legislature had established its control fully in all departments of a nation's affairs, the ruling Prince should, when desirous of encouraging the designs of those seeking combination for a laudable purpose, have had resort to the Roman device of incorporation in order to legalize such combinations. Hence it is that, for many centuries now, our Sovereigns have exercised an inherent power, the so-called prerogative of the Crown, to create Corporations for a variety of purposes, and this has been done by the grant of Charters. The exercise of the Royal prerogative in this particular manner is so old that its origin cannot be definitely traced; its first use is lost in antiquity, but public records are still extant to-day showing that grants of privileges by Royal Charter were made by Henry I. to corporate towns so long ago as in the year 1132, in connection with the protection of their manufactures. By such means municipalities were furnished with a form of government that never wore out; charitable and other trusts were secured to the objects for which they were formed so long as such objects should continue to be found; the protection, improvement and encouragement of trade were provided for; by and through such means, too, the growth of our Empire has been fostered. The great commercial companies, such as the Hudson Bay Company, the Honourable East India Company and the British South Africa Company, to name but a few, which have added vast territorities to the Empire, have all owed their existence to the exercise of the royal prerogative in relation to the grant of Royal Charters.

At one time, the only method by which a trading company or an Association could obtain the status of a Corporation was by the exercise on the part of the Crown of its Charter-granting powers. However, a Royal Charter was not always to be obtained from the Crown for every promising enterprise; moreover, it was costly. The difficulty was met, so far as commercial organizations were concerned, by the formation of the so-called "Common-law Companies," which were unincorporated companies or large partnerships. However, the Government stepped in at the beginning of the eighteenth century in order to check "these dangerous and mischievous undertakings and projects," the particular mischiefs charged against them being the presuming to act as a corporate body; the famous Bubble Act, 1718, (6 Geo. I, c. 18) was passed as a measure designed to prevent the existence of unauthorized Associations. The Act proved a dead-letter and was, a century later, repealed; the Legislature, finding it must tolerate the Joint Stock Company, eventually passed a series of statutes for the regulation of that which it could not suppress. The scope of these statutes is so wide that to-day an Incorporated Society can be brought into existence under the Companies Act for almost any legitimate purpose, But no Corporation can, by the law of England, be created, even to-day, without the consent of the Sovereign; this consent is implied or presumed in the cases of Corporations existing by the Common Law or prescription, and it is expressly given in those cases where the Corporation is created by one of the means available to-day, that is to say, where it is brought into existence by the grant of a Royal Charter, or by Letters Patent, or under an Act of Parliament.

The grant of a Royal Charter as a means of incorporation continues to possess to this day a distinctive value of its own. This is no doubt due to the fact that the Crown will not exercise its prerogative of incorporation merely to enhance the standing of a Society or Institution which petitions for a Royal Charter; on the contrary, the status and reputation of a Society must have already been established before it can hope that favourable consideration will be given to the prayer of its petitioners. There was a time, of course, when Royal Charters were sometimes granted for purposes which were held to be, and undoubtedly were, contrary to the public interest; cases are on record in which Charters of Pardon were granted so wide in their terms as to amount to a dispensation to commit crime. It was this abuse of the royal prerogative that constituted the earliest grievances against the Crown; these grievances were dealt with by statutes in the time of Edward III. and Richard II. Again, Henry VIII. made free use of the royal prerogative and, by the grant of Charters to towns, was able to pack the House of Commons with many willing to vote as the King or his Ministers might direct. The Stuarts, too, were guilty of a

number of excesses in the exercise of the royal prerogative, and to this fact it is largely due that limitations have been placed upon what, in olden days, was held to be an inherent power in the Sovereign. Since the passing of the Act of Settlement (12 and 13 Will. III., c. 2), it ceased to be possible to add to the Borough representation by the grant of Charters, or to tamper with existing Boroughs by the forfeiture and remodelling of their Charters. And to-day it is only on the advice of the Privy Council that the Crown can create a Corporation and invest it with privileges.

The procedure followed by those seeking a Royal Charter of Incorporation is to prepare a petition setting out the grounds which appear to entitle the Association, on behalf of which privileges are desired, to recognition. The petition, which is addressed to The King's Most Excellent Majesty in Council, must be accompanied by a draft of the Royal Charter prayed for. After the Petition has been lodged with the Clerk to the Privy Council, the fact of such a Petition having been presented to The King in Council is advertised in the *London Gazette*, and those who desire to oppose the grant of the Royal Charter are directed to notify their objections within a specified time from the date of the *Gazette* notice. This notice is no empty formality; objections, if any, receive most careful consideration if emanating from those who have a *locus standi*, as, for instance, bodies which have already received a Royal Charter. The Petition for the Charter and the Petitions, if any, against the grant, are in due course carefully considered and sent to such of the Government Departments as have a right to be consulted in the particular instance. These preliminary steps having been taken, the matter next is laid before the Privy Council: should their Lordships recommend the grant of the Charter, the final steps are taken by the Law Officers of the Crown and the Lord Chancellor. The Lord Chancellor's interest in the matter is affected more particularly by the mortmain clauses. In olden days, as is well known, the alienation of lands to Corporations was looked upon as of great detriment to the Crown and the lord, if any, of whom such land was held. In view of the abolition of many of the valuable incidents of tenure, the objection to a Corporation holding land is to-day not a serious matter; nevertheless, there are still certain statutory restrictions which apply, and hence it is that the Lord Chancellor, as well as the Law Officers of the Crown, require to be consulted; should they, in their turn, find the Draft Charter in order, The King in Council is asked to approve of the grant of the prayer of the petitioners, which he does by an Order in Council, upon which the Secretary of State for Home Affairs takes action.

It will be seen, therefore, that it is no easy matter to obtain a Royal Charter of Incorporation, and it may be of interest to place on record the fact that Royal Charters are so sparingly granted nowadays

that, since the year 1867, it has been in respect of some 170 only of the Petitions that have been presented that this method of incorporation has been approved by the Sovereign. It is not surprising, then, that a Royal Charter of Incorporation should be so highly prized that Institutions which, in the early days of their existence, have had to be satisfied to obtain Incorporation under the Companies Acts should, when they have acquired a recognized standing, have been known to seek the royal favour in order that they, too, may rank with other Chartered Institutions and Societies.

W. A. J. O'MEARA.

THE NECESSITY FOR ENGINEER INTELLIGENCE TO ENGINEER COMMANDERS IN WAR AND HOW IT MAY BE OBTAINED.

(*Second Essay for Cooper's Hill Prize*, 1922.) *By* PONTIFEX (Capt. and Bt. Major R. P. PAKENHAM-WALSH, M.C., R.E.).

BEFORE any operation, civil or military, can be undertaken, certain information must be forthcoming. This information must be sufficiently complete to allow the directing authorities to decide—first of all, on the feasibility of the whole scheme; then on the best method of carrying out the operation if attempted; and finally, to work out the preparations necessary for its completion.

In certain operations factors will be met with which are, necessarily, somewhat indeterminate. In war, more than in any other business, will these factors of uncertainty be encountered. They include, among others, enemy action, and questions of psychology and morale. To the military engineer, however, such factors are not of such importance as to his brother officer on the General Staff.

In every engineering problem, if all the facts are known, a clear-cut answer can be given to every question that may arise. The difficulty is, not so much the vagueness of the factors, as that of obtaining detailed information on all the necessary points. The success of engineering work, therefore, depends in the first place on the completeness of the information available. It is important for military engineers to have the most complete information possible about all engineering questions which may arise.

In the second place the success of engineer work depends on the time available for completing the necessary preparations. Special material may have to be designed, manufactured, and transported. Even if workshops were continuously available for this type of work, considerable time must elapse between the placing of an order and the delivery of the finished material on the site of the work. In great wars industry is so highly organized that such special orders must either wait their turn, or the output of certain other important munitions be delayed.

Even when special material has not to be transported from the home country, or the base, material will have to be found and prepared locally, all of which takes time. Further, to prevent interruption of other work, and unnecessary movement of technical labour,

programmes of work must be prepared beforehand. In order that the necessary time may be available for all these preparations, the earliest possible information on all points must be forthcoming.

The information required will include not only details of the actual work to be carried out, but also data as to the material and labour available. To these may sometimes be added the state of communications to the site of the work, and the congestion or otherwise of workshops and factories affected.

Engineer commanders of all grades have two functions to perform. They are, in the first place, technical advisers to the commanders of the formations to which they belong or are attached. They are also responsible for the direction and carrying out of all Engineer works within their spheres of responsibility.

To perform their first function they must be prepared, at all times, to give an opinion to their commanders on engineering questions affecting proposed or current operations. To do this efficiently they must be well posted in the proposals for future operations, and in all points of engineer intelligence which may influence such operations. This necessitates the Engineer Commander having ready to hand all the information that he may require as to engineering works concerned, both in the area occupied by his own troops, and in that occupied by the enemy. This information will frequently need to be, in the first place, of a very general description, but, once the course of action has been decided on, detailed information must be forthcoming on all the factors affecting the situation. It is manifest that this information cannot be produced at short notice when it is required, if it has not already been obtained, co-ordinated, and collated by some organization. Military Intelligence, including that of peculiarly Engineer importance, may be divided into two headings :—that collected in time of peace, and that collected in war.

In peace time, intelligence is largely collected by Military Attachés. These officers are very seldom engineers, and, therefore, can do little in personally collecting information of engineer importance. Though peace-time intelligence organization is outside the scope of the present paper, a certain consideration of its methods must be made in order that its activities in war may be continued with the maximum efficiency.

Many Europeans countries publish very complete reports of all engineering organizations, and these can be obtained in the open market. Other information, though not so publicly presented, can usually be obtained through British commercial concerns. While no organization for obtaining this information appears to exist in peace, it is considered that it could be obtained before, or at the outbreak of war, by the Central Engineering Board at the War Office,

which is the department most closely in touch with the civil industry of the country.

In war time, information as to the area occupied by the enemy is more difficult to obtain, but certain of our resources for obtaining information are largely increased. More money is available for agents, refugees are found willing to come forward with information, and an active Air Force is in being. Agents are seldom employed for their technical knowledge; a very small percentage of refugees will be capable of giving technical information of any value; and an Air Force can give few details of interest to an engineer.

Much reliance must, therefore, be placed on the reports of the troops as they advance. The number of engineers with the fighting troops is notoriously small for the work to be done. Engineer reconnaissance and transmission of reports must, therefore, be organized so as to produce the maximum of valuable information, with the minimum waste of time and man-power. To prevent such waste, it will generally be necessary to call for reports from Engineer reconnaissance officers, on certain definite points, though this will not exonerate them from the responsibility for forwarding all information of military or engineering interest.

No opportunity for gaining information should be wasted, and engineer reconnaisance parties should accompany any body of troops making important advances. Officers in charge of these parties should be given all the information available as to the ground to be covered, so that details may be verified quickly and new points rapidly recognized. It is a clearly proved axiom that in reconnaissance, the more one knows on setting out, the more useful will be the information gathered. It is essential that Engineer N.C.O.'s and men should be trained in this important duty, owing to the scarcity of Engineer officers.

The method of transmission of reports needs careful consideration. In the period of trench warfare in the Great War, bicycles became the standard means of communication within the Divisional Engineers. The value of the horse, however, soon re-asserted itself, as the pace of movement increased in the last six months of the war. The state of the roads, and the suitability of the country for the use of horses well forward, frequently made the latter by far the most valuable means of intercommunication available. It is of the greatest importance that subaltern officers should be trained to make full use of their own horses, and of mounted N.C.O.'s.

Engineer officers in action have much too much to do to write reports on all matters of engineer interest which they may notice. C.R.E.'s should, therefore, have on their staffs, officers available to visit units and individual officers frequently, to obtain verbal information of all natures. In this way very complete information on all points should be available.

No matter how energetic they may be, Engineer officers cannot expect to cover the whole ground, and some reliance must be placed on reports from non-technical units, especially the Infantry. To get the best results from this source of information, very close personal touch must be maintained between Engineer and other officers. Only by constant intercourse will troops come to realize what are the functions of Engineers, and till they do so they will not be in a position to give the Engineers useful information, which they may pick up in the course of their operations.

This personal touch cannot depend on organization or regulations. It can only be obtained by the officers of Engineer units constantly visiting and talking to officers of other arms, especially of the Infantry. Only thus will the Infantry officer get to know exactly what information is of use to the Engineers, and how it can best be transmitted to those who require it.

Besides the information gained from the fighting troops, valuable information will be gathered from other sources. As this information will cover areas not yet reached by the fighting troops it will be of special value. It will, in the main, be drawn from agents and prisoners of war; or from organizations which in peace-time are in charge of records and statistics as to means of communication, water supply, factories, workshops, etc. This is really an extension of peace-time intelligence work, and illustrates the importance of a sound organization built up before war breaks out.

As regards agents and the interrogation of prisoners of war. The organization of these services must be in the hands of the Intelligence branch of the General Staff. This raises the question of the responsibility for organizing the collection and collation of Engineer intelligence. Though it would seem at first sight to be correct for technical experts to give instructions for the collection of specialized information, and to select suitable persons for obtaining it, it will be found, on investigation, that such a course is impossible. It is vital that such a highly confidential organization as espionage and secret service should be controlled by one very small department. Otherwise secrecy may be sacrificed, work duplicated, and multiplicity of agents working for different masters may defeat each other.

Apart from this, all information about the theatre of war or the enemies' country, however trivial, or however technical, may contain items of vital importance to the Operations Staff. The Intelligence branch of the General Staff must, therefore, be the sole authority for the collection of information. Though Engineer Commanders may collect Engineer information from their own organizations, it is their duty to pass it on to the Intelligence branch of the Staff.

It is also the duty, however, of Engineer Commanders to inform the General Staff as to the points on which Engineer intelligence is required, and to suggest the most suitable means to be employed

in its collection. They may, at the request of the General Staff, arrange for its collection themselves.

If the information be in the hands of the General Staff, how then can it best be made use of by Engineer Commanders? One solution would be, to have a definite Engineer department of the Intelligence Staff which would arrange for the collection, collation, and distribution of all information of importance from an engineering point of view. For collection, this department would have to work through another sub-branch of the Intelligence Staff. All effort in this direction must be under unified control, though, as has been stated, power may be delegated for certain purposes. As to the collation of Engineer intelligence, some Engineer branch would seem to be necessary. Experts are required to arrange and produce, in the most useful form, most of the technical information received in the Intelligence Offices. Distribution of technical information would seem to be suitable work for an Engineer Intelligence Branch. But it is important that there should not be overlapping in this duty. As it is frequently necessary to include Engineer information in summaries distributed to all arms, it is important that the work of distribution should be co-ordinated by one Staff.

It is open to question whether an Engineer branch of the Intelligence Staff would be in sufficiently close touch with the needs of the Chief Engineer Officer of the Forces in the field, or be sufficiently accessible for advising or informing him on engineering subjects.

An alternative solution is to have a department of each Engineer Commander's Staff responsible for preparing for his use all the information he may require. This department, which will be referred to hereafter as the Engineer Intelligence Bureau, should obtain its data through the General Staff by means of *liaison* officers. These officers, having the entrée into the various departments of the General Staff, would see that all incoming information of interest to the Engineer Commander is transmitted to that officer's Intelligence Bureau. They would also be responsible for informing the General Staff on what points information of Engineer interest should be obtained, and for advising them on methods for its acquisition. The material thus collected could be collated in a suitable form for technical use by the Engineer Bureau. It would then be available for issue to the troops under the authority of the General Staff. Such an organization would further allow of the short circuiting of information of urgent importance, without interfering with the normal working of the Intelligence Staff. Being under the immediate control of the Engineer Commander himself, the Bureau would be more accessible to him than if it were under the General Staff.

In its simplest form this Engineer Intelligence Bureau would be represented by the Divisional Engineer Intelligence Officer referred to above. He would pass all engineer information obtained to the

General Staff, and also, if necessary, to the Engineer Intelligence Bureau of the Corps. Such an organization would ensure that all available information, both as to possible future work, and to completed work, should be in the hands of a definite officer from whom it could be obtained as desired. This would relieve executive officers of the necessity for frequent reports, or for answering the countless queries which do so much to keep them from their own proper duties. Information of special Engineer interest could be passed rapidly up and down the Engineer chain of administration without interfering with its normal communication through General Staff Channels.

At General Headquarters the organization would naturally reach its maximum complexity. Sources of information are available which, with the approval of the General Staff, can best be tapped by Engineer organizations. Special experts are available, such as geologists and chemists who would collect specialized information and express it in its most useful form. Interchange of ideas and information can be arranged with the Engineer Staffs of allies, or with the civil industry at home or abroad. The collection of all this information would be the duty of the Engineer Intelligence Bureau.

While almost all of the information thus collected should be transmitted to the General Staff, it would normally have to be converted into a form of more direct utility. For example, a cross section showing the geological formation of a certain area would be useless to a General Staff Officer. An estimate, on the other hand, as to the depth at which water could be obtained, and of the time necessary to sink a well to that depth under the given conditions might be invaluable to him. Again, details as to the nature of rolling stock, curves, gradients, and lengths of sections of railways, must be translated into terms of trains and tonnage per diem running over a particular line. The information may, in the first instance, be obtained through General Staff channels, but it will be passed to the Engineer Bureau for digestion and conversion into terms on which operation and administrative plans could be built.

Such conversion must take place in the offices of an organization which also knows the existing resources of the army and the country for repair, maintenance, and construction. This is only available in a centralized form in the office of the Engineer Commander at General Headquarters.

To perform its functions most efficiently, very close touch must be maintained by this Engineer Bureau with the General Staff. This can only be done in the higher formations by Engineer *liaison* officers living with the General Staff. Visits of working members of the Staff of Engineer Commanders to the General Staff, however frequent, can never achieve that complete mutual understanding

that can be reached by an officer living with the Staff and thoroughly understanding its needs and desires.

It is as clear at General Headquarters, as it is among the fighting troops, that personal contact and comradeship with those for whom they are working are necessary for the Engineer officer. The Engineer, to be efficient, must look far ahead and not await the requests for assistance from the General Staff and fighting troops. These may only come when plans are fully crystallized or difficulties actually encountered. It may then be too late to carry out satisfactory engineer work if the Engineer Commander has not started his preparation before the need became manifest. He can never look ahead, or take rapid action, if he is not supplied with the most up-to-date and complete information. This information will only be available if a sound organization for its collection exists in the closest co-operation with the Staff and the other arms.

ORGANIZATION OF ENGINEERING WORKS IN THE GREAT WAR.

By MAJOR-GENERAL SIR GEORGE K. SCOTT-MONCRIEFF, K.C.B., K.C.M.G., C.I.E.

THE experience of the Great War, where not merely armies, but nations were engaged, brought to light, among other important, but half-forgotten foundation truths, the intimate connection between military science and constructional engineering. Not *mechanical* engineering, be it noted. For that aspect of engineering science had never been forgotten. Ever since mankind first waged war, the improvement of weapons has been constantly borne in mind, and the skill of the mechanic has always been in request. That skill, used in the arts of peace for innumerable industrial purposes, was ever in demand for implements of war from the rudest weapons of the savage to the complicated and elaborate machinery of modern artillery by land and sea, and the more recent achievements of science in the air. When the expression "An Engineer's war" is used, therefore, it generally implies an "engine" of some kind. It assumes the "engineering trades," that is to say, those who work in factories equipped with elaborate machinery and tools, who convert the raw materials of steel and other metals into ingenious and wonderful combinations, formed for the utilization of natural forces, into channels for the achievement of definite purposes, it may be of beneficent value, or of terrible destruction. In war, the soldier, as a rule, has nothing to do with their production, except, possibly, in an advisory capacity. His business is to utilize them when constructed; he looks to the community, on whose behalf he is waging war, to supply him; and the work of manufacture and supply rests with the Statesmen, the Ministry of Munitions, and the great industrial army—composed to some extent, as we have seen, of women, who are non-combatant.

But there is another form of engineering, which in the parlance of the profession is known as "civil" (as opposed to "mechanical" and "electrical") which in times of peace is engaged in a constant warfare with the forces of nature. This is the profession which builds our railways, constructs harbours and canals, brings water supplies to our cities, carries out large schemes of drainage and sewerage, plans our factories and makes our roads. Its work is

often unrecognized or not appreciated because it is carried out with smooth and regular continuity. If the perfection of art is to conceal art, the work of many such an engineer is that of a great artist, only the concealment is so successful that many fail to recognize that there is any art at all. In a great city, for example, with its arrangements for water supply, lighting, sewerage, etc., how few of the inhabitants have any idea of the immense labour and exquisite science involved in the regular supply to the community of the services which they enjoy daily! But if any cessation of those services occur, they realize, with indignation, their dependence on the profession, and in demanding redress, possibly do scant justice to the immensity of the problems to be overcome.

It is obvious that the greater the population of our cities, and the more complicated the conditions of civilized life, the greater are the difficulties presented thus to the civil engineer in respect of the regular services which he thus has to render to the public. He has, it is true, greater facilities than his ancestors, greater means of transport, a wider and better range of materials, an enhanced degree of scientific knowledge, and better tools for his work, and more highly skilled specialists to use them. Yet essentially the problem for large cities to-day is the same as what it was when Appius Claudius first brought water supplies into the Eternal City, and, the work of the military engineers in modern warfare does not differ, except in detail, from that of the unknown chief engineers of Hannibal and Alexander who succeeded, in the one case, in getting an army, including elephants, across the Alps, and in the other case in taking a pontoon train from the Indus to the Jhelum, through the ravines of the Salt Range.

In modern civil life, the science of engineering is necessarily so subdivided that any large scheme, though initiated and controlled by some master-mind, is largely dependent on specialists for its successful and economical execution. If this is the case in the comparatively restricted and deliberate operations of peace, it became infinitely more necessary in the stupendous and swift operations of engineering in the Great War. There the co-operation of all experts had to be sought and co-ordinated. This, so far as the British Army was concerned, was the main occupation of one officer at the War Office, known officially as F.W.5. His duty was to see that nothing was left undone, from the placing of a contract for materials ready for use, and costing, perhaps, millions sterling, to the issue of a pass for a British workman proceeding to France, in a hurry to repair a machine. But the work of design and of execution was in other hands, his duty was that of a switch board or a clearing house.

As an instance of this co-operation may be mentioned the greatest

water supply scheme ever known in the annals of war—the laying of the pipe line from Egypt into Palestine. The entire success of the operations against the Turkish Army in the Isthmus of Suez depended on this. A project for carrying the water across the isthmus from Kantara, on the Canal, to El Arish, on the Palestine frontier, was worked out by the engineering authorities in Egypt. The distance was some 90 miles, the quantity required daily was 600,000 gallons. It was proposed in this scheme that there should be four relays of pumping stations, with reservoirs, in the total distance of 90 miles, and that 60 miles of 12-in. piping and 30 miles of 10-in., as well as certain engines, pumps and machinery for the reservoirs, etc., would be required. This was the scheme worked out on the spot, and cabled to the War Office.

The business of the War Office was to find the materials, viz. :—pipes, pumps, etc. The contract for pipes was placed in America, for no firm in England could produce what was required at such short notice. The War Office sent an expert to America to see the contract through, and to accompany the pipes to Egypt.

The Royal Navy specially escorted the ships bringing the piping. The Cairo Waterworks Company designed the filter plant, introduced new fool-proof devices, and installed the plant. The Suez Canal Company laid pipe syphons across the canal from west to east, this work entailing various diving and dredging operations. The military engineers of the force built the engine houses, settling tanks, etc., on the east bank of the canal, and (most difficult task of all, perhaps) laid the pipes. The total weight of pumping machinery and stores transported from overseas was over 10,000 tons. Special arrangements had to be made at Kantara to receive this ; sorting yards, workshops, etc., had to be constructed, and a wharf built of sufficient size to berth the ocean-going steamers which brought the materials. Finally, the War Office was asked to find and send out the best available expert on water works engineering to act as advisor and critic. He was found and went out accordingly and pronounced it all very good.

The scheme was initiated in July, 1916, and the Nile water flowed into Palestine in February, 1917. In spite of certain minor mistakes and failures this was a wonderful feat, and it was made possible by the co-operation of many active and capable brains.

By similar, though, perhaps, less clearly defined methods the whole of the works involved in the war were carried out, both in the United Kingdom and in each theatre of war.

Truth, however, obliges one to state that the one place where co-operation was faulty was in the spot where, above all others, it should have been most perfect, namely in the War Office itself. There was no engineer on the Army Council who could grasp the

significance of policy or aims of the General Staff with their possibilities or limitations from an engineering point of view, and translate them into orders for the engineering executive. It is obvious even to the veriest amateur that the evolving of schemes based on policy must take some little time to work out in detail, that materials for such schemes must be collected from some source, and that even if the end in view be similar to another scheme already worked out, there must necessarily be differences in circumstances which may call for separate treatment. Yet it often occurred that military operations of great importance, which depended to an enormous extent for success on engineering, only came to the knowledge of the head of the branch concerned by accident, having even escaped the wide-spread vigilance of F.W.5. It was apparently thought that an engineering scheme could be brought into being with the same readiness that a battery of horse artillery could come into action. Nor was this the only faulty part of War Office organization. There was no one head of engineering, not even although the main responsibility for works rested on the Master General of the Ordnance. Railway work was under the Quartermaster General (until a Director General of Transportation was appointed). Inland Water Transport was also under the Q.M.G. and, although there was no definite order exempting this branch from the normal rule that all building and constructional work should be done by the recognized Works Branch, from the first it did its own works. It did this extraordinarily well, and with celerity and economy. But the fact of there being two or three works departments in the Army meant inevitable competition. Now, competition may be the soul of trade, but in military operations it is anathema. It was bad enough to have the Ministry of Munitions competing against the War Office for materials and labour, and, regardless of expense, introducing complications into the market, but it was ruinous to have two or more branches of the War Office competing with one another.

It was to a great extent the same in the theatres of war. There was no representative there of the Master General of the Ordnance, so all engineer services were placed under the Q.M.G. But many of these services affected Operations with which the General Staff alone and not the Q.M.G. is concerned. To obviate this confusion, the chain of responsibility for orders became largely a personal matter, the Chief Engineer taking his instructions verbally from the General or his Chief Staff Officer. It was not sound administration, and it involved all sorts of friction, but it meant delivery of the goods. At G.H.Q. there was an officer who was "the opposite number" of F.W.5., and whose business it was to know everything that was being proposed, and everything that was required from England

to carry it out—whether stores, materials, tools, machinery, plant or personnel. Late at night he collected his reports for the day, and in the silent hours would keep up an animated talk over the wires with F.W.5. in Whitehall. Next day he would send a formal demand through the official channel, but long before the ink was dry on the paper, F.W.5. had switched off the demands to the proper quarter and was in a position to say how the problems were to be met.

Thus, although the organization was about as bad as it could well be (and this fact was brought to the notice of an important Committee immediately after the war, so as to avoid such mistakes in future), the work was being energetically done owing to indomitable pertinacity and good will on the part of individuals.

In considering the actual work to be done, it is well to bear in mind the difference between the rapid temporary works executed in the field by Sappers and Pioneers, and the more substantial semi-permanent work entailed nowadays by heavy artillery, tanks and motor traffic, as well as that necessitated by the vast numbers of men and vehicles in a modern army. No doubt, the experience of South Africa with its wide spaces, and the war against the Boers with their comparatively small numbers and preference for mounted tactics, was a misleading introduction to war in countries like France and Belgium. More probably the comparatively small armies which had been put in the field by our country in its numerous wars in Asia and Africa had tended to obscure the fact that, in addition to those regularly organized units of military engineers whose primary duties were inseparably connected with tactical operations, there is required in modern armies an organization of some sort dealing with engineering problems of accommodation and communications, and this necessity increases with the size of the armies concerned. In the Indian Army such an organization has always been recognized. In addition to the companies of Sappers equipped with entrenching tools and light bridging plant, it has been customary to have with brigades and divisions certain field engineers unattached to units, whose experience in peace has been on civil engineering works and whose functions in war are to arrange for the carrying out (generally by civil labour, locally obtained or imported) of similar works, such as the construction of roads and of bridges, the building of huts or other accommodation, the fortification of positions and the attack of fortified places of the enemy. Such an organization was not existent in the British Army at the beginning of the Great War, but of necessity it came into being early in 1915. Thus, while it happened that the pre-war training of our field units of engineers had, very rightly, been more and more associated with the tactical development of other arms, and had been essentially part of the

responsibilities of divisional generals, the scope of engineering as applied to war had been limited to these functions only, and the wider application of that science had been imperfectly grasped even by those whose special duty it was to visualize war in all its bearings. Even the most recent of great wars had given scant indication of the value of this. In Manchuria there were examples of the great tactical value of field defences, both from the Russian and the Japanese side and these examples had been studied with some effect in our army. But, beyond the fact that some new materials (such as steel and concrete) were employed in that campaign for the first time, there were few indications of the great value that might accrue to a commander of the extended use of engineering skill in the operations of war.

A superficial consideration of this matter might lead to the supposition that any developments of the kind indicated might apply only to work behind the fighting zone, that improvised works based on local materials only would be possible in that zone, and that, therefore, any assistance which a commander might obtain from an engineering organization at the base (in our case at the War Office) would apply only to the Lines of Communication and not to the operations of the Field Army. This view of the case was embodied in the Field Service Regulations of our Army and experience proved that it was erroneous. With large armies, and especially with a prolonged period of trench warfare, it was found that local sources of supply of materials were speedily exhausted. More and more as the campaign went on the engineers of the fighting zone depended on their base for supplies, and in this way the engineering authorities at the War Office became more and more intimately connected with operations and, therefore, with the policy of the General Staff whose intentions supplied the initiative. The most important engineering problems then became not merely how to build huts, defend naval bases, or to supply requisitions for pumps and boilers, but how to bring the science of the engineer to bear upon the problem of the defeat of the enemy. From this consideration rose the provision of tanks,* of accelerated and improved mining, of rapidly constructed

* The connection of the War Office, as represented by the D.F.W.'s branch, with the initiation and evolution of the tank was greater than is generally supposed, or than would be inferred from the proceedings of the Court of Award that considered claims of applicants in October, 1919. Misunderstanding on this subject (which was not unnatural, considering the published information) led to some unmerited criticism; among others, by Major-General Sir Charles Callwell, K.C.B., in his witty book *The Experiences of a Dug-out*. On being informed of the facts by the writer of this article, he kindly promised to amend it in any future edition. The true version of the case was known to Lord Moulton who was Chairman of the first Committee on Awards, and to Mr. Justice

and powerful bridges, of better signalling equipment, of anti-aircraft searchlights, and many minor inventions. From this arose a vast series of experiments, some of which were successful, some only proved the futility of certain proposals of hare-brained enthusiasts, and some reached a stage which promised well but were not completed at the conclusion of the war.

As may be readily inferred, the engineering branch of the War Office, even with the restrictions indicated above, rapidly expanded to meet the developments of the various campaigns. At first the work thrown on this branch was negligible, less even than the normal routine in time of peace. The arrangements for the defence of our home ports had been all worked out in various defence schemes in time of peace, and the local commanders knew exactly what to do on the outbreak of war. The Expeditionary Force took with it to France some of the best officers of the department concerned, who went prepared to carry out any work that might be necessary. But their successors, brought in from the Retired List, or from half-pay, had no work, at first, to do, for there was no policy to be carried out at home or abroad that involved any engineering duties. An organization for supply of materials was prepared, but until some indication of the development of the campaign appeared there was nothing that could be done, except watch the state of the markets for materials and labour. There was thus the extraordinary anomaly that, while every other branch of the War Office was working at high pressure, this alone had practically nothing to do.

Then came the call for the new army and increased hut accommodation, and at once the whole machinery of the works department sprang into life with an energy and momentum which increased in volume never ceasing till the close of the war.

Sargent and the members of the second Court, as well as to the Solicitors General (Pollock) and Attorney General (Hewart), who conducted the case for the Crown. My opinion of these legal dignitaries was that, as no officers of the D.F.W.'s Staff claimed any reward, and as the Court was convened for the purpose of examining such claims, and not vindicating the War Office, there was no need to refute any inaccuracies as to the latter that might have appeared in the proceedings. Moreover, it was apparently thought the reputation of the War Office for sloth and ineptitude is already so established in the public mind that any attempt to whitewash it would be received with incredulity. Evidently in an invention of this sort there must be many who had a share, and as long as the result was successful, the identity of the individual, or the office, is quite immaterial. As to whether officers of the fighting forces, whose business it is to defeat the enemy, should claim pecuniary rewards for their share in the matter, is, of course, a matter of opinion which need not be here considered. Anyhow, it must be a source of legitimate satisfaction to the Corps of Royal Engineers that both in the inception, the evolution, construction and fighting of the new engine of war, they had a notable share.

There grew out of a comparatively small nucleus no fewer than twelve subdivisions of the Works Organization in the War Office. These were known as F.W.1, F.W.2, etc. Of these the functions of F.W.5 have already been touched upon, and it will be observed that his duties were entirely concerned with works in the field. So also were the duties of F.W.8, the Chief Mechanical Engineer, and of F.W.9, the Chief Electrical Engineer. Both these officers had a large expert staff under them, and although each had some duty to do in connection with works for the defence of the United Kingdom, the greater part of their work lay overseas. There were others whose duties lay entirely within the limits of the British Isles. Such were F.W.2 who had control of the large plans for hutted camps and remount depôts and hospitals at home, F.W.3 who carried out a far larger scheme for the fortification of our home ports and naval bases than had been undertaken since the days of Lord Palmerston (and in some respects it was a greater scheme than even that celebrated one, though it cost far less), and F.W.7 whose duty it was to provide (until 1918) for the rapidly increasing needs of the Royal Flying Corps in aerodromes, aircraft depôts, etc. The office accommodation for all this great organization soon overflowed the congested limits of the War Office. Some were in a hired hotel near Blackfriars, some in St. James's Park, some in Woolwich Dockyard. There was a branch organization at the South West India Docks, there were five factories for signalling gear in and round London, there were experimental establishments at Claygate in Surrey, and on Woolwich Common.

Each of the twelve subdivisions was under the control of a senior engineer officer who had very wide powers of action, and practically a free hand to do as he thought best, with the reservation that he must keep the head of the branch informed as to what he was doing. Each had under him a staff, greater or less according to the magnitude of his operations, of officers, mainly civil engineers, wounded or invalided from one of the campaigns. Somehow or other, the round pegs fitted into corresponding holes marvellously well. The utmost harmony and co-operation prevailed and not a single case of "disciplinary action" was necessary in any of the staffs of officers, and hardly any among the subordinates. Valuable co-operation also came from the civil engineering profession. In the very early stages of the war the Secretary of the Institution of Civil Engineers was called into consultation as to contractors, individual candidates for commissions, etc. Later on (in 1915) that Institution was asked if they would appoint an advisory Committee to go round works in progress, criticize and advise (though not assume any responsibility for execution or administration). This they not only did, appointing a most influential Committee of present and past and future Presi-

dents of their Council, but they did all their work gratuitously, and, it need hardly be said, their technical advice was most valuable. It was considered right that in a matter where many millions of public funds were being expended, the very best technical opinion in the country should be directed to the procedure.

Contractors of great experience also offered their services at very moderate remuneration, for the execution of some of the great works, and without their expert aid progress would indeed have been far slower than it actually was.

The advent of the Ministry of Munitions in the spring of 1915, affected this branch of the War Office very little. It took over the manufacture of hand grenades and trench mortars which had been consigned to the Works Branch during the previous winter. But this really ought never to have been considered an engineer service at all, and was only made such because the artillery, to which branch it belonged, could not conveniently take it in hand. So in handing it over to the Munitions Ministry, the Works Branch felt they were only parting with what in truth never belonged to them. The Ministry of Munitions also took over the consideration of inventions, an immense relief to the Works Branch and to some extent carried out experiments. Beyond this they did not touch any of the multifarious R.E. Stores, nor concern themselves with the provision of any plant or machinery required for works. Indeed, in some cases the Works Branch of the War Office built magazines or storehouses for materials or ammunition provided by the Ministry of Munitions, though, as a rule, that Ministry did its own construction work.

Herein the practice of our English administrators differs somewhat from that of the Americans. In the U.S.A. specialization is carried to what we consider extremes. In the American Army, if a hospital, for instance, is built, one department surveys the site, another arranges for the water supply, another for the lighting, another for the drainage, another for the actual building.

Our English method is to have one officer in charge of each important work, or group of works. He need not be a specialist, for he has, or should have, under him, specialist subordinates, but he must know enough about each man's job to be able to co-ordinate and to exercise capable supervision. "I don't want," said Lord Kitchener, discussing this subject, "an Engineer officer who can only take photographs;" and another distinguished general expressed his desire in emphatic language for some one person to answer to him for the actions of all. It was found that even with the best and most capable contractors the existence of a responsible officer was an absolute necessity. These officers were found as a rule from the Retired List, some of them men who had held very important positions at home or in India a few years before, and several of

them were men of considerably advanced age. Many of them in course of the war served in the field, one, indeed, becoming Chief Engineer of an Army, rising to that position by strong character and merit.

In a vast and varied number of different works it was inevitable that there should be some complaints, but these were marvellously few, and the causes were not always due to engineering mistakes. The hutted camps in England in the first winter of the war, one of the wettest seasons on record, were a source of much legitimate grumbling. But the sites were not chosen by the Engineers and were often most unsuitable from a works point of view. At the outset the Engineers' proposal was that, while good dining rooms, recreation rooms and kitchens, etc., should be built at once, the provision of sleeping accommodation should be postponed till 1915, the men, meantime sleeping in bell tents with boarded floors. But the Army Council insisted on sleeping huts being provided concurrently with the other accommodation. To provide both in the few months between the outbreak of war and the rains of November was impossible.

Another complaint was the shortage of sandbags. This was more or less a mystery, for although it undoubtedly existed in the firing zone, the most searching enquiry, carried out at the time of the battle of Loos in September, 1915, elicited the fact that no requisition for sandbags at the forward "R.E. dumps" ever had to be refused for lack of material. That the sandbags were misused in all manner of ways was beyond any doubt, but there was never any shortage of supply, in fact at the very time English ladies were painfully making up sandbags with infinite trouble, millions were being poured into France every day from Calcutta and Dundee, and there were mountains of them at every forward depôt.

The last, and, perhaps, the worst complaint was about the School of Aerial Gunnery at Loch Doon. As this was the subject of a Parliamentary enquiry, it may be, perhaps, sufficient to say that the Engineers were exonerated from blame in a matter where there had been evidently hasty judgment as to selection of the site.

That the magnitude and efficiency of the work did not attract public notice at the time of the war is, perhaps, not surprising in view of the other deservedly admired features of administration, such as the feeding of the troops, and the treatment of the sick and wounded. Admirable and admired as these were, it is perhaps, not too much to say that those who were behind the scenes knew that they were even more efficient than the public were led to believe. The marvellously complete arrangements for the great bakeries at Dieppe and Rouen, for instance, or the enormously complicated and perfectly working arrangements for the wounded at great hospitals such as

those at Etaples and Le Tréport have never been adequately described. But in any case such matters as these, appealing, as they do, to the most urgent of human needs, would attract more attention than any work of engineering skill. Moreover, as has been already pointed out, the works of engineering depended on the developments of the situation. Troops have to be fed and the wounded have to be treated under *any* conditions of war, and weapons, clothing and ammunition have to be provided anywhere, but the conditions of a campaign alone have to determine the works to be carried out, and the nature of those works govern the plant and the tools required.

That the actual results were satisfactory is, however, proved by repeated and emphatic allusions to it in the dispatches of the successive Commanders-in-Chief and in one of these Sir Douglas Haig departed somewhat from custom in commending not only those who served under him, but in thanking the War Office Staff and manufacturers for their co-operation.

The complaint about the sandbags, though it fell on those who were already striving their utmost, and with genuine success, to keep their comrades in the fighting line supplied with accessories of combat, was a not unwholesome stimulant to continual endeavour. The personal nature of the relations between the Engineers of the front line and those looking after their wants in London has already been alluded to. It was the pith and marrow of the engineering enterprise generally. So much was this the case that when in the third or fourth year of the war it was proposed that all supply of equipment, engineering plant and stores should be placed under the newly appointed Surveyor General of Supply, the proposal was negatived, not because the newly-appointed official was not capable of appreciating the position, but because the valuable personal link might be endangered. It had proved a remedy for defective organization, it had been a living link between the front line and the base, and we could not afford to risk any weakening of the chain merely to satisfy academic arguments. The case, thus put before the Surveyor General, was wisely accepted by him. All he asked was that his experts should be given every opportunity of examining the procedure, and freedom to criticize. This was readily granted and the advice of the experts was to leave well alone.

Yet this co-ordination of the needs in the field and production at home was not accomplished without price. On both sides of the Channel the strain was unspeakably severe. It meant absolute break-down in more than one instance, and sudden death resulting from sheer failure of mental and bodily power.

The one dominant thought among those whose duty kept them unwilling purveyors at home for their more fortunate comrades in the fighting zone was that under no circumstances must the latter,

in their tremendous difficulties, be "let down." It was common knowledge, based for the most part on frequent visits to the front, how every possible advantage was being taken of local resources, how workshops and factories at Bailleul, Hazebrouck, Armentières, Bethune, the Somme area and many other places were being used for all they were worth, and in some cases for purposes for which they were not originally intended. It was known how the forests and quarries of northern France were being turned to account on a vast scale. Yet it was also known that, however heroic was the endeavour and ingenious the skill of the Engineers in the field, they had to deal with an enemy that had behind him the resources of Belgium and Germany, and who had thought out the means of applying those resources to war with characteristic thoroughness. Therefore it behoved engineers in England to meet the enemy in this as in other spheres of activity, and, if possible, to beat him.

How they did so is a matter of history.

MODERN FORMS OF CENTRAL HEATING.

By Brig.-General W. BAKER BROWN, C.B.

THE Royal Engineer is always on the look-out for any forms of construction or types of fittings which will enable him to effect economy in construction, so that he can get a little more result from his attenuated financial allotments.

Some modern forms of Central Heating in which the writer is interested, and which claim to give comfortable warmth with economy both in working and first cost, seem well adapted for many military buildings, and a short account of the principles and practice of this new system should be of interest.

The general principles of Central Heating are well known. Instead of the English practice of installing small heat-producing units in each room, one large heat-producing unit is established for a whole house, or even sometimes for a group of houses. The source of heat may be by burning coal, coke, gas, wood or refuse, and many suitable forms of furnace are on the market.

It is in the distribution of the heat that we find great variety, and in some cases great complexity in the apparatus, but the various systems may be classified by the agency used to convey the heat—air, water, steam or electricity. Of these electricity is, perhaps, the nearest to the ideal method, but is ruled out at present by the question of cost. Of the others, steam, especially at high pressure, involves considerable accuracy of fitting and consequent expense, while air conveyed in pipes or ducts is difficult to regulate because it is easily compressible. Of the systems using pipes or ducts, hot-water circulation seems the best for a private house. It has, however, the disadvantages of requiring a considerable length of pipes and apparatus, the circulation of the hot water is troublesome to regulate, and the heated air is uncomfortably dry. Also, in common with all systems which provide for heating each room independently, there is very little circulation of the air, producing a stagnant, stuffy feeling which is particularly offensive to the British skin, though tolerated on the Continent. Within the last few years a system of heating by hot air has been evolved in the United States which meets all the above objections. It has spread rapidly all over the United States and Canada, where the number of installations must much exceed 500,000, and is being added to at the rate of at least 100,000 a year.

These figures are sufficiently striking to ensure that the new system should be fully investigated by all interested in house warming. Simultaneously with this development, a considerable change has taken place in the views of ventilating engineers. The theory which at present occupies the text-books is that to ensure pure air it is necessary to remove all but a trace of the carbonic acid which is expelled from our lungs in the process of breathing, and that the only way of doing this is by expelling the whole of the air in a room and replacing it by fresh air from outside. All systems of ventilation are, therefore, based on changing the air of a building or room two to six times an hour, and replacing it with fresh air This again reacts on the heating arrangements, as the heat which has been transferred from the heater to the air is taken out from the room with the air and the new supply has to be heated afresh. In other words, the heating apparatus has to be large enough to heat up the air of the room every 10 to 30 minutes. The latest ideas on ventilation involve considerable modification of this theory.* In the first place, carbonic acid is not in itself poisonous. Our lungs always contain about five to six per cent. of this gas, so that it is obvious that air with this percentage cannot be poisonous. The reason why the presence of carbonic acid is regarded with suspicion is that it indicates a deficiency of oxygen and is also a measure, to some extent, of harmful impurities exhaled in the process of breathing. Actual experiment with human beings has shown that, provided certain conditions are fulfilled, the presence of 13 per cent. of carbonic acid in air causes no inconvenience.

Then, again, it must be noted that the fouling of air is not confined to breathing. The vapours from the skin are very considerable, and experiment has shown that a supply of pure air to the skin is only second in importance to the supply of air for breathing. To ensure comfort it is further necessary that this air supply shall reach a certain standard of warmth and moisture. If the air is too cold it chills the body unduly, if too dry it tends to draw an excess of moisture from the skin, if too wet, the evaporation from the skin is checked. Modern theories of ventilation, therefore, require continual *movement* of *warm*, *moistened* air.

Further experiment has shown that, however closely we may shut doors and windows, there is always a movement going on of the air in the house, air entering, not only through the "chinks" of the doors and windows, but through the walls. Professor Carpenter states :—"Recent experiments made in a building of ordinary schoolhouse construction indicate that in mildly cold and quiet weather such leakage equals the cubic contents of a room or building approximately once in each ninety minutes."†

* See *Heating and Ventilating*. Professor Carpenter. Chapter 11.
† *Heating and Ventilating* —Seventh Edition—Paragraph 239.

Everyone is familiar with the difficulty of keeping the smell of cooking out of a room showing that the warm air from the kitchen has penetrated the passages and rooms. With open fires the movement of air is even more considerable; every fire draws into a room large amounts of air from under the door and round the windows, and passes the greater amount of this air up the chimney. The air movement so produced is much more than is required for efficient ventilation and usually produces an uncomfortable "draught."*

Much of the change of air required for good ventilation is thus effected for us by Mother Nature.

The new form of central heating, called "Pipeless," is based on the principle of assisting and using the forces of Nature.

It is a hot-air system. The air is warmed by contact with a large stove or furnace of cast iron which is contained in a casing of galvanized sheet iron, so designed as to compel the air to pass in very close contact with the sides of the furnace. The products of combustion pass straight from the furnace to a flue and do not contaminate the air of the house in any way. The furnace with, its hot-air chamber, is usually placed in a basement or cellar, and is connected to the middle portion of a grating placed near the centre of the ground floor of the house. From this grating the warm air fills the staircase and passages, and gradually penetrates to every room of the house.

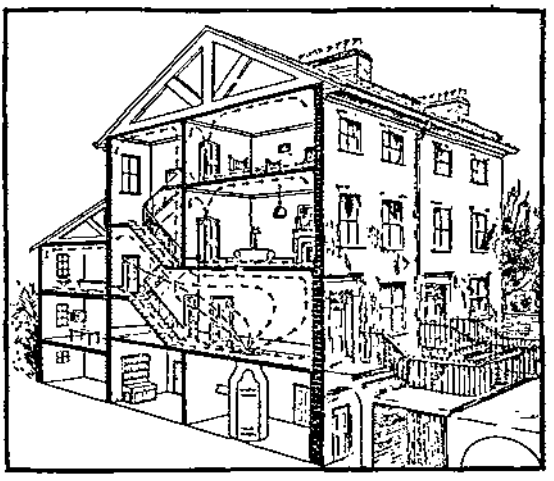


FIG. 1.

To maintain the circulation of the air, a second casing is added outside the hot-air chamber, forming a chamber for cold air which is connected with the outside of the grating through which the warm air passes. The two compartments are connected at the bottom.

* See *Domestic Fuel Consumption*, by Professor A. H. Barker, and *The Smokeless City*, by E. D. Simon and Marion Fitzgerald.

As soon as the fire is lit, the air in the inner compartment is warmed and rises through the grating, and is replaced by cold air drawn from the outer compartment and, therefore, from the air of the house. This movement is continuous so long as the fire is burning. Of the total energy obtainable from the fuel it is estimated that two-thirds is used in raising the temperature of the air and one-third is used in expanding and so circulating the air.

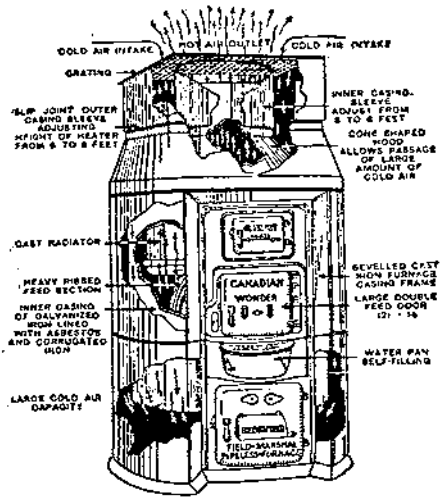


FIG. 2.

In the case of a building without a basement, the same effect is produced by omitting the outer casing and drawing in cold air at the bottom of the inner casing, discharging warm air about 8 ft. above the floor. In a simple building like a workshop a heater of this pattern could be stood on the floor of the shop, but for a house it is best to place the heater behind a wall, drawing cold air through a grating in the wall at floor level, and discharging warm air through a grating in the wall just under the ceiling.

With either pattern the only constructional details which have to be attended to are (1) a stone or concrete foundation for the heater; (2) protection by uralite or some non-conducting material round the grating if it passes through a wooden floor; (3) the connection to the flue. In an ordinary house with a cellar and suitable flue the fixing of the heater can be done by a couple of men in about 12 hours.

Now considering heating only, it will at once be evident that this system should be very economical as there is no unnecessary wasting of heat. Much of the heat from the air is used in warming the walls, floors and ceilings and the furniture of rooms, and as soon as these have received a certain amount of warmth, the general

temperature of the house is maintained at considerably above the temperature of the outside air. The air drawn into the outer compartment of the heater is thus already partly warmed and a less expenditure of fuel is required to bring it up to our working temperature. Compared with any system where fresh air is drawn from the outside, heated, passed once through the room and then out, the saving of fuel is very considerable.

But it is objected that this saving is effected at the expense of ventilation, as the same air is used over and over again.

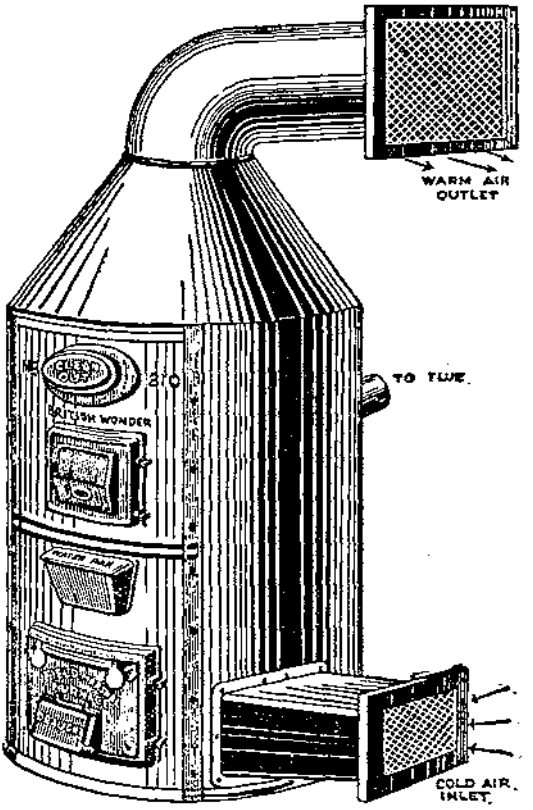


FIG. 3.

Systems of ventilation are often discussed as if it were possible to remove the whole of the air in a room and replace it by an entirely fresh supply. In practice this is never the case, however complicated may be the system of ventilation adopted. What actually happens is that the incoming air mixes with the air in the room and *dilutes* it, while an equal volume which may, however, contain much good air, escapes through ventilators, chinks, etc. The process is the same as if we try to change the contents of a pail of dirty water by pouring clean water in at one side and allowing

an overflow at the other. The contents of the pail will become much cleaner in time, but some trace of the original dirt will always remain. At best, therefore, a system of ventilation is one of *dilution*, not one of change of air.

Now Pipeless Central Heating applies the same principle by encouraging the mixing of the air throughout the house. It is evident that, while several people confined in one small room may seriously vitiate the air, they would have little or no effect on the air of a house as a whole. At the same time as the heater is mixing the air of a house there is a continual escape of warm air through chinks, or up the chimneys of fireplaces, and also a continual ingress of cold air from the outside, round door and window openings and through ventilating openings. The combination of this with continual movement produces an atmosphere inside the house which is quite pleasant and absolutely innocuous.

We have seen above that one of the ingredients of comfort is sufficient moisture in the air, and this is provided for by a pan of water placed in the hot-air compartment of the heater near the furnace. The heat causes a slow evaporation of the water and so produces a sufficient proportion of moisture in the ascending warm-air current.

It will be evident that there are certain special cases where some modification may be necessary. For instance, in churches, theatres or cinemas where there is a large number of occupants, the heating effect would be quite adequate while the hall is empty, but would not be satisfactory when in use. In such cases, it might be advisable to connect the outer casing of the heater with the outer air by a duct so proportioned that about one-third of the fresh air supply is drawn from outside. This duct should be closed by a damper when the hall is not occupied.

Again, in a large building the movement of air produced by expansion may not be sufficient to ensure circulation. In such cases the circulation can be helped by a fan so placed as to increase the movement of air through the heater.

The above is only an outline of the system and any attempt at calculation has been omitted. No doubt, in time a body of literature will be built up round the system, but at present the new art is in its infancy.

Some figures can, however, be given about fuel consumption. The heaters, as designed, will burn coke or coal, or can be adapted for wood or gas, but the best fuel is coke, as it is cheap and easily obtained and is smokeless, an important consideration in a town.

The consumption will, of course, vary with the size of the heater, but for an ordinary ten-roomed house using a No. 2 heater the daily consumption would be about 40 lbs., or about 8d. a day with coke at 40s. a ton.

It seems worth considering shortly how this system will affect the detailed arrangement of our houses. At present the arrangements of any room are conditioned by the necessity of avoiding cross draughts, so that the relative positions of door, windows and fireplace give a problem of some complexity. With an efficient system of central heating fireplaces are unnecessary, or, at best, are luxuries.

An open fire is undoubtedly a most comforting form of heating, and if the expense is not prohibitive, the use of a fire adds to the circulation of air and is in no way antagonistic to pipeless heating. But in many rooms no fire is required from year's end to year's end. It should, therefore, be possible to dispense with fireplaces and chimneys altogether except, perhaps, in the largest sitting-room and one bedroom. A very pleasant form of auxiliary heat, which would combine well with pipeless central heating, is a portable electric stove which could be used to keep individual rooms above the temperature of the rest of the house. This would be especially useful in cases of sickness.

Then again doors become largely redundant, except where privacy is required, as in bedrooms or a private study. In the United States it is a common practice to open all the sitting-rooms through one another, with archways instead of doors and curtains or screens to give some measure of privacy. Heavy portières over doors are, of course, unnecessary, or even harmful, while window curtains will be used mainly to keep out light, and not to control draughts Coupled with the fact that the abolition of fires will reduce dust and dirt, the whole house will thus be lighter and cleaner.

Of course, bedrooms must retain doors, and doors must also be used to shut off the kitchen premises.

Many people, seeing the system for the first time, ask " Must the doors be always kept open ? " and this is generally answered by the question, " Why must doors be kept shut ? " If special attention is paid to this point, it will be found that in summer-time, when the air is warm, doors are generally left open, so that the fetish of the shut door, which was one of the plagues of our childhood, is really due to a wish to exclude draughts. As stated, the United States dispense with doors in many cases, while the popularity of the lounge-halls in modern English houses show that the same principle is acceptable to the British. In the case of bedrooms, the doors are usually open for several hours every morning for domestic reasons and for ventilation. This amount of opening would be quite sufficient to allow of the room getting filled with warm air; once this is effected the normal leakage round and under doors should be quite sufficient.

In cases like hotel rooms or officers' messes, where doors must be kept closed for reasons of security, it would probably be necessary to add a ventilator over the door. This ventilator might be fitted

with movable louvres controlled by the occupant, and may become a normal fitting in all rooms in which fireplaces are omitted.

Windows in a house will still fulfil their primary function of admitting light; they can be opened with discretion as required. Each housewife will soon find the best combination of heater, open window and open door, which gives the most comfortable temperature.

To conserve heat in exposed situations, windows can be doubled or double-glazed.

It is evident that these principles can be applied to many military buildings. The ordinary barrack room is very badly warmed by open fires and there is little control of fuel consumption. The use of one heater for each block, with the draught doors of the heater controlled by a simple switch in a serjeant's bunk, and the heater itself in a locked room in the basement would ensure perfect control. The only constructional details required would be to fix swing doors (double, if possible) at the entrance, a few ventilating openings high up in each barrack room to ensure sufficient movement of air at night, and possibly to add gratings over the door of each room for the admission of warm air. The cold air will escape easily enough under the door.

In a military recreation establishment, this form of heating should be ideal, especially if the establishment is designed round one central large room in which the grating is placed.

Officers' and Serjeants' Messes can be warmed by a heater under the main passage. Gymnasium and Drill Halls could be warmed by a single casing heater placed in a corner of the room.

Single married-quarters are perhaps rather small to have a heater in each, but a block of married-quarters, with two or more floors, would be well warmed by a heater on each staircase, provided the latter is enclosed and fitted with swing entrance-door and a grating is placed over the door of each quarter.

The above are only suggestions, but probably sufficient has been stated to interest readers. If so, I should be glad to show any enquirers our heater in actual use, and to discuss the detailed application of our principles of working to individual buildings.

THE RAILWAY DISTRICT AS A BUSINESS ORGANIZATION.

A Lecture delivered to Junior Officers of the North Western Railway of India at Lahore in November, 1922.

By CAPTAIN G. WALTON, O.B.E., R.E. (*Lahore District Traffic Superintendent.*)

IT may perhaps be said that the title of this lecture is a self-evident truth, not worth further discussion. But this railway covers such an immense field, not only in track, number of men employed and so on, but also in the amount of business done, that we have to get down to the district unit to analyse and compare results and to get our ideas in proper focus. My object, therefore, is briefly this: To point out how a united effort by officers and men of all departments of any one district (which is in many respects a complete railway in miniature) will conduce to the real aim and purpose of a railway—that is, efficient and economical transportation in that district of the railway at a reasonable profit to the owners of the railway, and to the satisfaction of the public. At the same time, every detail of the work of district and assistant officers and senior subordinates of all departments, in office or on inspection—whether it be seeing that a wagon is riveted up to protect its contents from theft, testing a man for his fitness for a job, arranging water and food facilities for the public, checking control graphs, turning out coaching stock from shops, getting an urgent repair to stock or permanent-way done quickly, keeping station fencing in order, avoiding engineering restrictions and so on —must focus on to the district percentage of working expenses to receipts, and to the reputation of the district among the travelling and commercial public.

The business of a railway can be divided into two parts—soliciting traffic, and then moving it—which correspond quite closely to the customary separation of an industrial enterprise or shop into the selling end and the manufacturing end. The railway manufactures one commodity only, transportation, and sells it to passengers, merchants, shippers, the post office and so forth. The amount sold will depend upon (*a*) demand; (*b*) amount of competition; (*c*) quality of the commodity offered; and (*d*) price at which the commodity is offered for sale. The main distinction between the manu-

facturing done by a railway and that done by a cotton mill or a chemist's shop, from the standpoint of management and control, lies in the fact that the plant and equipment of a railway are spread over a tremendous physical stretch of country, while most of the work is done by transportation units, which are constantly moving from place to place so that they cannot be continuously supervised. It is not possible for the head officer of a railway actually to see on inspection more than a very small percentage of his railway's traffic moved. Therefore, since the eye of the head of the concern is necessarily limited in its physical vision, other means of control for the property must be provided.

With the gradual growth of railways, departments were created, sub-divided and again sub-divided; officers found that they must have more and more elaborate reports to guide them; the day of the specialist arrived, and the science of transportation was taken up in earnest. But, with this rapid development along special lines, it has become more and more difficult to obtain a true perspective. The department officer may work for his department alone, losing sight of the broader interest of the shareholder (or the Government in the case of State Railways), and finding it difficult to obtain any very clear view of the relation of his work to that of other departments.

It has been mentioned by Mr. Byers, in his *Economics of Railway Operation*, that the principal rule of organization is to provide a supreme authority at all points where action must be taken. The question in any organization is: At what point should this centralizing authority appear? There are two extremes. If the local officials are entirely unrestricted in their actions, harmony of action throughout the system as a whole becomes impossible. If, on the other hand, all power of initiative is placed in the hands of one central authority, he is so flooded with detail as to cause great delay. Two radically different modes of organization have been worked out, and are generally known as the divisional and departmental. The divisional system, adopted in America, and to a certain extent on the Continent and in England, is arranged on the basis of territorial division of the property as a whole, giving to each territory a more or less complete organization under a single officer. The departmental system, on the contrary, operates on the basis of territorially dividing each department, placing an officer in charge of each district and making him directly responsible to the head of that department. On the broad-gauge portion of the North Western Railway the organization is, as you know, departmental, and the actual unit basis of the railway organization is the district. It is my object to try and show how we should work with this organization to obtain the advantages of the divisional organization in general economy and efficiency.

In certain traffic districts at present we have, under one officer, Assistant Traffic Superintendents in charge of Commercial, Passenger, Transportation and Establishment matters respectively. The other branches of work in a district which have to co-ordinate with the above to form a homogeneous district are locomotive running, carriage and wagon, engineering, police and accounts. It has been mentioned to me that a district is, perhaps, a small unit; but in order that we should get a true sense of proportion, it may here be noted that several districts on this railway are of about the same length as and earn more than several separate small railways in Great Britain and other parts of the world, which are equipped with a chairman and board of directors, general manager and heads of departments. The Lahore District, for instance, alone equals the entire Great North of Scotland Railway, and will shortly equal the Highland Railway in mileage and earnings, and is well ahead of concerns like the Gold Coast Railway or the Ottoman Smyrna Railway. Before, however, the district unit can be considered a real one, the district of the various departments must be coterminous, and this is, I believe, gradually being done in connection with the installation of telephone control circles radiating from district headquarters. Thus we have got down to a manageable unit for detailed control within that unit, and for comparison of efficiency and economy from year to year, and also with other district units by the Agent and heads of departments.

To give some idea of the duties of a Station-Master, and how he is watched, a list of the efficiency points that traffic officers look into on their inspections is given in Appendix A. In addition, adequate statistics are required to enable district officers to see how the work which they are doing compares with work done in other districts, as there are many operating efficiency factors, such as average loads of trains or wagons and so on that cannot be expressed in rupees, annas and pies in the balance sheet, but must be compared with previous figures and with other districts. Statistics are necessary also to see that districts are not retrograding, but improving, in efficiency year by year. It is possible that district officers, in ignorance of what their neighbours have accomplished, would lag far behind the achievement which they might reach were they stimulated by knowledge of the results attained elsewhere. The general tendency, however, is to try and express as many statistics as possible in terms of money as in this workaday world the comparison in a man's mind with the rupees, annas and pies of his monthly salary conveys more to him than juggling with figures of net ton miles per engine hour and so on. As an example the American railways have calculated, and told their staff, that in July, 1922, it was necessary to haul a ton of goods 68,996 miles to earn a sum sufficient to pay the annual wages of one permanent-way man, and 124,646 miles

to pay those of a clerk. Tell a driver or a station-master how a few more pounds per mile in coal consumption, or a few more hours per week of a shunting engine, compares with his monthly salary, and he will sit up and take notice, or he should be made to. Railway control, through statistics, might be defined as the process of finding the unit in each operation, of seeing to it that these units are rigid, that they are collected and reported accurately, promptly and economically, and then of taking the necessary measures to correct the defects which they indicate. Statistics are the clinical thermometer of industry, but don't worry the invalid by taking his temperature too often, and then pulling a long face over the result without using your best skill as a doctor to improve his health. Sir Sam Fay, in his presidential address to the Institute of Transport, uttered a word of warning about statistics, when he said that an average is not always a fact, and can easily become a disease, and that the accuracy and legitimate use to which any figures, costing time and money to compile, are put should be carefully analysed by men who are engaged in actualities before they are ordered, or the red-tape-worm will, in the course of time, have crowds of clerks administering to his growth and the extension of his clogging power.

It is suggested that the following graphs (which show statistics in a clear way) would give a District Traffic Superintendent a complete summary of the financial and efficient working of his district month by month :—

(*a*) *Passenger train running*—

Percentage of trains arriving right time. (These can be got out weekly.)
Percentage of trains not losing time.

(*b*) *Goods train loading*—

Average net starting wagon load, varying with commodity.
Average net train load on each engine run.

(*c*) *Goods operating*—

Average speed of goods trains on each engine run.
Net ton miles per engine hour.
Shunting engine miles per 100 train miles.

(*d*) *Earnings*—

Number of passengers carried : number of passenger miles.
Gross coaching receipts.
Number of tons carried : number of ton miles.
Gross goods receipts.
Total train mileage.
Total receipts.
Receipts per train mile.

(*e*) *Expenditure*—

Expense under each budget head, with a line showing sanction for each.
Total working expenses.
Percentage of working expenses to receipts.

(*f*) *Commercial expenditure*—

Total outstandings at large stations.
Total claims paid.

(*g*) *Miscellaneous*—

Number of accidents, by classes.
Number of fines, punishments and reductions.
Amount collected on excess fares and undercharges.
Number of employees.

The important graphs of gross receipts, percentage of working expenses to gross receipts and expenditure under each budget head, varying with the department concerned, would probably be found useful by the district officers of departments other than the Traffic Department. Moreover, under the organization in a district where each Assistant Traffic Superintendent is responsible for a particular function—Establishment, Transportation, Commercial or Passengers —an Assistant Traffic Superintendent would, no doubt, like to keep up graphs of his own particular subject so as to be prepared to justify some adverse trend in the graph, and he would also consider some graphs useful for himself to watch more carefully the work of his Inspectors, Controllers, Station-Masters or Goods Supervisors.

The Acworth Railway Committee pointed out that economical railway management cannot be ensured without a proper system of railway cost accounting, not merely to say whether expenditure incurred has been duly authorized, or receipts duly accounted for (which is the business of an outside firm of accountants), but to say whether expenditure has been wisely incurred, whether retrenchment of habitual expenditure is possible under any one head, whether new expenditure under another is proving profitable, whether a larger expenditure would be likely to be fruitful, or whether by arrangement and a little better administration a certain difficulty cannot be met without spending other people's money, and so on. The last point is a particularly important one in this country. Would requisitions for costly material or extra establishment be signed so gaily if an officer personally, as owner of the business, had to furnish the cash, instead of signing his name and spending another man's money? Cost accounting enables every commercial concern to get in closer touch with the operation of its works and to keep a very close control over expenditure. By comparing wage costs at

different periods, the danger of overstaffing, which frequently occurs in large districts or works, can be readily detected. Similarly a check is obtained on any waste of materials that may be occurring. This not only applies to the materials of manufacture, but also to such items as gas, water, fuel, oil, etc. Overhead charges should be frequently revised, as any changes in the methods of any department will make a considerable difference to this item. From this information, profitless lines of business may be detected, as also the relative value of each department to the business as a whole. It is, however, necessary that the cost accountant should present his information in a lucid and clear form as up to date as possible. In England they have gone so far as to say that many labour disputes can be avoided by negotiations on wage rates taking place on the basis of the cost and selling price of the commodity produced as the only equitable means of deciding such a matter. With a simple district balance sheet and summary of comparative statistics, and periodical study of them at the monthly district officers' meetings and at the Agent's annual inspection, where they might be presented in a similar manner to the annual progress report submitted by a board of directors at the annual shareholders' meeting, it should be possible for district officers to improve the State property entrusted to their management, and thus to carry more traffic, even with existing facilities, and largely increase State profits—a matter of considerable interest to every taxpayer.

Every department, except the Traffic Department, is almost entirely a spending department, while the check of the correct receipts of revenue is done by the Audit Department, so a district balance sheet will bring home to district and assistant officers of all departments the relation between the expenditure and revenue for their district, and the necessity of combining to keep down the district percentage of working expenses to receipts, and to bring their district above all the other districts of the railway. This balance sheet is actually made out by the Audit Department, and, when these balance-sheets are prepared for coterminous districts and at a shorter interval after the period under review, their use will be much enhanced. The balance can in the same way be extended to stations so that comparisons may be made between stations of percentage of cost of staff or stores to earnings and so on. This will also bring out the efficiency or otherwise of different members of the staff, Booking, Parcels, Goods Clerks, etc. The book of Operating Statistics prepared by the Audit Department is about to be brought still more up to modern practice and gives you the efficiency facts, which supplement the financial facts in the balance sheets.

In analysing the balance sheet, it is necessary to obtain a proper sense of the relative importance of the different items making up the operating expenses.

The cost of the North Western Railway in 1920–21, in crores of rupees was :—

Establishment	4·61	or 42·6 per cent. of whole expenditure.
Maintenance of property	2·63	
Fuel	1·34	
Other expenses	2·24	
	10·82	

It is therefore clear that the greatest scope for economy is in establishment.

Analysed by departments, the results for the North Western Railway in 1920–21 were :—

	Percentage working expenditure to gross earnings.	Percentage of total expenditure.
Maintaining the plant—		
Table A—Engineering Department ...	13·87	19·82
,, B—Locomotive Department ...	26·48	34·62
,, C—Carriage Department ...	7·86	12·12
Doing the work—		
Table D—Traffic Department ...	12·71	17·60
Maintaining the organization—		
Table E—Agency and Audit, Medical and Police Department ...	4·60	8·31
,, G—Provident Fund, Law, etc.	3·83	7·53
TOTAL ...	69·35	100·00

while the percentage of net earnings on total capital or the dividend was 4·51. This compares very unfavourably with 1916–17, when the percentage of working expenditure to earnings was 45·54, and the percentage of net earnings on total capital was 7·21. So far as the Engineering Department is concerned, the primary object is to make possible the transportation, at a profit, of freight and passengers. The expenditure will, therefore, be made principally for the following reasons :—

(*a*) to permit the safe, and also comfortable, passage of trains at usual speeds ;
(*b*) to improve the appearance of the property ; and
(*c*) to reduce the cost of future maintenance.

The high cost of the Locomotive Department is due very greatly to the cost of fuel, and it is for this reason—especially on this railway, which is at such a distance from the coal-fields—that very careful check on fuel has to be made by statistics of efficiency of operation, and, wherever possible, statistics should be translated into cost of

service as people take more interest in rupees, annas and pies. One can thus examine in turn each head and sub-head of expenditure, and see how economies can be made without reducing efficiency. The various balance sheet headings of expenditure for the Traffic Department in 1920–21 compared with gross earnings were as follows :—

D I (*a*)	General Superintendence ...	1·33% or 6th out of 10 leading railways of India.	
(*b*)	Station staff	6·88% or 9th	do.
(*c*)	Train staff	1·81% or 8th	do.
D II	Fuel, light and water ...	1·84% or 8th	do.
D III	Clothing	0·59% or 10th	do.
D IV	Printing, stationery and tickets	0·26% or 1st	do.
		12·71% or 9th out of 10 railways.	

The Madras and Southern Mahratta Railway is first with only 7·67 per cent.

It will thus be seen that the greatest scope for economy lies in (*a*) station staff and (*b*) uniform; though we are worse than most other railways under each head except printing and stationery. It must, however, be remembered that the North Western Railway has a considerable proportion of its mileage built for military and strategical reasons rather than purely commercial. Just as from the Administration Report comparisons can be made with other railways, from the balance sheet of the less unwieldy unit—the district—is obtained the healthy rivalry between districts, and not between departments. In general terms, therefore, we may say that the expenditure on railways divides itself into that on establishment and that on material. The figures for German State railways are interesting in this respect. In 1913, before the war, expenditure on material amounted to 40 per cent., whereas the expenditure on establishment amounted to 60 per cent. of the total expenses of the railways. In 1919, owing to the overstaffing of railways, the 8-hours' day and the depreciation of railway plant, the above proportions had changed to 30 per cent. material and 70 per cent. establishment. Then, when the Government undertook to put the railway plant in order, the proportions in 1922 came to 53 per cent. material and 47 per cent. establishment.

On the other side of the account, every effort has to be made by each department to increase the revenue, and departments other than the revenue-earning one can help considerably in this vitally important matter. There are two general methods of inducing people to use the railway more frequently: one is the reduction of fares and rates, the other is the improvement of the services. Before even considering the former, we have to get our percentage of working

expenses to gross receipts very much better than at present, but all departments can work towards the improvement of the service, passenger, parcels and goods. Formerly the Engineering, Locomotive and Carriage Departments and the transportation branch of the Traffic Department greatly overshadowed the commercial and passenger branches of the Traffic Department, but, with the growth in volume and variety of traffic, with the extension of services and with the ever-increasing importance of developing and enforcing rate policies that both harmonize with changing economic conditions and yield the railway profitable revenues from its many services, the position of the commercial and passenger branches of the Traffic Department in the general organization of the railway has become as prominent as that of any other department. To sell our commodity, we have to give every reasonable satisfaction to our customers, even though we may be a State railway and without a competitor for the traffic. Every engine and every carriage is a travelling advertisement of our business, every serious accident a blot on our reputation, every late train, whether due to engineering restrictions, crossing other trains or what not, a reflection on the undertaking, while much depends on the comfort of passenger carriages, and courteous treatment. For goods and parcels traffic, our reputation depends mainly on the time required for transportation and the safety of the goods while in our possession, which latter is, however, a most important financial matter in the saving of claims in our debit account. One of the greatest leakages in revenue is in the matter of fraudulent travelling, and reasonable expenditure is justifiable to bring in the large amount of revenue lost yearly through this cause.

To show the rate at which railway traffic in India is rising, goods earnings on all railways have more than doubled in 20 years. Passengers in 20 years have trebled in number, and quadrupled in earnings, showing increased prosperity and importance in railway policy. Nevertheless, goods traffic is still the more important item from the standpoint of revenue, being 52 per cent. of the total revenue on all Indian railways in 1920–21, passenger revenue being 44 per cent. and miscellaneous 4 per cent. The earnings per mile per week show the development in material prosperity of the areas served in India :—

			Rs.
1890	...	...	243
1900	...	...	245
1910	...	...	306
1920-21	...	...	478

The constant effort of every railway is to secure the volume of traffic, and to maintain rates and fares that will jointly yield a maximum net profit. Net revenues are the resultant of three factors —traffic, rates and transportation expenses. The transportation

branch seeks to operate the district as economically and efficiently as possible; the commercial branch endeavours to keep revenues at a maximum by establishing rates and fares that will enable traffic to move in large and increasing volume. The rate and fare policy that yields largest net returns in the long run is not to make charges as high as they might be put at any given time, but, while keeping them high enough to be profitable, to maintain them at a level below the maximum to guarantee the unhampered growth of industry and travel, and thus of traffic. The operating statistics show, for instance, the effect of the increase of rates on the number and class of passengers and the gross earnings. In July, 1922, on the Lahore District, although there was a decrease compared with July, 1921, of 1,240 first class, 20,276 second class and 33,045 intermediate class passengers, there was a net increase of 151,250 passengers in all forwarded and received owing to the continuous increase of third class passengers. Incidentally it may be mentioned that 92 per cent. of the passenger traffic on the Lahore District is third class, and the above figures give us an indication of the urgent need for third class stock. The total earnings of the Lahore District have risen from Rs. 14·4 lakhs in July 1921 to Rs. 18 lakhs in July 1922—the earnings are thus about £4,000 a day, and the expenditure about £2,800 a day; and this expenditure is gradually decreasing as a result of the Economy Campaign.

From the balance sheet and statistics, recommendations can then be made regarding the extent to which expenditure for maintenance and betterment may be safely increased, or to which they must be reduced for the ensuing period. The development of traffic, both for passengers and goods, is dealt with very much more intensively in England and America, and the fact that English railways, after being grouped, continue their system of advertising, traffic canvassers, agricultural trains and so on, shows that this matter does not neces sarily depend on the keenness of competition. General Magniac, President of this year's Indian Railway Conference, remarked on the necessity of publicity to bring to the notice of the public the good work that the railways do, and the efforts being made to improve matters. The American railways contend that getting a share of traffic that already exists is an important part of a railway traffic officer's duty, but making business that does not exist is the greatest end they should strive for. So far as passengers are concerned, we cannot provide sufficient third class stock at present to carry the existing traffic, but reduced first and second class excursion fares for Christmas, etc., will help to fill the first and second class as the number of these passengers had fallen after the general increase of passenger fares. Indian third class rates are still the cheapest in the world. The Traffic Department is the one which represents the railway in its dealings with its customers, passengers and

merchants, and it is from the latter that the larger part of its revenues is obtained. The Head Office Commercial Department makes thousands of rates in which tens of thousands of persons have a vital interest. Upon the rates charged by the railway, and on the services we give on the district, depend the success or failure and adversity of numbers of business enterprises. To satisfy the reasonable demands of the public, to convince other business organizations of the unwisdom of unreasonable or impracticable requests, to give the staff a responsible standard of comfort, reasonable hours, to enforce charges that are profitable to the railway, and generally to establish and maintain harmonious relations between the railway and the men and communities it serves, these are the difficult tasks of traffic officers and men, and they cannot possibly carry them out without the whole-hearted co-operation of officers and men of all other departments. To quote again from Sir Sam Fay's address, the public are always ready to lend an ear to charges of inefficient management, and he emphasized the necessity, now that the tentacles of transport stretch to every factory, office and home, of having the district officer in close daily touch with the point of the tentacles. Then, having secured the best results obtainable in the operation of a district as it exists, it becomes desirable to consider in what way the net earnings can be increased by additional expenditure for betterments in the way of heavier track, more powerful engines, quicker yard work, reduced road delays, electrification and so on. One of the points necessary to hold constantly in mind is the securing of evenly-balanced "capacity of line" facilities, as yard and track facilities must keep pace with engines, bridges and shops. This has been clearly brought out in the report of the Agent's Committee regarding the improvement of facilities between Lahore and Rawalpindi.

Balance sheets and statistics are not, however, going to run a business concern. They are the guides which will indicate to a certain extent what is happening. The one and only way to ensure that things are moving with that ease and simplicity which usually characterize competence in its highest expressions, and that the district balance sheet and statistics will improve each month, is by constant personal inspection by officers of the details of working, as well as the broader aspects of district working. "Trifles make perfection, but perfection is no trifle."

APPENDIX A.

(1) Monthly pay of staff under each branch—coaching, parcels and goods.

(2) Other monthly expenditure incurred by station in stores, fuel, stationery, etc.

(3) Money receipts per month in each branch—coaching, parcels and goods.

(4) Number of passengers booked per month, number of maunds of parcels and luggage booked per month and number of maunds of goods booked per month.

(5) Duty hours.

(6) Number of invoices and parcels way-bills dealt with.

(7) Courtesy, general conduct and smart appearance of staff, knowledge of rules by staff.

(8) Platform, clock, telephone, telegraph and line clear service and traffic regulation: posting of station working rules.

(9) Time made up at the station by mail, passenger, goods and other trains.

(10) Movement, loading and unloading of rolling-stock, good average loads to wagons.

(11) Booking-office service.

(12) Tidy and clean appearance of station premises, gardens and approach roads.

(13) Posting of time and fare tables and notices.

(14) Dealing with signals, train, telegraph or other failures, avoidance of accidents.

(15) Suggestions for improvement of traffic earnings.

(16) Lighting and upkeep of all lights, supervision of bookstalls and other contractors, handling of goods.

(17) Prevention of trespassing, keeping station entrance and exit clear of loafers, etc.

(18) Expeditious opening of level-crossing gates to road traffic.

(19) Working of vendors and watermen.

(20) Upkeep of fire- and theft-protection arrangements.

(21) Upkeep of goods and parcels registers, and absence of complaints from merchants.

(22) Disposal of unclaimed property and goods and parcels outstandings.

(23) Marking of goods, and riveting and labelling of wagons.

(24) Amount collected on excess fares, and on undercharges for luggage, parcels and goods.

A SUGGESTION FOR ANTI-AIRCRAFT GUNFIRE.

By LIEUT.-COLONEL D. M. F. HOYSTED, D.S.O., R.E.

HAVE you ever watched a large fire in London and noticed the wonderful accuracy with which the firemen can guide the powerful jets so as to reach the exact spot which they wish to strike with the water-stream?

The men in charge of the nozzles are chosen for their size and strength, in order to be able to hold them steadily so as to ensure accuracy of aim. Obviously they reach their target by very quick correction of aim (elevation and direction), which they are easily able to apply because the curve of the water-jet is continuous and they can see where it is falling at any given instant. As they increase the elevation, the point of impact of the jet with the target rises to correspond, and the fireman can stop elevating when he sees that the water-stream is washing over the object he wishes to strike.

During the war, how many times must the casual observer of an anti-aircraft artillery attack on a Boche machine in France have been struck with bewilderment at the fact that it was possible for the burst of shells to maintain such an immense error of distance from the target.

It is true that to be successful as an anti-aircraft gunner is extraordinarily difficult, and that the difficulties hardly appear till one begins to study the theory of aircraft flight with the hope of finding some very weak point on which to base an easier method of attack.

The airman can move instantaneously in three dimensions while travelling at any speed up to a hundred yards a second. His height and speed are unknown, the only obvious factor being his direction at any given instant. Even this factor is disturbed by the knowledge that he can alter it with great rapidity. The time of flight of the shell may be twenty seconds, during which period the machine may have moved over a mile.

There are some wonderfully clever instruments by which the height and fuze range may be determined quickly, but when one realizes that the machine, if passing straight over the gun at 150 or 200 miles an hour, may only be within range for a couple of minutes while coming and another couple of minutes while going, the troubles of the gunner's life may be more easily imagined. Besides which, only a very small portion of the actual target is vulnerable, and only the vulnerable parts count at this game in which the result of a

shot is either a hit or a miss, and a splinter may pass through wings, tail or fuselage without recording a counting hit.

The method of attack at present in vogue is to find the height and consequent fuze range before the hostile machine is within fire range, if—and this one is a very big "if"—it is a clear day, *and* it is spotted in good time, *and* there are no other hostile distractions. A burst of five shells is fired: time taken, about fifteen seconds. As soon as the bursts can be observed, correction is made for lateral and horizontal deflection and another five sent on their way. If the initial computations are good and the gun is well handled, the second correction of deflections should give the best results obtainable. The firing record would be approximately as follows:—

First five rounds	15	seconds
Time of flight (say)	12	,,
Observation and correction	5	,,
Correcting fuze settings for next burst ...	5	,,
Second burst	15	,,
Time of flight (say)	8	,,
Observation and correction	5	,,
Correcting fuze settings for next burst ...	5	,,
Third burst	15	,,
Time of flight (say)	5	,,
Total ...	90	,,

The corrections must be judged and applied with lightning speed, as the essence of the whole operation is time—to get in the greatest number of carefully aimed rounds that is possible, in the period during which the target is within effective range. But these corrections can only be based on conditions noted ten seconds before the shells are fired, and are ancient history by the time the shells reach their positions of burst.

When speaking to a gunner who had a large percentage of successes compared to others, the writer was told that the study of the psychology of the enemy pilot played a large part in the estimation of his correction for deflection, because of the great difficulty of obtaining and applying them correctly when mechanical means were used. On one occasion, when he was firing at a German Intelligence patrol machine, he realized that the pilot always made his turn in the same direction at more or less the same point. So, instead of following him up on his line of flight as before, he laid for him at the turn and brought him down.

The chief reason why it is necessary, at present, to fire sets of five rounds and observe the bursts for correction of deflections, is that otherwise so much ammunition would be used up that it

would be impossible, at present, to ensure the continuity of the supply. But this difficulty is obviously governed by relative values, which are subject to fluctuation. A few years before the war, while the writer was in Egypt, officers were invited to write an essay on their opinion for an ideal infantry company. The writer's suggestion was as under :—

Riflemen (with bayonets)	100
Maxims and crews	5
No. of Companies to the Battalion	6

The adverse criticism made by the General Staff was to the effect that the number of machine-guns was beyond all possible requirements and that the ammunition supply would be impossible. Yet how many machine-guns, exclusive of Lewis guns, did the end of the Great War find affiliated to a battalion?

Even supposing that the supply of ammunition for an anti-aircraft gun must not be increased beyond the present establishment, would the gunner not have a better chance of bringing down his target if it were possible to apply his correction in the same way as the fireman makes them when using his hose? Supposing the gun were of the nature of a 3-in. automatic feed machine-gun, firing one shell every two seconds, the number of rounds fired per minute would be thirty. But, and it is with this "but" that the value would be noticed, the chain of bursts would be definite and would approach the regularity of the water-stream. So that the gunner could apply his correction much more quickly and automatically, as the corrector would be the gun-commander, who would be independent of section officer and all instruments as soon as he found he was near his target. There would be more chance of obtaining a hit in this way with sixty rounds in two minutes than there would be with sixty rounds spread irregularly over six minutes.

Of course, the comparison of the shell and the jet fails to a certain extent, because the latter is directed at a large and solid object and its efficacy does not depend upon the correct time of flight. But it should be quite possible to apply correction for fuze range while the shells are held in their belt or other feed arrangement. So that, taking an average time of flight of ten seconds, the gun-commander and setters should be able to apply the necessary fuze correction to, say, the tenth and subsequent shells, while making sure of correct alignment with all. The ease and certainty of the correction would be much enhanced if every fifth projectile in the belt were a tracer shell.

There would be great difficulties in the design of an automatic gun of the size indicated, though the construction of a 4-inch machine gun for naval use was mooted some years ago in the United States. The maximum weight of shell hitherto fired from a machine gun is only two pounds, while the tendency for efficient anti-aircraft work is to increase the weight even of the present shell.

LEAVES FROM AN OLD LETTER BOOK.

(*Extracted by* COL. C. W. DAVY, C.M.G., R.E.)

THE source of the following extracts is an old Confidential Letter Book which came to light recently in the R.E. office at Hong Kong. They throw an illuminating side-light on R.E. activities in the early days of the colony and will, I think, be read with interest, especially by those of my brother officers who have served in the Far East.

The first item in the book is dated, 1st April, 1847, and consists of a lengthy report by Lt.-Col. G. Phillpotts, R.E., of a reconnaissance of the fortified river approaches to Canton made in company with Major Aldrich, R.E., between the 28th and 31st March, 1847.

The report is addressed to Major-General D'Aguilar, C.B., the then G.O.C. in China. It is too long to quote *in extenso*, but the opening paragraph will convey the general idea :—

> Sir,—In obedience to your orders of the 27th ulto., to examine the Chinese defences on the river, and to report to you how far I deem it prudent or practicable for you, with the small force under your command, to go up and attack them, with a view of passing up from hence to Canton, with Her Majesty's Plenipotentiary in order to demand redress of certain injuries that have been repeatedly offered to British subjects by the Chinese."

Lt.-Col. Phillpotts summarizes his conclusions as follows :—

> " From what we have thus seen of the present state of the Chinese defences in the river between this port and Canton, we are both of us of opinion that, although there is a very large number of heavy guns mounted on them, you may safely proceed, with every prospect of success, with the Force now under your command and take the most important of them by surprise, spike their guns, blow up their powder magazines, and then pass up to Canton : provided you embark to-night, in H.M. Steam Frigate *Vulture*, the H.E.I.C. steamer *Pluto*, and private armed steamer *Corsair*, get under weigh before daylight, and anchor close to the Anunghoy Forts as early as possible to-morrow morning. Having taken these, it is necessary that you should post on to the other forts and above-mentioned, if possible before the Chinese have time to hear of your movements and make preparations for a vigorous defence.
>
> " During my absence at Canton the powder bags and light ladders which you ordered to be prepared have been made, and the detachment Royal Sappers and Miners have everything ready for this service.
>
> " On arriving at Canton you will find ample accommodation for

all the troops in the English Factory, which is surrounded on the three land sides by a very high brick wall, and open on the side towards the river to the steamers which may anchor immediately in front of them, so that you will then be quite safe from any force that the Chinese are likely to attempt to bring against you while you remain at Canton.

"In performing this duty I have received great assistance from Major Aldrich, whose previous knowledge of the country, etc., has been very useful to me."

The G.O.C. appears to have lost no time in acting on this report, and the next item in the book consists of a copy of a General After-Order, dated 1st April, 1847. I think this is worth quoting in full, if only to bear witness to the fact that "methods of frightfulness" had then, as now, no place in the conduct of British troops towards non-combatants.

"The Major-General Commanding acquaints the officers and troops under his orders, that they will embark for service, according to the undermentioned detail, to-morrow morning at 3 o'clock the detachment of Royal Artillery and the acting gunners of the 18th Regt., under Lt.-Col. Brereton, C.B., and K.H.

"The Royal Sappers and Miners under Lt.-Col Phillpotts.

"The whole of the 18th (R.I.) Regt., with the exception of 3 subalterns, 12 serjts., 5 drummers and 170 rank and file, including the sick in hospital under Lt.-Col. Cowpers, C.B.

"The 42nd Regt. M.N.I. to the amount of 300 rank and file with the proportion of officers and under Major Fitzgerald.

"Major Fitzgerald will select one captain and a proportion of subalterns to do duty in Victoria.

"The troops will embark with their knapsacks containing:—1 pair of black trousers, 2 pairs of white trousers, 2 shirts, 1 towel, 1 flannel waistcoat, 1 pair of good shoes.

"Hold-all complete.

"Each man to take with him his great coat, the bedding to be folded and prepared for embarkation at 8 o'clock to-night, the white cap covers to be taken into wear. The Major-General congratulates the officers and men he has the honour to command on the opportunity afforded to distinguish themselves in the service of their Sovereign and their country, and he feels the highest possible pride and gratification to find himself at their head.

"He has only one word to add—that is the word Humanity, and abstinence from everything in the shape of plunder or outrage, as regards the defenceless inhabitants, that could sully the character of British soldiers.

"Major Aldrich of the R.E. is appointed to act as Aide-de-Camp to the Major-General Commanding until further orders.

"The detachment at Stanley and Saiwan to be reduced immediately to the following strength:—*Stanley*—1 lieutenant, 1 ensign, 1 assistant surgeon, 2 native officers, 3 havildars, 50 rank and file. *Saiwan*—1 havildar, 2 Naigues and 12 privates.

"The Major-General Commanding depends upon the vigil nce and zeal of the captain left in command here, for the preservation of security and order."

A brief account of these operations will be found in Vol. I. of Porter's *History of the Corps* at the beginning of Chapter XXI.

The book now proceeds with copies of reports from the various O.C.'s detailing, at considerable length, their particular share in the operations, which appear to have met with but little resistance. The spoils of war seem to have been plentiful as evidenced by the following :—

"Return of the iron and brass ordnance taken and spiked by the British Force under the command of Major-General D'Aguilar on 2nd, 3rd and 5th April, 1847.

"Total, 847 iron ordnance, 32 brass ordnance. Grand total, 879.

"Time did not admit of taking the calibres of the guns of their several forts; their bores were found to be of unusually large diameter, some nearly 13 inches, and none under 5 inches. All were mounted upon new garrison carriages, on the English construction, and with iron truck wheels."

It will suffice if I give the report of the C.R.E. ; the others cover much the same ground :—

"Sir,—I have the honour to report to you for the information of the Hon. the Major-General Commanding that in obedience to his directions, conveyed by your letter of the 4th inst., I proceeded on the morning of the 5th inst., at 7 o'clock a.m., accompanied by Major Aldrich and the other officers of Royal Engineers, together with the detachment of Royal Sappers and Miners and a supporting party consisting of the Grenadier Company of the 18th Royal Irish Regt., under Captain Campbell in the boats of H.M.S. *Vulture*, for the purpose of destroying the stone tower or keep within the fort, called the French Folly ; as well as any defensive arrangements that might be found in the Dutch Folly and Rouge Forts, which had been reported to the Major-General on the previous day to have been re-armed and preparing for action

"The French Folly Fort, which is situated about two miles below the city, on the north side of the river, opposite to the western or upper end of Napier's Island, though much smaller than either of the Anunghoy Forts, is far more formidable, inasmuch as, besides standing on a small island that renders it very difficult of access on all sides except by boats, it had a stone tower or keep, 54 ft. by 42 ft. and 24 ft. high, built of very large ashlar, on which twelve guns were mounted that completely commanded the parapet of the large sea battery that surrounds it, and they afforded a heavy plunging fire over this battery, which, if well directed, would prove very destructive to any party advancing to its attack

"The walls of this battery are 8 ft. thick, and 14 ft. high, above the level of the river. There are 24 heavy guns mounted on it, *à fleur d'eau*, from 8 in. to 12 in. in diameter ; which, if properly served, would effectually prevent any vessels from passing up or down the river.

"Over these guns is a *banquette* with loopholes for musketry, the whole forming a very strong defence against any attempt that might be made to take it by assault.

"When this fort was taken under the Major-General's own immediate supervision on the 3rd instant by the party under Major Aldrich, R.E., the guns were all spiked ; but, as the garrison threw

water on the powder in the magazine before they evacuated it, we had not then the means of blowing it up.

" On approaching the fort on the 5th instant, Major Aldrich landed with the supporting party, and having ascertained that it was in same state as when we left it on the 3rd instant, I directed him to cause the party to extend round the neighbourhood, in order to keep the mob from molesting us; and likewise to drive away the inoffensive inhabitants to such a distance as would prevent their being injured by the explosion.

" Acting on the principle laid down by the Major-General for our guidance on this expedition, not to do anything that would in any manner injure the defenceless inhabitants, nor, indeed, to do any other injury to the forts, etc., on the river, than merely to render them useless for the time being, I considered it desirable only to employ such a quantity of powder as would merely throw down the keep, without destroying the outer walls of the fort, and thus save the people, who reside all round it, from suffering any ill consequences from the explosion.

" I accordingly directed the charge of powder to be limited to 300 lbs. and while the Sappers, under Lieut. Dacosta, R.E., were placing the powder in the magazine and preparing it for explosion, I directed Captain Durnford, R.E. to make as correct a sketch as possible of the fort, etc., in order that he might be able, at his leisure, to prepare a plan of this work for the Major-General showing the effect produced.

" While these preparations were going on, Lieut. Pascoe, Lieut. Coote and Lieut. Durban, R.N., with the pinnace and paddle-box boats of H.M.S. *Vulture*, the former carrying a 12-pounder Corronade, and the two latter a 24-pounder Corronade each, with a detachment of the Royal Marine Artillery, under Lieut. Davis were employed in driving away the numerous boats and junks that were anchored close under the walls of the fort.

" These arrangements being all made, the supporting party withdrew, and re-embarked.

" I left Captain Durnford, R.E. to complete the train, and fire the charge, on a signal to be given, as soon as the boats with the troops had pulled off to a sufficient distance to be out of danger.

" Captain Durnford performed this duty in a most satisfactory manner. A short time after the signal was given for the explosion, he was seen pulling out to the rest of the party in the gig of the *Pluto* and in five minutes afterwards, being the time agreed upon, a low rumbling sound was heard, a large dense mass of black smoke was seen to rise from the fort, and when it had subsided, the keep, with the exception of a portion of the west end wall, was no longer visible.

" On returning to the fort, in order to see the effect produced by this explosion, I found the keep entirely destroyed, not a vestige of it remained standing, except the wall of the west end, which, however, was so much shaken as to render it highly dangerous to pass near it. The large hewn stones which had been used in building it (many of them 8 ft. in length) were overhanging the foundation, ready to fall at any moment. At the same time the walls of the surrounding battery remained uninjured, with the exception of two cracks that had been made on the south side, about 30 ft. apart, between which two of the heavy guns had forced open the doors, by which the embrasures were closed, and their muzzles appeared outside.

"Having completed this service we visited the Dutch Folly and Rouge Forts. The guns of the latter remained spiked, as they were left by Major Aldrich on the 3rd instant. Twenty guns were found mounted in the Dutch Folly Fort, all of which we spiked, and returned to the British Factory about eleven o'clock a.m."

The next item of interest is a letter, dated 17th June, 1850, from Major Vincent Bircal, R.E., to the Brigade Major at Hong Kong. It sheds a pathetic light on the terrible mortality which prevailed among the troops in China in those early days.

Sir,—In forwarding my first half-yearly inspection report of the detachment of the 6th Company of R.S. & M. serving at the station, I beg to call your attention to the length of time a portion of the detachment have been kept in this most unhealthy and disagreeable climate.

"The first detachment sent to this station left England in May, 1843, and landed at Hong Kong 34 N.C.O.'s and Privates. Of this number 12 have died here, 14 invalided, leaving 8 men with worn-out and shattered constitutions.

"The second detachment left England, February, 1845, and landed at Hong Kong 15 strong, but of this number 4 have died and 4 have been invalided, leaving 7 men who appear to have suffered from the general effects of this climate as much as the 8 men previously detailed.

"The third detachment embarked for Hong Kong July, 1846, and arrived here 18 strong. Of these 5 have died, 2 been transported, leaving 11 now doing duty. These men have also suffered severely from the climate.

"All the men of these three detachments have served longer in Hong Kong than the other troops of the Garrison. Allow me to mention that after the arrival of the last detachment showing no immediate intention of relieving them, the good men's spirits seem broken and the drunkards get worse. The duties the Sappers have to perform here are more severe and trying than other troops', being constantly obliged to be out in a burning sun superintending contractors and other works, whereas the men of the regiments are not allowed to be out of their barracks between 8 a.m. and 5 p.m. It is supposed the period of service here for the Ceylon Rifles (Malay) and European Regiment to be three years, whereas the first detachment of Sappers have been upwards of seven years from England.

"Out of 67 men sent to Hong Kong up to October last the casualties amount to no less than 41. Under these circumstances I think it becomes my duty to represent the case of their speedy relief for serious consideration.

"It is with much satisfaction I have the pleasure to report the conduct of the last detachment arrived here in October last to be *most exemplary, no crime* having as yet been recorded against any *one man*."

We now make a jump to 1862. This item consists of a copy of "The Field Journal of Operations undertaken against the (Tai-ping) rebels in the vicinity of Shanghai between the 4th April and 11th June, 1862, compiled by Lt.-Col. H. C. B. Moody, R.E., Captain C. G. Gordon, R.E. and Lieut. Sanford, R.E."

The journal is divided into six expeditions, as follows :—

No. 1. Expedition to rebel entrenched camp at Wong-Ka-Dza—3rd and 4th April, 1862.

No. 2. Expedition to the rebel entrenched camp at Chaou-fou—17th and 18th April, 1862

No. 3. Expedition to the rebel fortified walled town and depôt Kuh-din, including the attack on the redoubts and stockade at Nesiang—26th April to 2nd May, 1862.

No. 4. Expedition to rebel fortified walled towns of Tsing-foo, strongly entrenched village of Nan-jow and fortified walled town of Tso-lin—7th May to 22nd May, 1862.

No. 5. Expedition to evacuate Kuh-din—(no dates given).

No. 6. Expedition to evacuate Tsing-foo—(no dates given).

The first three expeditions seem to have been of the military promenade type and present no particular features of interest.

The fourth expedition was a more ambitious affair. In this, as in the previous expeditions, it was carried out by a mixed force of British and French, both nationalities sending a naval brigade as part of their contribution. Lt.-Col. Moody estimates the total allied strength at 2,500 bayonets.

The R.E. were represented by Lt.-Col. Moody, Captain Gordon, Lieuts. Sanford and Maud and 26 O.R. of the 8th Company, R.E.

The journal of this expedition covers about twelve pages of foolscap, so I will not refer to it further, but pass on to No. 5, which possesses a special interest, due to the fact that Gordon was the C.R.E. owing to the sickness of Lt.-Col. Moody.

The R.E. detachment on this occasion consisted of Capt. Gordon, Lieut. Maud and 16 O.R. of the 8th Company, R.E.

The journal reads as follows :—

" On the 24th May, 1862, an expeditionary Force, consisting of the Wings of 31st Regt. and 33rd Punjab N. Infantry, French's and Wortham's demi-Batteries of Field Artillery and a detachment of Royal Engineers under Captain Gordon, R.E. The whole under Brig.-Gen. Staveley, C.B., started from the Stone bridge (Shanghai) at 5 a.m. and proceeded towards Kah-ding.

" The Force reached ' Nesiang ' about 11 a.m.

" The stockade outside the town (which was taken on the 29th April, 1862, was reoccupied by a detachment of 22nd Punjab N. Infantry. Here the troops halted until the arrival of the boats, which (being detained by the tide) did not arrive until between 4 and 5 p.m., when it was considered too late to advance upon Kah-ding, and as it was known the rebels were in the neighbourhood it was determined to halt for the night, and push on early the next morning.

" Some of the Commissariat boats only arrived *this morning* about 4 a.m., owing to their being too large and having thereby to wait for the flood tide.

" About 6 a.m. a body of rebels were observed advancing on the left

of the town—about 300 of 22nd Punjab N. Infantry proceeded at once to drive them back (as also a party of rebels attacking the stockade) and after a sharp skirmish succeeded fully.

"During the course of the day the rebels attempted to drive in an out-lying picquet on our left flank, but without success.

"In these skirmishes about 100 rebels were killed and 2 of Punjab N.I. wounded.

"During the day every effort was used to push the boats through the creek which flows through the town.

"It was determined this day to push on to Kah-ding with a small portion of the Force and relieve the Garrison at that place.

"This expedition started about 5 p.m. and reached Kah-ding without meeting any serious opposition.

"In about two hours they spiked all the Chinese guns, destroyed all the rice captured at the taking of the place on 1st May, and then returned (preceded by the Imperial Chinese) to Nesiang, which place they reached about 4 p.m.

"During this day the rebels were observed hovering round Nesiang in large numbers. They made some desultory attacks on our outposts, but with no results, except a loss to themselves of some 20 men.

"It being determined, if possible, to recover a field-gun taken a few days previously from a small escort proceeding to Kah-ding and hearing that it was at the village of Wong-poo (?Wham-doo) (*vide* sketch), a distance of some five or six miles, a small party started about 6 a.m., but before proceeding any great distance, a report of firing was heard in the direction of Shanghai (*vide Note*).

NOTE:—The firing heard came from some Imperialist camp outside the city and was of no serious importance. The Chinese sometimes fire their guns like watchmen of old (and Chinese watchmen of the present day) spring their rattles to show they were awake and give notice to thieves, etc., *to get away in time*.

"From this it was thought possible that the rebels had made a dash at the settlement knowing that most of the troops were absent.

"Without loss of time, orders were given for all the troops to return to Shanghai and the greater part of the Force reached Shanghai at 3 p.m., *having seen no rebels*.

"The convoy of boats and their guard, etc., returned about 9 a.m. on the 28th May, 1862."

Lt.-Col. Moody's report on these operations addressed to the I.G.F. and dated 26th August, 1862, appears to be worth quoting in full. Gordon seems to have made an excellent impression.

"I have the honour to forward the accompanying reports, etc., o the late operations in the neighbourhood of Shanghai. I had hoped to have forwarded a copy of the General Order relative to the same before this, but, though the Brig.-Gen. informed me he would publish one as soon as the proceedings were over, as yet none have been published.

"Relative to the officers and men of the Corps under my command nothing gives me greater pleasure than bringing their constant zeal and gallant conduct to your notice and favourable consideration.

"With reference to Captain C. G. Gordon, R.E., the 2nd in com-

mand in the field, I cannot speak in terms too high—always willing, zealous, active and, when work was to be done, in fact, indefatigable.

" In fact he fully bore out in all things the very high character I had previously heard of him.

" I am also able to enclose the accompanying letter from Captain Gordon, R.E. relative to Lieut. Sanford, R.E. I can fully corroborate his statements as far as the short period he was under my command permits me, and such a statement as Captain Gordon's in favour of Lieut. Sanford bears its own weight.

" The conduct of the men in the field was also highly satisfactory.

" I regret that it was not considered advisable to confirm the acting rank given (subject to your approval) by me to 2nd Corpl. Collins, 8th Company, R.E. At the commencement of the operations he was the only Sapper with me, he was also Acting Foreman of Works and indefatigable at Shanghai in superintending the erection of the defence at Stone bridge post near Shanghai, the work being performed by Chinese workmen (most difficult to deal with) and in unfavourable weather and under a general pressure of work. His conduct in the field I considered also highly satisfactory, and as such I wish especially to bring his name to your favourable notice for services performed.

" I regret to state that of late there has been much sickness among the men of the Corps, and the strength of the Company is very seriously reduced. To perform routine duties we are now very weak-handed—any extra ones are performed under serious pressure.

" I may also say the same of the Civil Branch of the Department, as I had to detach Mr. Medlin, C.W., to Shanghai where he is at present.

" Mr. Studd, C.W., at Hong Kong I expected to have to invalid shortly and have only Mr. Taffs, Hd. Qr. Clerk of Works, for duty here.

" Mr. Rawling, C.W., was lent to the Civil Government here, and it would seriously impede the progress of the public works to cause him to return to his duty, and from all I can learn he is doing his duty with great credit to the Department to which he belongs.

" Should there be any chance of further operations here (and events uncontrollable by us, may force them on us and at a short notice) we are so short-handed that we could not meet any serious demands; and the extra work on the few already available would soon exhaust even the present limited supply.

" The 10th Company, R.E., was sent from here previous to my arrival, and previous to any of the late signs of hostility—nominally indirect, but which sooner or later must have been directly developed."

It will be noticed that the troubles of a C.R.E. have not altered much in the last 60 years.

The next item is a copy of a memorandum addressed to the I.G.F., by Lt.-Col. Moody, dated 9th June, 1862, in which he complains that he, as C.R.E., was practically ignored during the preparations for these expeditions, was given no opportunity to furnish his views either as to engineer requirements or the scheme generally. He criticizes the commander of the force (Brig-Gen. C. Staveley, C.B.), with considerable freedom and mentions his opinion that the general field operations would have been as successful as the Engineer operations but for a certain order, against which he deemed it his duty to remonstrate and was told to mind his own business.

He raises an important question of principle in the following words :—

> "I have therefore to request information and guidance on the following subjects—am I as C.R.E. in China to witness what I considered a grave military error, and not give notice?—and would I not be held personally responsible by you and H.R. Highness if I did not jealously consider the honour of our arms, as well as the serious position we would be placed in by the loss of prestige in any manner?"

Moody seems rather to have thrown the fat into the fire by this communication, which "merited the extreme displeasure of H.R.H. The Commander-in-Chief." Several pages of the book are now taken up by explanations and apologies which are too long and hardly suitable for publication.

All the same, I think that a good many R.E. officers, especially those who were C.R.E.'s of Divisions in the Great War, will feel a good deal of sympathy with poor Moody.

The next is an interesting item, being a copy of Gordon's official application for permission to accept service under the Chinese Government. It is short and to the point.

> Shanghai, 25th December, 1862.
>
> Sir,
>
> I have the honour to request that you will move the Brig.-General Commanding the Forces in China to forward this my application for the permission of Her Majesty to accept service under the Chinese Government.
>
> I have, etc.,
> (Signed) C. G. GORDON,
> Captain, R.E.
>
> D.A.A.G.
> SHANGHAI.

This led to Gordon's connection with the "Ever Victorious Army," and laid the foundation of his future greatness.

The last item is a memorandum to the I.G.R.E., dated 29th June, 1863, by Lt.-Col. Moody, who appears to have survived the little trouble of the previous year.

It furnishes an interesting echo of the recurrent squabbles which on more than one occasion nearly led to war between England and the Union Government during the War of Succession in America.

> "In consequence of an alarm of an immediate prospect of war with America, and the fact of a heavily-armed American Frigate, and two gun-boats being reported at Macao—and in the absence of a naval force in our own waters and the very insufficient existing land defences. His Excellency the Acting Governor ordered a Council to assemble and requested my attendance to give any assistance as C.R.E.
>
> "On a previous occasion of a similar alarm, I, in conjunction with the Offr. C.R. Arty., selected certain sites for defensive batteries, but they were for Armstrong guns (110-pr.). That alarm was soon over,

and as it would have entailed extra detachments and duties on an already hard-pressed garrison if these batteries were erected without urgent cause, the service was postponed—and none of the £500 authorized has been expended. (*Vide* joint report, dated Hong Kong, 7th October, 1862.)

"There would have been no difficulty in occupying these sites already selected *had the Armstrong guns arrived*—but they have not; only the Ammunition has come as yet.

"These sites were not available (owing to the ranges) for any shorter-ranged guns, so fresh sites had to be selected to meet the limits of the defensive weapons available.

"The batteries are revetted on the Kowloon side with Commissariat Casks—Embrasures with Jones patent Gabions—on the Hong Kong side; the Commissariat had broken up their casks so we used the patent Gabions throughout.

"Detailed plans and estimate will be furnished by the earliest opportunity. I merely send this preliminary report for your information.

"The expense will be comparatively trifling—but I feel the want of Sapper superintendence very seriously—our detachment here is so very weak for the duties they have to perform and the men are constantly breaking down, as shown by the number of invalids sent home from time to time and also by the present weak state of the 8th Company, R.E.

"I am led to expect that I will be able to remove the Head Quarters of the 8th Company, R.E., from Shanghai to Hong Kong before long.

"This will give me a great assistance."

THE LIGHTER SIDE OF "I."

By LT.-COL. E. P. LE BRETON, R.E.

INTELLIGENCE and Spy are terms of high romance only second to those glowing words "Pirate" and "Buried Treasure." Innumerable spy novels, many spy plays and a respectable number of Intelligence officers' memoirs have been given to the public in the last six or seven years. They vary, of course, in merit from the *Thirty-nine Steps* and its sequels: Books that will rank with *Treasure Island* itself to the Penny Dreadful of commerce. They have, however, one common quality,—they none of them remotely resemble the truth. The writer of this article was for the greater part of '18 an insignificant cog in the machinery of the Intelligence of one of our Eastern Armies.

The incidents he here sets down, though less exciting than is common in spy stories, have the rare, the all but unique, distinction of being true. Names, places and regiments have, of course, been suppressed or altered.

* * * *

All women and six men out of ten envisage the head of the Intelligence of an army as a cosmopolitan individual who periodically envelops himself in a false beard and fades away. He then proceeds direct to the dwelling of the enemy commander-in-chief. Having entered the palace, the camp or the bivouac of the Hindenburg of the moment, our Intelligence officer either:—

(*a*) kills one of Hindenburg's staff, steals his uniform and passes himself off as the victim, or
(*b*) conceals himself in a cupboard in Hindenburg's office, or
(*c*) hangs by his finger-nails to the window-sill some eighty feet above the ground.

No sooner is the scene laid than Hindenburg and his Chief-of-Staff enter. Are they overheard complaining about the quality of war bread, the disgraceful way their new orderlies clean their buttons or the absurd nonsense written by War Office clerks? Not a bit of it.

They begin at once something like this:—

Hindenburg: Ah, good morning, Count.

Enemy Chief-of-Staff (saluting, bowing and clicking his heels): Your Excellency.

Hindenburg: At last we have them (hits table with closed fist).

As you know, I have prepared a trap for them, and the fools have fallen into it. They think I am about to attack their centre—Not so! At dawn on Tuesday 200 Army Corps advance to crush their left flank and sweep them to perdition.

Enemy Chief-of-Staff (saluting, bowing and clicking as before) :—Your Excellency is irresistible.

This is enough for our hero; he fades again, and reappears on the nearest beach or open field. Thence he is retrieved by a friendly submarine or aeroplane and taken back to the British lines. Still enveloped in his false beard, he walks up to the British commander and asks for a private interview. The Staff are horrified, but Field-Marshal Lord Jones, with his shrewd and kindly smile, dismisses the crowd of scarlet-throated popinjays who surround him and beckons the unkempt stranger into his sanctum. Some twenty minutes later the Marshal emerges. In a few well-chosen words he shifts 250 Army Corps from his centre to his left and the situation is saved. The work of the Intelligence is done.

* * * *

As a matter of unromantic fact the Intelligence Staff at a General Headquarters are a set of tired overworked men, constantly exploring false trails, for no chance can be lost, gradually building up, from an indication here, and a report there, statistics of the enemy's forces, records of their movements and plans and sketches of the characters and dispositions of their leaders.

With every confidence (and in the certainty of being contradicted by "Operations," "A," "Q," and the other branches of the Staff), I state that the work of the Headquarters Intelligence Staff is the hardest, the most exacting and the most exhausting in the army. At Baghdad the "I" branch assembled daily shortly after 8 a.m., and, with brief intervals for lunch and dinner, worked at high pressure till 11.30 p.m. seven days a week, for Sundays do not occur in war. Month after month, and year after year, there were no intervals for rest. It was safe, but it was not an easy life. And Intelligence work is all original brain work. There are no comfortable matters regulated by routine, drawn out by a well-trained clerk and signed after a casual glance.

Moreover, it is impossible to file precedents and records so that all one's knowledge can be handed over with the key of the safe to a successor. No Intelligence officer is worth much till he has stored six months of memories in his brain, and the longer he stays the more valuable he is. Consequently, though the General officers at the head of the various G.H.Q. Intelligence Staffs were among the best soldiers the Empire has produced, their very value sometimes prevented their promotion to the high commands which they would otherwise have attained. The Chief of the Intelligence of an army

in the field may be said to be the only exception to the maxim that no man is indispensable.

For those who don't like that sort of thing, it is the sort of thing they will most heartily dislike. For those who do like it, Intelligence work has an overpowering fascination.

* * * *

The work is very varied. All foreigners are dealt with by th "I" branch. In Baghdad this was a formidable part of the functions of the Intelligence. Masses of Russian refugees from the broken fragments of the Imperial army, prisoners of war of every nationality who had escaped from the Bolsheviks and made their way to Mesopotamia, enemy officials and free-lances who had been apprehended in Persia, friendly free-lances who were almost more trouble (all through the war swashbucklers of every nation pervaded that ancient but unhappy land), and lastly organized missions sent out by one or other of the amazing Governments from which most of the Allies suffered.

A certain Russian Colonel, whom I still remember with vivid dislike, would send for me day after day at my busiest time. "You spik ze French—Yes? No?—I can my complaint make much more couramment in ze French" and then followed the day's complaint—half an hour at least. We still hoped for help from the Russians. They could not be spoken to as they deserved. One of the lesser gems of official correspondence was sent me by a young officer I had deputed to meet a party of Russian refugee nurses arriving by train from Persia.

It ran :—

Sir,—In compliance with your instructions I met the Russian nurses arriving at Hinaidi railway station at 21 hours last night. On alighting from the train one of the ladies was safely delivered of a female child. Your further instructions are requested as to its disposal. Both mother and child are doing well.

(Signed) J. BROWN,
Captain Gen. List.

Poor little lass! —it was a dismal place to start from.

Then there was a Balkan nobleman who had escaped from Odessa, and married a wife on the way down. We thought rather well of him at first and we lodged them in an official guest house we kept in the city. Unfortunately he had a weakness for arrack, and that night he was seized with the conviction that our harmless and aged Moslem doorkeeper was Sultan Abdul Hamid in person. With a drawn sword in one hand and a loaded revolver in the other he chased that dignified official half over Baghdad before the police intervened and brought him to the "I" Branch in handcuffs.

He started on his long trail back to Eastern Europe the next day minus the revolver and its ammunition.

Propaganda formed another of our many sub-branches. Propaganda at home is a comparatively straightforward matter. Having decided on some simple fact that the nation is to believe, you repeat it *ad nauseum* until some wit forms it into a popular catchword and the trick is done.

In Mesopotamia it was a more subtle affair. We had propaganda for the Turk and for the Kurd, for the nearer Persian and for the Azerbaijan Tartar, for the Shirazi, the Armenian, the Yezidi and the Baghdadi, for the Bedouin Sheikh, the Chaldean Christian, the Moslem Ulema, the Jew and the Yankee. In each case the facts had to be—presented somewhat differently—shall I say.

This complicated business was concentrated in the hands of a witty and able sportsman from Wales. He is nearly seven feet high and his desk looked like a torpedoed haystack. Yet he could always plunge an unerring hand into the tangled mass and produce appropriate literature for any of the nations, peoples and languages with whom we had to do.

I only remember one disastrous mistake, and the responsibility for that lay with the Air Force. We had on hand two lots of propaganda. No. 1 was for the Tartars of the north, who were showing signs of throwing in their lot with the Turk. No. 2 was for the Shirazis of the south. No. 1 reminded the Tartars that they were Persians before all and besought them to hold fast to their old allegiance, not to lose their freedom to the Turk, their ancient enemy. No. 2 reminded the Shirazi that the Tartar was not a true Persian; that, in fact, he was little better than an accursed Turk. It exhorted the men of the south to hold together and prepare to resist the union of Turk and Tartar. No. 1 showed that if the Tartars went over to the Turk all Persia would be left in the hands of the Shia sect. No. 2 emphasized the disappearance of the Shia faith which would follow a Turk-Tartar coalition (where have I heard that word before?) sweeping into Persia from the north.

All Persian writing looked alike to our Airmen.

You see what happened?

We managed to stop the Shirazi getting the Tartar propaganda, but Azerbaijan was white with the propaganda meant for Shiraz. It didn't really matter much, as the Tartar had already committed himself to the Turk and the Bolshevik, but it caused some consternation at the moment.

Our Propagandist, once widely known in Baghdad as "Pongo of the 'I' Branch" now serves in one of the few really human ministries in Whitehall, while his leisure hours are given to a fortunate and very individual troop of boy scouts in a crowded part of London. Deserters, prisoners of war, captured documents, the censorship, the

Desert Blockade that starved the Turkish Forces, the records of the innumerable Arab chiefs and Persian notables and of their shifting sympathies, the making and distribution of maps of the all but unexplored lands behind the Turkish lines, all fell within the province of "I."

Spies, or rather "agents,"—it was considered very impolite to refer to the knaves who did our dirty work as "spies." The enemy used spies, we employed "agents." Agents, then, were dealt with by a separate branch of "I" which lurked in a house in the city, with a bolt-hole on to the Tigris. The information gained by spies is of trivial importance compared to that obtained from deserters, prisoners, aeroplanes, etc. The Eastern spy is always a liar. They were, however, to a certain extent useful for keeping in touch with affairs at the enemy H.Q. in Mosul, and we had a well-organized department which procured them and sent them out. It is obvious that an agent is greatly tempted to work for both sides—he doubles his profits and halves his risks.

In the Aden Hinterland (that murkiest of side-shows) our agents hardly troubled to pretend that they were not working for the Turk as well as for us, and I always suspected that most of our Mesopotamian ruffians drew pay simultaneously from the rival G.H.Q.'s at Mosul and Baghdad.

The obvious corollary of an organization of agents is a counter-organization to prevent the enemy spies getting any useful information.

Counter-espionage is a very difficult affair at the best of times. In an Eastern country it is a heart-breaking business. Every native servant to an officer, every employee at a Church Army or Y.M.C.A. hut, at a club or an hotel, and all the gay ladies of Baghdad had opportunities of acquiring information worth much money if brought to the right market.

Amateur spy-hunters abounded. They always do. I believe even in England spy-hunting was a not unpopular sport. They were generally wrong, but we always carefully investigated their stories. The clearest case on record of signalling to the enemy was discovered by one of my subalterns while we were assisting to hold an infernal place called Sheikh Othman.

We went swiftly to Brigade H.Q. and from the roof of their billet were able to point out the flag-wagger, still at it, to the G.O.C. A guard was produced and the hunt started.

Sweating like bulls (the climate of Sheikh Othman is warm even for Arabia), they surrounded the offending house and found on the roof the C.R.A.'s red blanket airing itself between two poles.

One hot-weather morning at Baghdad, as we sat and dripped slowly each on his own pile of files, we became aware of a loud and confused noise without. I went out and found the Abbot of the

French Monastery in the city. His hands waved wildly up and down till they all but vanished into a haze. His beard and cassock flapped as if in a hurricane while he poured a torrent of agitated French on to two wooden-faced Intelligence police. I drew him into an empty room and soothed him. The English and the Scotch are the only nations who come to the point at once. My Prelate was no exception to the general rule, and I sat down sadly to an eloquent and patriotic disquisition on the aims and feelings of France, her passionate affection for the English and the fervour with which the Abbot himself shared the attitude of his countrymen. It wasted nearly half an hour, and half-hours were very precious, but I knew from sad experience that any attempt to stop this preliminary spate of eloquence would merely aggravate the offence.

When we "got to the 'osses" the story was interesting. The Monastery has been for many years a power in Baghdad. The monks have for generations educated the children of the notables, whether Moslem, Christian or Jew. So established were they as an institution that even the Boche did not dare to interfere with them, and under Turk and German, as later under the Union Jack and now under Faizul the First, the great Monastery goes quietly on in its accustomed path. The buildings are large and solid enough to stand a siege. They are situated in the heart of the city, surrounded by a network of native bazaars. To them, the Abbot said, had come two British officers who held the Catholic faith. They had asked for a private room in which they might sit and talk by themselves. They had further indicated that if they were pressed to partake of Irish whisky it would not be unacceptable. The monks (I have omitted another small pæan of eloquence on the Entente which, to my horror, burst out at this point) were delighted to entertain any soldier of England and glad to find Catholics amidst the waste of heretics. But the next week the incident had repeated itself and now on each successive Friday at 11 a.m. the two officers appeared, took their room and their whisky, conferred for an hour and departed. A horrid doubt assailed the men of God; could they be harbouring spies, enemies of France? And whisky so expensive withal! Well, it sounded promising. We arranged that next time it happened, news should be brought us at once. Next Friday the Abbot appeared again, if possible more agitated than before—the birds were in the covert. Two A.P.M.'s were procured. A life preserver was pressed into my hand. We shovelled the monk into a car and hurried to the Monastery. The Monastery is two stories high and built round a hollow square. All round the first floor runs a projecting balcony reached by wooden staircases from the cobbled square. The Abbot led us into the courtyard, pointed out a door on the first floor, murmured that he was a man of peace, picked up his skirts and fled down a passage.

Pointing out to the A.P.M.'s that the apprehension of criminals was a police business, I suggested that they should lead the rush. The A.P.M.'s, however, held that they were merely present to support the General Staff. Finding myself in a minority I led the way quietly upstairs.

We gathered for a moment outside the door and then, throwing it open, burst into the room. There we found two gentle and much-surprised soldiers, a subaltern of Commissariat and a corporal from a Heavy Battery. Feeling a number-one-sized ass, I demanded and obtained particulars. (Particulars which I afterwards checked and found correct.) The Abbot's "spies" were old school friends, one commissioned, one a non-commissioned officer. Owing to the etiquette of the Service they could not meet freely in public. As they were both Roman Catholics they had devised this harmless and inexpensive method of entertaining each other at the expense of their Church. Unfortunately, Lieut. Jones had a sense of humour.

Thenceforward, whatever function I attended at Baghdad I became aware of Lieutenant Jones eyeing me with a slow quiet smile. He became an obsession. A real ghost would have been less objectionable. I consulted the A.P.M.'s—they suffered from it, too.

* * * *

A minor difficulty which beset the higher command in the last phases of the war was the reluctance of post-war officers to sanction or inflict severe punishment for an offence of a strictly military nature. But the safety of the army does require this duty from those officers to whom it falls to try such offences.

Similarly, it is essential that a convicted spy should suffer the extreme penalty. The rewards of the successful spy are large. Many men will risk imprisonment to gain them, far fewer men will risk death. Consequently, if, in the rare cases where spying can be proved, the criminal is shot, spying as a trade goes out of favour and casualties to our own men are saved. For in the end the aim of the spy and the result of his work are to increase the casualties of the army spied on.

I have in mind two glaring cases of this sort. A native of Persia was found attempting to pass through our lines with a code message to the enemy concealed in his hookah stem. The evidence was clear; it was assumed that, if convicted, no court of officers could do other than sentence him to be shot. In order to convict him it was necessary to prove that the letter was one to the enemy and consequently to disclose the fact that we could read this particular code. The prisoner was convicted, but was only sentenced to a comparatively short term of imprisonment. There can be little doubt that this leniency encouraged spying, and that he managed

to convey to his employers the fact that the code used was a "compromised" one.

In the second case one of our "superior agents" was convicted of sending information to the enemy. These men did not work as agents themselves; they were used to procure men willing to act as spies as and when we required them.

The man in question let us call him by the fictitious name of Sheikh Kabir, was trusted by the "I" branch and was much employed in this work. In the spring of '18, Sheikh Kabir's father arrived in Baghdad from Mosul. He said that the Turks suspected his son's activities on our behalf, that they had brutally ill-used him in consequence and that he had barely escaped to us with his life. We were taken in and he was given a grant of money for subsistence. He then, unknown to us, returned to Mosul where he was a Turkish agent. Two or three months later Sheikh Kabir called up a spy, whom he had used on our behalf before, and sent him, with a letter for the enemy, to his (Sheikh Kabir's) father in Mosul. The spy, an honest man, as spies go, thought he was still acting for us and on his way back gave the answer and the payment for Sheikh Kabir's treachery to a British Intelligence officer whom he met en route. The fat was in the fire, and on enquiry Sheikh Kabir's dealings with the enemy were proved without doubt, but to the encouragement of all traitors he escaped the fate he so richly deserved. No nation has ever produced finer soldiers than our "New Army officers" but their clemency in these matters showed a curious and isolated flaw in their sense of duty.

The incidents described above deal mainly with failures, but I do not think the Intelligence of our armies in the field requires defence. I have on one occasion sat in a room while our interpreter read off the telephonic communications of the G.O.C. of the Turkish Corps on our front. They had left a wire behind which was discovered to be still in connection with their telephone system; an instrument was hitched on and for the better part of three eventful days we wrote down, as issued, a large part of Ali Akbar Bey's operation orders.

The last message we got gave us some amusement. The Bey sent for his signal officer. "Did you" he asked "cut all the telephone wires behind you as we retired?" "I cut them, sir," he said, "with my own hands." He was only anticipating the truth; half an hour afterwards there was a slight click and that source of Intelligence ceased to function. I hope the signal officer escaped detection, we were very grateful to him. And now I am faced with the task of finding a suitable peroration wherewith to end these discursive notes. Perhaps, it would be better simply to stop.

MAP-MAKING FROM AEROPLANE PHOTOGRAPHS

A Lecture delivered at the S.M.E., Chatham, on 8th March, 1923, *by* MAJOR M. N. MACLEOD, D.S.O., M.C., R.E., *Chief Instructor, Artillery School, Larkhill.*

THE idea of using photographs taken from the air for making maps is no new one. Long before the war continental investigators had devoted a good deal of study and experiment to the question and had elaborated apparatus and procedure for this purpose.

These experiments do not seem to have attracted much attention in England, and though I have been told that we did get as far as purchasing an aerial camera, designed by an Austrian named Scheimpflug* and intended for use in a balloon, this camera does not appear to have been used and cannot now be found.

During the war, however, the question of mapping from air photos received a fresh and powerful impetus, and the lessons and experiences derived from it are summed up in the Introduction to the Report on Surveys on the Western Front, which states that "Air photography is of fundamental importance to survey in war," and goes on to add: "A clear policy should be laid down for co-operation between airmen and surveyors, and research should be carried on in the development of methods and apparatus, for use both in the air and on the ground."

The particular attribute of aerial photography, which is of "fundamental importance in war," is that it is the only method of survey which can be applied to regions inaccessible and invisible to the surveyor on the ground.

At present, as will be seen, we cannot apply it to regions which are completely inaccessible, but it is to be hoped that further research and development will enable us to do so.

Such a development will have an important bearing on tactics, because the tactics and training of troops depend in great measure on the nature of the maps in their possession, and it will entail a complete revision of our ideas on the subject of tactical maps.

Hitherto the nature of the map issued to troops has depended, not on what sort of map would be of greatest value, but upon what sort of map happened to exist at the outbreak of war.

If we can devise a satisfactory method of mapping inaccessible areas we will be in a position to give to the troops the type of map which will really be of most use to them.

* Described in *R.E. Journal*, September, 1910, page 219.

Before the war our tactical maps were small-scale maps because, in most probable theatres of war, nothing but small-scale maps were to be expected; during the war it was soon found that the small-scale maps first issued were inadequate; and at the end of it, we had not only produced accurate large-scale maps for general use, but had elaborated methods of fighting which depended absolutely upon them.

We have now to forecast the conditions under which future wars will be fought and to come to a decision as to whether we shall be able to use these methods, counting on the possession of a suitable map, or whether we must go back to our pre-war ideas.

I think that most officers who have used a large-scale map can think of reasons which make the provision of large-scale maps desirable, but there are one or two reasons which, in my opinion, make the provision of such maps, not only desirable, but almost essential, at any rate in large wars.

Of these reasons I will give only one. It is this :—

When great masses of artillery are deployed on the battlefield, the old method of fire direction by ranging and registration breaks down. A large number of batteries cannot range on a limited area at the same time because of the impossibility of distinguishing the shells of one battery from those of its neighbours. Ranging, if done at all, must be done by batteries in succession, causing great delay, and, as we found by bitter experience, generally resulting in premature disclosure of the tactical plan.

Ranging, however, can only be dispensed with when it is possible to locate the target as well as the gun with an accuracy commensurate with the performance of the gun, that is to say, within somewhere about 20 yds. of the truth.

The gun can be visited by a surveyor and can be fixed by other methods, but the target is often invisible from our own lines and can then only be fixed from the air with the aid of a map, sufficiently accurate, and of sufficiently large scale. The smallest scale which will give the accuracy really necessary is about three inches to a mile. It is important also to remember that, in hilly country, accuracy of heights and contours is almost as important as accuracy of position.

The artillery are naturally anxious to know if they can count on having such a map. In almost all tactical schemes they are called upon to arrange for barrages and counter-battery action, which can often only be done if they are given a suitable map; in their own training, also, it is essential that they should know if they will be able to use the procedure and methods evolved during the war.

It is the duty of the Corps to produce and supply maps, and it is to us that they look for an answer to this question. Unfortunately, we must admit that we are not yet in a position to give it.

The fact that we were able to produce large-scale maps in France

with the aid of aerial photographs does not imply that we can do so elsewhere by using the same methods.

In France there was available, in the *Cadastre*, and in the French systems of triangulation and levelling, a wealth of topographical data which we could and did make use of.

Without any help from aerial photography we should have been able to produce an accurate though not very detailed map.

The aerial photograph in France was used mainly for putting in trench systems and filling in detail on a framework already complete as regards the main features.

The survey of a complicated trench system would be a slow job for a ground surveyor under any circumstances. A vertical air photo which shows it in full detail in plan is obviously an excellent way of mapping it, provided the framework is there first and enough of it appears on the photo.

When there is no such framework it is a very different and much more difficult proposition, as was found in Palestine, Salonika and Mesopotamia. Even in France the air-photo had more limitations than most people realized and some of our first attempts at mapping from them were sad failures !

To understand the problem of mapping inaccessible regions we must consider these limitations.

A photo taken from the air in such a manner that the plate is parallel to the ground at the moment of exposure will give a print analogous to a map whose scale is the focal length of the camera, divided by its height above ground. We must obviously know what this scale is before we can make use of the photo. If, as in France, we have the main outlines of the map complete and only require the photo for filling in such things as trench systems, some of the map features are sure to be visible on the photograph and we can deduce its scale from them. When we have not got such a framework to start from, it is not so easy, because our instruments for measuring height in an aeroplane are not accurate enough for the standard we require in the map, and measure, not the height above the ground below the aeroplane, but the height above the starting-point of the flight.

However, when the ground is hilly, a flat plate cannot be placed parallel to the ground. It may, perhaps, be placed horizontal but most of the ground will not be horizontal; it may slope at all sorts of angles, all of which are unknown.

Consequently the image of the ground on the photograph will be distorted in all sorts of ways. The "detail" will all appear on the photograph, but it will not be in its correct place, and we cannot make a map by simply enlarging and copying it.

Now it may be thought that, except in mountainous country, the distortion should not be very great and that in ordinary country

it might be neglected. This depends on the standard of accuracy required in the map. In France the generally-accepted standard was that the absolute position of a point shown on the 1/20,000 map should be within 20 yds. of the truth. When we remember that the artillery want to use the map for fixing the positions of their targets, and that the " 100 per cent. breadth zone " of most guns is less than 20 yds., it is evident that this standard is not too high. Yet a point only 300 ft. above the general level may be easily displaced by the equivalent of 20 yds. on an aerial photo. If we work to this standard it means that in country where differences of height exceed 300 ft. we must take this distortion into consideration.

Again, we must also remember that in hilly country an essential, and often the most important point of the map, is the contouring, and the aerial photograph does not show contours at all. As we have to show ground forms we must find some way of deducing the heights of points from their " displacements " (*i.e.*, the distortion) on the photograph.

In practice, when the camera is carried in an aeroplane, it is not even possible to ensure that the plate is always horizontal. An aeroplane vibrates, rolls and pitches. If the camera is rigidly attached to the machine it will partake of these movements ; if, on the other hand, it is suspended in gimbals, or attached by any sort of pendular suspension, acceleration or deceleration, banking, etc., will give rise to centrifugal forces which are unnoticed by the pilot, but which are quite sufficient to tilt the camera out of the vertical to quite appreciable amounts. Superimposed on the distortion due to irregularities of the ground there may be, therefore, a distortion due to the fact that each plate exposed is inclined at a different and unknown angle to the horizontal.

These distortions will naturally affect the size of the various parts of the image and will, unless we can allow for them, prevent us making a really accurate determination of its scale.

Nor do the difficulties end here, because the aeroplane cannot yet hover in the air ; on the contrary, it must keep moving very fast. Unless the exposure is very short indeed, the camera will move appreciably while the plate is being exposed, and a point on the ground will record itself, not as a point, but as a line.

At present our only way of giving very short exposures is by means of a focal plane shutter. A blind in which there is a narrow slit is drawn across the face of the plate. Usually the slit takes 1/50th second to travel across the plate. If it is 1/10th the width of the plate, each part of the plate will be exposed for 1/500th second. A point can thus be induced to record itself virtually as a point, but this does not get over the difficulty, because points on the first part exposed, are photographed from a slightly different view-point to those on the last part.

Distortion due to this cause is small and for certain purposes can be neglected, but if, as is probable, we have to use aerial photographs for really precise work, we may have to take it into consideration.

Many attempts have been made to devise a satisfactory "between lens" shutter which will give very short exposures, but so far without success.

Lastly, there remains a possible source of distortion in the optical properties of the lens itself. It is not difficult to make a lens in which, when a wide aperture is necessary, there is no distortion in the *centre* of the field, but, as will be seen, in photographs required for mapping, the ability to photograph a large area at a single exposure is an important advantage. This factor limits the size of the field which can be included on a single plate.

Distortion of the image due to the shutter or lens will probably be eliminated by improvements in the construction and design of the camera. Distortion due to tilt and to irregularities of the ground must, however, always be reckoned with and allowed for by the way in which the photo is used after it is taken.

The distortion due to tilt may be dealt with in two ways. If the amount and direction of the tilt can be determined, the negative can be printed in a suitable enlarging lantern in such a manner that the resulting print is, so to speak, redistorted to what it would have been, had the camera been held vertical when the original negative was taken. This process is termed "rectification."

This would seem to be the simplest and most direct way of dealing with tilt, but, of course, it depends on the ability to discover beforehand what the tilt is. Were we able to devise apparatus for measuring and recording in the aeroplane the height at which each photo was taken, and the amount and direction of any deviation of the optical axis from the vertical, there would be no difficulty in obtaining from the aerial negative prints of any desired scale from which tilt distortion had been eliminated.

Unfortunately, we have not yet succeeded in doing this, and it is doubtful if we shall ever do so. Experiments are at present being carried out with gyroscopic devices for recording the direction of the vertical. If these prove successful we shall get over the tilt difficulty, but this will not touch the question of scale determination, which is, as explained, a function of the height above ground.

Up to the present we have been unable to measure accurately either tilt or height in the aeroplane, and have only been able to eliminate tilt distortion and determine scale when there appear on the photograph at least three, and in certain cases, four points, whose map positions have been fixed by some preliminary independent survey process.

The advantages of a wide field of view in a mapping camera are here apparent. The greater the field covered by each plate, the

smaller will be the number of independently fixed points required in any given area.

It is here worth noting that the points normally fixed as " control points " for survey on the ground are not necessarily suitable for aerial photography. A mountain peak, for example, or a factory chimney, though an excellent point for a ground surveyor, may be quite impossible to identify correctly, and therefore quite useless for an aerial photograph. The points of an ordinary topographical triangulation, such as may be available when small-scale maps exist, will probably be altogether inadequate as " control " points for an aerial survey.

The mapping of inaccessible country by aerial photography therefore resolves itself into two problems :—

(*a*) The use of the aerial photograph to fix positions and heights of sufficient control points.

(*b*) The use of these control points to eliminate tilt and other distortion from subsequent photographs.

For neither of these problems can we yet claim to have found completely satisfactory solutions.

It is hoped to deal with the first by methods analogous to those used for photographic survey from the ground.

In survey by photography from the ground the photograph is not used to determine the position of a point directly, but only in its direction. If the direction of the optical axis of the camera is known, the horizontal and vertical angles to all other points on the plate can be deduced from linear measurements made on it. A point can then be fixed both as to position and height by photographs from two view-points whose positions have been surveyed. Photographs for such surveys are usually taken from tops of mountains with the optical axis horizontal.

In using this method for aerial work it is necessary to provide some means of fixing the position in space of the aeroplane, and of determining the direction of the optical axis of the camera. It is hoped to do this by constructing a " multiple " camera, which is, in principle, five cameras rigidly fixed together so that the plates form five contiguous sides of a cube, one plate being horizontal and the others vertical.

The intention is to expose these plates simultaneously, so that one vertical plate takes a photograph of the inaccessible area and at least one of the other plates a previously surveyed area.

From the horizontal plate, which may be expected to show " control " points, it is hoped to determine the position and height of the camera, the amount and direction of tilt, and the orientation of the whole apparatus. This orientation can then be checked from one or more vertical plates, and from the data thus obtained the

horizontal and vertical angles to points in the "forward" area shown on the other vertical plates can be deduced.

Such a camera has just been completed by the R.A.F. and is undergoing trials. Its successful use evidently depends on our ability to deduce the amount and direction of tilt from the horizontal plate on which the control points appear.

Now the elimination of tilt distortion from a photo does not necessarily involve an actual determination of the tilt.

If four control points appear on the photograph, any other point on it can be plotted in its correct map position by a fairly simple construction, and the detail might be transferred from photo to map point by point in this way.

This method, which is described in the *Manual of Map Reading and Field Sketching*, 1921, is all that is required when it is only necessary to use the photo for locating a few new features on an otherwise complete map, *e.g.*, for getting the position of a hostile battery.

When much detail has to be thus transferred, it is possible, by means of a graphic construction, to draw on the photo a grid which would be the distorted image of some particular grid on the ground or map, and to draw in the detail from its relation to the corresponding lines, in the same way that a map is often enlarged or reduced.

Again, the photo may be projected optically on to an adjustable screen or copying board on which the control points have been plotted and the board moved about until the control points on the photo project into their correct positions.

These optical methods are, to some extent, still in the experimental stage, but it seems probable that they will eventually prove to be the best way of dealing with tilt distortion, when a complete map has to be made.

Only two methods of thus projecting the image need be described, the *camera lucida* and the projecting lantern.

Before describing them, however, it is advisable to consider the theory of rectification in order to understand the geometrical principles on which it must be based.

In the theory it is supposed that the photograph is a true perspective of the ground, that is to say, that straight lines joining points on the ground to their images on the photo all pass through a single point at the centre of the lens. If lens and shutter distortion are small, this is sufficiently near the truth.

Fig. 1 shows the geometry of the conception.

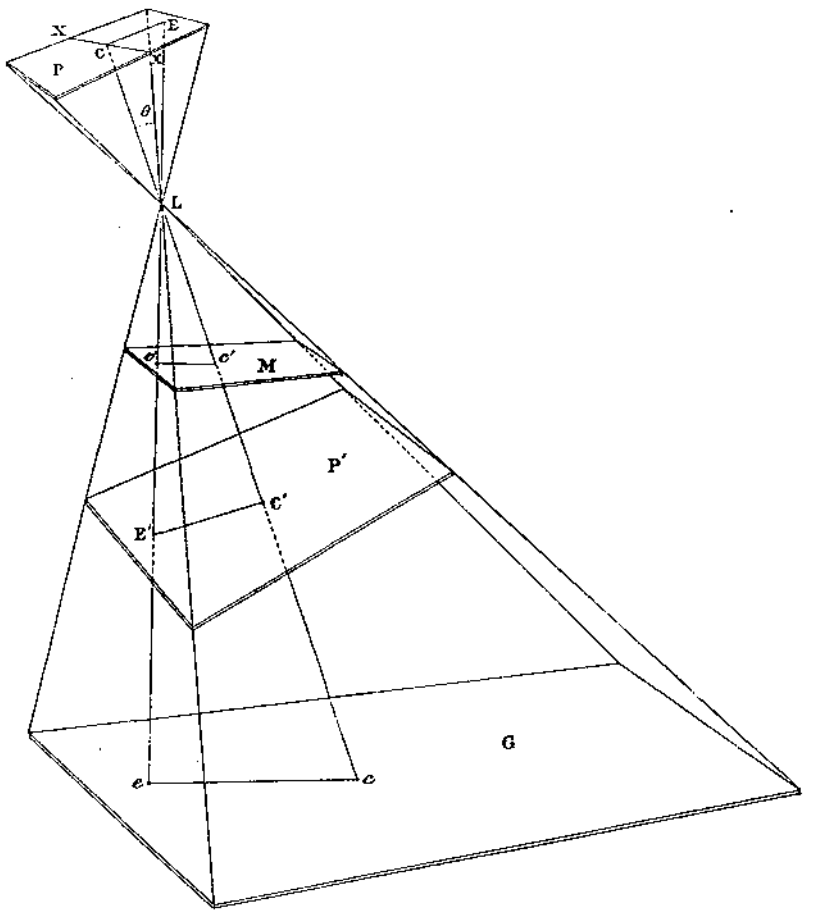
In this, P represents the plate and L the centre of lens. LC, the optical axis of the lens, is assumed to be perpendicular to the plate and to meet it at its centre C.

The distance LC is the focal length of the lens and can be determined before the camera is taken into the air.

cLE is a vertical line, G the ground, and M a horizontal plane, such that Le'/Lc is the scale, or R.F., of the map.

The map is regarded as a perspective from L on the plane M. It can be seen from the figure that the tilt of the photo, which is the deviation of the optical axis from the vertical, is determined by the line CE. CE is called the " principal line " and gives the direction

Fig 1.



of the tilt, while CE/LC is the tangent of the angle of tilt, lettered θ, whence its magnitude can be found.

The principal line represents the intersection of a vertical plane containing the optical axis with the plane of the photograph. A line perpendicular to it in the plane of the plate will therefore be horizontal. Such a line, lettered XCX, through the centre of the plate is called the " axis of tilt," and is, of course, not necessarily parallel to any of the sides of it.

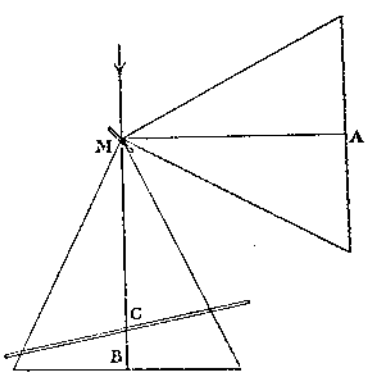
Optical methods of projecting an image of the photo on to a screen aim at reproducing the geometry of this figure. In the *camera lucida* the projection is done by means of a small sloping mirror, in which is sometimes drilled a small hole

If the photo is pinned up at A (*Fig.* 2) the mirror placed at M, and the operator looks into the mirror along the arrow, a virtual image of A is seen in the direction of B.

This image can be, as it were, intercepted by a copying board placed at C. The copying board can be seen through the hole at the same time as the image, which can be drawn in by running over the lines with a pencil.

To obtain an image of the photo from which tilt distortion is eliminated it is necessary to plot the control points on the board, and then adjust the board so that these points coincide with the corresponding points, suitably marked, on the image of the photo.

Fig. 2.



If the mirror M is placed in the same relation to A as the lens of the aerial camera was to the plate, the geometry of the figure is clearly analogous to that of *Fig.* 1.

When the coincidence of points has been obtained, the copying board C in *Fig.* 2 will be in the same relative position to M as the plane M in *Fig.* 1 is to L.

This would enable the tilt to be determined, or conversely, if the tilt were known, the copying board could be set in the correct position.

The *camera lucida* was used a good deal during the war, particularly by the French. Though cheap, and simple in principle, it suffers from some important practical defects, rendering it troublesome and tiring to use.

In the enlarging or projecting lantern the image is thrown on to the screen by means of a lens and a beam of light. The control points may be plotted on the screen and both camera and screen adjusted until the points of the photographic image coincide with

the plotted points. The process is generally similar to the adjustment of the *camera lucida*, but an additional complication is introduced by the necessity of getting a real image in sharp focus on the screen.

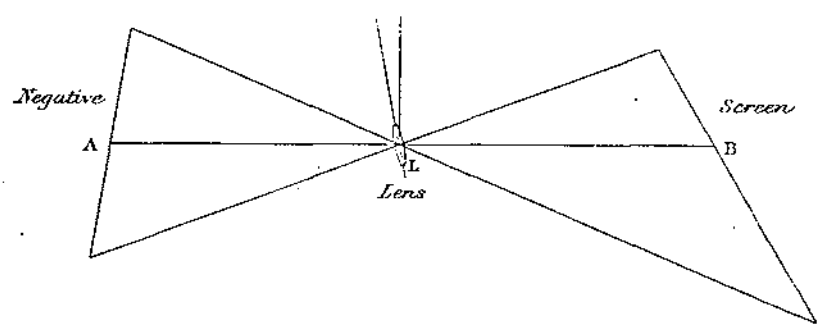
To do this it is not generally possible to place the lens in the same position relative to the plate, as in the aerial camera.

The geometrical conditions of *Fig.* 1 cannot, therefore, be reproduced exactly, and unless this is done the plane on which a rectified image is obtained will not be in the same position relative to the lens as the plane M in *Fig.* 1. It is not, therefore, a very simple matter to deduce the tilt of the aerial camera from the setting of a projecting lantern.

Fig. 3 shows diagrammatically the adjustments usually necessary to obtain a rectified image.

Practically the adjustment of either the *camera lucida*, or the enlarging lantern, by trial in this way is not easy. Commandant Roussilhe, of the French Army, who has made a study of photographic

Fig. 3.



rectification, states that he can adjust his lantern in half an hour, but our experience is that it often takes much longer.

If, however, the tilt, etc., can be found independently, the positions in which to set the various parts of the lantern can be computed from fairly simple formulæ.

The tilt can be determined by a graphic construction drawn out on the map or photo, or by a computation, depending on linear measurements of the relative positions of the control points on map and photo.

Both methods are, however, rather laborious, particularly the latter, and it is doubtful if either would be any quicker than the adjustment of a lantern by trial.

To try and simplify and quicken up the determination of tilt, a special apparatus called a "tilt-finder" was constructed a short time ago by the Ordnance Survey, and an improved model is now being made by the R.A.F. at Farnborough.

This apparatus is designed to enable the points E and *e'* in *Fig.* 1 to be found, and to enable the distance L*e'* to be measured.

To understand its working it is necessary to imagine a direct enlargement of the photo placed as at P' in *Fig.* 1. That is to say, parallel to the plate P and at a distance from L equal to the focal length LC multiplied by the scale of enlargement. If we replace the lens L by an eyehole O (*Fig.* 4), mark three control points A, B, D on the photo, and plot the three corresponding points of the map on a transparent screen S, we can place the screen S with the points on it in perspective with ABC by looking at it through the eyehole O and moving it about until we get each point on it aligned exactly on the corresponding points on the photo. The screen S will then

Fig. 4.

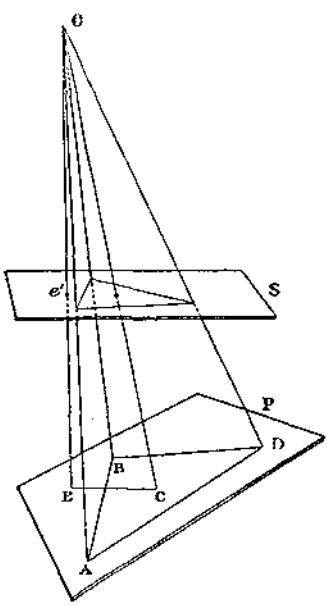
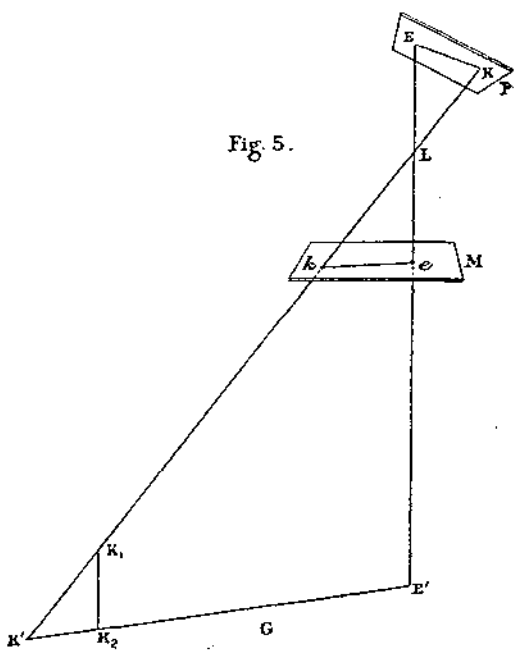


Fig. 5.



be in the same relation to O as the plane M in *Fig.* 1 is to L; we can then drop a perpendicular on to S and mark its foot *e'*. The point E on the photo will be in prolongation of O*e'* and can be marked also.

CE gives the direction of tilt EC÷OC, the tangent of the angle of tilt, and O*e'* the height above the map-plane.

The original or Mark I model of the tilt-finder is designed on the assumption that the control points are of the same height. In the Mark II model, now being constructed, the screen is replaced by a frame on which allowance for the height of a point can be made.

The mechanical arrangements are such that the adjustment of the screen can be made on a definite system, and only takes a few minutes. Such experience as is available from the use of the

existing model seems to indicate that the apparatus is likely to be sufficiently accurate for all purposes that we can at present foresee.

If these hopes prove to be justified and we find that we can deduce tilt easily and quickly from control points of different heights, we are in a position to tackle the problem of determining position and height of points in hilly country.

In *Fig.* 5, if P is a photograph, M a print of it in which tilt distortion is eliminated, K_1 a point on the ground, and ELE′ a vertical line through the lens. It can be seen that *ek* is the undistorted image of EK and gives the length and direction of E′K to the map scale $\frac{Le}{LE'}$.

When we have found *e*, we can plot the line *ek* in its correct position on the map and know that it passes through the map position of K_1, which is the point corresponding to K_2.

If we take another photo of K_1 from some other view-point, we obtain another line passing through this position, which is determined by the intersection of the two lines.

Again, since we know the relative positions of E, K and L, we can determine the angle ELK, and consequently the angle $K_1K'K_2$.

The distance corresponding to $K'K_2$ can be found from the plotted line *ek*, and the height K_1K_2 can be computed.

In theory, therefore, if we can measure tilt and rectify each photo, we can determine position and height of any point from two photos.

We have not actually tested these principles in practice. No doubt it would be a laborious job to plot an area point by point in this way.

It is not very likely, however, that this will be necessary.

We might be tempted to condemn the plane table as a method of survey on similar grounds, did we not know that the plane tabler fixes instrumentally only sufficient points to control a drawing which he does by eye alone.

We will probably be able to proceed in a similar way with aerial photographs, because, if the photos are taken in a suitable way, we can view them in a stereoscope and see the relief of the ground quite distinctly.

The " stereoscopic " principle may be applied also to instrumental methods of fixing points. It has been exploited for this purpose in Germany, where the firm of Heyde in Dresden have made a machine, analogous to the " Stereoplotter " invented by the late Major F. V. Thompson, R.E., to the specification of Professor Hugershoff of Dresden University, for mapping from stereoscopic aerial photographs. The firm of Zeiss are believed to be working out details of a similar machine.

In this machine " Vertical " photos are not used. The aeroplane camera is hand-held and pointed out to the side of the aeroplane.

By means of a bubble on the camera the optical axis is held at an angle of approximately 30° below the horizontal. The aeroplane flies at a height of about 1,000 metres and photos are taken as nearly as possible parallel, at intervals of about 1 km. It is assumed that the foreground of these photos can be made to include three or more control points on each (the inaccessible area appearing in the background only), and Professor Hugershoff has worked out a method by which the position in space of the camera and the direction of the optical axis can be computed from the positions of these points on the negative.

This computation is rather a formidable affair, but, once it has been done, the machine can be set in adjustment, diapositives of the negatives placed in the stereoscope, and the map drawn in quite mechanically, both as regards detail and contours.

The machine is very large and heavy (I would estimate its weight as at least 5 tons) but is not as complicated as might be imagined. It is, however, very costly. The price asked by the firm being about £10,000.

The makers claim that it is really an instrument of precision and to vindicate their claims have offered to produce from photos taken by us in England, of an unspecified area, a map which we can compare with our Ordnance Maps of the same region.

This offer has been accepted by us; the aerial camera is now in England and a number of photographs have been taken with it for dispatch to Germany.

Until this trial is complete it would be premature to venture an opinion as to which of the methods described will eventually prove of most practical value.

Sufficient has been said, however, to show that in theory, at least, aeroplane photography can supply all the data required for preparing maps of country up to, let us say, 20 miles behind an enemy's front line.

There are in existence a few civil firms engaged in aerial photography with a view to mapping, but it is believed that the maps produced by them make no claims to great accuracy.

The photos are simply built up into "mosaics" without any attempt to eliminate distortion. The whole is then rephotographed and enlarged or reduced to some particular scale determined independently.

This is essentially the method of mapping developed in Palestine and Mesopotamia, and of which the principal exponents are now Capt. Hamshaw Thomas and Professor Melvill Jones of Cambridge University.

For this type of work, depending on the adjustment of a complete "mosaic" and not on that of single photos, it is important that the tilt of the aerial camera should be as small as possible. Professor

Melvill Jones has accordingly carried out a considerable investigation into the possibilities of level flying, and has shown that under peace conditions it is possible to train pilots to fly so that the camera will remain within a degree of the vertical all the time.

Whether it will be possible to do this under war conditions is another matter. In any case, however, whatever may be the success of this method for civil work, and it must be admitted that for many purposes a map prepared in this way is all that is required, we must not be led into thinking that it will do for a tactical map.

For war we require not only completeness of detail, but a high standard of accuracy, and, above all, heights and contours.

To determine heights it is probable that a photo tilted to 20 or 30 degrees from the vertical will be more useful than one only half a degree from it. I think it is evident that, apart from other considerations, the question of contours alone must lead us on to try and perfect one or other of the methods and systems I have described, and I venture to think it is quite time that we set about giving them really practical and comprehensive trials, even though these may cost a little money.

The theory of the subject is fairly complete, but in view of the importance of the time-factor in war, we have not only to decide what method to use but also to devise and construct apparatus for it with which we can practise till we can work it quickly, so that we can produce the map in time in the first instance and keep it always well up-to-date afterwards.

The situation at the present time may be summed up thus :—

"We believe that in the aerial photograph we have a means of mapping country up to at least 20 miles behind the enemy's front line.

"We cannot, however, yet guarantee that the results will be up to standard of accuracy required, nor can we give any idea of how long it would take to produce them.

"We are not yet in a position to say what sort of equipment would be required or how many men would be necessary to work it."

We cannot, therefore, yet count on being able to produce an accurate large-scale map in sufficient time, but I think the prospects of being able to do so are quite good enough to justify our devoting both time and money to experimental work for this object.

Experimental work and research is carried out, as mentioned by Col. Winterbotham in the last number of the *R.E. Journal,* under the direction of a Committee composed mainly of R.E. and R.A.F. officers.

Lack of properly thought-out equipment has, so far, prevented this Committee from getting on very far with the practical side of the subject. It has, however, gone pretty fully into the theory and has initiated the construction of such equipment as it has been

possible to make with the funds available. When this equipment is ready for use one may hope for more rapid progress.

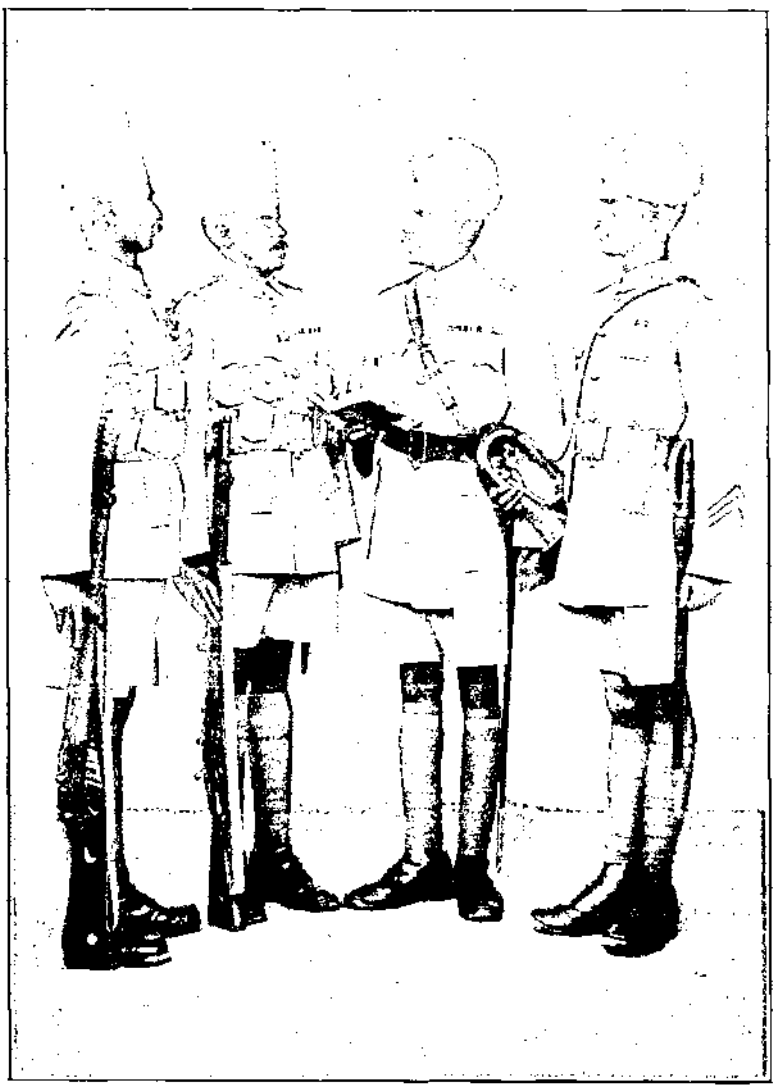
The Committee also endeavours to keep in touch with what is being done by civilian departments and firms both at home and abroad.

The subject is beginning to arouse interest in a good many quarters, and several considerable surveys by aerial photography are in contemplation, from which, if they eventuate and are organized on correct lines, it should be possible to obtain useful experience.

For civil work, of course, the economic factor is of prime importance. I have not touched on it because it is really outside the scope of this lecture, and because also there are, at present, very few data from which the cost of aerial surveys can be estimated.

We cannot yet say, for example, how many hours of flying will be necessary to photograph a given area, nor have we any idea at all how long it will take to deal with the photos after they have been taken. Some estimates have been made which seem to indicate that, unless the country is particularly difficult for survey on the ground, aerial photography is not as cheap as the topographer on foot. It has, however, this advantage, that the field work can be done very quickly, and in places where the "field season" is short, this may be important. Some time or other I have little doubt that aerial photography will compete economically with existing methods, even in accessible country, but he would be a bold man who would say that this time has arrived.

THE MADRAS SAPPERS AND MINERS.



Sapper. Havildar. Indian Officer. Bugler.

TYPES OF THE MADRAS S. & M.

THE MADRAS SAPPERS AND MINERS.

By THE COMMANDANT.

THE CYPHER OF QUEEN VICTORIA WITHIN THE GARTER.

THE SPHINX.

A GOLDEN DRAGON WEARING AN IMPERIAL CROWN.

"Sholinghur" "Carnatic" "Mysore" "Seringapatam" "Egypt" "Assaye" "Java" "Nagpore" "Maheidpoor" "Ava" "China" "Meeanee" "Hyderabad" "Pegu" "Persia" "Lucknow" "Central India" "Taku Forts" "Pekin, 1860" "Abyssinia" "Afghanistan, 1878–80" "Tel-el-Kebir" "Egypt, 1882" "Tofrek" "Suakin, 1885. "Burma, 1885-87" "Chitral" "Malakand" "Tirah" "Punjab Frontier" "China, 1900."

"WHAT *are* these Sappers and Miners? Are they soldiers?" Such was the innocent question of a certain Major of British Cavalry, arrived for the first time in India to join his regiment, on being told that it had shortly before been defeated in the local Polo finals by "The Sappers and Miners."

The following few notes have been compiled in the hope of doing something to dissipate this mental fog (which, it is feared, obscures the minds, even of R.E. officers, who have not served East of Suez) as to the exact relationship between the R.E. in India, the Sappers and Miners, and the Indian Pioneers. These notes may also serve to inform the young officer, proceeding to the East for the first time, as to what he will encounter, if posted to a Corps of Sappers and Miners.

The Indian Sappers and Miners consist of three* Corps, the Madras, Bengal, and Bombay relics of the days when these three Presidencies maintained each its own army. Since these three Corps are entirely independent, and differ materially in history, establishment, composition and personnel, I will deal mainly with that with which I am best acquainted, the senior Corps, "Queen Victoria's Own Madras Sappers and Miners."

Historical.—It was in the year 1639, that the English first settled down in Madras. The incessant wars of the succeeding century

* There is a fourth Corps, "The Burma Sappers and Miners," which was established in 1922. It consists of a single company of Burmese, which had previously (since first raised in 1887) formed part of the Madras Sappers and Miners.

led to the raising of the Madras army, while the atrocious roads of the period, and the numerous sieges, called for the services of a "Military Working Corps." Between 1760 and 1780, accordingly, companies of Pioneers were from time to time raised to meet special emergencies, by taking volunteers from the Infantry regiments, but disbanded again on the conclusion of the operations. In the latter year, however, this unsatisfactory system was abandoned, and two permanent companies of Pioneers made their appearance, under the following order :—

> "The Honourable the President and Select Committee are pleased to direct that two companies of Pioneers be raised as soon as possible by the Commissary of Stores, each Company consisting of 2 serjeants, 3 corporals, 5 havildars, 5 naiks and 100 black pioneers—the Pioneers to be clothed in blue jackets, and to be armed, 50 of each company with light pistols and 50 with pikes 6 ft. long. When these Pioneers are raised, they are to be employed with the army to clear and mend roads, etc."

Now, the Madras *Engineers* had come into being 10 years previously, but were merely a small* body of officers, without any rank and file to execute their orders. The pioneers were commanded, not by them, but by Infantry officers, seconded from the Madras army, who drew double pay of rank while so employed. The Pioneers only came under the orders of the Engineers when detailed to assist them in some specific work, such as a siege.

Although this was somewhat similar to the system existing in the home army till after the Crimea, the officers being "Royal Engineers," while the men were "The Royal Sappers and Miners," it could hardly have been expected to please the Madras Engineer officers, who had to work with the pioneers in war, without having been able to train them in time of peace. The following is an extract from the writings of one of them† :—

> "The only men generally available for the duties of that department (*i.e.*, The Engineers) have been the Pioneers, and as these men have never been employed in military works of this description, excepting when on actual service, it has been the hard fate of the Engineer officers to be obliged to teach them everything . . . when exposed to fire.
>
> "Poor indeed would the Sapper and Miner be considered in Europe whose skill, like that of our most experienced native pioneers, extended no further than the making of a fascine and a gabion, and having some knowledge of the nature of a

* Nine only, in 1770.

† *Sieges of the Madras Army*, pub. 1825. *By* Lieut. Lake, of the Hon'ble East India Company's Madras Engineers. Pp. 237 and 239.

battery. By these observations, I am far from wishing to depreciate that respectable body of men . . . every Engineer, who witnessed their exertions, must admit that they deserve great credit for having shown so much zeal . . . But the opinion of those officers . . . who maintain that the present Pioneers have always been a perfect model of a military working Corps . . . cannot be too highly reprobated."

The fact that the Pioneers were under the Commander-in-Chief, while the Engineers were under the Governor, constituted a further anomaly. The second Mahratta War (1817–19), a campaign peculiarly prolific of sieges, appears to have brought matters to a head. In 1821, the Chief Engineer (Major de Havilland, M.E.) delivered himself of a truly monumental memorandum on the subject, and a long and acrimonious correspondence ensued between him and the Quartermaster-General. The latter considered that the Pioneers were his special property, and was loth to part with so useful a Corps, which had by this time grown into two battalions, each of eight companies.

De Havilland, however, carried his point, and in 1823, the Court of Directors decided to abolish one battalion of the Pioneers, and convert the other into a Corps of Sappers and Miners, to be officered from the Madras Engineers. They assigned the following reasons :—

"It is obvious that the utmost advantage cannot be derived from the labour of Pioneers unless it be scientifically directed, and consequently it would be for the interest of the service that the whole of the Pioneers should be put under the command and direction of officers of Engineers regularly instructed in the art of sapping and mining, making pontoons and bridges, roads and surveys, fortifications and other buildings. We have for many years, with equal care and success, and at great expense, educated young men for these purposes at Addiscombe, and it seems high time that we should reap the benefits derivable and expected from that institution."

The change was eventually carried out in 1831, and the Madras Pioneers were transformed into "The Corps of Madras Sappers and Miners," with an establishment of eight companies.* Since

* Although the original "Madras Pioneers" were thus re-incarnated as Sappers and Miners, "Madras Pioneers" still exist, since certain regiments of the Madras Infantry were converted into Pioneers in 1885. These, however, have no connection with the Corps of Sappers and Miners.

The "Pioneer Battalion" is, I believe, peculiar to India, and practically amounts to an infantry battalion trained in road-making and plate-laying. It is officered from the Indian infantry (much as were the original Madras Pioneers of 1780), though the officers no longer draw "double pay of rank while so employed."

that date there have been few changes worth recording here. When, after the Mutiny of 1857–58, the H.E.I. Company's army was transferred to the Crown, the Royal Engineers absorbed those of the three Presidencies, and has since officered the Sappers and Miners. The number of companies in the Madras Sappers and Miners has naturally fluctuated a good deal during its existence (from a minimum of 6 field units in 1837 to a maximum of 23 in 1918), but the strength of the individual company has meanwhile steadily increased, till it now stands at 230 of all ranks, a very pleasant command for a R.E. captain.*

Organization.—As already stated, the three Corps of Sappers and Miners, although training on identical lines, differ from each other to a certain extent as regards establishment and internal economy.

Each is similarly composed of (*a*) headquarters and depôt companies, and (*b*) field units, which consist of field troops, field companies, army troops companies, divisional headquarters companies, railway companies, bridge train, printing sections, and photo-litho sections. The proportion of these various field units is not, however, by any means the same in each of the three Corps. For instance, the bridge train is peculiar to the Bengal Sappers, while the Bombay Corps has a monopoly of the railway companies, but has no field troops at all.

The present establishment by units of the Madras Sappers and Miners is as follows :—

2 Field troops.
5 Field companies.†
2 Army troop companies.
1 Divisional Headquarters company.
1 Printing section.
1 Photo-litho section.
3 Depôt companies.

—or a total of 35 British officers, 57 R.E. Warrant and N.C.O.s and 2,167 Indian ranks.

The field units of the three Corps are not all congregated at the headquarters of their Corps any more than those of the R.E. are all massed at Chatham ; each Corps has so many "out-stations" allotted to it, and its field troops and field companies occupy these in rotation on a two or three years' tour. The Madras Sappers and and Miners (for example) have one field troop in Sialkot, and two field companies in Waziristan, places at the other end of India, and some 1,500 miles from its headquarters at Bangalore.† The field

	B.Offrs.	B.N.C.O.	I.Offrs.	I.N.C.O	I.R.&F.
*Est. of S. & M. Co., 1831 ...	1	1	1	7	80
,, ,, 1923 ...	2	2	4	22	200
Est. of whole Corps, 1831 ...	10	10	8	57	640
,, ,, 1923 ...	35	57	47	307	1813

† There is also at present a 6th Field Company in Iraq, earmarked for eventual disbandment.

company Sapper may in peace time, therefore, expect to average two years at headquarters for each year at an out-station. The remaining field units are located at headquarters in time of peace for the sake of the training in the Corps workshops, but are allocated to war divisions, and join them on mobilization being ordered.

" Headquarters " consists of a Commandant (Lt.-Colonel, who is also the C.R.E. of the War Division to which the field companies of his Corps are allotted); two Majors, responsible respectively for workshop and fieldworks training; an Adjutant, who deals *inter alia* with recruiting; a Quartermaster; and some 20 R.E. Warrant and N.C.O. Instructors. Each Corps is entirely independent of the others, and carries out its own recruiting, training and administration, and its headquarters (located respectively at Bangalore, Rurki and Kirkee) is consequently a miniature S.M.E. At headquarters also are the three depôt companies, the first composed of Indian instructors, storekeepers and " employed men " generally, the second a " pool " of trained men ready to replace casualities in the field units, while the third consists of recruits in various stages of training.

Training.—The Madras Sappers differ very greatly from the British R.E. in the fact that they are recruited almost entirely from unskilled labour, recruits with " ready-made " trades being practically unobtainable. This is partly due to the fact that in India handicrafts (such as carpentry, etc.) are hereditary occupations, whose exponents are rarely of the military classes; partly also to the fact that in India any sort of an artisan can get far more pay in civil life than in the army. The Sappers and Miners are accordingly obliged to draw their men from the vast agricultural population, and make shift to teach them trades after enlistment. It is mainly for this work of trades instruction that the R.E. Warrant and N.C.O.'s are maintained. It will be realized that having to teach the Indian ploughboy to become *both* a soldier *and* a craftsman is rather a larger proposition than that confronting the Training Battalion at Chatham, which counts on catching its recruits already grounded in some trade.

Accordingly, the training of the Sappers and Miners recruit is a somewhat lengthy process. In the Madras Sappers it is reckoned to take two years to turn out a reasonably efficient sapper. In the first year he is classed as a recruit, and does six months' drill and musketry, followed by six months' fieldworks. At the beginning of his second year he is told off to a trade and begins his instruction therein in the Corps workshops. In the course of this second year he is expected to become, at least, a " 2nd-rate " tradesman,* and fit for posting to a field unit. His trades instruction, however, continues unabated throughout the whole of his service, his normal year working out roughly at one month's musketry, three months'

* There are 6 rates, " A," " B," " C " (artificers) and " 1," " 2," " 3 " (ordinary). The 3rd rate is the " labourer " rate.

fieldworks, and eight months in the workshops. This last is not, however, nearly as much as it looks on paper, since guards, furlough, manœuvres (to say nothing of the numerous religious and other holidays given the Indian soldier) make a pretty good hole in it, and the average man does not in practice get more than 80 to 100 days in the workshops in the year.

For the training in drill, musketry and fieldworks the Company Commander is always responsible, whether the unit is at headquarters or at an out-station. Also for trades instruction in the latter case, each detached unit being provided with some sort of workshops, and having its two R.E. N.C.O.'s as instructors. At headquarters, however, the whole of the trades instruction is concentrated in the hands of one of the two Majors, who is assisted by a staff of R.E. Warrant and N.C.O.'s representing all the trades concerned.

The relation between the R.E. Warrant and N.C.O. and the Indian officers of the field units is that the former are (in the Madras Sappers and Miners, anyhow) entirely instructors, and have no disciplinary powers. There has to be a good deal of "give and take" between the two, and it requires the exercise of some tact on the part of the British officer to prevent them from clashing at times.

Personnel.—The personnel of each Corps consists of British officers, R.E. Warrant and N.C.O.'s, Indian officers, Indian N.C.O.'s and and Indian sappers.* The British officers and R.E. Warrant and N.C.O.'s are naturally much the same in each case, but the Indian ranks are markedly different, since the three Corps recruit from widely diverse classes of men.

Those who have not served in India may, perhaps, not realize that Bangalore, the Headquarters of the Madras Sappers and Miners, is about the same distance from Rurki, that of the Bengal Corps, as Madrid is from Berlin, and that the men enlisted by the two are racially, linguistically, and in appearance, at least, as far apart as Spaniards are from Prussians.

The Madras Corps draws its recruits from the great Tamil race of South India, which follows several religions and is divided into a variety of castes. The "caste composition" of the Madras Sappers and Miners varies slightly from year to year, but averages out at :—

Mahomedans	10 per cent.
Hindus	40 ,,
Parayers	27 ,,
Christians	13 ,,
Other castes	10 ,,

* Although the Indian ranks of the S. & M. naturally belong to the Indian Army, the British ranks do not. The W. & N.C.O. of the Madras Sappers are officially known as the "Bangalore Detachment, 'H' Company, R.E.," and both they and the British officers come under the same regulations as men of British regiments serving in India.

No hard-and-fast composition by races or religions has, however, been imposed on the Corps, and the Commandant is at liberty to recruit them in any proportion he pleases.

The name "Parayer" may, perhaps, require explanation. This Tamil word

> "is the original from which the English "pariah," or outcast, is derived, and is an unfortunate name for a class which contains a large proportion of intelligent, strong, hardworking men, who make excellent soldiers and sappers. Outcasts, or rather 'out of caste,' they certainly are from the Brahmin's point of view; but as they form the majority of the population, and are its most useful members, there is no reason why any European (himself, by the way, just as much an 'out caste' to a Brahmin) should consider them as such. . . . They come from cultivating the soil in Arcot, from working on the railways, from gold mining at Kolar, or from the rice fields everywhere. They seem to have in them something of the spark of roving energy so seldom found in the native of India, but which is an invaluable military quality. . . . In fighting spirit the Parayers are second to none of the other classes enlisted by the Corps; and it is largely to them . . . that its excellent reputation for hard work and hard fighting is due."*

The Parayer and the Indian Christian are closely allied, since the ancestors of most of the Indian Christians were Parayer converts. The name "Indian Christian" is unfortunately one of evil savour to the European of Northern India. This is possibly due to the comparative recency of the conversions there, converts of the first generation being sometimes open to suspicion as to their motives. In South India, however, there have been Catholic Missions for several hundred years, and the Indian Christian has had time to settle down and develop into as useful and self-respecting a community as any other. However that may be, the Indian Christians provide the Madras Sappers with some of its best recruits—men who are as trustworthy, brave and hardworking as the rest of their comrades, while usually a good deal better educated and more intelligent.

This question of castes and religions brings us naturally to a matter in which the Madras Sappers and Miners differ fundamentally from the other two Corps, and, indeed, from the whole of the rest of the Indian Army. This is its practical non-recognition of caste. The caste or religion claimed by a recruit is, it is true, duly entered in the appointed place on his attestation paper, but there the matter

* *The Characteristics of the different Types of Men in the Q.V.O. Sappers and Miners.* By Captain E. K. Molesworth, R.E., 1907.

ends, as far as the Corps is concerned. Mahomedan, Hindu, Christian and Parayer stand shoulder to shoulder in the ranks, live together in the same barrack room, and eat the same food from the same cooking pot.

It must be understood that this happy state of affairs is not by any means typical of the Madrasi as a whole. The Madras Infantry regiments, which recruit much the same material as the Sappers and Miners, are just as caste-ridden as any others of the Indian Army. It is solely due to past generations of Sappers and Miners officers having always refused to allow the intrusion of caste into service matters, till in the end its non-recognition became a Corps tradition. As Gen. Sir Harry Prendergast, V.C., G.C.B., wrote over 40 years ago :—

> "If you ask a Sapper about his caste, he will probably say he is 'sapper caste,' that is, he is first a Sapper and next a Mahomedan or Hindu."*

Another writer, a former Adjutant of the Corps says :—

> "So little do caste prejudices affect the Q.V.O. S. & M., that very often one man does not know the caste of another in his own Company."†

This results in a broadmindedness and toleration, unusual in an Indian. In the Madras Sappers the Hindus, Christians and Mahomedans actually subscribe towards, and take part in, each others' religious jollifications, such as the Dasara, Christmas, and the Mohurram. This characteristic is well described by Gen. Prendergast in the person of Subadar Seeloway, who received the Order of Merit for gallantry in the Mutiny :—

> "Seeloway was a typical Sapper, very black, with a good-natured, ugly face. He was a good disciplinarian, and insisted on being treated with due respect. A Hindu by descent, he would enjoy a Hindu feast ; a Christian by conviction, he appreciated Christians' cheer, and, being liberal, he joined in Mahomedan festivities."‡

It is hardly necessary to expatiate on the convenience of such an economy, compared with the usual system of caste segregation as observed in the rest of the Indian Army. In the Madras Sappers, for instance, the best man is always taken to fill a vacancy, whatever his caste or creed. In other Corps, however, a Hindu vacancy has to be filled by a Hindu, even were there a dozen more deserving

* *Life of General Sir Harry N. D. Prendergast*, V.C., G.C.B. (Vibart), p. 157. Gen. Prendergast was Commandant of the Madras Sappers from 1869 to 1880.

† Capt. Molesworth.

‡ *Prendergast*, p. 158.

Mahomedans available. In the Madras Sappers, in fact, "The *man* is everything, the *caste* nothing."

Possibly owing to his daily contact with the R.E.N.C.O. instructors in the workshops, the Madras Sapper has developed several curiously English habits, rare in the rest of the Indian Army. He astonishes officers from North India by having a canteen, where he may daily be seen sitting at a table, smoking a short pipe, and enjoying a mug of beer. He is well known for his proficiency in English, a very desirable qualification in a sapper, who has to work with British troops. He is astonishingly friendly with the latter, too :—

> "During the Mutiny campaign, the comrades of the Sappers were not the native Indian regiments of the same brigade, but the 86th Royal County Downs. At Larnaka in Cyprus 20 years later there was a special friendship between them and the bluejackets." *

A historic friendship has existed since 1843, between the Madras Sappers and the 22nd Foot (now the Cheshire Regt.). This had its birth at Meeanee, in which battle the two fought side by side.

Another curious custom of the Madras Sapper, in which I believe he is again unique in the Indian Army, is his habit of referring to himself and his comrades by their regimental numbers, instead of their names. For instance, a sapper's name may be Venkatasaperumal, Gnanapragasam or Abdurraham Khan, according to his caste and creed, but if his regimental number is (*e.g.*) 1516, he will invariably be addressed as "Fifteen Sixteen," and as "Sixteen" *tout court* by his familiars. Strangely enough, this custom only maintains in the ranks; when a Havildar is promoted to Indian officer, he resumes his name.

The Madras S. & M. has always been an essentially long service Corps. Enlistment is originally for four years only, as in the rest of the Indian Army, but very few men claim discharge at the end of their engagement. The small pension granted after 15 years' service is, no doubt, an inducement, but even after qualifying for this, the majority still serve on until turned out on completion of 21 years in the ranks. The Indian ages early, and experience has shown that after 21 years of the arduous life of a sapper the average man is too old for service in the field units.

Fortunately, the pensioned sapper is in considerable demand by employers of labour, and he may be met all over South India in such jobs as foreman, storekeeper, watchman, policeman and forest guard. Many pensioners obtain employment in the large town of Bangalore, and settle down there permanently with their families. There is thus a strong colony of ex-sappers living round the headquarters of the Corps, and this produces many excellent recruits.

* *Life of General Sir Harry N. D. Prendergast*, V.C., G.C.B., p. 158.

Some families, indeed, can claim to have served in it, father and son, for three and even four generations.*

Perhaps in this connection it should be explained, for the benefit of the reader in England, that Bangalore stands in the Indian State of Mysore, and is a considerable distance from the normal recruiting ground of the Corps, which is British Madras. The inhabitants of Mysore are Canarese, a race quite distinct from the Tamils, talking a different language, and of no value as soldiers. It is much as if the Headquarters of the Royal Engineers was still located at Chatham, but recruited only Welshmen, either direct from Wales, or from a Welsh colony of ex-sappers settled round the S.M.E.

From the point of view of the British officer, the Madras S. & M. is extremely fortunate that its Headquarters are placed, not in the stifling plains of Madras, but on the table-land of Mysore, some 3,000 ft. above the sea, with a delightful climate all the year round.

Services.—Of the services of the Corps between 1780 and 1922, what shall be written? Are not the more notable already recorded by its thirty-one† official "Battle Honours," as shown at the head of this article? Few other Indian Corps can claim to have left their dead in places as far apart as Mauritius and Lhassa, Lagos and Pekin. The Corps collection of medals shows that out of the 42 distinct medals awarded for services in all parts of the world, between 1780 and 1922, which it has been possible for *any* Indian troops to receive, the Corps has qualified for no less than thirty-one. Its mentions in Orders and Dispatches would fill a fat volume, so the following must suffice as interesting examples:—After the "First War in Burma (1824–26)," the last which the Corps attended as a battalion of Pioneers, their services were acknowledged in the following General Order:—

> "To mark the high sense which the Government entertain of the indefatigable exertions of the Corps of Pioneers throughout the war in Ava, the Honourable the Governor in Council is pleased to resolve, as a special case, that Jemadar Andoo, of that Corps, whose gallant conduct has been particularly brought to notice, shall be promoted to the rank of Subadar, that he be presented with a palankeen, and an allowance of Rs 70 monthly for the support of that equipage, and that a

* An excellent example of the hereditary S. & M. family is that of Subadar Seeloway (*vide* page 264). Seeloway served from 1823 to 1860, dying as a Subadar. His son, Chinnapen, served from 1855 to 1880, and rose to be Colour Havildar Major. *His* son, Maricruz, served from 1884 to 1919, and retired as Subadar-Major. The fourth generation is represented by three sons of the latter, now serving in the Corps, one being a Jemadar and two Lance-Naiks.

† No "Honours" for the war of 1914–18 have yet been awarded to Indian Troops, at the time of writing.

pension of half pay be granted to his nearest heir after his decease."

The War in Coorg of 1834 was the first considerable operation attended by the Corps in its rôle of Sappers and Miners, and to this it sent five out of its eight companies. On the conclusion of the operations, a Court of Enquiry was held " to ascertain the claims of certain native soldiers of the Madras Army, reported conspicuous for gallantry," and reported that " Havildar Chokalingham, of the Corps of Madras Sappers and Miners, has satisfactorily established pretensions to eminent bravery." The Governor General, then, " as a mark of the high sense he entertains of the distinguished conduct of that non-commissioned officer, is pleased to confer on him an honorary medal,* and an increase for life of one-third of his present pay."

In the suppression of the Mutiny of 1857–58 (which, it must not be forgotten, was one of the *Bengal* Army only) the Madras Sappers had three companies engaged, " C " Company at the Relief of Lucknow, and " B " and " L " Companies in Central India. Of the first it is recorded :—

> " The Madras Sappers were in the van of the advance, blowing open the gates, and breaching the walls of the fortified buildings that blocked the way. They were the first to hoist the British flag on the roof of the Martinière. After the relief of the Residency they were left with Sir James Outram's force at the Alumbagh, and took the chief part in the fortification of his position, working all day and every day, and sometimes all night also."

The same author† writes of the companies in Central India :—

> " The ' B ' Company had been engaged in the Persian War, and had just returned from the Gulf to Bombay, when the Mutiny broke out in Bengal, and the Madrasis at once volunteered for service against the mutineers. . . . It took part in all the sieges and battles of that brilliant campaign, serving as infantry in the line of battle when there was no work to do in its own special line. . . . The Company was in action eighteen times in the field and in the assault of fortified places, besides being constantly under fire during siege operations. . . . Two of its native officers and five of its

* This medal (which is quite unique) is in the Corps' collection at Bangalore. Chokalingham rose to the rank of Subadar, and when the " Order of British India " was founded in 1838, he was admitted direct to the First Class, being thus the first native officer of the Madras Sappers to attain that honour.

† *The Services of the Madras Native Troops in the Suppression of the Mutiny of the Bengal Army.* (Tyrrell) p. 26.

rank and file were admitted to the 'Order of Merit*' for bravery in this campaign. The 'B' Company took the field with six European officers and 120 native officers and soldiers, and it returned to Madras with a strength of 40 of all ranks, commanded by a junior subaltern, after twenty months of continuous service in the field."

"Overseas" jobs have fallen much more to the lot of the Madras Sappers than to either of its sister Corps. Its companies have attended all three of the China wars, and have been no less than five times† to Egypt or the Soudan. One of its most valued honours was gained in the latter country, at Tofrek,‡ near Suakin, in 1885, where "F" Company threw itself into the broken face of the square, where a Bengal infantry regiment had given under the Arab rush,§ and indubitably staved off a very serious disaster to the British arms. In so doing the Company lost of its three British Officers, two killed and one wounded, and suffered over 30 casualities among the some eighty Indian ranks present.

In the Great War of 1914–18 the Corps increased its establishment from 6 field companies to 3 field troops and 20 field companies, and served in France, Egypt and Palestine, Mesopotamia and Persia, East Africa, and on the Indian Frontier.

A certain distinguished General told the writer the following story of his first meeting with the Madras Sapper:—It was in the early part of the war in France, and a somewhat impromptu retirement of our line had taken place. He, being then a Staff officer, was making his way warily round the abandoned position, when he came upon an Indian N.C.O. and some men, whose appearance was strange to him. "Who are you?" he asked in surprise, as the spot was far from healthy, "and why have you not cleared out with the rest?" The havildar replied simply, "We are the Queen's Own Sappers and Miners, Sahib, and we have not had the order to retire." This apparently struck the Staff officer as remarkable.

The bulk of the Corps, however, served in Mesopotamia, where two of its companies bore a distinguished part in the crossing of the Tigris at Shumran in 1917:—

"On the night of 22–23 February, under cover of darkness, the three columns advanced to their respective points on the river, pontoons were off-loaded by the sappers, and carried

* In the Indian Army the "Order of Merit" was the equivalent of the Victoria Cross, for which Indians were not eligible before 1911. In the Mutiny the three companies of Madras Sappers managed to secure no less than eleven "Orders of Merit" between them.

† Expedition under Gen. Sir David Baird, 1801. Tel-el-Kebir, 1882. Suakin, 1885. Suakin, 1896. Egypt and Palestine, 1914–18.

‡ Also known as "McNeill's Zariba."

§ *My Service Days* (General Sir Norman Stewart), p. 122.

as close as practicable to the water's edge. Just before dawn on 23rd February, all pontoons were simultaneously launched, and ferrying commenced.

"At the centre ferry (run by No. 12 Field Company) the pontoons came under heavy fire from a Turkish picket and machine-gun on the far bank when about three-quarters way across. Three pontoons were knocked out and ten reached the far bank. Of these, eight returned for a second trip, being heavily fired upon the whole time. In an hour and a quarter 150 men of the 2/9th Gurkhas with four Lewis guns were ferried across and established on the far bank. Only four pontoons now remained in action . . . Casualties among the rowers were very heavy, many of the crews being completely wiped out.

"At No. 3 ferry (run by No. 13 Field Company) the pontoons came under heavy fire from a Turkish picket when about half way across, and were enfiladed by a machine-gun. Many casualties occurred among the rowers, but six pontoons managed to return for a second trip. After three-quarters of an hour, eleven pontoons were out of action, and only two remained. By this time 100 men of the 1/2nd Gurkhas with four Lewis guns were across and established on the far bank."*

Although it is not well to blow overmuch even the trumpet of one's own Corps, I cannot resist concluding with a quotation from the writings† of Field Marshal Lord Wolseley, who had seen the Madras Sapper in Burma, in the Mutiny, in China and in Egypt :—

"The best native soldiers, taking them all round, whom I ever served with in India were the Madras Sappers. Their coolness under fire, indifference to danger, and their pride of regiment, marked them on all occasions as first-rate soldiers."

Emanating from such an authority, this is probably the most valuable of the many testimonials standing to the credit of "Queen Victoria's Own Madras Sappers and Miners."

* *Historical Record of the Q.V.O Sappers and Miners*, vol. II, p. 10-11.
† From an Article entitled *Courage*, in the *Fortnightly Review*, of August, 1888.

DESCRIPTION OF THE WAR MEMORIAL

ERECTED BY THE Q.V.O. MADRAS SAPPERS AND MINERS AT BANGALORE.

(*Furnished by the Commandant, Q.V.O. Madras Sappers and Miners.*)

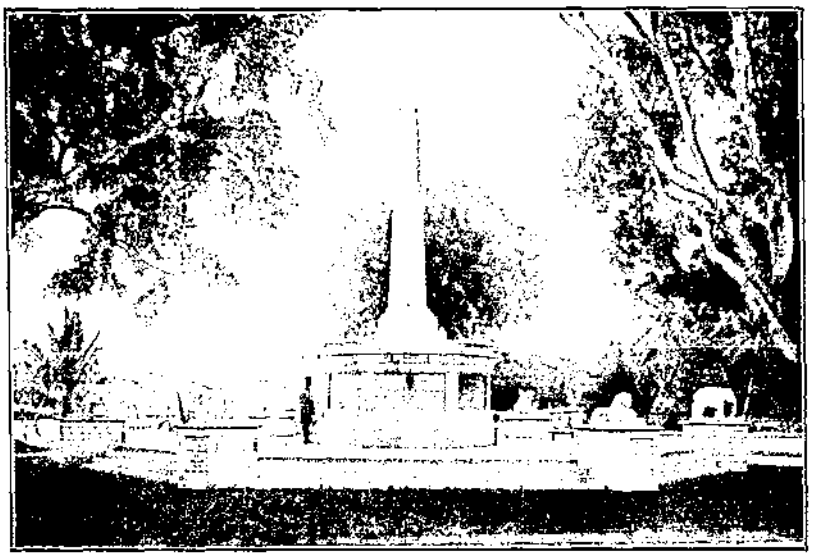
THE Memorial is constructed of grey Mysore granite, and consists of a hexagonal platform 60 ft. in diameter, raised two feet above the ground, and ascended by four steps. In the centre of this platform is a hexagonal plinth, surmounted by an obelisk, the whole reaching a height of 30 ft. The six faces of the plinth bear polished granite panels devoted to the theatres of war in which the units of the Corps served, *i.e.*, France, Egypt, Palestine, Mesopotamia, Persia and East Africa. On each panel are engraved the titles of the troops and companies which served in that particular theatre, followed by the names of the officers and men of these units, who lost their lives therein. The obelisk surmounting the plinth is a monolith of granite, weighing over ten tons.

At each of the six corners of the lower platform is a granite pedestal, about 4 ft. high, bearing a small panel inscribed with the battle honours of the Madras Sappers (31, exclusive of the late War, for which none have, so far, been awarded to Indian Troops), and surmounted by the stone figures of a sphinx, a dragon, or an elephant. These figures represent the badges awarded for the campaigns of Egypt, 1801; China, 1842; and Assaye, 1803, in all of which the Corps served.

The Memorial was commenced in October, 1919, and completed just three years later, practically entirely by the hands of the men of the Madras Sappers. Its construction was much delayed by the Afghan War of 1919 (and subsequent frontier troubles) and by the rebellion of 1920 in Iraq, to all of which the Corps had to dispatch units.

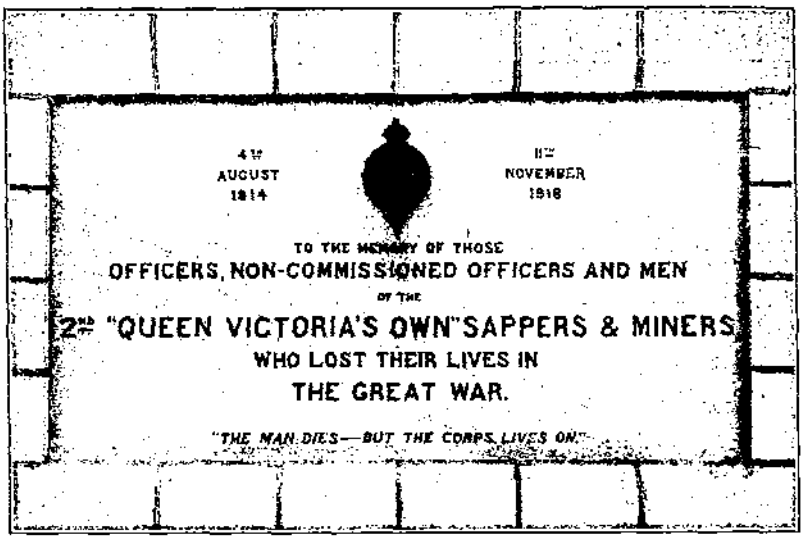
The cost was defrayed by subscriptions from all ranks, and amounted to just under Rs.15,000, or about £1,000.

WAR MEMORIAL ERECTED BY THE Q.V.O. MADRAS SAPPERS & MINERS AT BANGALORE.

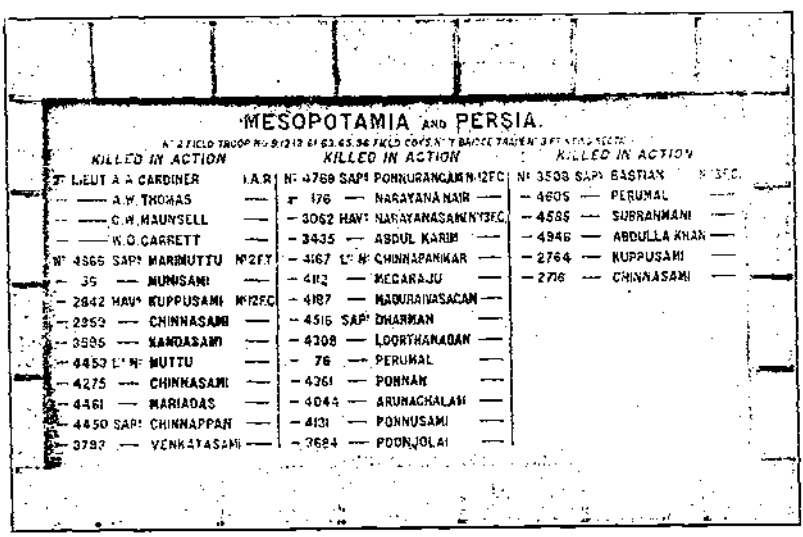


The Memorial.

Seen Across Ulsoor Tank.



The Front Panel.



One of the Five Panels of Names.

BORING IN PALESTINE.

Mr. A. W. Dawson, F.S.I., has presented to the R.E. Library a copy of a lecture by Captain Paul H. Mangin on the subject of Boring in Palestine, which was read at a recent meeting of the Institution of Petroleum Technologists. The lecture describes fully the extraordinary difficulties, due to the treacherous sands and the absence of suitable plant, which were met and overcome by these officers when serving with the Royal Engineers in Egypt and Palestine, and will be read with interest by all those who require information on this most important subject, which is necessarily treated in no great detail in the volume on *Water Supply in Egypt and Palestine* of the *Work of the Royal Engineers in the European War* series.

The following contribution to the discussion by Dr. Hume is reproduced in full, as being of exceptional interest to the study of the water supply problem of this campaign :—

" It was my privilege to study the water operations from their first inception on the Suez Canal to the time when there was the long wait along the line at Gaza. It may be of interest broadly to state the conclusions arrived at in the course of the advance, these forming the basis of subsequent operations.

" In 1915 the line of defence was on the Suez Canal, and the military authorities felt the need of water supply for the troops occupying the desert side of the canal. The writer did not expect much success from boring operations undertaken here, as these were mainly sunk in the lagoon or lake formations connected with the Mediterranean and Red Sea respectively. His only hope was that water filtering through from the run-off of the Sinai Hills might improve the brackish water supply. The tests proved that no such help was afforded, and all the bores were abandoned.

" As dunes are notably good water-collectors, he then suggested that boring operations should be conducted in the dune region some little distance east of the canal, and personally selected a position in front of the line at Katib el Aruk. Here the results proved more favourable, and the water was sufficiently good for animals, and just drinkable by men. So far as the writer knows, this plan was widely developed, and enabled the line to be maintained some distance inland of the canal itself. In this sand-dune water the salt was about 2,500 parts per million.

"A suggestion was also made to endeavour to tap the gravels of the ancient Nile arms which passed Pelusium, and to this end a bore was sunk at Mehemdiya in close proximity to a sand-dune region, but the water obtained was practically sea-water.

"In the course of the investigation the interesting point came out that in the sand-dune areas there seemed to be a layer of fresher water resting on a more salty one at sea-level.

"In the original reports made by the writer to the military authorities it was stated that the most noticeable feature proved was the existence of a water-table of wide extent at or near sea-level. Bir Mahadat, Bir Abu Aruk (*Bir* means "well") proved to be all in this position. The water-table where it reaches the sea border is represented either by marsh, gypsum swamp, or palm grove depressions (as at Romani, Katia, etc.). It was broadly concluded that along the Mediterranean border water of some sort could be met anywhere at zero level. Thus, if any point were, let us say, 100 ft. above sea-level, the depth of the well required to reach water would be about 100 ft. As regarded quality, the nearer the water was to the lagoons or sea border, the greater its salt content. One could, in fact, divide the underground water into zones of diminishing saltness, which were more or less parallel to the borders of the great lakes (Menzala and Bardawil). The quantity of water was small at any one spot, but, by tapping it at many localities, a large army was maintained on the Romani line many miles to the west of the canal over a considerable period.

"The next study of importance was in connection with the El Arish area, which the writer was invited by the military authorities to visit within a week of its occupation. Here it was evident that the rainfall absorbed by the sand-dunes and that flowing from the hills by the great drainage line of Wadi-el-Arish had given rise to a most favourable area of water-supply, the best water, as in the previous case, being tapped when sea-level was attained.

"It was calculated that the rainfall absorbed by the dunes would, if tapped by borings near their base, supply some 120,000 gallons per day. A total of 300,000 gallons per day was required for the troops on the spot, and this was obtained by boring to the east of the Wadi-el-Arish, and in the bed of that valley.

"A notable feature was the excellence of the water close to the sea coast. This is true for the sand-dune area bordering the sea in the Nile Delta, and also for a similar region west of Alexandria.

"Broadly speaking, such good supplies may be expected where a great drainage line carrying fresh water descends from the hills, especially if, at the same time, there is a water-collecting sand-dune area near the shore to strengthen the supply.

"The importance of these shallow bore operations will be realized when it is remembered that nearly 150,000 men and 100,000 animals

(horses, mules, camels) were maintained at this spot throughout a long period.

" During the French expedition, Reynier's far smaller army found itself in a difficult position owing to the exhaustion of the existing wells, and was totally ignorant of the excellent supplies which lay close to the surface. The Germans and Turks seem to have been ignorant of the rich store of water thus available, and it will always stand to the credit of the Egyptian Expeditionary Force that it worked its advance on a basis of continuous study with striking results.

" The writer had again the privilege of being invited to examine and report on the question of water supply for the Wadi Ghuzze line held by the Army to the west of Gaza.

" Here the rules already laid down applied to the obtaining of the water from the sand-dunes, on which the left wing of the British Army largely depended.

" As regards the centre and right wings, a new and important fact came into play. An examination of the springs at Sheilal, Essani, etc., proved that a second great source of water supply for the Gaza front was found in the valley deposits, the water being carried in gravels derived from the erosion of the limestone hills to east and south-east. This water was protected from evaporation and diffusion by overlying and underlying clays. As those camped in these parts learnt by sad experience, the quality of the water was less good than that of the consolidated dunes, and the gallant men on this portion of the line had to drink water which, under ordinary circumstances, would be regarded as unsuitable for human consumption. Nevertheless, these limestone-derived waters played a most important part in enabling the British Army to maintain its grip until the decisive advance took place."

F.E.G.S.

UNARMED DEFENCE.

By TWO SAPPER OFFICERS.

SOME time ago one of us said to the other: "The French action in the Ruhr promises to be an important and interesting experiment. If France fails to get anything out of Germany, will it not show that, under modern conditions, an army is no use against the passive resistance of the civilian population of an enemy state? If Germany, unarmed, can repel the armed invasion of France, will it not show that armies are not required for successful defence? The pacifist will then say that armies are impotent in aggression and unnecessary for defence; that the surest defence for a state is its defencelessness; that armies are therefore useless and expensive encumbrances; 'Away, then, with armies!'"

Such a line of argument is, on the surface, extremely plausible, but we knew that there must be a fallacy in it somewhere. Further cogitation on the part of us both has, we think, enabled us to discover some of its failings and to arrive at certain conclusions on matters of general interest. We think that the results may be of interest to some of our brother officers, especially as it is not always easy to find readily a simple sensible answer to a simple silly question. Hence this article.

Firstly, the argument is from the particular to the general. This does not mean that the deduction is necessarily unsound, but it suggests that a further examination of the attendant circumstances is desirable before we accept the deduction as proved for universal application. We propose to examine the problem in the following way. First, let us see what ends France is trying to attain by her military action in the Ruhr. Then, assuming that she fails to attain those ends, let us try and find out why she failed, and whether, in any other circumstances, she might have succeeded. Then we may be in a position to form an opinion as to the future value of an army to a modern state.

The question as to what are the aims of the French action in the Ruhr has been asked, if not answered, in Parliament, but, as our study is military rather than political, let us leave Hansard on the shelf and open *Field Service Regulations*, Vol. II, at page 17. There we have a definition of war which fits the French action like a glove.

"War is the ultimate resort of policy whereby a nation, when every peaceful means of settling an international dispute has failed,

seeks to impose its will on its enemies in defence of its honour, its interests or its existence.

" The armed forces of the Empire are the instruments by which, in the last resort, the national policy is supported and enforced.

" The aim of a nation which has taken up arms is, therefore, to bring such pressure to bear on the enemy people as to induce them to force their government to sue for peace."

Within the meaning of *F.S.R.*, therefore, France is waging war, but before leaving *F.S.R.*, let us turn back to page 14. There we find the following statement :—

" The ultimate military objective in war is the destruction of the enemy's main forces on the battlefield."

But in the case under review the enemy has not got any " main forces " to destroy, and this lack of an objective is the root cause of France's military difficulty. She is trying to use her army, not to bring indirect pressure to bear on the German people through their army, but to bring direct pressure on the people themselves, and that pressure is being countered by passive resistance.

The point is whether such military action could possibly succeed. Could a nation ensure success of military action against civilian resistance if it did something that France, in this case, has not done ? It is reasonable to suppose that force, if used with sufficient ruthlessness, will, in all cases, overcome passive resistance. History abounds in instances of an invader exterminating the entire population of an invaded territory or transplanting them as slaves and colonizing the country with his own nationals. The Israelites did it to the Amalekites and the Assyrians to the Israelites in the Old Testament. The Turks do it to the Armenians in the twentieth century whenever they get the chance. Large portions of the American continent were won in this way. The attacker gained, at least, a cheap supply of labour and the natural resources of the conquered country. These, of course, are extreme cases, and it may be argued that such methods of waging war are only used against savages and that they cannot conceivably be used in modern Europe. It must be admitted, however, that in every case there must be a limiting degree of ruthlessness, far removed from the absolute ruthlessness instanced above, which will overcome the maximum of passive resistance which the invaded nation is prepared to offer.

We are therefore forced to the conclusion that an armed invader will fail against civilian resistance only if the ruthlessness which the invading army is prepared to employ is strictly limited. The invaded state, being itself defenceless, can do nothing to limit the invader s ruthlessness. The limitation must come from the invader himself or from external sources.

There are three factors which, in practice, limit the ruthlessness

which an invader can employ against a defenceless nation. These are :—

1. Humanitarian considerations.
2. Self interest—the fear of destroying the resources of the invaded territory.
3. Fear of intervention from outside.

One would like to think that modern civilization has so developed the humanitarian instincts of civilized nations that this factor of itself would be sufficient to set the required limit to the ruthlessness of an invader. Alas, this is not so. The old fallacy that " the end justifies the means " is still rampant. It has been detected by their enemies in various creeds : in Imperialism and Sinn Fein, in Capitalism and Communism. It may exist. A state may be, or consider itself, so civilized that its citizens regard their neighbours as revolutionary or reactionary savages, who should be treated accordingly in the cause of progress. Who, bearing in mind the pre-war mentality of the German nation or the post-war mentality of Bolshevist Russia, would rely on civilization to protect his state from the ruthlessness of an invader ?

The second factor—fear of destroying the resources of the invaded country—is hardly likely to deter an invader from being ruthless, but it may rule out certain forms of ruthlessness and thereby, to a certain extent, limit ruthlessness. For example, a nation in need of coal, invading a state rich in coalfields, would not try to bring pressure to bear by the destruction of its mines. It might, however, limit the import of food and allow rations only to the miners and railway employees who continued working. There will usually be plenty of ways of bringing the invaded nation to a humble frame of mind without killing the goose that lays the golden eggs. So the second factor is, in reality, as broken a reed as the first.

It is the third factor—fear of intervention from outside—that is by far the most powerful deterrent of ruthlessness. Neighbours who are not parties to the quarrel are more disinterested and, therefore, more humanitarian than the invader. Or they may be afraid that it will be their turn next to be attacked, and for that reason will not desire that the invader should set up a precedent to be used upon themselves later. They may decide to interfere, to protect their trade interests in the invaded territory. They may be genuine friends of the invaded nation and anxious to help it, or they may hate the invader and jump at the chance of using his " atrocities " as an excuse for biting him in the back while he is busy in front. These are some of the reasons why neighbours may interfere to prevent undue ruthlessness. But there are many cogent reasons which may prevent them from interfering, such as friendliness to the invader, hatred of the invaded, pacifism at home, desire to continue trading

with both belligerents, fear of ultimate defeat, mistrust of the other neighbours. Who can say which scale will kick the beam in any particular case?

Intervention may take one or both of two forms, military and economic. Military intervention presupposes that the intervening nations are armed and presents a purely military problem which need not be discussed further. It could not be applied in time to be effective were disarmament general. Economic intervention might be extremely difficult to apply, especially against a state that was more or less self-supporting, and it would be very apt to recoil against the state applying it in the guise of shortage of commodities, loss of trade, unemployment, etc. It is conceivable that the recoil might be so strong as to force the intervening state to raise the blockade. Fear of the attack being turned on them would always make the nearest members of the blockading ring hesitate in applying the economic pressure. Furthermore, it is doubtful whether such a blockade could be rendered effective unless it were supported by force. At least, blockade runners of the blockaded and neutral nations would have to be dealt with somehow.

Nations have in the past disarmed, wholly or partially, trusting to international guarantees of "neutrality." The more recent cases have been far from reassuring. The nation which relies on intervention is, therefore, taking a very grave risk. The intervention may come too late, or it may fail in its object. It may even take the comparatively innocuous form of a series of "notes" which may serve to salve the consciences of the neighbours who send them, but will not help the defenceless nation at all.

So we have come to the conclusion, in spite of the lesson of the Ruhr, that disarmament as a policy of defence is unsound, except if adopted by a state so situated geographically or economically that an aggressor's attack on it would be impossible or fruitless; that passive resistance can only succeed where the ruthlessness of the attack is limited; that the strongest factor in limiting the ruthlessness of the attacker is the fear of intervention backed by force, but that to rely on such intervention as a pretext for disarmament would be a policy full of risk; and that, paradoxical as it may seem, the risk would increase in proportion as disarmament became more general.

HILSEA ORDNANCE DEPÔT.

By COLONEL J. C. MATHESON.

A SHORT account was given in the March, 1922, number of the *R.E. Journal* of the buildings in Hilsea Ordnance Depôt which presented some points of interest. It has been suggested that a brief general description of the development of this depôt would round off the former article.

This development is best indicated graphically and the attached plan shows the depôt :—

(*a*) As it was before the war.
(*b*) The additions made during the war.
(*c*) The reprovision rendered necessary by the handing over to the Navy of the Gunwharf, Portsmouth.

Before the war the Ordnance establishment at Hilsea was on quite a small scale and contained only the mobilization stores for :—

2 Reserve parks R.A.S.C.
1 General hospital.
2 Clearing hospitals (really C.C.S.).
1 Field ambulance.
2 Ammunition parks (less vehicles).

and some war reserve ammunition.

During the war a number of large sheds were erected, those lettered A.1, A.2, B.1, B.2, C.1, C.2 being for camp stores. The site of these sheds is the old R.E. Fieldwork ground of 30 years ago. The roof-covering of these stores was mostly non-galvanized corrugated iron. In spite of periodical attention to these roofs, they have naturally deteriorated to some extent. In 1922, however, measures were taken which it is hoped, judging from results elsewhere, will prolong their life for many years.

These measures consisted in covering the roofs with felt, well pressed down into the corrugations and made to adhere by a mixture of super-hydrated tar and mastic applied hot, with a top dressing of the same dashed with sand.

Other sheds, marked A, B, C, and D, now used for mobilization equipment, were also erected in war time and were then used for the storage of ammunition.

Another large structure is the vehicle shed, close to the railway

into Portsmouth. This, during the war, was used to house guns and vehicles on deposit for Woolwich, as they were received from the contractors. Thence they were issued to the various theatres of war.

Before the war there were no railway sidings into the depôt. The war expansion rendered these a necessity and the plan shows their ramifications. It also indicates the fire main. An interesting point about this main is that a portion of this was laid in ashes from the gas works. This caused such serious chemical action that within eighteen months large renewals were necessary, together with the removal of the cinders.

The main works required on the reprovision item have already been mentioned in the March number. There were, however, many minor services :—

Armoury.
Timber shed, coal-yard and wood store.
Locomotive shed.
Railway weigh-bridge.
Movable 15-ton crane.
Loading platform (railway).
Rifle testing range.
Roads.

The original drainage system was a small one and discharged into Langstone Harbour near the depôt. It was not satisfactory and in any case the fall was insufficient to take the whole of the depôt without the use of ejectors. Thus the new drainage scheme was put in, as shown on the *Plan*, discharging into the town sewer. The drainage of the married quarters is separate from the main scheme and discharges into the town sewer, no ejectors being required.

Owing to the ground being so low-lying, a considerable amount of filling has had to be done. The material for this has been obtained from some of the old traverses protecting the rear of the flanks of the bastions of the Hilsea Lines.

It may interest some of its former occupants to know that Hilsea Lodge, the old quarters for the D.O. Hilsea, is now the official residence of the D.A.D.O.S., Portsmouth.

MODERN DIESEL ENGINE PRACTICE.

By CAPT. J. H. DYER, M.C., R.E.

GENERAL.

OF recent years great development has taken place in Diesel engine design, due mainly to the increasing adoption of engines of the Diesel type for ship propulsion. Diesel engines can now be constructed of up to 15,000 h.p. per shaft and 2,000 h.p. per cylinder. The main reasons for the high efficiency of Diesel engines are (*a*) the high compression possible, as air only is compressed and not a combustible mixture, as with a gas-engine (in which case the temperature of ignition of the mixture limits the permissible compression, to avoid pre-ignition); (*b*) a leaner mixture may be employed than with a gas-engine, thus reducing the weight of fuel burnt and the loss in the cooling water.

I. OBJECTS IN DESIGN.

1. *Maximum Economy.*—The fuel consumption of modern Diesel engines has been considerably reduced, an average consumption being ·42 lbs. of fuel oil per b.h.p. hour. The adoption of a "dished" piston or a conical shape of combustion chamber has enabled the fuel to be sprayed into a good depth of air, in spite of the small clearance volume. This has resulted in better combustion by making all the air in the clearance space "interested" in the fuel spray and avoiding pockets of dead gases.

2. *Reduced Weight.*—For driving dynamos, high-speed engines running at from 180 to 350 revolutions per minute have been largely adopted. These engines are totally enclosed and have forced lubrication at from 35 to 80 lbs. per sq. in. High speed gives reduced height, weight and capital cost, besides minimizing the size and weight of the dynamo. This engine is not suitable for all purposes, *e.g.*, main engines on ships, as propellor efficiency is a maximum at about 85 revolutions per minute for ordinary cargo vessels, *i.e.*, 12 to 14 knots speed.

3. *Reduced Cost.*—The cost of a Diesel installation is very roughly 25 per cent. more than an equivalent steam plant (including boilers) or gas-engine plant: the cost has been reduced by increased speed, two-stroke cycle, etc.

4. *Reduced Space.*—By increasing the output per cylinder. Amongst other improvements, the Mean Effective Pressure has been raised to 110 lbs. per sq. in. (from a former average of 95 lbs. per sq. in.). By "supercharging," *i.e.*, a preliminary compression of from 2½ to 8 lbs. per sq. in. of the charge, a great increase in the M.E.P. may be obtained.

II. Modifications of Design.

1. *Solid Injection of Fuel.*—In the older designs air injection is employed: before each power stroke a certain quantity of fuel is delivered by the fuel pump into the fuel valve casing. When the fuel valve opens, oil is blown into the combustion space in a finely divided state by an air blast from the compressor at from 700 to 950 lbs. per sq. in. With the solid injection system, the fuel oil is maintained by the fuel pump at a high pressure (varying between 2,000 and 10,000 lbs. per sq. in. for different designs) in the fuel valve casing and fuel piping. When the fuel valve opens, fuel oil is forced into the combustion space by its own pressure, being atomized by passing through a number of fine holes in the sprayer. The advantage of solid injection is that it eliminates the air compressor, which is always a possible source of trouble and takes up space. As a compressor absorbs from 7 to 10 per cent. of the output of an engine, the mechanical efficiency is improved by the adoption of solid injection, but the I.H.P. thermal efficiency is less, so the fuel consumption on a B.H.P. basis remains about the same. In any case, an air compressor is required to charge the starting air vessels except (*a*) where the engine is driving a direct current generator and storage batteries are available to drive the generator as a motor for starting, (*b*) engines of the Still type, which may be started up on steam on the steam side of the double-acting piston, the steam being generated by lighting up oil burners in the regenerator. It is difficult to obtain good atomization with solid injection, if using very heavy fuel oils of high viscosity. The system has, however been largely adopted for submarines, though the engines are started on air, as an air compressor is required in any case for discharging the ballast tanks.

2. *Two-stroke Cycle.*—In sizes up to about 600 b.h.p. the four-stroke cycle is preferable, as it gives slightly greater economy and is more reliable, as greater experience has been gained in its manufacture. A disadvantage of single-acting two-stroke engines is that the pressure on the main bearings, crossheads and big end bearings, is always in the same direction, and forced lubrication must be adopted; should the lubrication pressure fail, the oil film cannot form in the bearings and a seizure will quickly take place. With the four-stroke cycle the pressure on the bearings alternates, especially on the pumping strokes, and ring or syphon lubrication may be adopted;

The chief advantage of the two-stroke cycle is that the engine occupies less space for a given output, the power per cylinder being about 1·8 times that of the four-stroke engine of the same size. The adoption of the two-stroke cycle, either single or double acting, is imperative for the largest outputs, as a four-stroke engine of, say, 8,000 b.h.p. would be excessively unwieldy. A scavenge pump is required with two-stroke engines; this does not cause a great increase in the space occupied by large engines, as now turbo-blowers are used. To obtain a high mean effective pressure, supercharging is adopted: the Sulzer design for obtaining efficient scavenging and supercharge by auxiliary scavenge ports is worthy of note. *Fig.* I shows vertical section of cylinder. The air is delivered by the scavenge pump to a scavenge trunk A at a pressure of about 3 lbs. per sq. in. There are two rows of scavenge ports, B and C, the admission of air

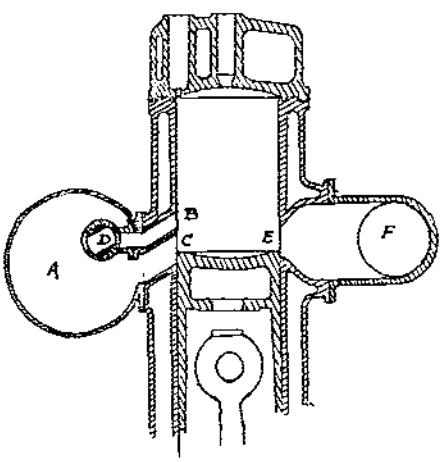


Figure I.

Port Scavenging: Sulzer Engine

to the ports B being controlled by the rotary valve D, driven off the vertical intermediate shaft. As the piston descends, it first uncovers the ports B (which are at that moment cut off from the scavenge trunk by the rotary valve), next, the exhaust ports E are uncovered and the products of combustion escape to the exhaust main F. The lower row of scavenge ports C is now uncovered and the air admitted helps to drive out the burnt gases. As the piston rises the ports are covered in the reverse order: the rotary valve D is now admitting air through the ports B, helping to scavenge the exhaust gases until the exhaust ports E are covered and, after that, raising the pressure in the cylinder to about 3 lbs. per sq. in., giving a supercharge.

3. *Reduction of Compression Pressure.*—With solid injection, the fuel sprays in fastest when the fuel valve first opens, tending to

cause a rise of pressure at the commencement of the injection period (instead of operating on approximately the constant pressure cycle). In several designs the compression pressure is reduced to about 380 lbs. per sq. in., the pressure rising to 500 lbs. per sq. in. on combustion. As there is less danger of a heavy overpressure due to pre-ignition with this design, the crank shaft may be made lighter, reducing the capital cost. There is only a slight reduction in the thermal efficiency by reducing the compression ratio to give 380 lbs. per sq. in. compression pressure, but the engine is not "cold-starting," as a sufficiently high temperature for ignition of the fuel oil is not attained by compressing air from atmospheric temperature to 380 lbs. per sq. in., when the cylinder walls are cold. The scavenge air must therefore be pre-heated or hot water circulated through the cylinder jacket before starting up.

4. *Double-Acting Engine.*—The advantage of a double-acting engine is saving of space and first cost, especially for very large outputs, as practically double the output can be obtained per cylinder, or, for a given output per cylinder, a much smaller sized cylinder is required; thus the pressure stresses in cylinder liner and cover are reduced, so their thickness may be reduced. This in turn reduces the heat stress, which is the main factor limiting the output per cylinder of Diesel engines. A successful double-acting engine is difficult to design: the lower combustion chamber, through which the piston rod passes, being less efficient than the upper combustion chamber, owing to the following causes (*a*) the cooling effect of the rod on the fuel spray; (*b*) the rod gets cut away by the flame impinging on it; (*c*) difficulty in keeping the piston rod stuffing box tight; (*d*) if two fuel sprays are used, directed eccentrically so that the flame does not impinge on the piston rod, there is a tendency to cause a vortex of unused air, causing incomplete combustion.

5. *Opposed Piston Engine.—Fig.* 11 shows arrangement of pistons and cranks for one design of this type (Junker's type). There are two pistons per cylinder; the top piston is attached by a beam lever to two side-rods coupled to two connecting-rods driving a crank on the crank shaft each side of the cylinder. The lower piston drives the crank shaft by one connecting-rod in the usual way. The pistons move in towards and outwards from the centre of the cylinder at the same time. The engine operates on the two-stroke cycle, the exhaust ports being at the top of the cylinder and scavenge ports at the bottom so that the scavenge air, when admitted near the outer end of the stroke, sweeps up through the cylinder, driving out the exhaust gases through the exhaust ports. The fuel is injected, by a valve arranged horizontally in the liner, when both pistons are at about inner dead centre. The main advantages are: (*a*) As there are no cylinder covers, many difficulties of cooling and jointing are avoided; (*b*) there are no reactionary stresses on the

framework due to combustion load, as the opposed pistons balance these forces; (*c*) engine should be vibrationless, as the reciprocating masses are balanced. The Fullager opposed piston engine is of somewhat different design: the upper piston of one cylinder has a diagonal connecting rod to the lower piston of the next cylinder and *vice versa*. This engine has been adopted for several land installations; it has several advantages over other opposed piston types, there being only two cranks between each main bearing.

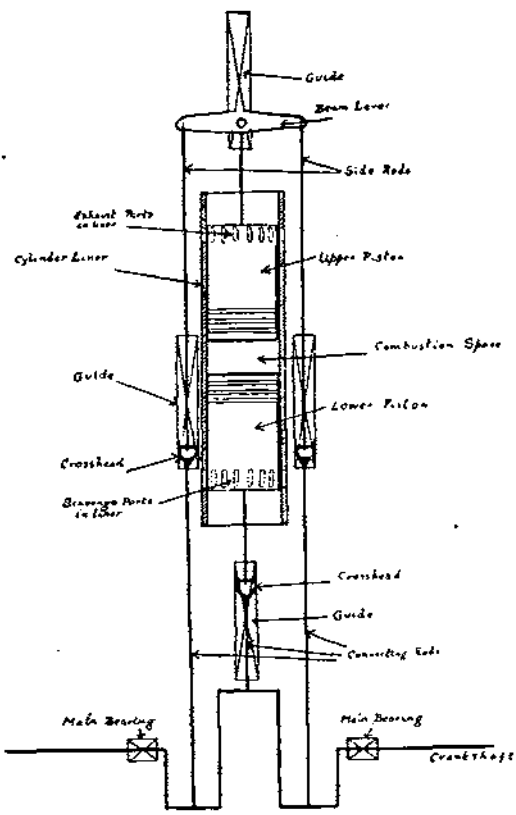


Figure II
Diagrammatic Sketch of Opposed Piston Engine (Junkers Type)

6. *Combined Steam and Internal Combustion Engine.*—This type has been developed by the Still Engine Company and is applicable to gas or oil-engines as well as to an approximation to the Diesel Cycle. With this type the waste heat passing through the cylinder walls during combustion and the heat of the exhaust are used to generate steam which drives the piston on the under side. The feed water is heated in the combustion cylinder jacket to about 340° F. and steam generated in a regenerator, consisting of a water-tube boiler through which the exhaust gases circulate. For starting up on

steam, and to obtain extra steam for over-loads, auxiliary oil burners may be lit up in the regenerator. This design gives the highest over-all thermal efficiency of any prime mover, but has certain limitations, *e.g.* the high temperature of the piston crown limits the permissible diameter and, therefore, the output per cylinder. The following Table (from Kempe's Engineer's Year Book) may be of interest :—

Type of Engine.	*Thermal Efficiency.*
Marine steam-engine, superheated ...	16 to 17 per cent.
Parsons steam-turbines	15 ,, 20 ,,
Gas-engines	22 ,, 30 ,,
Petrol-engines	23 ,, 27 ,,
Semi-Diesel engines	27 ,, 30 ,,
" Still " gas-engine	31 ,,
" Still " petrol-engine	33 ,,
Diesel engines	30 ,, 36 ,,
" Still " oil-engines (Diesel type) ...	38 ,, 44 ,,

III. Fuel for Diesel Engines.

A wide variety of fuel oils can be successfully used in Diesel engines, the usual fuel being the residue left from crude petroleum when the lighter oils have been distilled off. Some oils having an asphaltum base, such as Mexican fuel oil, are unsuitable for Diesel fuel without special distillation, as the hard ash formed is liable to cause scoring of the cylinder walls. Up to 3 per cent. of sulphur is admissible, as, the exhaust being at a temperature far above that of the dew point of sulphuric acid, corrosion could only take place in the exhaust pipe. Tar oil, obtained from the distillation of coal tar, is successfully used, but requires generally the use of special ignition oil or an increased compression pressure to ensure cold starting and certainty of ignition on light loads, as the ignition temperature of coal tar oil is high. Animal oils (such as fish oil) and vegetable oils can be used, but are generally too expensive. It is interesting to note that in the original design the Diesel engine was intended to run on pulverized coal, but the objections to its use were: (*a*) the highly explosive nature of coal dust ; (*b*) the choking of fine jets ; (*c*) the large amount of ash formed.

IV. Limitations of Diesel Engines.

1. *Largest size.*—The output per cylinder is limited by the heat stresses. The larger the cylinder, the greater the hoop stress in the liner and bending stress in piston crown and cylinder cover. These parts must, therefore, be increased in thickness and this in turn increases the heat stresses, as a greater temperature gradient is required to conduct away sufficient heat through the thick walls to maintain a working temperature in the cylinder.

2. *Smallest size.*—Below about 35 b.h.p. a hot-bulb engine is more suitable, especially for military purposes, as less skilled attendance is required, first cost is less and fuel consumption is only slightly greater.

V. ADVANTAGES OF DIESEL ENGINES.

1. Fuel costs per b.h.p. hour are less than for any other type of engine.

2. Great saving in personnel required for attendance, compared to an equivalent steam plant.

3. Efficiency remains nearly constant over a wide range of load as compression remains the same. Overload capacity of 15 to 20 per cent. for 2 hours.

4. No stand-by losses, as engine can be started up at once from cold. About four hours is required to raise steam in a boiler or to light up a producer plant from cold

TRAINING OF TERRITORIAL DIVISIONAL ENGINEERS.

A lecture by "A CHIEF ENGINEER OF A COMMAND."

WHEN the G.O.C. of the Division asked me to lecture on this subject, my first thought was that none knew better than the Territorial Engineers themselves what facilities they have for training officers and men, and that, with their war experience and the advantage of the new training manuals, the solution of their problems was in their own hands. But I should have been so loth to dissociate myself from their efforts that I am here this afternoon, not in order to push a "nostrum" of my own down your throats or to burden you with personal experiences, but in the hope of examining, so to speak, with you the general principles on which the R.E. work in the field, so that you, perhaps, may be helped in doing your own work, for *you* have to do *for yourselves* the hard thinking that training involves. What is the objective you are aiming at? What are the doctrines you wish to instil? They are laid down for you in *Engineer Training*. Departure from the principles of that manual or the practice of methods not based on those principles is forbidden. This is a hard word not often used. Don't forget it. It is the one point in which enterprise and originality need repression. There is scope enough and to spare for these great qualities, but not in trying to improve on the principles of this little book (*C.I.G.S.*, p. 4).*

May I ask whether every officer and N.C.O. has his own copy of these two books, *Engineer Training* and the *Manual of Field Works*? They have to be mastered—not only read carefully; but as, in many cases, the subject matter is necessarily condensed, they have to be read with a lot of common sense. For example, on page 6 of *E.T.* you will find that the *section* commander's duty is to teach his subsection commanders how to train their subsection in field works, "but it is essential that he should allow them to learn from their own mistakes." Of course, a senior officer in peace training must interfere if he sees a mistake in progress that will endanger life, and pretty quick, too, sometimes. Again, on page 8 of *E.T.* the aim of training is to produce in the men moral attributes of a soldier, fighting spirit, discipline, *esprit de corps*, physical fitness, skill at arms, and skill at his trade. Of course, the latter point includes his trade

* Read extracts from pp. 4 and 5 on C.I.G.S. Staff exercise; Oct., Nov., 1922.

as a sapper too—the technical R.E. knowledge that he has to add to his qualifications as a carpenter, or whatever his trade in civil life may be.

Again, if you read the amendment of December last to *F.S.R.*, Vol. II, you will find that the erection and maintenance of wire is an infantry task. That doesn't mean that the R.E. are not to be experts at it—digging trenches is infantry work, but I should be sorry for sappers who could not dig. So we want to read the principles intelligently. The exact following of the manuals in details of work is altogether another matter, but when carefully thought out and dimensioned drawings are given us we should always gain by sticking to them. Otherwise, if an officer teaches something else, the learner confuses that with the book example and loses the advantage of seeing the picture reproduced in concrete form. Stick to the book for all the points it covers, and develop originality and resource in any other works that are not in the book. So there we are, with good books for our guides. What is the difficulty in carrying out the training? Of course, in the case of the Territorial Army it is want of time—and sometimes want of materials.

You have to cut your coat according to your cloth. But what are you to select, and what are you to reject? Now, *you* know best what time you can get in the case of each company—even of each section, and how much enthusiasm you can call up so that one hour can be made to serve the work of two. I know you do not expect me to dish you up a syllabus for annual training and save anyone the thinking of his share out for himself. Indeed, I should be gratified if I can give you cause for even greater thought than before. Hard thinking, forethought—that is the work to do if you want to avoid having to change your mind. Avoid change of plan.

But to get on with our training.

First of all, what is the objective? To produce a first-class field company in the field ready for all the tasks that await it. What are these tasks and what is the method of employment of the company? The new regulations and manuals have cleared up a great deal of doubt as to how engineers should be used in the field, and I think that each officer can get a much clearer picture of how the work is to be initiated, authorized and carried out than he could before, or even during, the war. There were great differences of opinion and practice about using the field companies during the war. Now I think I may be able to asist you in stating shortly how the work is to be done in future. Of course, I turn to *E.T.* again. On pages 65–6 you will find that work is ordered by a commander. As a result of the C.R.E.'s reconnaissances and of conferences the G.S.O. of a division in conjunction with the C.R.E. prepares a programme of work and they together take the orders of the G.O.C. as to the

priority of the works and the agency by which they should be carried out—either by the R.E. or by units other than the R.E. This programme should not include, as I understand it, the ordinary work that troops undertake for their own defence, including obstacles and cover, but would include defence works given to the R.E. as requiring special organization. Brigades are given orders for work by the staff of the division, who also give work orders to the C.R.E., and he issues the necessary orders to his engineer units. Advice may be required to be given by the R.E. to working parties of other arms, for which purpose some R.E. personnel may be present. Before the commander orders work he will satisfy himself by consultation with his C.R.E. that the work is a necessary public service in accordance with the military requirements, and that his resources will enable him to carry it out.

Under battle conditions the procedure is, of course, somewhat modified. We see on page 73 that a proportion of the R.E. are well forward in the order of march, and the rest of the field companies near the head of their division With regard to this the C.I.G.S., p. 34, says, " The bulk of the R.E. should normally march concentrated under the Divisional Commander's orders and not be attached to lower formations." Any portion of a field company detached for a task should rejoin its company on completion. In the attack you will find *E.T.* says (p. 86) that " the engineer assistance required by advanced formations can best be provided by engineers being pushed forward to them from time to time as the situation demands from the engineer reserves in the hands of the C.R.E."

The C.I.G.S. also said, " In an attack the allotment of bodies of R.E. to advance close in rear of the attacking infantry is wasteful of personnel and conducive to loss of control, and it is difficult to conceive of any circumstances in which such employment would be justified. In defence, R.E. should usually be employed on definite technical tasks under the order of the C.R.E.

I should like to quote another exponent of the doctrines laid down in *E.T.*, not quite of the same eminence as the last authority but closer by environment to the point at issue. In the last December number of the *Royal Engineers Journal* there is an interesting lecture by Major Sim, the Brigade Major, S.M.E., on the employment of Divisional Engineers in conjunction with other arms in war. In comparing the two systems that prevailed in the war he speaks of the brigade group school as opposed to the divisional control school and points out that it is this second system, namely, the concentration of the whole engineer problem in the hands of the C.R.E., that has now been officially adopted in our army and on which the doctrine taught in *Engineer Training* is based. Of course, Major Sim is referring to the execution of work, not to the selection and authorization of work which is the function of the G.O.C. assisted by his

staff and advised by the C.R.E. It is interesting to see from the same lecture that our friends the French have come to the same conclusion as we have. We may now happily conclude that it will be very rare indeed to see field companies either allotted to a brigadier's group command for general use or frittered away among other troops, or wiped out unnecessarily in infantry operations, or employed on works that the other arms can perfectly well do for themselves.

I have not been able to trace these principles of R.E. employment as definitely in any other book as in the *Engineer Training*, and even there they need some searching out and collating. It seems to me a pity that they are not concisely collected in *F.S.R.*, Vol. II—if they are, perhaps someone will correct me. There are many officers who, in war time, are not inclined to accept the training manual of a specific arm as an authority for general guidance. The result, however, is that the C.R.E. is definitely recognized as the G.O.C.'s agent for R.E. work, and he and his officers must be trained to carry out the duties involved, which are reconnaissance, design, *liaison* and intercommunication, consultation and executive work.

Now let us turn to the training of the officer for this. I venture to say that in a R.E. unit more depends on the officers even than in other arms. For one thing, the more highly specialized the machine, the more it is capable of being mishandled. On the other hand, an expert engineer can do amazing work with almost unskilled men. We old hands from India will not forget how Capt. Aylmer (now Lieut.-General Sir Fenton Aylmer, V.C., etc.) thirty years ago, at the back of beyond the frontier, built excellent suspension bridges out of telegraph wire and timber with wild hillmen as his labourers and only an Indian sapper or two to help him. I read the other day of the shifting back of the whole side of a street in Canada, and what interested me most was that the labour was expressly stated to be of the lowest-skilled grade.

Our manual says that in field companies a preponderance of unskilled man-power is required. That is right. But it is very certain that no unskilled officer is required. The civil profession of our R.E. T.A. officers does not teach him all the technical work of the field engineer, but it does teach him to organize work and get it done, and he can learn the rest in training his men, in special exercises for officers of all arms, in reading and in keeping his eyes open all the year round. In my humble opinion no R.E. officer should pass an excavation in the street without looking in to see what is going on—as a matter of fact, he does look in and generally delays the work. When he goes to the seaside he naturally defends the coast line against a boat landing. I do not see how an R.E. T.A. officer can carry on unless the field engineering work is his hobby and his pleasure, and while I am on that point I should like to tell you that when my time is up, the clearest memory of my service

as C.E. in this Command will be the admiration that I have felt for the Territorial R.E. officers, and the patriotism and keenness that has inspired them in the past. I am sure you and your successors will carry on the torch.

In the first years of their service T.A. R.E. officers go through courses at Chatham and Aldershot—make the most of these, they are a grand opportunity as well as, I hope, a pleasant experience of meeting the regular R.E. at home. They are, I know, a great pleasure to your comrades at Aldershot and Chatham.

Is there any difficulty about complying with the instructions for these courses?

Now how about the officer's normal training?. Without the need of troops or materials, and in his own time, he can practise reconnaissance, design, the detail of working parties and demands for material and transport—and, to make a success of this work *with his men*, he should practise it beforehand before he tries his hand on them.

Schemes of all kinds can be tackled and discussed, examples will occur to all of you such as—

(*a*) Engineer works required for the defence of a brigade or division front with detailed working-party Tables.
(*b*) The preparations for erection of a long length of wire entanglement or revetting of a trench by night, including supply and carriage of materials.
(*c*) Water supply for a brigade.
(*d*) Reconnaissance and construction scheme for a "medium" or "light" bridge.
(*e*) Assault crossing of a river.
(*f*) Preparation for demolition of various types of bridge.
(*g*) Area demolition scheme for a force retiring.
(*h*) Engineer reconnaissance of an area, etc.

One useful practice is estimating task work for infantry working parties. I have never known this sufficiently practised in peace, and have seen sorry errors in the field as the result. Sometimes the task given is far too much, sometimes far too little—one has to take a normal task and apply all sorts of factors for weather, the spirit of the troops, the physique of the unit—in order to get a fair task. Note your own men's work and compare it with the Table in the *Manual of Field Works*.

Before I leave the officer, may I, as in all cases, commend to him the words of *Engineer Training* on the functions of a leader, and stress the last lines of the instruction there given on p. 7: "Lastly, the ability to command includes the ability to execute an order through subordinate commanders without interference with their personal responsibility."

I wish the words were not quite so long, but the doctrine is all

right. It is more than a training note ; it is a great truth. I should only like to cap it by the words of a very gallant and distinguished general, who told a conference of officers that he wished to give them something to take away with them. He said, " The corollary of the delegation of responsibility is effective supervision." We can carry both these precepts into practice in our civil life, and so train ourselves for war, although I do not quite recommend them for household use.

One point more, train your junior officers so that they may have the tact and humanity to be successful as *liaison* officers and in dealing with commanders and their staffs. It is better to risk hurting their feelings when young than to find they are not *persona grata* later on. When we are in uniform we do not mind having our feelings hurt.

Now, as to the training of the N.C.O.'s and men. Hold tight to the principle of giving the sub-section commander his own job to do. You know better than I can tell you how to deal with the individual training of the men. Lectures, discussion, reduced scale work, model-making and the study of models all help you indoors. I should be glad to hear to what extent companies have models.

Now as to the collective training of the unit ; this is the puzzle. How are we to produce a field company capable of facing its varied tasks in war without having time to practise in peace the works in which you wish to make the unit efficient ?

At first sight it appears impossible, but, of course, it is not so at all. Records of the territorial companies in the war show how valuable the companies were as soon as they got out. The difficulty is not special to R.E. work. The infantry cannot really practise producing an effect on a living enemy with rifle and machine-gun fire, the artillery cannot practise a creeping barrage and see how closely the infantry can follow it up. One cannot reproduce in peace the sensation of being warmly shelled. I think you will agree that the *technical* difficulties of military engineering are really more easily to be reproduced and tackled in peace than are the difficulties that the other fighting arms are more specially trained to encounter. And as regards the practice in peace of certain particular works, remember that, as so many of you know, a field company in war spends a great deal of its time in doing things that it has never heard of before, things that certainly are not in the pictures in the books. What you want to produce is a body of divisional engineers in which the whole or any part, down to a sub-section, can work as a team under its commander. The R.E. leader who can look ahead, foresee his needs, organize his labour, materials and transport, will never find his sappers fail him—never. Even the restricted opportunities of a ten-days' camp will give plenty of practice in this team organization. If, after the day's work is done, every

officer and N.C.O. feels that sound but not dull instruction has been given to every man all the time—then all is well. Not a man off the work who can possibly be got on to it. No standing about waiting for this or that, no crowd of men too thick upon the ground or doing each other's jobs, no precious camp-time wasted in doing something that might just as well be done indoors in winter-time, no change of plan that wastes work and makes men feel that they would not have worked quite so hard if they had known *that* was coming, no miscalculation of the time the job will take, no smash caused because something that was thought "just good enough" has, as usual, turned out "just *not* good enough," no accident because a safety precaution was overlooked. If he can fill that bill every day, even a successful civil engineer will find that a Territorial R.E. camp has stretched him a bit.

But he will have gained the confidence of his men. Then the unit or the section will work as a team *whatever* the task. Remember that, with the training that their trades give them and this confidence of which I speak, territorial sappers under a trained officer will do most of their jobs as quickly as a regular company, and perhaps some even more quickly, because the T.A. men of the building and engineering trades are in more regular practice at those trades. Remember that time is generally the essence of the contract.

Let us turn, therefore, to the R.E. jobs in which a man's civil trade does not help him directly, and ask how the principles of engineer training apply to these. Which are the most important of these, which of these can be done at other times than in camp? How far can a progressive system of training be adopted for successive camps? But you must think these out in detail for yourselves. One principle seems to me to need decision: what standard of work should you attempt?

Let us consider the *Manual of Field Works for All Arms*, not forgetting that the special engineer's work begins where this leaves off. If I were a territorial infantry officer with so much else to teach my men, I should rather stand in awe of that book. I should almost be reduced to hoping for the best.

But for the sapper it is a really friendly book, it tells you a great deal of your job and tells it very well. The *Manual* is divided into five parts:—

FIELD FORTIFICATION.
BRIDGING.
ACCOMMODATION.
COMMUNICATIONS.
DEMOLITIONS.

In the case of "Field Fortifications" and these other headings, should those who are responsible for R.E. T.A. training try to exercise and perfect their men in these simple works, or aim at

combining with them more elaborate works as shown in the various parts of *M.M.E.*? It may be held that, as the greater includes the less, men exercised in the more elaborate work will learn enough about the simpler work by models, pictures or examples carried out by others. On the other hand, the danger is of trying to run before you can walk, and the more elaborate an engineering work is the more time it takes from other training and the more materials it requires. This is the point that I would rather hear T.A. officers discuss than press my opinions on them. May I hope that when I sit down the C.R.E. and other officers will tell us their views? Only one revised volume of the *M.M.E.* has appeared yet, namely, *Bridging*, so one would naturally turn to that for the latest practice.

I am afraid that materials will form the ruling factor and that, unless the locality of the camp provides special facilities, or special stores, such as heavy girder bridges, are available, the simpler training will be the rule. But in bridging and structural work I should always feel happier myself if I were practising something that the infantry cannot be expected to try. One might be obliged to let successive companies or sections take the job on, and even then only complete it in part. Of course, if one can find a job that wants doing and that gives good instruction, that may be the ideal opportunity; for instance, one field company last year felled a tall chimney for a corporation—and with success.

As regards the *Manual of Field Works (All Arms)*, every R.E. unit ought to feel sure of itself in the whole work, but I think especially so in certain points. These are revetting, trestle and floating bridges, the use of heavy spars, blocks and tackles and anchorages, watermanship and demolitions. In preparing a programme of training, read carefully p. 111 of *Engineer Training*, which discriminates between the duties of divisional and corps engineers, and follow the principles for the normal distribution of work, bearing in mind that we are, at present, training for mobile warfare.

Now, as I have attempted to deal with general principles, I hope I have led you to the point when your own knowledge of circumstances is the best guide, and I should like to ask for your own conclusions as to how far territorial engineers can find the time to make good in the various more elaborate technical works described in the several parts of *Military Engineering* as contrasted with the *Manual of Field Works*. I am only sorry that the conclusion of my time in this Command prevents my visiting you again in camp next summer, and that this may, perhaps, be the last occasion when I can hope to see a gathering of the officers of the Divisional Engineers.

DISCUSSION.

In the discussion that followed company commanders were asked to speak first and to deal, among other points, with the question

whether nowadays the company training in camp should be in the simplest subjects, or whether more advanced work should be attempted.

The Officer commanding one Field Company said: One must face the fact that at present men join for the pay and the outing in camp. Patriotism may be a greater incentive when the effects of the war wear off. The first thing is to get the military training of the recruits done by the permanent staff. You cannot get sufficient regularity of attendance and uniformity of instruction from the T.A. N.C.O.'s. Let the recruits do their technical training with the platoons; none of the men are so advanced as to make this unsuitable. Get the range practices done before camp. There may be 25 hours for collective training apart from week-ends and officers' training. Company commanders should know the C.R.E.'s skeleton programme for the ten days in camp a month before the camp begins, and they can fill it in.

C.R.E. to arrange lectures for wet days.

The important subjects for camp are:—

1. *Mobility.*—To pack and unpack, know all the tools that are carried, and why. To get quickly to work.
2. *Field Fortification.*
3. *Bridging.*—Stick to the divisional engineer's tasks. Specialize in light bridging rather than girder bridges.
4. *Water Supply.*—Distinctly a field company job, wanting more practice by officers and N.C.O.'s than by the men.
5. *Demolitions.*—Officers and N.C.O.'s are those who need the training. In his war experience he had noticed that the British Field Company demolitions were generally futile, while the German demolitions were efficient. He believed that the Germans rightly made the preparation for demolition in case of retreat a corps job. Field companies have not the time. British field companies were sometimes not allowed to prepare demolitions lest it should have a demoralizing effect on the infantry.

Omit mining and tunnelling from field company camp work at present.

The ten days' programme for camp might be (including the training in mobility):—

Three days, defences (including camouflage, not too much digging). Each company to see the other company's work.

Two days, pontooning and use of spars.

Three days, each company to specialize in one type of bridge—trestle, pontoon, barrel-pier and flying bridges (to change the type in the following camps). Bridging to include approaches to those and marking communications.

One day, rapid wiring and obstacles.
Leaving one day unallotted.

The Officer commanding the second Field Company said that it is difficult to get recruits of the best class. Get the men together to make the company drill-hall a club and get the company established. The T.A. has to count on a period of intensive training before going into the theatre of war.

Keep to the simplest forms of technical training, with illustrations of the work, full knowledge of what the equipment is and what it is for. Great difficulty in organizing lectures. The same lot do not turn up twice running and you have to begin again. Models very useful.

The Officer commanding the third Field Company said he agreed with the two company commanders who had spoken before him. Every sapper should have a *Manual of Field Works*, if only for the illustrations. The best results will be from training in the simplest subjects. Make the camp programme progressive over four years. Officers to take the N.C.O.'s separately from the men. Officers depend on self-education. Lectures are difficult. He started a course of lectures for the men; ten days, 1½ hours, once a week—two men turned up. In camp each subaltern should have his section, horse, vehicles and equipment, and be responsible for his men's clothing and equipment.

T.A. officers would be glad to hear results of Chatham researches dealing with advances in military engineering. He expressed great appreciation of Chatham courses.

The Adjutant: Try and work N.C.O.'s towards the *Manual of Field Works* standard. Men to keep to field works and simplest forms of bridging, *e.g.*, assault bridges. Officers to get on to the military engineering volumes.

Recruits certainly should be in the hands of the S.-Serjt. instructors; T.A. N.C.O.'s cannot provide the necessary regularity.

Keep a "backward squad" going in camp to catch those who would otherwise try to be spectators.

The C R.E.: Agrees with company commanders; certainly keep recruit squads under permanent staff. The "backward squad" in camp is a good suggestion. Agrees with proposal for a four-years' training programme.

The companies must have an attractive headquarters, a good "canteen institute" for the men, and a good mess for the serjeants.

The salvation of the T.A. lies in getting the new lad. Make the whole thing a club; it can get along all right without drinking. Stick to the elementary technical training. Make it simple and interesting.

ADMINISTRATION OF ENGINEER SERVICES IN PEACE-TIME.

By COL. G. WALKER, C.B.E., D.S.O.

"WHAT a dull subject," I think I can hear someone say. "What do I care about Engineer Services in Peace-time?" whispers another. Dull in some respects, I grant you, but still, every one has to think about dull things sometimes, not necessarily for his own amusement, but for the good of other people.

If anyone gets as far as this, I hope he will go on and finish reading this article, as I can assure him that he will not be bored with dull technicalities or statistics, as I propose to approach the subject in rather an unofficial way. I want rather to point out a train of thought, than to force attention to the Regulations for Engineer Services.

The young Engineer officer is taught certain technicalities relating to building and estimating for which he is sometimes at a loss to know the reason. He imagines they have nothing to do with war and war is, in his mind, the ideal employment. He is wrong; the knowledge he is acquiring will be most valuable in war, and his application of it in peace will help him immeasurably in war.

Why are there such things as Engineer Services during Peace? The answer is that they are carried out in order to provide for the comfort, health and consequent efficiency of the Army during peace. An army is a collection of human beings (a fact too often forgotten), who require just the same amenities in their lives, as do their brothers and first cousins in civil life. Like the civilian, the soldier requires a comfortable roof to sleep under, he wants to wash and bathe, he enjoys well-cooked food, he marries and requires a comfortable home in which to keep his family, he desires to worship his Maker with his fellows and hence requires a church, he reads the papers, plays cards, is fond of games and exercise, as other young men, and requires facilities to enable him to do all these things. A paternal Government realizes all this, and as far as in them lies, considering their straitened finances, they provide for these things through the agency of the Engineer Services; an agency which is administered by the officers of the Royal Engineers. Somebody will say, "we all know that without anyone writing about it." Some do, no doubt, and as it is no use trying to teach old dogs new tricks, may I particularly draw the attention of junior officers

to these brief remarks that follow? How is the young officer personally affected? I think as follows. His first connection with the administration of R.E. Services will be probably as an Assistant Division Officer somewhere, possibly he may have a whole division thrown at his head. His first duty is to keep quite cool about it, survey the situation, make the acquaintance of his subordinates (foremen of works, etc.) size them up and look at his show from the outside for a bit to see how it is going on.

Speaking generally, his business is to see that the money allotted to him for definite works is being properly and economically expended, that the money he has in his own hands for allotment to work is allotted so that the greatest benefit shall accrue to the troops, that he shall have such a thorough personal grasp of the situation, the condition of his buildings and the requirements of his troops, that he may be able at once to say what is the most beneficial way to spend any money that may come his way in the future. In all this he must be in constant touch with the officers commanding the troops in his Division and must know their wants. He must advise them as to how the regulations affect their aspirations and prove to them that he is only out to help them in every way, consistent with the rules of the game. To do this properly our young officer must have cheerful manners and he must know the technicalities of his job thoroughly, so that he can advise judiciously.

Now a few hints as to methods :—

(*a*) A thorough knowledge of your fellows is not attainable unless you constantly rub shoulders with them, learn *their* point of view; to achieve this it is useful to feed with them and play games with them. Therefore, our Assistant D.O. must try and do all these things. He must not be a recluse, who is only seen in plain clothes in his office. He must go amongst the troops and be in uniform; there is nothing derogatory in the King's uniform, and, moreover, it is not uncomfortable; but also it must be clean.

(*b*) In making Inspections do not be perfunctory. Do it well, talk to the men you see and ask them about things. If you go into a barrack room, ask if the light is good. The solitary occupant will probably say "yes sir," whatever is the state of the case, his idea being that this expression is non-committal and will save him trouble in the future. He has visions of irate N.C.O.'s who will want to know "what the devil odds it makes to him whether the light is good or bad." If you look up you will possibly see no mantles on the incandescent burners, or that the electric light bulbs have been removed, because it is the summer season and the evenings are long. The point is, see for yourself, don't believe all the smooth things you hear from

people, who want to move you on, so that they may do something else, which is more amusing. Another thing about this light is, that the summer-time is the time to get it right, so that there shall be no discomfort when the days are short and dark. Lighting should occasionally be inspected at night. A "D.O." can do a lot in helping to make barrack rooms cheerful if he tries. The colouring in many barrack rooms is offensive to the eye. Many have always been coloured the same way since the flood, almost. When redecoration is on the *tapis*, consult the people who see the rooms every day, and get their views, then help them within your money. They will babble of green fields and "hedge-sparrow green" and what not; listen and do your best. It will give trouble; it may even alter the details in certain ancient records labelled "painting" and your understrappers may think you are a fool. Never mind, you know better. Remember you are in command of your little show, that you have made up your mind you are going to command it. You also are determined that people who worry you are going to drop in for more trouble than they thought. That's the only way to live. The Engineer officer must be the mainspring of his show and not just let it jog along on its own.

(*c*) I have dealt with barrack rooms at some length, but there are other things also. The married quarters, for instance, where some of the men and women of the next generation are growing up. If they are to be well brought up, they must see nice things and be happy. Our Asst. D.O. can help in that, but he must go and see; don't wait for reports. The troops must report their difficulties, but, if our R.E. officer's subordinates are allowed to wait for reports, before doing anything, that officer's show will be a bad one. Another item, there are churches to be looked after. The troops *have* to go to church and hence their church must be decent in appearance and comfortably warmed and lighted. The chaplain will not be slow in telling of his troubles, but, quite apart from the fact that it is good for him to go to church like the men, it is the R.E. officer's duty to be in church sometimes, both morning and evening, to see what he can do to help things along. It is better that he should abstain from breakfasting in "plus fours" on an occasional Sunday morning and do his duty both to God and to his fellows. Similarly, canteens, recreation establishments, shooting galleries, serjeants' messes, officers' messes and hospitals must be thoroughly investigated. Hospitals in particular require constant care and attention, particularly

in those stations where they are of old construction. Modern standards of hospital design and finish should be studied, and a good way of doing so is to get some one to conduct you over some first-class modern hospital and to note the points where care and attention in the treatment of walls, floors, sanitary annexes, etc., will remove possibilities of dirt or germs being harboured. It is seldom possible to provide all the amenities asked for by medical officers, but much can be done by intelligent co-operation with them to improve the conditions for the care of the sick.

(*d*) Inspections are of various sorts, the casual ones alluded to above, and the more formal, Quarterly ones, when every defect is supposed to be written down for future action. While on this subject, the young R.E. officer must not, when he notices something during a casual inspection, be taken in by the remark, "that's down on the 'Quarterly,' sir." It may be quite true, but the point I want to make is that it is not enough to have defects written down on a piece of paper or in a book. The R.E. officer exists to get things put right and it is up to him to raise Cain if they are not put right and struck off the book in reasonable time. The great point to realize is that the young officer's job is to *command* and supervise his subordinates and see that they do their work. Hence, he must avoid embroiling himself in details that are the work of other people, though he must know broadly how the detail should be done, to see that it is done properly by his subordinates.

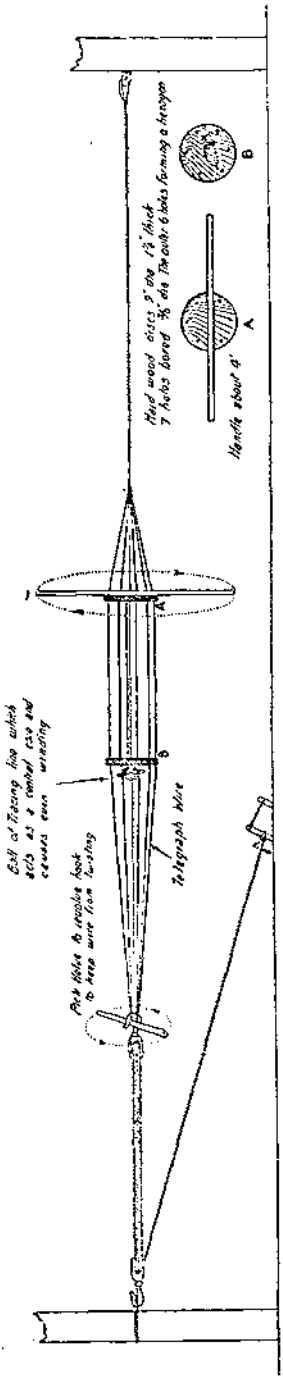
The foregoing remarks may seem rather appalling to a person who is going in to the business for the first time. There is really no reason that it should be so. The great thing is to take an interest in the people for whose comfort you are responsible, then it all follows quite easily. There is no slavery in a well-organized show—when everyone has his allotted task and is allowed to do it *without constant interference*. Command and supervision don't mean interference: some people forget that no two men do the same thing quite the same way; the thing to do is to look after the principles upon which methods are based.

If our R.E. officer has knowledge, tact and an interest in the people he is working for, he will soon find that his little command seems really all his own, and then his work will have no semblance of drudgery. It may take time to get into it at first, mayhap long hours occasionally, but that will pass. It should never be forgotten that the time given to any job is not necessarily a measure of the efficiency with which it is done. Some men stick in an office from early morn to dewy eve and never do anything much worth while.

Over-anxiety about things is another pitfall. It is waste of energy and brain tissue. "Care killed a cat" is a very true saying. Let a man do his best according to his conscience and, if his conscience passes his work, he need fear no other critic, but you must listen to your conscience !

Lord Macaulay says that, in his day, some men in the House of Commons disclaimed essays and hence failed to convince, while some literary people wrote speeches and also failed—I fear this article comes under the latter category. I hope it may not fail in its object, namely to show that the administration of R.E. Services by Royal Engineer officers is important, and that it is the spirit in which work is undertaken that really matters and makes the difference between success and failure.

PROFESSIONAL NOTES.



METHOD OF MAKING UP A WIRE ROPE OUT OF TELEGRAPH WIRE.

THE following method of laying up telegraph wire to form a wire rope has been found to be an improvement on that shown in *Plate* XXVI, M.E., Vol. III (a), 1913.

Six strands of telegraph wire are threaded through the outer holes, and a tracing line through the centre hole, of the two hardwood discs A and B. The ends of these seven lines are made fast to a post. The other ends of the wires, after being strained evenly, are attached to the revolving hook of a block and tackle which is connected to a post at a suitable distance away. The wires are twisted together by revolving the disc A which is gradually moved along the wires according to the angle of lay required.

The centre hemp core is kept taut by being fastened in a ball to the disc B, which is moved along as required.

When completed, the wire rope is "seized" two or three feet from the end and the spare part cut off, as it is found that the rope does not commence to lay evenly until this distance is reached.

With six strands of Z.23 telegraph wire and a core of tracing line an evenly laid 1½-in. wire rope can be made by two men.

THE INSTITUTION OF MECHANICAL ENGINEERS.

Memorandum Regarding Admission to the Institution of Officers Engaged in or Having Passed Through E. and M. Course.

The Institution of Mechanical Engineers has very recently revised the conditions of entry to the classes of Associate Members and Graduates, and has created a new class of Students. Under the new arrangement it is intended that the Student class should be open to engineering students or apprentices at the outset of their training, whereas the Graduate class should be confined to those who have actually "graduated" (*i.e.* passed the Associate Membership Examination or a recognized exempting Examination) and have also had some workshop experience, although they may at the time be undergoing instruction either in works or in Engineering Colleges. The position of the Graduates has thus been greatly improved; this class was formerly practically equivelant to the new class of Students, but is now intermediate between the latter and that of Associate Members.

Under these new regulations, the Council of the Institution have very generously agreed that the E. and M. Course should be looked upon as the equivalent of an apprenticeship in Works, and that the normal course passed by officers at Woolwich, Chatham and/or Cambridge University should be considered as the equivalent of the non-technical portion of the Associate Membership Examination.

The Institution is, therefore, prepared to consider application as under from officers who are undergoing the course or who have passed through it.

As Graduates.—Those under 30, provided they pass two subjects in Section C—Technical Knowledge in the Associate Membership Examination. On passing this portion of the examination, their names would appear in the printed Pass List as having passed the examination, and, after election, they would be able to obtain a Certificate of Graduateship.

As Associate Members.—Officers of 27 years and over who have passed an E. and M. Course and the Associate Membership Examination under similar conditions as those just described, and in addition can satisfy the Council that they have had sufficient practical experience in mechanical engineering, and are at the time of their application engaged in mechanical engineering work.

Officers who hold the Cambridge B.A. Honours Degree in Engineering Science, or the B.A. Ordinary Degree, provided they have passed the Special Examination in Engineering Science and the Special Examination in either Chemistry or Physics, are exempt from the whole of the Associate Membership Examination.

The following letter has been addressed to the Secretary, Institution of Mechanical Engineers, by the Secretary, Army Council:—

43/Misc./4317 A.G.7.

2nd May, 1923.

SIR,

I am commanded by the Army Council to inform you that it has been brought to their notice that the Council of your Institution has very kindly consented to extend the privileges already granted to Officers of the Corps of Royal Engineers in the matter of admission to your Institution and have sanctioned the Electrical and Mechanical Course, which some officers now undergo, being looked upon as the equivalent of an apprenticeship in Works.

The Army Council desire to express to your Council their appreciation of the action taken and to assure them that the privilege will go far to accentuate the close relationship between civil and military engineers, which the Army Council have so much at heart.

I am, Sir,
Your obedient servant,
(Signed) H. J. CREEDY.

The Secretary,
Institution of Mechanical Engineers,
Storey's Gate,
St. James's Park, S.W.1.

REPORT ON THE HOT-WATER APPARATUS ERECTED AT 28TH DIVISIONAL BATHS, CHANAK KALE, ON CAPT. K. B. S. CRAWFORD, R.E.'s PRINCIPLE FOR SUPPLYING HOT-SPRAY BATHS FOR THE TROOPS.

By COLONEL P. T. DENIS DE VITRE, D.S.O., R.E.

1. *General Description.*—The apparatus consists of:—

(*a*) A closed brick furnace and flue, into which is built a coil of iron piping made of water-pipe fittings. The latter takes the place of a boiler.

(*b*) A hot-water cistern just above the brickwork of the furnace connected by flow and return pipes with the coil in the furnace.

The secondary flow is taken off from the top, and cold water admitted at the bottom of the cistern.

There is no secondary return.

The apparatus was made of odd materials. The cylinder is apparently a Turkish oil-drum. The brick furnace was built by a miner. The opening for admission of fuel is closed by a piece of biscuit tin. The apparatus is rough and cheap; nothing elaborate about it.

2. *Working Conditions.*—Eight sprays are used. These are of the French spray pattern (Ch. Blanc); in fact, the heating apparatus is connected to the secondary flow of a French spray set, which is at present out of order, thus allowing of the admission of cold water to temper the hot water coming from the new cistern. The furnace is constructed for wood and charcoal; it is too large to burn coal economically. This, however, could be arranged with a narrower coil and firebox if desired.

3. *Particular Points in the Construction.*—

(*a*) The coil is square in plan, 16 in. each way outside measurement, these being the inside dimensions of the furnace, and consists of six complete turns of inch piping.

(*b*) The primary flow pipe comes from the top coil and is taken up through the bottom of the cistern to within one inch of the top. It is not essential that it should go up through the bottom of the cistern, provided the hot water from the coil is delivered near the top of the cistern; but a certain amount of radiation is thereby saved.

(*c*) The primary return also passes through the bottom of the cistern and is taken up 20 in. above the bottom, this height being two-thirds of the height of the cistern; here, again, the height is the essential point; this pipe is connected to the lowest point of the coil.

(*d*) The cold water is brought into the cistern as low as possible, and rises to the point of delivery, so as to prevent any circulation in the cold-water pipe.

(*e*) An expansion pipe is fitted.

Capt. Crawford's contention is that the admission of the cold-water supply to the bottom of the cylinder instead of into the boiler, and the extension of the return pipe up to two-thirds of the height of the cylinder, results in a continuous flow of hot water to the baths.

4. *Test.*—By order of the Divisional Commander this apparatus was tested under the supervision of an R.E. officer and an R.A.M.C. officer.

The fuel was weighed before consumption and the number of men bathed was accurately recorded.

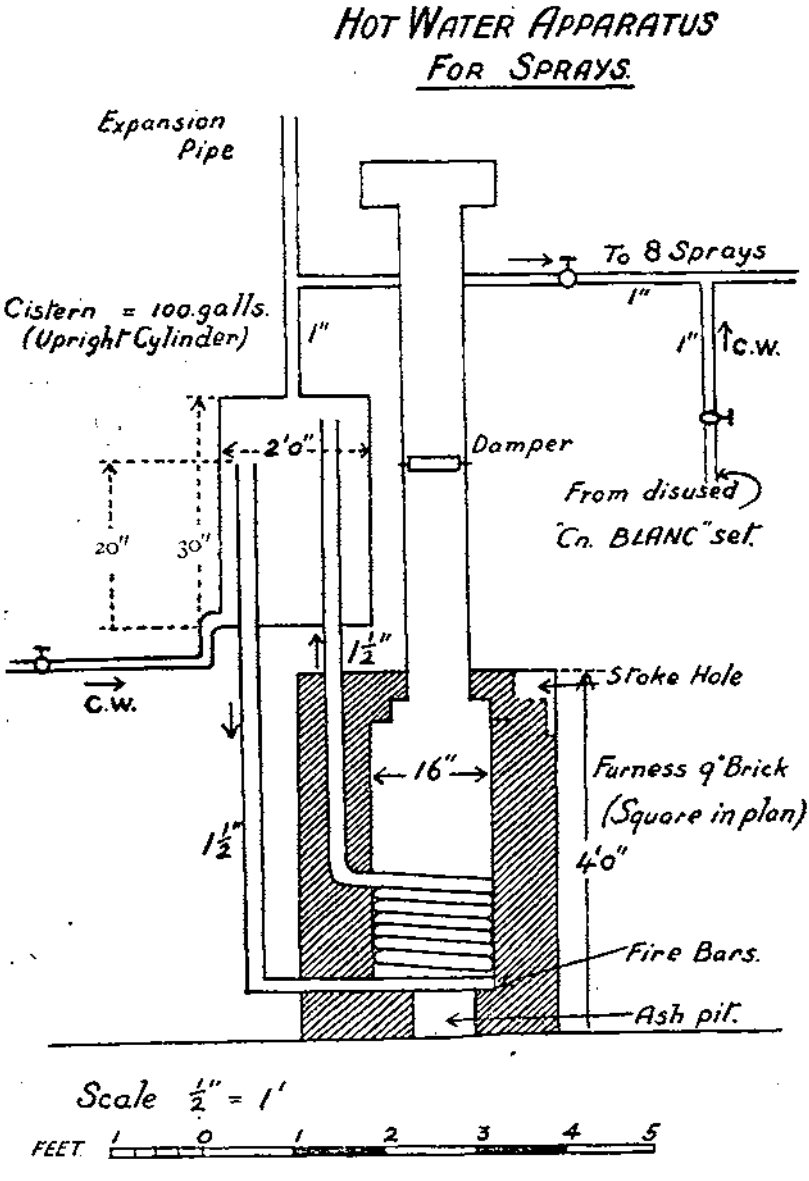
Water at 110° F. at the furthest rose, 31-ft. run from the R.W. cistern, can be obtained within fifteen minutes after lighting the fire.

Between the hours of 0830 and 1730, less an interval of one hour, for dinner, 787 men were bathed with a consumption of fuel of 286 lbs. of wood, *i.e.*, 0·363 lbs. of wood per man bathed—or total cost of 4s. 7d. at local price for wood.

At the beginning, and again just after the dinner-hour, water was too hot, so a little cold water was admitted [*vide* 2 above]

for an hour or more, when it was cut off again, the continuous supply of water sufficing to keep it from getting too hot.

This test, I think, thoroughly justifies Captain Crawford's contention in para. 3. During the test I, on three different



occasions, felt the cylinder and found the bottom two-thirds cool and the top one-third too hot to hold the hand hard against it.

The consumption of fuel records of this apparatus during a normal day's work, when men were not being constantly bathed, but when the

boiler had comparative intervals of rest and reduction of fuel consumption, the fuel consumption during 8½ working hours, less one hour for dinner, was 110 lbs. of wood, costing 1s. 9d., or 80 lbs. of charcoal, costing 3s. 6d. (before the present emergency this would have cost 1s. 10d.).

Normally, with eight sprays 100 men can be bathed per hour.

5. *General Remarks.*—This apparatus was designed on the lines of the experimental apparatus now fitted in No. 1 Cookhouse (men's baths), Buller Barracks, Aldershot, which was tested in July and August, 1921. The results of the test are filed in the Division Office, R.E., Stanhope Lines, Aldershot.

A further point is there illustrated, *viz.* (*f*) Secondary return delivering into the cistern at a height above the bottom equal to two-thirds the height of the cistern, *i.e.*, at the same height as the primary return.

The points mentioned in (*b*), (*c*), (*d*) of para. 3, and (*f*) above, are all considered essential to economy in fuel consumption.

The French spray boiler uses upwards of 1 cwt. of English coal (lump) in the working day, but it will not burn slack. Local value of lump and slack combined as supplied to troops is 2s. 9d. per cwt.

The French spray sets are too fragile for continuous work; they require constant repairs.

The sprays are too small—get choked up with grit, and men unscrew them to get more water.

(EDITOR'S NOTE.—The apparatus here described appears to be a modification of the "Nissen" down-draft incinerator, with water heating coil, which was extensively used in France.)

SLUMP TESTS FOR CONSISTENCY OF CONCRETE MIXTURES.

CONSIDERABLE importance is now attached to the question of the amount of water which should be used in concrete-mixing. It has been clearly established that excess water in a mix causes loss of strength, and that, provided the concrete be properly mixed and consolidated, a fairly dry mix will yield a concrete of greater strength than the mushy mix frequently employed. On the other hand, in certain classes of work, notably reinforced concrete, where tamping is difficult, a wetter mix must be employed to enable the concrete to flow readily in the moulds. But here again, the mix should be no wetter than required for practical reasons, in order to avoid unnecessary loss of strength. Workmen employed in mixing will always have a tendency to add too much water, in order to lessen

the work of mixing and placing. It is, therefore, very desirable to have some means of specifying the consistency of a mix, so that the proportion of water used may be as small as is compatible with the practical conditions of the work.

The amount of water used for each gauging is not a true criterion of the plasticity of the mix, for this will be also affected by the porosity and varying moisture content of the aggregate and the grading of the sand.

The object of slump tests is to provide standards which will enable the engineer to determine the amount of water required in a mix for any degree of workability, and to check the consistency as work progresses.

The method consists of filling the freshly-mixed concrete into a bottomless mould, which is lifted as soon as it has been filled. The slump or subsidence of the mass is then measured, and the amount of subsidence is taken as a measure of consistency. No standard apparatus exists in England, but a suitable mould consists of a truncated cone of 12-in. vertical height, and having diameters at the top and base of 4 in. and 8 in. respectively. Handles should be provided on the outside of the mould to facilitate removal.

To carry out an experiment, the mould is placed on a sheet of iron or other impermeable material, and the mix to be tested is filled in and consolidated by lightly rodding with a pointed iron bar of about $\frac{5}{8}$-in. diameter. Some little practice with the apparatus is required before consistent results can be obtained; it is, therefore, advisable that the first determination of consistency and subsequent checks should be carried out by the same person.

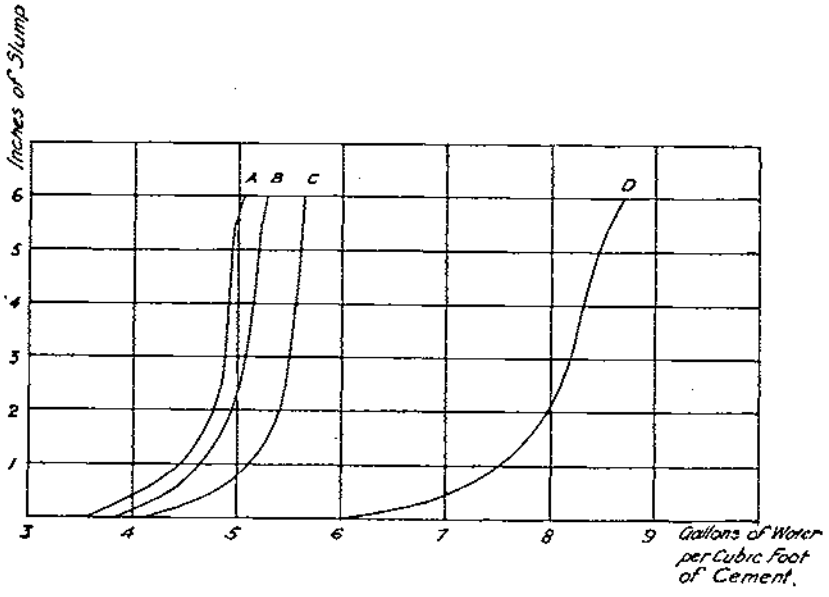
Fresh tests should be carried out for each consignment of materials received, and for varying atmospheric conditions, as the amount of water required for a given consistency will alter with the nature and water content of the aggregates.

The results of some experiments carried out at the School of Military Engineering, Chatham, are given in the accompanying graphs. Curves A and B are for a 1 : 2 : 4 mix, using Thames ballast passing a $\frac{3}{4}$-in. sieve and retained on a $\frac{1}{4}$-in. as a coarse aggregate, and Thames ballast passing a $\frac{1}{4}$-in. sieve as a fine aggregate. Curve A was obtained by taking the aggregates from a heap exposed to the weather; while curve B was for dry aggregates. Curve C represents the conditions for a 1 : 2 : 4 mix, in which a different sand was used, and curve D is for a 1 : 3 : 6 mix.

A common characteristic is the high rate of increase of the slump after a slump of about 2 in. has occurred. This is due to the complete collapse of the cone after the mould has been lifted. The occurrence of this collapse does not indicate any definite physical change in the mix, since it is obvious that the consistency at which it occurs will vary with the slope of the sides of the cone; nor does it correspond

to a sudden loss of strength on the part of the concrete. It does, however, indicate a consistency at which the concrete will readily flow into intricate moulds without much tamping, *e.g.*, in reinforced concrete work.

At a slump of 6 in. the consistency is so fluid that the fine portions of the mix tend to flow away from the coarse ; such a mixture would, therefore, fail to give concrete of uniform consistency.



The consistencies recommended for different classes of work are indicated by the following slumps :—

For reinforced concrete—2 to 3 in. (depending on the intricacy of the reinforcement and possibility of tamping).
For mass work—about 1 in.
For unreinforced roads—0 to ½ in.

The value of the slump test as a method of specifying consistency lies in the elimination of the uncertain factors of the water content and porosity of the aggregates. The limitation of the method is the difficulty of obtaining consistent results after a slump of 2 in., *i.e.*, about the point of collapse of the cone. The slump test should, therefore, not be interpreted too strictly ; in other words, a batch of concrete should not be rejected simply because the slump is a little higher than was intended. The principal value of the test as a check is to prevent the habitual use of such an excess of water as will materially lower the strength of the concrete.

J.C.P.T.

APULIAN AQUEDUCT.

IT is, perhaps, worthy of note that, on the completion of the Apulian Aqueduct in Southern Italy, a water distribution service, comparable to many of the large works carried out on the other side of the Atlantic, will have rewarded the genius of Italian engineers after 16 years spent in construction. An account of this gigantic undertaking appears in the *Engineering News Record*, of March 1st.

Water is taken from Caposele Springs on the western side of the Appennines and brought by means of tunnels totalling nearly 50 miles in length to the Eastern side, whence it is distributed to a population of some 3,000,000 people scattered over an area of 8,100 square miles.

The main trunk running to Taranto is about 150 miles long and there are 840 miles of main and subsidiary branches. The maximum *capacity* of the aqueduct is 137,000,000 gallons per day and the *allowances* of water per head per day vary from 24 gallons in the case of the bigger towns to 10·6 gallons in the case of small communities dependent on pumped supplies.

The *Storage Capacity* is at present low and at the best only allows for a 72-hour supply. As the country is subject to violent earthquakes, which may cause, in the main trunk, damage requiring much more than 72 hours to repair, it is probable that means will be found to remedy this defect in the system.

Aqueduct Headworks.—Springs were intercepted by means of about a dozen tapping galleries which empty into a common collecting channel which conveys the water through a feeder canal to the intake of the aqueduct. These tapping galleries have a uniform rectangular section of 2 ft. $7\frac{1}{2}$ in. × 3 ft. 11 in. The bottom is unlined natural rock. Side walls are of concrete blocks whose vertical faces are 6 in. apart. Roofs consist of concrete slabs resting on the sidewalls. (See *Fig.* I.)

All the collecting and intaking system is under cover.

Main Trunk.—Tunnels of circular or horseshoe section are considered good against earthquake shocks. They are all lined with brick or concrete. Three main tunnels are each about 10 miles long and their sectional area varies from 75 sq. ft. to 52 sq. ft.

Most of the remainder of the main trunk is composed of a cut and cover canal, the top of the conduit being ballasted with not less than $6\frac{1}{2}$ ft. of selected material, in order to maintain a low water temperature.

Ravines, etc., are crossed :—

(i) By means of aqueduct bridges, a feature of which is that the conduit is made structurally independent of the bridge. It is insulated by means of air spaces in order to keep the water cool. (See *Fig.* II.)

(ii) By means of siphons, employed where bridges would have cost much more. Siphons all consist of twin pipes of steel or reinforced concrete. A siphon over 70 miles long has been designed for the Lecce branch.

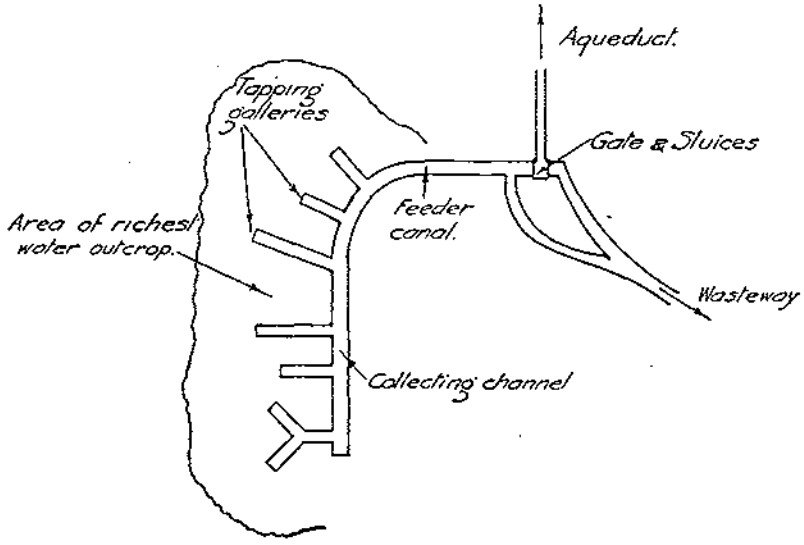


FIG. I.

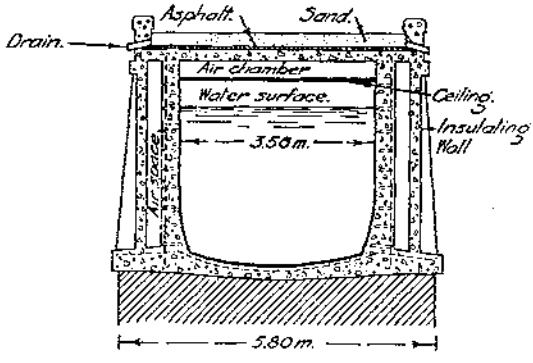


FIG. II.

Main Branches.—These consist largely of reinforced concrete pipes varying from 6 in. to 32 in. diameter, and made mostly by the centrifugal method.* Concrete is fed into a rotating steel cylinder containing the reinforcement which consists of helical wires crossing each other. The centrifugal force generated by the rotation of the cylinder distributes the concrete and produces a pipe shell of uniform thickness. An interior coating of $\frac{1}{8}$ in. of asphalt is applied in the

* A notice of this method, under the title of *Hume Reinforced Concrete Pipes*, appeared in the *R.E. Journal* of July, 1921.

same manner. The pipes are left in the cylinder for 24 hours, then kept wet for 48 hours, and finally buried in gravel for 15 to 20 days. On removal from the gravel they are stored in a shady place for a period of 1 to 2 months. The standard length manufactured is 3 metres.

"Eternit" pipes (asbestos and cement) have also been largely used with satisfactory results.

Cost.—The original estimate for the scheme was about £5,500,000.

A.G.B.B.

Lieut.-Colonel Hugh Drummond Pearson, D.S.O., R.E.

Photo by Swaine.

outlying districts south of the Orange River. In this he was successful, and when he reached Upington, on April 3rd, there was nothing to do but to arrange for the policing of the disaffected districts. Settle then returned to Cape Town to resume his work as Inspector-General of Lines of Communication.

In September, 1900, Settle, in co-operation with Methuen, was ordered from Vryburg to relieve Schweizer Reneke. He entered the town unopposed, and then, in October, he was ordered to the Free State. In the Boer invasion of Cape Colony and the great hunt for De Wet, from December, 1900, to March, 1901, Settle played his part. Kitchener adopted his recommendation that martial law should be at once proclaimed in Cape Colony, and ordered him to take command on the line of communications between De Aar and Naauwpoort, and to organize all available troops to prevent the passage of this railway. At the end of December, Settle, in command of four columns, pursued Hertzog, who was forced back to the north-west. In Kitchener's plan of the following February against Hertzog and De Wet, Settle, who became for the purpose of the operations, Lyttelton's Chief of Staff, was entrusted with the duty of giving all orders for moves to the fifteen columns engaged. The plan was so far successful that the fear of an immediate rising in Cape Colony was removed, and in March, Settle resumed the direction of operations against Kritzinger and his comrades. In April he was transferred to the Western part of the Colony to organize resistance to some rebel bands under Maritz and Conroy. In May he left South Africa on temporary leave of absence, and the huge territory he had controlled was split into four. At the end of October, Settle returned, and, after an inquiry into the administration of martial law and a short term of command at De Aar, succeeded in December to the administrative command of Cape Colony in succession to Major-General Wynne. For his services in the war he was twice mentioned in dispatches, promoted to the rank of Major-General for distinguished service in the field, and advanced to K.C.B.

In 1904 General Settle returned to England, and in 1905 was given the command of the Coast Defences at Portsmouth, where he remained until 1908, when he was promoted to the rank of Lieutenant-General. He retired from the Army in 1911.

General Settle married, in 1875, Edith, only daughter of John Rigg, of Wrotham Hall Park, Kent, by whom he had a daughter and a son. The latter was killed in action in 1918.

The funeral was at Bath on Thursday, April 26th.

(Extract from "The Times" of Tuesday, 24th April, 1923.)

MEMOIRS.

LIEUTENANT-GENERAL SIR HENRY HAMILTON SETTLE, K.C.B., D.S.O., Colonel-Commandant R.E.

LIEUT.-GENERAL Sir Henry Hamilton Settle, K.C.B., D.S.O., R.E., whose death at the age of 76 is announced elsewhere, will be chiefly remembered for his services during the South African War. From that test he came out with credit. He had retired some three years before the European War.

The second son of Captain H. T. Settle, of Southover, Lewes, he was born on January 27th 1847. He was sent to Cheltenham and gained his commission as lieutenant in the Royal Engineers in 1867 He first saw active service with the Sudan Expedition of 1884–85, when he took part in the operations on the Nile as D.A.A. and Q.M.G. at Gemai and on the lines of communication, being mentioned in dispatches and promoted Brevet Major. From 1886 to 1892, Major Settle filled the post of Surveyor-General and Q.M.G., Egyptian Army. In the meanwhile he was engaged as Senior Staff Officer in the operations at Suakim, being present at the actions of Gamaizah and Toski, and at the capture of Tokar. For his services he received two mentions and was promoted Brevet Lieutenant-Colonel and awarded the D.S.O. In 1892 he was appointed Inspector-General of Egyptian Police, and three years later came home to take up the appointment of Assistant-Inspector-General of Fortifications at the War Office. In 1898 he was created C.B.

For a few months in 1899 he commanded the Royal Engineers at Malta, whence he was called in October to take part in the South African War. Before Paardeberg, Roberts had already ordered three small columns to be formed by Settle, the commander at Orange River Station, to check the course of the rebellion in Cape Colony. Settle himself took the right column to cut off Liebenberg. One of the other two columns, however, was repulsed, and Kitchener was sent to take command of the operations with strong reinforcements. His plan was the same as Settle's, who joined him in Prieska on March 21st, and was given the task of bringing to order the rebels left in the

Lieut.-General Sir Henry Hamilton Settle, K.C.B., D.S.O.,
Colonel Commandant, R.E.

Photo by Elliott & Fry, Ltd.

LIEUT.-COLONEL HUGH DRUMMOND PEARSON, D.S.O., R.E.

HUGH PEARSON died of blackwater fever at Um Dafog, Darfur Province, Sudan, on the 28th December, 1922, on the eve of the completion of his work as British representative on the Anglo-French Commission for the delimitation of the frontier between the Anglo-Egyptian Sudan and French Territory (Wadai). The protocol was to have been signed by him and the French Commissioner on 1st January. This work, which had been in progress for some fourteen months, was the crowning achievement of eighteen years' service as Director of Survey in the Sudan, broken only by special service during the Great War. On its completion Pearson was to have left the service of the Sudan Government and he was looking forward to the enjoyment of a well-earned rest after many years of arduous work.

He was the second son of the late David Ritchie Pearson, M.D., and Jean Rae, and was born at Kensington on the 17th February, 1873. He passed direct into Woolwich from St. Paul's School and obtained his commission in the Corps in 1892. Two years later he went to India. He saw service in the Tirah Expedition of 1897–8 and with the China Field Force in 1900–2; he was present at the relief of Pekin and was mentioned in dispatches. In 1902–3 he was British representative on the Anglo-Liberian Boundary Commission. Returning to West Africa in November, 1903, he was in charge of the Colonial Survey Section operating in Sierra Leone, when he surveyed the sources of the Niger at Tembicundo.

In January, 1905, he succeeded Colonel Talbot as Director of Survey to the Sudan Government. Survey work in the Sudan was then, a short time only after the re-occupation of the country, in its infancy, and offered a wide field for Pearson's untiring energy. One of his first tasks was to push on the cadastral survey of the cultivable lands watered by the Nile, a necessary preliminary to the all-important question of settlement of native land-ownership. In addition to dealing with the land bordering the river north of Khartoum, in Khartoum, Berber, Dongola, and Halfa provinces, there was the problem of the tract known as Gezira, lying in the triangle, south of Omdurman, formed by the two branches of the Nile, White and Blue, and approximately the 14th parallel, the scene of the great schemes now being executed for bringing this area under cotton cultivation. The country is flat and featureless, and Pearson decided on a system of squares, with sides of a minute of arc, marked on the ground by beacons, from which points the detailed survey was filled in. Some 5,000,000 acres have been surveyed in this way at a cost of about a shilling an acre.

At the same time the triangulation begun by his predecessor was steadily continued, extending over the western province of Kordofan, south to the Lado Enclave and the Bahr-el-Ghazal province, and on the east to the Red Sea littoral. In 1911, in Kordofan, Pearson himself, in less than three months, fixed upward of 100 points over an area of 20,000 square miles. At various times he fixed personally a large number of telegraphic and chronometric longitudes at places on the upper reaches of the Blue and White Niles and at other remote points of the country. Although the topographical survey of the country is not completed, maps of the whole of the Sudan on the 1/1,000,000, 1/250,000 and other scales are now available. Town surveys of the principal cities and many special surveys in connection with concessions, the demarcation of basins, etc., have also been carried out.

In 1910 Pearson presided over the Commission appointed to take over the Lado Enclave from Belgium on behalf of the British and Sudan Governments. In 1912 he accompanied the expedition in the Beir country, taking this opportunity to obtain valuable information regarding the Pibor River system. In 1913 he received the Murchison Grant of the Royal Geographical Society " for his surveys and other geographical work in the Sudan."

During the war Pearson was employed on a variety of special services. In 1916 he proceeded in charge of a mission sent to Lake Tsana in Abyssinia to obtain information and data required in connection with a proposed dam at the neck of the lake. During the same year and in 1917 he was at Jeddah as *liaison* officer with the Arab forces. Later in 1917 he represented the Sudan Government at the coronation of the Empress of Abyssinia, and was charged with conveying the G.C.M.G. to the Regent at Adis Ababa. Subsequently he joined the Egyptian Expeditionary Force, was for short periods Military Governor at Jaffa and of Jerusalem, and at the time of the final overthrow of the Turks in Palestine was C.R.E. of the Desert Mounted Corps. For his services during the war he was awarded the brevet of Lieutenant-Colonel and the D.S.O. In addition to war medals, he received at various dates the Orders of the Osmanlieh and of the Nile, the Star of Ethiopia, and the Nahda, the latter from King Hussein.

Pearson's last work, the delimitation of the Darfur-Wadai boundary, some two thousand miles of frontier, has already been referred to. Actuated by his high sense of duty, he continued this work throughout the rainy season in Darfur and this, no doubt, undermined his strong constitution. He had married, in 1919, Blanche, daughter of the late Colonel R. E. Grigg ; she was on her way from England to join him in the Sudan when the news of his death reached her.

The above is a record of Hugh Pearson's services to his country.

To describe what he was to his many friends is not so easy. There remains the impression of a most lovable personality. Most vividly, perhaps, one remembers his almost childlike simplicity, his complete unselfishness, and his intense vitality. Whatever he did, at work or at play, he did with his might, and, whatever doing, and with whomever dealing, he missed no detail in his constant endeavour to make things go happily.

Sir Lee Stack, Sirdar and Governor-General of the Sudan, writes of him: "By Colonel Pearson's death the Sudan has lost a keen, energetic and capable officer, an able administrator and a delightful personality. Whatever the post he held—and they were many and varied—his conduct was marked by the same enthusiasm, the same efficiency and boundless energy, the same cheerfulness and sympathy with others in the face of difficulties, which made him the ideal type of officer for a country like the Sudan. He won the regard and esteem of everyone with whom he came in contact, and his tragic death, at a time when he was on the point of retiring from Government service to enjoy a well-earned rest, has been universally mourned by all races alike."

Another friend in Khartoum says: "He was just the type of man fitted to help in building up a country like this; always cheery and happy himself, he strove to make other people cheery also. Nor was his interest in people limited to those of his own race, but he was also courteous and sympathetic to all races that worked under him, and, as we know, won their confidence and great regard. He gave his support to everything that went to form a good, healthy public opinion in the community in which he lived."

The following appeared in the *Spectator* from a civilian friend, now in Baghdad, who was Pearson's contemporary for many years in the service of the Sudan Government: "The death from black-water fever of Colonel Hugh Drummond Pearson, D.S.O., R.E., which took place in South-Western Darfur, many miles from road or rail or navigable water, at a moment when the Wadai-Darfur Commission, over which he presided, had delimitated some two thousand miles of frontier and had all but completed its labours, will arouse public sympathy and regret for a gallant and distinguished officer serving the Empire in its outposts. . . . The area of the Sudan approximates in size to that of India, and its inhabitants had just emerged from a disastrous and savage tyranny. Yet in a few short years the political and technical services, hand in hand, under the wise and tactful guidance of Sir Reginald Wingate, had conferred the benefits of civilization on much of that vast area. Pearson was Director of Surveys for nearly twenty years, and a glance at the map will show that he had, perhaps, the most strenuous task of all, the mapping of desert, forest, marsh, and a maze of varying and uncertain waterways, in addition to the more detailed work connected with

land settlement and the like. He was a great hunter and a fine athlete. . . . At headquarters he was the life and soul of Khartoum society, the friend of all and the hero of many. . . . England and the Royal Corps may well be proud of Hugh Pearson and the type he represented."

To those who had the privilege of his friendship Hugh Pearson's life remains a lasting inspiration; to the younger generation of Sappers the record of his career should be an incentive to follow his example of self-sacrificing devotion to duty and strenuous service.

E.V.T.

(*A very appreciative memoir was published in the Geographical Journal for March*, 1923, *over the initials R.W.*—EDITOR).

BOOKS.

THE D.U. TECHNICAL SERIES.

LINE Charts for Engineers, by W. N. Rose, B.Sc. Eng. (Lond.), published by Chapman & Hall, Ltd., 11, Henrietta Street, London, W.C.2, price 6s., is a useful little book for those who are interested in the application of "nomograms" or "alignment charts" to the solution of technical problems.

The author has explained in a very clear manner how to adapt formulæ for representation by charts, and how to construct suitable charts.

He commences with simple addition and subtraction charts carrying natural scales and in easy stages works up to charts involving logarithmic plotting.

Practical examples are given, such as a chart for the solution of Unwin's Formula for welded steel tubes,

$$P = \frac{1472600\, f^{2\cdot1}}{l^{\cdot9}\, d^{1\cdot16}}.$$

Unless a large number of calculations has to be made from the same formula with varying functions, the time spent on the compilation of a chart will not be repaid, nor can extreme accuracy be obtained from any chart, but under certain conditions "nomograms" are very valuable as time-savers.

Great stress is laid in the book upon the choice of suitable scales of notation; otherwise there will result a chart difficult to read.

As an example of a choice of suitable scales and for the benefit of those designing reinforced-concrete beams, three charts have been prepared for the solution of the formula

$$r = \frac{A_t}{bd}.$$

Fig. 1 is graduated in a natural scale.

Fig. 2 is graduated in a natural scale derived from the square roots of the functions

$$\sqrt{r} = \frac{\sqrt{A_t}}{\sqrt{bd}}.$$

Fig. 3 is plotted from logarithmetic values and is based on the fact that

$$\log r = \log A_t - \log bd.$$

Of the three charts probably *Fig.* 3 is most easily read.

The values used when graduating the charts are the natural values, and not their square roots or logarithmetic values; otherwise the charts would be of little convenience.

The value of $b \times d$ has been plotted as one of the variable functions, as the multiplication of these two values is usually a very simple operation.

It may be argued that the results obtained from the use of alignment charts could more easily be found from tabulated Tables of values, with less liability of error, but the compilation of such Tables would usually be a much longer process, and in most engineering problems the degree of accuracy obtained from a well-designed chart is sufficient for all practical purposes.

D.K.E.

FIG. I.

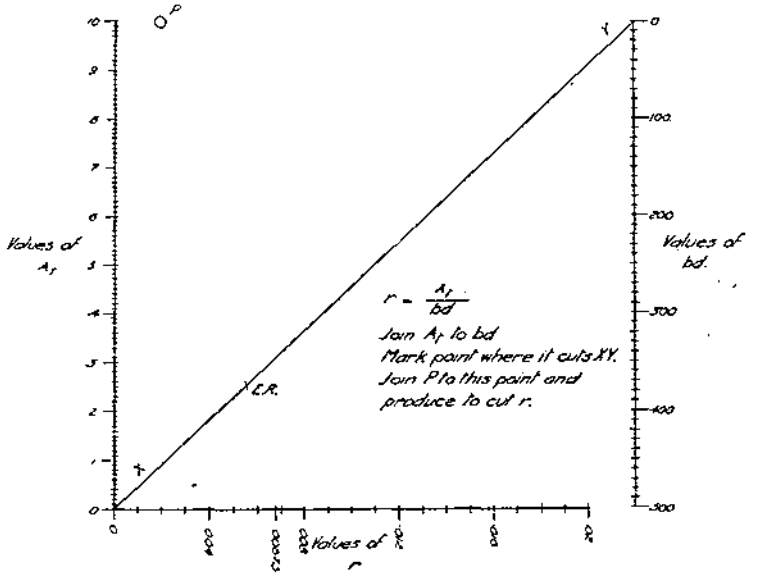


FIG. II.

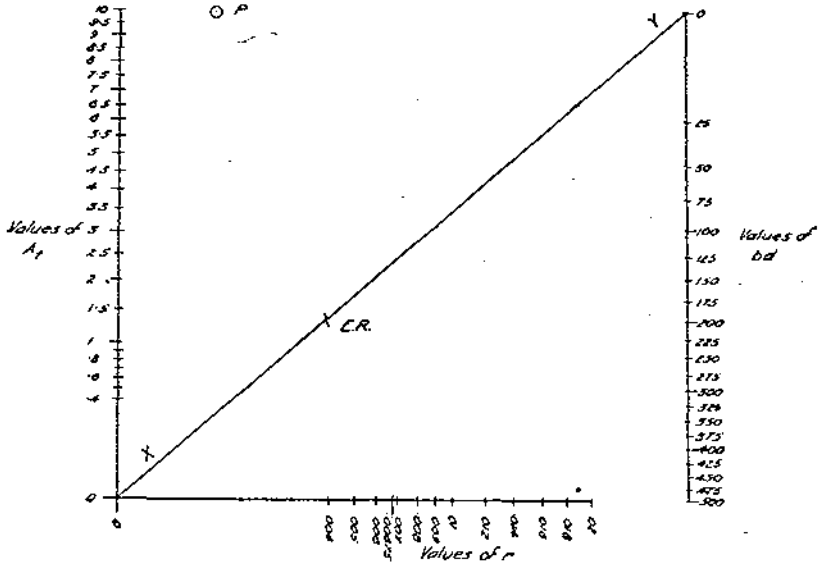
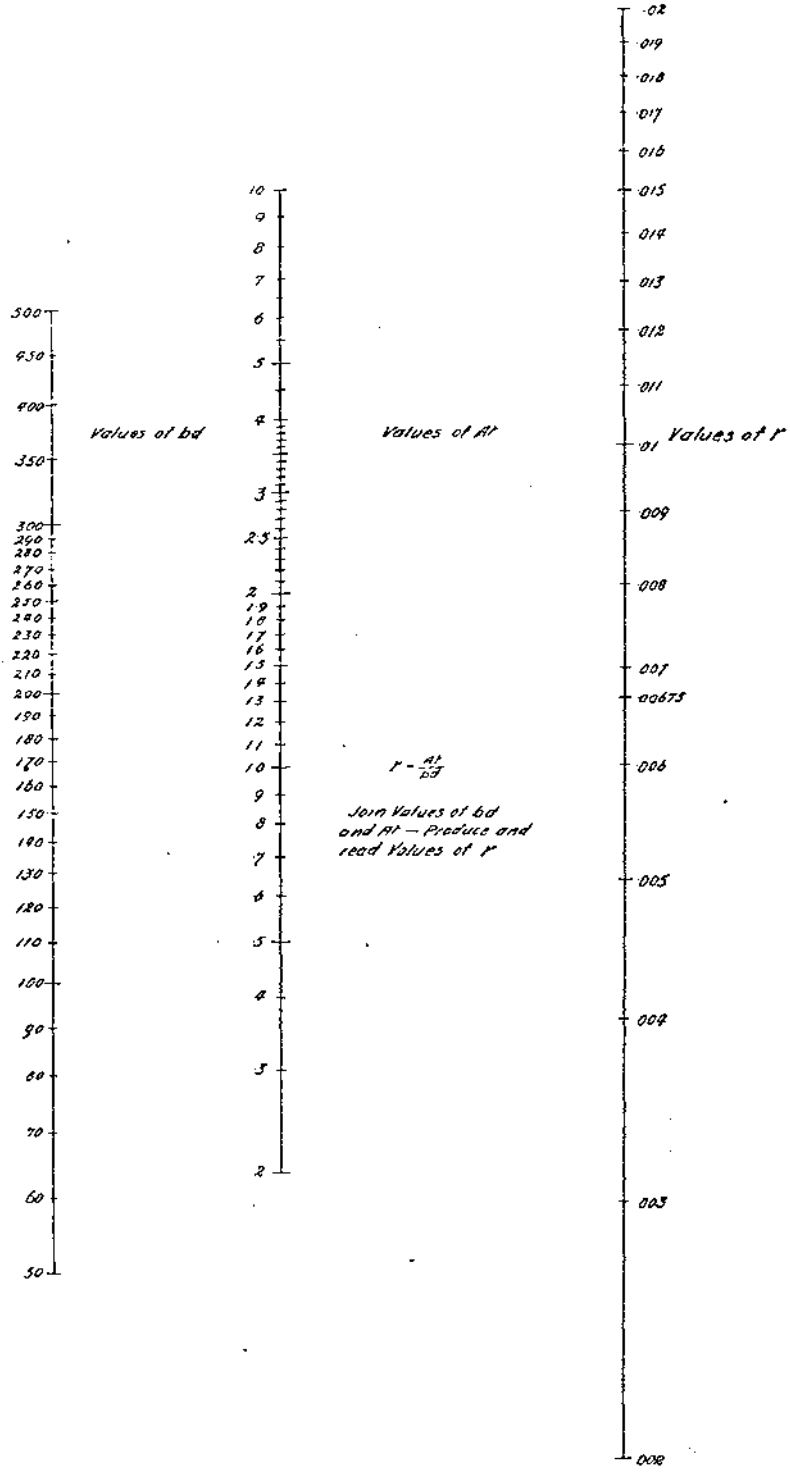


FIG. III.


Values of bd
Values of Δr
Values of r
r = Δr / bd
Join Values of bd and Δr — Produce and read Values of r

SIWA—THE OASIS OF JUPITER AMMON.

By C. DALRYMPLE BELGRAVE. With an Introduction by General Sir REGINALD WINGATE. (John Lane. 15s. net.).

SIWA, the original home of the Senussi, has a special interest for the Corps, from the fact that during the war Colonel the Hon. M. G. Talbot negotiated there the triangular treaties between Italy, Great Britain and the present head of the Senussi Confraternity, a little-known but most important achievement.

Mr. Belgrave spent two years in Siwa in 1920-21 in command of a section of the Frontier Districts Administrative Camel Corps, and for some time as District Officer of the oasis; and he devoted his spare time to discovering as much as possible about the history of the place and the manners and customs of the community. As a result, he has produced a most valuable and entertaining book, illustrated by his own brush and camera.

The story of Siwa begins in the 13th century B.C. It is the father of all the oases, in that Herodotus gave it the name "Oasis," and from it all other fertile spots surrounded by desert have derived their generic title. Nevertheless, it eventually fell into British hands, taken by a 200-mile dash of armoured cars from the coast: it almost seems an act of vandalism, or at any rate disrespect, to such antiquity. The natives, we are told, now have a wholesome dread of "trombiles," as they call motors.

The author has secured a sixteen-page preface from General Sir Reginald Wingate, in which he, with his unique knowledge of and authority on things Egyptian, reviews the connection between the Egyptian Government and Siwa in recent days. It is a most important piece of historical work, and should be read, it may be said without derogation to Mr. Belgrave, even by those who have time only to skim the rest of the book.

J.E.E.

A CHAPTER OF MISFORTUNES.

By Major-General W. D. BIRD, C.B., C.M.G., D.S.O.

(Forster Groom & Co. 8s. 6d.).

Reviewed by Major H. N. KERMACK, R.E.

THIS book deals in detail with the battles of Ctesiphon and the Dujailah Redoubt in the Mesopotamia Campaign, with a summary also of the events leading up to each battle. The author did not personally take part in the campaign, but has compiled the account from reports, war diaries and personal narratives, including that of a Turkish Staff Officer. The two maps are based on the Ordnance Maps, but are on rather a small scale. They are suitably placed in the book and open clear of the pages. There is a good index.

General Bird has written an unbiassed, though very critical, account of these operations. He has been very fair in "endeavouring to interpret the feelings and mental workings" of the men with whom

the decisions rested, and only gives his opinion after stating the arguments on all sides. It is a book from which many lessons, both strategical and tactical, can be drawn, and is a valuable addition to the military history of the Great War.

Two of the principal points regarding this campaign, over which controversy has raged, are discussed in full :—

(i) The further advance for the purpose of gaining Baghdad after the capture of Kut-al-Amarah by General Townshend. The author's views of the lessons to be gained can perhaps best be summarized by the following extracts : " It has been said that the military professional mind is of necessity an unimaginative mind. But it can hardly be suggested that the sometimes fatal power of imagination was not in the ascendant as regards operations in Mesopotamia, for almost everyone was so much absorbed in considering the advantages of gaining Baghdad that the dangers and difficulties that must be encountered were somewhat too readily discounted " ; and again : "The moral, therefore, is that the probability of obtaining success cannot fail to be jeopardized when unity of direction and control is absent."

(ii) The decision to stop at Kut after Ctesiphon. Here General Bird comes to the conclusion that, tactically, Kut was unsuitable for withstanding a siege and that, strategically also, the balance of argument was against stopping.

The book brings out well how the predominant factors in both strategy and tactics were those of time and transport. Can the relieving force delay until certain reinforcements or certain transport can arrive from Basrah ? If we delay, can the Turk bring up more reinforcements in the time than we can ? For how many troops can we manage to bring up supplies from Basrah ? How many troops can the Turk keep supplied east of Kut ? Have we sufficient land transport to operate at a distance from the river ? These were the type of problems which the Army and Corps Commanders had always before them.

As regards the battles—

(i) No very clear impression can be obtained from the description of the battle of Ctesiphon, possibly owing to the war diaries relating to it having been lost at Kut. Probably, however, the impression of confusion which is given corresponds to the actual state of affairs, many changes and interchanges of position having been made by the various columns. Diagrams showing the actual situation at different times would, however, help considerably. It may be noted that the Sappers and Miners appear to have been employed more as infantry than as sappers.

(ii) The action at the battles of Shaikh Saad, Wadi and Hannan is only indicated by means of small diagrams.

(iii) The battle of the Dujailah Redoubt is described in full, from the approach march to the retirement. The author criticizes frankly the orders issued by General Aylmer for the attack

and also comments adversely on the action of certain of the Column Commanders in carrying them out. Diagrams of the situation at different times would again assist very materially in understanding the position.

Although intensely interesting, the battle of the Dujailah Redoubt is depressing reading, for it is one of the most striking examples of what might have been.

The Campaign and the book end in the same tone :—

" Kut-al-Amarah surrendered on the 29th April and the attempts which had been made by the British to reach it had then involved some 23,500 casualties in battle, or a larger number of men than that with which Aylmer had first advanced in January, 1916."

A SCIENCE OF INFANTRY TACTICS SIMPLIFIED.

By CAPT. B. H. LIDDELL HART. (William Clowes & Sons, Ltd. Price 5s. 6d.)

THIS book was first published in 1921 and has now been revised. It is an elaboration of the lectures delivered by the author in the R.E. Lecture Theatre, which were published in the *Royal Engineers Journals*, of April and May, 1921.

SUSPENSION BRIDGES.

By Dr. D. B. STEINMAN. (Chapman & Hall, Ltd. 1922. Price, 20s.)

THIS volume is divided into four Chapters. Chapter I (68 pages) deals in a concise and clear manner with the stresses occurring in both stiffened and also unstiffened suspension bridges. This Chapter is very useful, as the majority of text-books on the subject are far too abstruse for the average reader. The so-called " approximate theory " is alone dealt with here, and, by its use, both truss and cable stresses can be computed with quite sufficient accuracy even for very large bridges with three, two or no hinges in the stiffening girders. An Appendix contains several charts to facilitate the calculations, and these should be of great assistance when checking designs. In Chapter II the various types of existing suspension bridges are discussed, and information is given upon the structural details and materials employed. Chapter III gives the complete computations for several selected type designs. Chapter IV deals with the methods used in the erection of suspension bridges, but is perhaps more of general interest than actual utility to a Royal Engineer officer, as the systems described are those employed upon larger bridges than he would be called upon to construct. The book, as a whole, certainly fulfils the author's aim in producing a practical hand-book on a subject which is often either omitted from other works or else dealt with in a purely theoretical manner. From the point of view of the average engineering reader the book is well worthy of note, if for no other reason than its Chapter describing in detail the erection of several of the longest single-spans in the world.

E.F.T.

WORK OF THE R.E. IN THE EUROPEAN WAR, 1914–19.

MILITARY MINING.

THIS volume has been edited in three Parts: Part I—Historical. Part II—Mine Rescue Work. Part III—Technical. The author must be congratulated on the patience and skill with which he has compiled such an interesting and instructive account of the mining in France and Belgium, from the mass of correspondence and reports which had been accumulated during the war.

Mine Rescue Work is very fully described, although not strictly speaking R.E. work; but it must be remembered that the development of this science was absolutely essential to the success of our mining operations, and it has been wisely decided to ensure that the experience gained in this branch of mining should not be lost, by finding a place in a R.E. Publication for the contents of a pamphlet on the subject written by the expert Medical Officer specially attached to the Staff of the Engineer-in-Chief.

Part I, Chapter I traces the gradual development of the mining organization, from the blowing of the first mine of the war on our front about December, 1914, to the appointment of the Inspector of Mines' Staff at G.H.Q. and the subordinate staffs of the Controllers of Mines of the Armies.

The lightning speed at which the first eight tunnelling companies were formed is the strongest testimony to the fiery energy of Major Norton Griffiths (now Lt.-Col. Sir J. Norton Griffiths, K.C.B., D.S.O., M.P.) who, while personally escorting clay-kickers from England to the front by night, found time during the day to hold parades of men in the mining trade in every sort of unit at the front, and to select, by special charter, from A.G., G.H.Q., all or any of those men he considered suitable—a most remarkable charter, it must be admitted.

The tunnelling companies from overseas were a most valuable reinforcement. It was unfortunate that the mining situation at the front did not permit of the tunnelling units from each Dominion, etc., being grouped together in battalion formation. The staff of experts brought to France in the Headquarters of the Australian Mining Corps were of untold value.

The organization of the staffs for the Inspector and Controllers of Mines deserves study for use in the future. The reasons for the formation of these staffs were to obviate extravagant demands on the tunnelling personnel, to effect technical control over the work in hand and to ensure the economical distribution of the tunnelling companies.

At one time, in 1916, a rough census was taken of the men employed all down our front on underground work. It was found that as many as 24,000 all ranks was the highest number under the control of the Controllers of Mines.

These numbers included those men employed on dug-outs, but they indicate how the fighting strength of an army may be prejudiced by the too generous development of mining work.

The importance of the science of geology is very properly insisted upon and must never again be allowed to be omitted from any text-book

on military mining. We were very heavily handicapped at one time by our ignorance on this subject.

Chapter II is a very able and interesting *résumé* of the development of the mining work from March, 1915—December, 1918, showing how the operations gradually improved from individual instances of mining spectacles and reprisals in shallow mines, in most unsuitable ground, to really important mining operations which formed a definite part of the scheme of a general offensive.

The only representative of the earlier period of mining included in the main operation of the Battle of Messines was the Berlin Tunnel at Hill 60. This was a long, inclined shaft to mine galleries 60 ft. or 70 ft. below the surface, driven through the wet clays overlying the good "blue."

This tunnel proved conclusively that an inclined shaft through wet clay is a very grave mining extravagance, for, when the incline was eventually superseded by a vertical shaft, the working party for pumping only was reduced by 70 men a day!

The organization of craters for defence is a most important study. The occupation of a crater is, of course, a tactical matter, but when the occupation has been decided upon, the actual organization of the defences is a highly technical matter and is, undoubtedly, work for the R.E. Time after time it happened that craters were blown for a definite purpose, which was fully achieved, priceless observation being obtained over the enemy trenches, but these craters never remained in our hands more than a few hours. The Germans, on the other hand, fully realized the value of such observation and made a point of occupying and retaining possession of nearly all important craters.

The mining under the Double Crassier at Loos is well told, but our success there does not appear from the text as important as it really was.

It will be seen from *Plate* IV that we occupied only 70 yards' length of the Southern Crassier. If this length had been taken by the Germans, they would have obtained observations over the whole of our trenches between Loos and Hill 70—which must have led to the evacuation of a very important portion of the ground won by the battle of Loos. It was essential that the German mining system should be destroyed, and the company which had this work in hand did it so thoroughly that the enemy never gave any more trouble.

The temperature of some of the headings under the Crassier was very high. This is said to be due to the effect of rain-water on the débris which formed the Crassier.

Chapter III gives detailed accounts of the more important mining operations which were undertaken in conjunction with a general action by other troops.

It opens with the mining for the attack on Hill 60 on 17th April, 1915.

This is the first mining operation of any importance in the history of the British Army since the Crimea and it is probable that the total charge fired was largely in excess of anything attempted in those days.

It was carried out under a R.E. officer, in accordance with the regulations and with the equipment of 1914.

The complete success which attended the operation is an eloquent testimony to the efficiency of the designer and the personnel employed under him, for this work was done before the days of silent tramways and noiseless ventilating apparatus, and the science of listening was still in its infancy.

The result of the combined operation was neutralized not long after by the use of poison gas by the Germans.

St. Eloi.—A year after all but a month, mines were again used in combination with an infantry offensive in the adjacent salient of St. Eloi. This may be said to be the first mining effort under the control of the new mining organization. It is instructive to compare the depth of mines, size of charges, etc., with those of Hill 60.

Here again the operation, both from a mining and infantry point of view, was emminently successful, but failure to hold the craters as a second line to that consolidated by the infantry resulted in our capture of St. Eloi being annulled by the German counter-attack, and the Germans occupied the craters from which they commanded a view over our trenches until 7th June, 1917.

From the firing of these mines we obtained the first authentic description of the phenomena which accompany the firing of a deep heavy mine.

First the earth-shake, then the silent gradual growth of an enormous mushroom which soon disintegrates, falling outwards to form the lip, at the same time releasing the flames, gas, smoke and other products of combustion of the charge to form a pillar of fire and cloud to a height of 200 or 300 feet; lastly the pale-blue flickering flame which darts hither and thither like a will-o'-the-wisp, licking up the inflammable gases which escape as the débris settles.

The Bluff.—The description of this mining adventure is well worth careful study and those who have garrisoned the Bluff during 1916 will appreciate the action and, perhaps, recollect the officers of the Canadian Tunnelling Company who led the attack on the German System from " the top," after the successful blow of the flank-attack mines.

The accounts of entries by us into enemy galleries and *vice versa*, and the resulting underground scraps, read more like the description of a " stunt " film than real war, but they are none the less facts.

Chapter IV deals with the underground work carried out in connection with the Battle of the Somme.

This was of four varieties:—

(*a*) Mines for the destruction of enemy works.
(*b*) Galleries or Russian saps to provide advanced emplacements for machine-guns and Stokes mortars; these were to be prolonged to the enemy front line to form covered communication trenches across no man's land.
(*c*) Similar galleries for communications only.
(*d*) Similar galleries for emplacements only.

The mines which were fired at zero in close connection with the infantry attack were highly successful; the experience gained by the offensive at St. Eloi was thus confirmed. On the other hand, the Haw-

thorne Ridge mine which was fired a few minutes before zero was of no assistance to the attack, as the enemy had time to occupy the lip of the crater before the infantry attack developed.

The Russian saps in the sections of the attack which succeeded were of great value, and in one or two cases were the only possible means of maintaining communication across no man's land for some considerable time.

Pipe pushing (a type of bored mining) was tried in High Wood and proved that this method was suitable during operations only when the ground was favourable. It is futile in a wood. Its use was afterwards confined to blowing short lengths of trench.

The mining at High Wood is an example of the wonderful spirit and determination to overcome all difficulties, by which all the tunnelling companies were inspired.

Chapter V deals with the preparations for the Battle of Arras and the Vimy Ridge.

In these operations offensive mines played a very small part, the efforts of the tunnelling companies being mainly devoted to the construction of subways, the value of which had been demonstrated on the Somme.

The main underground feature of the Battle of Arras was, undoubtedly, the development of the caves at Arras into subways and accommodation for the attacking troops.

The caves were discovered by us by accident, though the inhabitants of the town knew of their existence. They are in reality the series of underground chalk quarries from which, at a certain depth, chalk of sufficient hardness to form a reasonable building-stone had been extracted at various periods to build the town. The quarries ran roughly in the direction required and were of the greatest value, both as subways and as shell-proof shelter for troops.

From the plans it can be seen that, by connecting the sewer tunnel with the caves, the troops could walk under ground from the centre of Arras right into the German front line, a distance of nearly three miles.

Living accommodation was constructed for about four brigades of infantry.

An excellent account of these caves and tunnels is contained in the History of the New Zealand Tunnelling Company, by which unit this work was done.

On the Vimy Ridge the subways played a most important part, indeed. After the original attack on a portion of the front had been held up, the necessary reinforcements were sent up through a subway which took them under the German barrage and brought them out, untouched, in no man's land, whence they delivered the successful assault. Without the subway no reinforcement could have crossed the barrage.

The subways on the Vimy Ridge were not Russian saps; they were all constructed at shell-proof depth below the surface. It is unfortunate that there is no map showing the subways and where they were located on the length of front. Considering that the whole of the work was done under the close observation of the Germans from a crater which enfiladed our front and from which they could

watch the daily growth of our spoil dumps, the successful completion of the scheme was a remarkable achievement.

Chapter VI is devoted to the description of the mining work for the Battle of Messines. It is not generally known that this work was commenced in October, 1915, when the Berlin Tunnel at Hill 60 was begun, and completed only a few hours before zero on 7th June, 1917. Permission to continue work on a system of purely offensive mining was obtained from the Commander-in-Chief in January, 1916, and from that date the plan which had its origin in the office of the Engineer-in-Chief at G.H.Q. in August, 1915, was pushed forward to its ultimate successful conclusion.

Of 24 mines which were completed, only one was definitely lost by enemy interference, four were not fired, as they were outside the zone of the attack of the 7th June.

The Germans knew that we were mining deep from their capture of our mines at Petite Douve farm, but they never discovered where we actually were, though they broke our galleries three times by the heavy charges they fired at intervals down their front. A great deal of trouble was taken in 1916–17 to conceal the fact that we were mining.

Their persistent activity at Hill 60 was an unceasing anxiety to the Controller of Mines Second Army, and the patient courage displayed by all ranks of the 1st Australian Tunnelling Company in spite of a heavy casualty list incurred above and below ground was beyond all praise.

The story of Messines mining is well told. It is a pity that through want of space many most thrilling incidents in the crowded life of the tunnellers have had to be omitted. All important details of the mines are given on *Plate* XVIII. A German authority stated at the time that the earth-shake of the mines was felt at Lille to such an extent that the inhabitants were seized with panic and German soldiers were seen running madly up and down the streets.

Besides the mines the tunnelling companies were employed in making underground shelters for headquarters of formations for use during the action. This was done on such a lavish scale that for the Battle of Messines, and the subsequent operation of the Fifth Army on the left, dug-outs were provided for every headquarters from battalion upwards.

This Chapter closes with a quotation from Ludendorff memoirs which is the finest compliment which has been paid to our "tunnellers" by the enemy in writing.

Another and almost greater compliment was the complete surprise of the enemy.

Though the work had been in progress for over 18 months, the mines were not openly talked of either at home or abroad. The tunnelling people proved that they could work and keep silent.

Chapter VII describes the work undertaken in connection with the offensive of the Fifth Army on 31st July, 1917. As stated above, this consisted mostly of making dug-outs.

The Messines mines had made the Germans very suspicious of any work which looked like mining. All dumps of blue clay were systematically shelled and work was delayed but never stopped.

Dug-outs in the canal bank meant for storage of pontoon equipment

were thought to be mine shafts and effected the withdrawal of the German line on the canal, a distance of 500 yards, thus enabling our troops to cross the canal at zero without opposition. The Germans fired 14 mines in no man's land near our railway wood system, and reported that they had played havoc with our works. This was quite untrue, for, though we knew that the charges had been fired, we did not know where the craters were until they were depicted on an aerial photo, nowhere near any of our trenches or mines.

Chapter VIII closes Part I, with a description of the work done by the tunnelling companies during the period of open warfare, and from it a very good idea can be obtained of the versatility of these units.

Part I is illustrated by 40 Plates and Tables which, with the exception of the omission of the Plan of the subways on the Vimy Ridge have been well chosen for the purpose.

PART II.

Mine Rescue Work.—This Part is a condensed version of a very full report by Lt.-Col. D. Dale-Logan, D.S.O., M.D., R.A.M.C., who was responsible, under the Engineer-in-Chief, for the whole of the mine rescue organization throughout the war.

The treatise is a thoroughly up-to-date pamphlet by a practical expert in the science he writes on, and contains all the information necessary for the training of all those who in the future may have to undertake mining operations in war—without this knowledge no military mining can be thoroughly successful.

In successive Chapters the author deals with the investigation and selection of apparatus, discussing fully the relative advantages and disadvantages of the various patterns on the market at the present time and the relative value as gas detectors of mice and canaries; the organization of mine rescue work which deserves special study; the difficulties and dangers of rescue work in the trenches which is the outcome of actual experience gained in all parts of our front; concluding with a description of the German system of mine rescue compiled from captured documents and equipments, from which it appears that in mine rescue work, as in other things, the German started first and best and we ended up immeasurably superior.

The Illustrations and Plates are very clear and explain fully the text.

PART III.

Technical.—In this Part general principles only are dealt with. As may be imagined, since the personnel of the tunnelling companies was recruited from the mining profession all over the world, it was impossible to standardize details of construction—considerable control was exercised over the nature of explosive instruments, tools and equipment.

Chapter I deals with the general procedure in laying out a mine system. It must be understood that this idea was rarely possible. We usually took over a front which was already under attack by mining by the Germans, and the first thing our miners had to do was to try and make the position safe as soon as possible. When the situation was again normal, it became more or less possible to work on a plan.

Chapter II describes the various methods of disposing the spoil from the face.

Every conceivable method of tramming, hauling, winding up vertical and inclined shafts and every method had its own devotees, but on arrival at the surface there was only one general principle which ruled the disposal, and that was, spoil heaps must be concealed.

The skill of the Germans in this respect was most clearly instanced when the German systems had been captured on the Somme front, where the locality of each British shaft was advertised by an enormous chalk mound, while the German shafts had to be marked with flags so that their position might be explained to the Inspector of Mines. Survey instruments were standardized to the Miners' Dial, theodolite and dumpy level, with prismatic compass and Abney level, as aids for hasty work. Accuracy in mining work is essential. As an instance of the importance of accuracy, it may be noted that, when the centre of Hill 70 system had been flooded, a mine already laid, and so placed as to wreck the most important branch of the enemy system if he should advance, was found by a boring machine worked at a calculated angle—the mine was actually fired by a small charge placed at the bottom of the borehole from a higher level and the delay caused to the enemy work was sufficient to enable us to make a new system and be ready to push back any attempt of the enemy to advance underground when he resumed activity. Without this result, which was entirely due to accurate survey, it is extremely likely that our infantry would have been blown off Hill 70.

As for ventilation, the Roots Blower was quickly found to be a source of danger, as the noise it made was a most unwelcome advertisement of mining activity.

The improvement in silent ventilation progressed with the improvement in listening apparatus.

Every sort of explosive was tried, but ammonal was proved to be the best for mining work.

Chapter III (Miscellaneous Notes) gives further details of the construction of subways which formed a very important item in the latter mining period.

Such systems as are described which run from Cuinchy to Hulluch can only be thought of when a front stabilizes for a year or more.

Comparison of British and German reports of the same mines is interesting reading and tends to show that both sides had the same optimism in claiming important effects of their own mines and never admitting that the enemy did them any harm.

Chapter IV is a detailed treatise on the subject of listening. It was in this science that the most remarkable progress was made. The first listening apparatus used by us was the Board of Trade microphone used by water engineers to detect a leak in a water-pipe. These were succeeded by French waterbottles which were filled partly with water and to which a medical officer's stethoscope was attached. The idea was developed into the Geophone which was the most useful and compact of the lot. This and the various electric listening-sets are fully described.

This Chapter is one of the most important in the book and should be specially studied. The degree of progress made during the war may be

estimated by comparing the scale of distances in various ground with the fact that we thought 15-ft. thickness of clay would stop any sound, in 1915!

The article on central listening must be regarded as an ideal which is very rarely possible; it was developed to a wonderful degree on the First Army front after the Germans' mining activity had almost entirely ceased; still, it is a possibility which should be noted.

The course of instruction in listening is important. Good listening is the foundation of safe and successful mining.

Chapter V gives in detail the organization of a mine school and the instruction given there. Mine schools are necessary to ensure that the standards and experiences gained during the campaign are passed on to the new personnel who come out as reinforcements and have no knowledge of the conditions of the front, however skilful they may be in their own calling as miners.

The details given are those of the First Army Mine School, and from them may be drawn an idea of what is necessary.

This part is also well provided with good Plates to illustrate the text.

Taken as a whole, this volume is a very valuable addition to any military library and, though many soul-stirring incidents have been crowded out, it can claim to be the plain unvarnished tale of mining on the Western Front.

R. N. HARVEY, *Maj.-Gen.*

MULTI-WHEEL AND TRACK MOTOR VEHICLES.

By MAJOR T. G. TELLOCH, late R.A. (Published by The Institute of Automobile Engineers).

THIS paper begins with the causes that are responsible for the breaking up and corrugation of modern highways, together with suggestions for bettering road transport.

Heavy commercial motor vehicles are shown to be responsible for the breaking up of good concrete roads built on ordinary subsoil. Overloads caused by the modern, heavy, four-wheeled commercial vehicle crush a slightly elastic road into the soft soil beneath. On the load passing, the road recovers itself, but the subsoil does not.

A gap is, therefore, left between the road surface and the subsoil. This gap gets bigger as more loads pass over the road and finally the road surface must fail owing to lack of support from beneath.

The cause of corrugations in roads is explained as being due to the vibrations in the road surface itself. A vehicle passing over a road causes it to vibrate, and at the same time a vacuum is caused in rear of the moving carriage. The heavier and faster the vehicle the greater the amplitude of the vibrations, and the greater the vacuum effect.

In the case of a road surface, the air that rushes in to fill the vacuum behind the vehicle encounters the surface of the road already in a state of vibration, and in consequence in a state of potential corrugation. Eddies

are formed at once in the troughs of the vibration waves, and their circular scouring action at once lifts out any particles of disintegrated road material and displaces them. Thus the beginning of a permanent corrugation is made.

Opinions as to how corrugations are actually formed, and how road surfaces are actually broken up may differ, but it is generally admitted that the immediate cause of all road evils is the fast-moving commercial vehicle whose weight is concentrated on four points. It is this heavy spot loading that does the damage. Efforts to minimize the effect of this by pneumatic and other shock-absorbing tyres are only palliatives, and not cures.

The author puts forward as a cure for this heavy spot loading the principle of giving the road vehicle more wheels and suitable springing.

The De Mole eight or ten-wheeled truck is illustrated; the principle of its design being described as the greatest step forward in road vehicle design. The truck is provided with a large number of comparatively lightly-loaded wheels, the springs of which are prevented by chains or dash-pot arrangements from expanding beyond the flexion imposed by the load, whilst being open to further compression on encountering an obstacle. The result is that, in passing over a hole or depression in the road, the spring cannot shoot the wheel down into the hole, so that no damage is done to the road in the way of further enlargement of the hole by wheel impact on its further edge. At the same time, since the wheel is geared to the other wheels, it cannot spin freely while unsupported; no damage is done to the tyre when the level of the road is reached on the other side of the hole.

On the other hand, when passing over a lump in the road, the spring, being lighter than the ordinary type, will give easily without a tendency to lift the whole chassis. This means less wear on the chassis and fewer road shocks. Further, the wheels and axles being light, the unsprung weights are less—a most important advantage.

The steering permits the whole vehicle to turn in two-and-a-half times its own length.

A diagram is given, showing different road impacts for different vehicles. A multi-wheel vehicle with a useful load of $8\frac{3}{4}$ tons was passed over a 2-inch obstruction at $17\frac{1}{2}$ miles an hour; the maximum road impact was 7,000 lbs. An ordinary lorry with a useful load of 5 tons under similar conditions gave a road impact of 29,000 lbs. At the same time the running costs of the multi-wheel vehicle are less than those of four-wheeled lorry. The cost of moving a useful 8-ton load 1,500 miles in one year was, for the multi-wheeler, £1,162, while the cost of doing the same work with four 2-ton 4-wheeled lorries was £2,395. These figures prove that the multi-wheeler is cheaper to run and does less harm to the roads. The logical conclusion is, therefore, to use multi-wheelers with more and more wheels. But if this is done the wheels get small; therefore, they must be given a track to run on and, therefore, in the end you get a tracked vehicle.

The author, however, is not entirely wedded to the idea of the truck carrying its own track. He admits it is necessary for war, but does not

admit that it is best for road work in civilized countries. Here he would prefer the multi-wheeler, his reasons being :—

(*a*) That the multi-wheeler is faster.
(*b*) That the tracked vehicle will wear out its tracks instead of the roads.

With regard to (*a*), vehicles with spring tracks have attained a speed of 27 miles per hour across country—fast enough for most heavy commercial trucks.

With regard to (*b*), this seems an advantage. In working out road repair costs, the author states that the owners of commercial vehicles who ply for profit on public highways pay 12 per cent. of the road repair bill and do 95 per cent. of the damage, the balance of the damage being made up by the ratepayer who gets no share in the profit. The railways have to lay and maintain their own track. Why not, therefore, make it compulsory for commercial vehicles to be tracked? In this way the cost of upkeep of track will be transferred to the right persons, and at the same time there will be a demand for commercial tracked vehicles which will be a potential war reserve.

The author states that the multi-wheeled vehicles are a half-way house between bad present practice and ideal future practice, but he would keep them for road work.

But why not strive now for the ideal, cut out the multi-wheeler and concentrate on the tracked vehicle as being the one and only suitable solution for both war and commerce?

G.C.G.

MAGAZINES.

REVUE MILITAIRE GÉNÉRALE.

(*February*, 1923.) *The Influence of Sports on Education for Action.* By Lieut.-Colonel A. P. Cour.—In the term "Sports" the writer includes all forms of physical exercise. Evidently a strong believer in exercise, he upholds the French method of lessons graduated according to age from primary for children, through secondary, to the severer forms only suitable for the more adult of 18 years of age and upwards. While giving England full credit for her people's addiction to sports, he considers that games are confined too much to particular classes. For France he would have more universal practice of games, so that by the time a man is called up for active service in the Army he will have received sound physical and moral training as a foundation for drill and discipline.

Those destined for the liberal professions, industry, and the Army must not jeopardize their intellectual development by too great attention to sports. For the higher Army commands, however, both are equally important. Command in war demands a good technical and general education with development of the critical sense, and at the same time the spirit of combativeness and initiative which is brought out by sports.

He deplores the neglect of sports by the French *bourgeoisie*, and their preference for quiet, stay-at-home pursuits, while some of the universities even look on indulgence in sports as a wasteful expenditure of intellectual energy. Amongst the French there is a lack of the joy of living, as evidenced by the decline in the birth-rate, by their ceasing to compete with other nations in the modern economic struggle, by their having to employ native soldiers to defend their home frontiers, and by the fact that other nations are usurping their places in French colonies. But they are an old and warlike people, and the call of danger will find them standing ready. More time spent in the open air, either at rest or taking physical exercise, would raise the tone of the nerves of both men and women, give them a higher zest for life and its transmission, for facing the pangs of childbirth, and the trials of bringing up a family.

The general impression left by the perusal of this article is that, as a general rule, the French do not naturally turn to exercise, sports or games as a pleasant form of recreation, and that education to that end must be fostered in every possible way.

How the 29th Regiment of Chasseurs à Cheval Fell at Lille. By Commandant de Civrieux.—This article shortly describes the operations round Lille from 30th September to 13th October, 1914, when the town and small garrison surrendered. The Germans would hardly believe that the defenders were so few, and Prince Rupert of Bavaria personally returned his sword to the Commandant in recognition of the bravery displayed.

The Operations at Lodz in 1914. By Captain Salmon.—On the supposition that war with Germany may again break out, it is probable that neither side will at first have enough troops under arms to hold a continuous line. A war of movement for some weeks may therefore be expected. The object of this article is to show that, if Ludendorff pushes too far the Napoleonic doctrine of economy of forces, when he is opposed by more skilful leaders than the Russians had, he may run a very grave risk. In support of this opinion is taken the counter-offensive of the Grand Duke Nicholas immediately following the German attack towards Lodz. The situation on 10th November, 1914, is described. Briefly, Mackensen's army of 5 Corps was opposed to 3 Russian armies, totalling 12 Corps, yet by attacking with his whole force successive portions of the Russian armies, Ludendorff was at first successful, broke the Russian front, and caused the retreat of a considerable portion. After this, from 22nd November onwards, he took risks hardly justified even by the incapacity of some of the Russian generals. As a result, by the skilful dispositions of the Grand Duke, the German left wing was practically surrounded, but by dint of sheer hard fighting and an extraordinary night march through the Russian bivouacs, when the worn-out Russians took no notice of the noise of the retreating column, it was able to extricate itself. Ludendorff's confidence in himself and his troops was doubtless increased by this success, but it did not bring him victory when, in 1918, he engaged his last reserves in Champagne.

A Stage in the Pacification of Morocco.—This is the conclusion of the article by Captain Cagnat, and describes the operations from April to June, 1921. No incident of marked interest is related.

Swiss Chronicle.—The military estimates for 1923 have been passed by the National Council for three million francs less than in 1922. To facilitate discussion, the Government circulated to the deputies a statement of the military situation, pointing out that Swiss neutrality was never respected except when the Army was strong enough to enforce it, and that preparation after the outbreak of war would be too late. Seven and a half millions are for the purchase of horses. Before 1914 remounts were obtained from Ireland, East Prussia, and Hungary; during the war from Spain and America. At the present time Ireland is the principal source of supply, the Irish horse possessing all the qualities desired, but purchases have also been made in France, and this source is worthy of development owing to the disturbed state of Ireland. The central cavalry remount depôt is at Berne, that for officers' chargers and artillery horses at Thonne. At the national horse show of 1922 a battery was shown horsed with *Franches Montagnes*, an improved breed of horses of the Jura strain, which may turn out entirely satisfactory.

Bibliography.—Ludendorff's *Conduct of War and Policy*, translated by Captain Koeltz (Berger-Levrault) is reviewed. It is said to be still more interesting and suggestive than its predecessors in that, more than they, it shows up the man and his principles. After four Chapters devoted to speculative considerations of war throughout the ages, the general raises the true question of his own conduct of the war in relation to politics. To exculpate the third great General Staff, to crush the civil power under the accusation of its sole responsibility for the final disaster, to throw into relief the personal work of the Q.M.G. by carefully refuting the attacks made against his former books, such are the true aims of this voluminous work.

Another book reviewed is Ludendorff's *Documents of the German Great General Staff*, Vol. II, translated by Battalion-Commander Delestraint (Payot). The first volume appeared at the end of last year as an Appendix to Ludendorff's *Memories*, and dealt with the part played by the G.G.S. and its chief in the home policy of the Empire. The present volume deals with their relations with foreign policy. The collection is of the highest historical interest, but in no way enhances Ludendorff's reputation.

A. R. REYNOLDS.

BULLETIN BELGE DES SCIENCES MILITAIRES, 1923.

(*Nos.* 1 *to* 4 *inclusive*).

The account of the operations of the Belgian Army during the Great War, 1914–1918, is continued in Nos. 1 to 4 inclusive of the *Bulletin* for the current year. Further details are given of the part played by the detached forts in the southern sector of Antwerp during the German siege operations, and of the effects produced on them by the German Heavy Artillery. The situation as it existed in Belgium at 5 p.m. on October 3rd, 1914, when the British First Lord of the Admiralty attended the meeting of the *Conseil de la Défense Nationale* held under the Presidency of King Albert is briefly described. Mr. Winston Churchill explained to

the *Conseil* on that occasion that Great Britain could assist Belgium to the extent of providing 2,000 men at once (a Naval Brigade reached Antwerp the same evening); further, that 7,000 men would be forth coming within the next three days, and an Army Corps could be landed at Dunkirk within the next ten days. The question was whether Antwerp could hold out until October 13th: unfortunately, the situation was then a desperate one. The permanent forts on the front Walhem-Lierre were no longer garrisoned, but the line of the Nèthe and Rupel was still held by the Belgians, who had determined to hold on to it as long as possible, and eventually to make a stand, with fortress troops, along the parapets of the old enceinte. The decision had already been taken to send the Belgian Field Army south to join the French and British forces. The possibility of saving Antwerp, if it had ever existed, had by now completely passed away.

Capitaine-Commandant Paquot contributes an article to No. 1 of the *Bulletin*, on the subject of "strong points" based on the Belgian *Instruction provisoire sur le combat de l'infanterie*. The matters which require to be attended to in designing a network of "strong points" are dealt with in some detail in the original article, which concludes with a useful summary of the main features of such a system of defence works.

Colonel Fastrez contributes to Nos. 3 and 4 of the *Bulletin* an important and interesting article in which he shows how strategical and tactical problems are affected by the conditions of the epoch at which a conflict of arms takes place. For this purpose, he examines the various phases of the Great War of 1914–1918, and traces the influence of recent developments upon the strategy and tactics of the opposing sides: he then touches upon certain features of the last war with a view to indicating the influence which the more recent developments of the past decade are likely to have in a future war. In dealing with the Great War, Colonel Fastrez incidentally remarks that certain incidents connected therewith have, to some extent, resulted in a confusion of ideas as to the distinction between the two branches, strategy and tactics, of the art of war. The employment of what Colonel Fastrez calls the *arme-machine*, an expression intended to cover all the recent developments in armaments and everything connected therewith had, undoubtedly, a very far-reaching effect in the Great War. Germany's initial plan of campaign was largely influenced by the potentialities of the *arme-machine*: fearing that it would be difficult in the face of the *arme-machine* existing there to batter down the defensive barrier on the eastern frontier of France, the German General Staff planned that the German I and II armies should be the principal striking force, the *masse de manœuvre*, and should march through Belgium. It was hoped thus to turn formidable military obstacles on the eastern frontier of France, but the adoption of this course brought in its train very serious inconveniences of a political order, and really also, as it turned out, other complications which, to some extent, affected the strategical situation. The decision of the German General Staff alluded to robbed the Teuton strategy of flexibility right away in the initial stage of the war. The Germans were fully aware that the French intended in the opening phase of the war to assume the offensive with their right wing

from the very part of the front they were shunning, and had taken the precaution of establishing in that region a thin defensive screen, but amply provided with the *arme-machine*. The French, it is suggested, underestimated the resisting power of this thin German line. The events that happened in August, 1914, on the Western Front demonstrate that the Teuton had assessed at its real value the *arme-machine*: the French First and Second Armies suffered heavy losses in their engagements with the German left wing and were held up. On the other hand, the German right wing was able to forge ahead, but the *arme-machine* at Liége upset the German programme and the original *manœuvre stratégique* designed for this wing had to be abandoned: moreover, an attempt made by the German General Staff to resuscitate the *manœuvre stratégique* failed. Colonel Fastrez argues that the operations subsequent to the Battle of the Marne in connection with the "Race to the Sea" do not fall in the category of strategic movements. The mere fact that troops were transferred from one part of the theatre of operations to another widely distant from it, involving the use of the railways and of automobiles, cannot, he thinks, alter the character of the movements, which were really tactical incidents in a battle fought over a widely-extended front. The first step, after the belligerents had settled down to trench warfare, adopted to bring strategy into play again on the Western Front was, according to Colonel Fastrez, taken in the summer of 1918, and not until then: this was when Marshal Foch, correctly appreciating that the heavy wastage suffered by the German armies during the offensives of March, April and May, 1918, rendered them incapable of effectively parrying a series of blows in quick succession, planned a concentric offensive along the whole German front. The principal feature of this offensive consisted in the repeated blows against the German front following quickly upon one another and delivered by assaulting troops which were supported by formations in reserve moved with great rapidity from one part of the front to another, as required, for the purposes of a definite scheme of attack. The operations in connection with this offensive fall, says Colonel Fastrez, in the domain of "grand tactics" rather than of strategy, but, although they do not constitute the *manœuvre stratégique*, they lie on the confines of strategy. Had Marshal Foch planned to drive the German pivot of retreat completely out of its place and thus turned the enemy's left flank so as to bring about a surrender of Germany's beaten forces, that, says Colonel Fastrez, would have been *une belle manœuvre stratégique*; had such an end been attained, there could have been no doubt but that the war had been fought to a finish and there would have been convincing evidence of the hopeless defeat of the Central Powers, much to the advantage of the future of Europe. In the events that actually happened it was a political act, and not a military one, that brought the World War to an end; it has created a dangerous and most unsatisfactory situation.

Among the other important features of the Great War upon which Colonel Fastrez touches are the economic and industrial factors which came into play and, at times, had a dominating influence on the course of events. As far as the economic situation in Germany was concerned, the presence of a German fleet in the Baltic, which it was difficult to put

out of action, to some extent diminished the value of the blockade maintained against the Central Powers by the British and French Navies, which later were joined by the American Navy. Throughout the war, Germany was able to import much raw material, which was contraband, from and through Sweden and possibly Norway also.

Finally, very instructive is the forecast which Colonel Fastrez gives of the influence that continued developments in the use of poison-gases, aviation and tanks are likely to have in a future war. It is not possible to do justice to the subject in a short notice of this description.

In view of the immense importance of fuel oil for military purposes in a modern war, the articles on the petroleum question contributed to Nos. 3 and 4 of the *Bulletin* are timely. One has but to read the German technical papers dealing with the petroleum industry published during the war period to get an idea of how very great were the inconveniences suffered by the Central Powers, first, when the naval blockade cut off the American sources of supply of this important commodity, and later, when the Russian armies occupied the Galician oil fields: so inadequate was the supply of petroleum products in Germany at one time that researches were carried out with a view to discovering substitutes. Not only was it the Central Powers who felt the pinch owing to supplies from the United States being cut off, but the French were also placed in so difficult a position that Clemenceau, in December, 1917, made a personal appeal to President Wilson, asking him to divert to France the large quantities of petroleum which, owing to the greater safety of transport across the Pacific, were being exported to Asiatic markets. The original article contains, *inter alia*, information concerning the chief oil fields of the world, and technical information as to the characteristics of the oil produced there, and also statistical information.

Other articles deal with the handling of a Division (No. 1); "Tanks" (Nos. 1 to 4 incl.); Transport Corps (Nos. 1 and 2); the handling of an Army Corps (No. 2); the principle of the Battle (No. 3); the Cavalry question (No. 4); etc.

W. A. J. O'M.

REVUE MILITAIRE SUISSE, 1923.

(*Nos. 1 to 4 inclusive*).

Colonel Sarasin contributes an article to No. 1 of the *Revue* on the important subject of *l'exploration de combat*, which, for want of a more precise equivalent expression, may be termed "battle reconnaissance." He points out that it has always been necessary to base one's own tactical dispositions upon as full and as exact information as can be obtained beforehand concerning one's foe and the terrain upon which a collision of the opposing forces must take place—the Great War demonstrated the importance of providing a suitable organization for such a purpose. Colonel Sarasin warns us that, in spite of the enormous assistance to be derived in a modern war from aerial reconnaisances, the signal service, the "tapping" of the enemy's messages, etc., infantry advancing to the attack should never neglect the older methods of obtaining intelligence,

e.g., by sending forward fighting patrols to pierce the veil which will still always cover the front of a skilfully handled force: he throws out some valuable suggestions relating to the organization of such patrols and insists upon the necessity of establishing "observatories" for the purposes of "battle reconnaissance." The subject is obviously of wide importance and requires to be treated not alone from the point of view of the infantryman, but also from that of the gunner, sapper and tank crew. Colonel Sarasin rightly points out that specially selected men should be detailed for duty in connection with reconnaissances of the kind dealt with in his article; that they should be correctly informed as to the situation of the troops for whom they are working as well as that of the enemy (so far as known); that they should be qualified correctly to appreciate the tactical features of the ground in all aspects. Although the author of the original article does not definitely so state his proposition, what it really comes to is that, in the case of the "battle reconnaissance," there should always be attached to a fighting patrol a few selected officers or N.C.O.'s of all the combatant arms, in order that they may each collect the information of the particular kind which is essential to their own branch of the service and will assist it efficiently to co-operate with the infantry in attack, defence or counter-attack. Obviously those detailed for so important a duty should always be provided with instructions in writing, setting out the particular points upon which they should concentrate their attention. Another article dealing with an important tactical subject is that in No. 4 of the *Revue* from the pen of the Colonel Turrettini, who discusses therein the question of effective *laison* between the infantry and artillery.

Nos. 1 and 2 of the *Revue* contain the concluding parts of the notices by Colonel Poudret relating to Grouard's *La conduite de la guerre jusqu'à la bataille de la Marne* and Hanotaux's *La bataille de la Marne*. The contents of No. 1 of the *Revue* are likely to prove of special interest to British soldiers; therein Colonel Poudret sets out the criticisms directed by Hanotaux against the British Commander-in-Chief and his handling of the B.E.F. Although the Higher Command is criticized, there is nothing but praise for the British soldier; it is recognized that the latter did all that he was called upon to do and did it splendidly. High praise is given also to Lord Kitchener for the part he played in December, 1914, in overcoming certain objections of Field-Marshal Sir John French to Joffre's plan of campaign. The view is expressed that the British Commander-in-Chief did not make the most of the opportunity which presented itself for the effective employment of the British Army at a critical period of the war. Several other points are touched upon, among them being the suggestion that at one time the subject of withdrawing the B.E.F. entirely from France was contemplated by at least one highly-placed staff officer. Rumours to this effect were afloat at the time, but the idea was entirely ridiculed in this country that such a step could have ever been in contemplation even in the mind of the most hopeless pessimist: Dame Rumour may, however, not have lived up to her reputation of being a "lying jade" on this occasion. Notices such as those of Colonel Poudret are of special value to the student of military history at the present time. The volume of literature relating

to the Great War is already so great that even a man of comparative leisure has not sufficient time in which to study the contents of even the more important tomes being poured out by the Press; a succinct analysis such as that contained in the articles under notice here cannot fail to be of very considerable assistance to those desiring to form conclusions of their own upon matters which are in controversy. It is particularly important that those who aspire to high command, or important staff jobs, should by study develop their critical faculties in relation to military questions, in order that when their "day" arrives they may exercise that sound judgment by which alone they can defeat their adversary. No better way exists of learning the true value of criticisms of the kind in question than by setting to work to dissect them, that is to say, than by becoming a master in the art of criticizing the critic.

Colonel Lecomte undertakes in Nos. 3 and 4 of the *Revue* the task of examining the criticisms which have been directed against von Ludendorff's strategy by General Buat and by his own countryman, the well-known Professor Delbrück: on some points these two writers are in accord. Delbrück is the more severe of the two; he charges von Ludendorff with having committed every conceivable strategical mistake, and holds him to be a man of mediocre intelligence only: indirectly then, the Professor pays an unhandsome compliment to the leaders who were opposed to the distinguished German Chief-of-Staff. Delbrück is of opinion that it was von Tirpitz and von Ludendorff who were responsible for the destruction of the Empire built half a century ago by von Bismarck and von Moltke, the Elder. As might be expected, a great deal of controversy rages round the German offensives of 1918. Buat, who has written a good deal on the subject, in no way attributes blame to von Ludendorff for having launched these offensives at the period that he did so; however, he is of opinion that the most favourable part of the Entente front for such an enterprise was not chosen when the first blow was delivered in March, 1918. Buat considers that Amiens, the German objective was too distant from the immediate base from which the first offensive was launched; he would have preferred the blow to have fallen on the part of the line near Lens, with the mouth of the Somme as the objective. At the conclusion of his article, Colonel Lecomte gives, in a short summary, his own views on the German strategy: he is of opinion that the fundamental idea of the German plan of campaign was quite sound, namely, first to crush France, and then Russia, while Great Britain was getting ready to play her part in the war. Neither Napoleon nor Frederic the Great would, he says, have disapproved of the German plan of 1914. The only question that arises in connection with the closing phases of the war is, he thinks, whether, after the blow to gain Amiens in March, 1918, had failed, von Ludendorff was justified in calling upon German armies to continue their effort by delivering the stroke of April 9th in Flanders, and that of May 27th against the Chemin des Dames. Colonel Lecomte unhesitatingly approves of the scheme executed by von Ludendorff in connection with these offensives; it was based, he says, both on good strategy and on good sense: he analyses the situation, and shows that on May 25th the Germans still had the advantage of superior numbers, *i.e.*, 81 divisions

against 67. However, when the Germans met with their check on June 15th, von Ludendorff should, in Colonel Lecomte's opinion, have realized that he could no longer hope to gain a decisive victory; in the events that happened, von Ludendorff, from that moment, ceased to play the part of a general and assumed the rôle of a dangerous gambler.

The article on the "Sixth Arm" by M. Jacques, begun in No. 9 of the *Revue* for 1922, is concluded in No. 1 of the current year. The author of the original article contends that the use of poison-gas in warfare is no more reprehensible or inhuman than that of many others of the means employed to destroy the morale of an enemy and to obtain the superiority over him: a soldier, who is "gassed," is a victim of war entitled to no greater compassion, he argues, than the soldier wounded by the explosion of an ordinary shell. M. Jacques considers that the condemnation of gas-warfare is illogical and not based on a sound knowledge of the true effects of poison-gases: the "chemical arm," according to him, came in for universal reprobation during the Great War alone, because, in using poison-gas, Germany was guilty of a flagrant violation of engagements entered into by her at The Hague. In support of his contentions M. Jacques quotes American statistics and claims that these demonstrate that, whereas in the case of wounds caused by bullets, shells, explosions (including mines) and the *arme blanche* 30 per cent. proved fatal, in the case of soldiers gassed 1·5 per cent alone died; allowing, he says, for deaths that have taken place since the armistice, "chemical warfare" was responsible for 50 per cent. fewer victims in proportion to those caused by all the other weapons of war put together. M. Jacques is satisfied in his own mind that "chemical warfare" has come to stay and, in consequence, urges those whose duty it is to prepare for the next great conflict of arms to pay more attention to the scientific elements that play a part in war and less to matters connected with "drill."

The remaining articles in the Nos. of the *Revue* under notice deal, *inter alia*, with the problem of the "conscientious objector" (No. 2), the conversion of the mountings of the Swiss 75 mm. gun (No. 3), the bearing which emigration has on the problem of national defence (No. 4), and questions affecting mountain artillery (No. 4).

W. A. J. O'M.

HEERESTECHNIK.

(February, March and April, 1923, numbers inclusive.)

CAPT. JUSTROW continues his article on the theoretical conditions affecting the life of barrels. The complete series will evidently form an important volume, which is to be published presently by "Offene Worte." The mathematical conclusions are well illustrated by diagrams and equations—and these and references to former works on the same subject will be of value to a serious student. Some sample computation is given in the April number. There is nothing in these articles of peculiar interest to the Corps, however, and discretion being the better part of valour, it will be as well to leave to the regiment a more detailed examination.

Major Klingbeil continues his article on the construction of fortifi-

cations in sand-dune country. He gives examples of the burying by sand of observation and position-finding stations. In a discussion on protection he divides his types into those which are rigid and absolute wind-screens, such as walls, those which are penetrable by wind and non-rigid, such as hedges, and those which are at once penetrable and rigid, such as post and rail fence. The behaviour of driving sand results in the curious fact that sand driving against the first type piles up some way in front and leaves a deep trench-shaped hollow along the foot of the wall on the windward side. In the second type the sand piles high immediately to leeward of the hedge, falling gradually and evenly away. No trench is formed. In the third type a parapet forms with crest line coincident with the fence. Natural wind-screens, such as trees and bushes, are strongly advocated—and various hardy grasses and " bents " suitable for fixing the sand in position are described. The mere deflection of the sand invasion may cause unlooked-for damage to others—and it is considered wise to unite the interests of the neighbourhood. The greatest difficulty is to keep in place the sand which covers concrete aprons. A list of such grasses as will grow on so shallow and unstable a bed is given. Paths and roads should be curved, so as to avoid the usual direction of the wind.

In the March number the movements of sand below high-water mark are considered. Broadly, the deposit of sand by water follows, as it does by wind, in accordance with the penetrability and rigidity of the obstacle. The use of groins, sea-walls, etc., is dismissed somewhat curtly, but it is a subject amply dealt with already.

Major Malbrandt contributes an article on bridges, flying bridges and fords, which outlines the instruction he recommends for officers in charge of mechanical transport. A knowledge of the simpler rules and formulæ is necessary in order to be independent of technical help. A list of the points to investigate in various types of bridges is accompanied by a précis of the precautions to be taken in crossing. The article does not go deeply into the subject but does give a common-sense and useful syllabus. There are several other articles in the " official " section which are of no particular interest to the British Army.

In the " unofficial " section Lieut.-General Schwarte takes up his description of the storming of " Camp des Romains " with the advance of the 1st and 2nd Battalions of the 11th Regiment to within 1,500 metres of the Fort. Ladders, planks, ropes and pliers were brought up by the Prussian Pioneers and not a shot was fired, until the Pioneers advanced further in the belief that the fort had been abandoned. The assault was ordered for 5.30 a.m. on the following day, and eight company columns were detailed—three for the north side, three for the south, and one each against the east and the south-east corner. Detachments of Pioneers were detailed for each column. Ladders and hand grenades were issued after dark, and the columns moved forward to assaulting positions. It was not until the cutting of the wire began (under heavy rifle fire) that reports were received to the effect that fort, wire and trenches were practically undamaged and that the French were in force and ready for the attack. The columns detailed for the southern front reported that the 28-cm. mortars were getting mostly over on to the

southern glacis, and that wire-cutting was impossible in consequence. The outlook was unpromising, but a delay undesirable, so at 5.30 the assaulting columns moved out and effected so complete a surprise that the wire was past, ladders erected and a lodgment effected in the fort itself before a shot was fired. At this point a dog appears to have emulated the geese in the Forum; the defence awoke to the situation and for three hours with machine-gun, bomb and bayonet kept the attack within bounds. At 8.30 the Commandant surrendered the fort and secured for the garrison the privilege of marching out with military honours. The German artillery comes in for some criticism. The observation of fire was poor and the effect of the heavy mortars much below expectation. The old masonry fort, however, is more difficult to breach than had been anticipated before the war. The troops were quite new to siege warfare, and the lesson which the author desires to preach (that is, a preparation in peace for a type of warfare which will be inevitable in the future war) is finally insisted upon. The principal lesson of the operation, as described in this article, however, would appear to be afforded by the lack of alertness in the defence.

Lieut. von Stammbach discusses the repairs to heavy iron bridges which can be executed by pioneer battalions. There are obvious advantages in eliminating calls for civil engineers, as the situation is grasped quicker, and something solid is sooner achieved, even if not in theoretically proper proportion. The necessity of a clear waterway below and the labour of excavating deviations often impose a reconstruction. By substituting struts for ties, wood may often be used. Field units can generally count on being able to lift up to 200 tons with the facilities with the troops, or to be found in neighbourhood of the bridge. It is often desirable to limit reconstruction to the smallest width possible in order to eliminate the heavy and lengthy task of replacing portions of piers, driving new piles, etc.

Following on a controversy in the *Artilleristische Monatshefte* with Lieut.-General Rohne, Capt. Justrow contributes two articles which maintain the superior effect of shell splinters over shrapnel upon the majority of war targets. Shrapnel are wanted, but in smaller proportion than heretofore. If hits by splinters are fewer, they are much more likely to be fatal or crippling.

Major-General v. Borries writes a critique of the fourth volume of *Der Grosse Krieg*, 1914–1918 (M. Schwarte) which has recently appeared and includes parts dealing with naval air and gas warfare as well as with the campaigns in Asia Minor, Gallipoli and the German colonies. The enormities and the lies of the less-cultured allied armies appear to find considerable expression. It is impossible to judge the book by this critique, which is itself an *ex parte* statement.

Extracts from the 1920–21 report of the German Survey are interesting. They hint at a new national 1/50,000 map, or, at any rate, at certain experimental sheets. The question of copper engraving *versus* heliozincography is being investigated, and the use of a decimally-divided degree is also raised. It will add one more horror to life if we have to think in thousandths of a degree as well as in established grade and sexagesimal systems.

H. ST.J.L.W.

MILITAR WOCHENBLATT.

(*21st October*, 1922.)—In a condensed but lucid account of the recent Greco-Turkish war the writer of the leading article in this number sketches the main events, their causes and effects, from May, 1919, to the conclusion of the Mudania agreement. It is interesting to observe the hand which the writer of the article thinks to have been played by the Allies, and particularly by England, in this Greek gamble. He begins by saying that one of the most important aims of English policy in the Great War had been to secure unrestricted mastery of the eastern portion of the Mediterranean by means of the disruption of Turkey into small, powerless states. The issue of the war had deprived Turkey of its vast Arabian territories. Anatolia had remained the centre of the Turkish state. Although Turkey had been sorely weakened by the wars of the last ten years, there remained, nevertheless, the possibility that she might regain her strength at no very distant date. How this was to be brought about the writer does not say, but English policy after the war was directed to preventing the possibility of this resurrection, and found a willing partner in Greece. With the watchword of "Liberation from the Turkish yoke" for the Greeks living on the coast of Asia Minor, the Greeks, in May, 1919, occupied Smyrna "without a previous declaration of war;" they hoped that consideration would be given to the national claims in the peace to be concluded with Turkey. But Turkey showed herself not so powerless as the Great Powers and Greece had assumed her to be, and the Angora Government was set up under the energetic leadership of Mustapha Kemal in opposition to the Government in Constantinople. The Angora Government succeeded, in a short while, in making its influence felt over nearly all the territories which yet remained to Turkey; it was firmly determined not to submit to a peace dictated by the Entente. For the latter, therefore, there remained no other course but either to recognize the claims of the Angora Government or to compel it, by force of arms, to accept the proposed conditions of peace. At the instigation of England the Entente adopted the second alternative, and Greece was commissioned at the Hythe Conference in May, 1920, to bring the Angora Government to reason by an offensive to be launched into the interior of Asia Minor. So much for the writer's idea of the political causes of this war. The events are then described with reasonable fairness. For the Army collected by the Greeks in Thrace in the summer of 1922 the writer points out that 15,000 men were withdrawn from Asia Minor. The Greek project of an advance in the direction of Constantinople was vetoed by the Entente. The repeated representations of the Greek general in Asia Minor to the Government at Athens that the front should be withdrawn in view of this reduction of troops met with no response. After describing briefly the Turkish successes of August–September which then followed, the writer goes on to say that after the collapse of the Greek army England recognized that she must herself take an active part if she was to attain her aims in Asia Minor. On 5th September she asked the Dominions, her Allies, France and Italy, and even Rumania and Yugo-Slavia to take their share in the defence

of the Straits, if need be, against attack by the Turks. France and Italy declared their wish to remain neutral in the event of a war between England and Turkey. The attitude of both Balkan States was doubtful. Even Canada and South Africa "declined to send troops." England was therefore faced with the question of undertaking alone the defence of the Straits. English naval and military reinforcements were sent to the Straits. After describing the political events that followed, the writer goes on to ascribe to M. Franklin Bouillon the success of arriving at an understanding with the Turks, from which the Mudania Conference resulted; the tension between France and England is made much of, agreement being arrived at, according to the writer, by the adoption of a middle course. The main points of the Mudania agreement are then given. Not a word is to be found of the influence of General Sir C. Harington on the proceedings, while the whole tone of the article displays the desire to belittle British policy and activities in the Near East.

In an article on Danish Army Organization there is the following conclusion:—"The Danish Defence Force has, by the new law, experienced a not inconsiderable increase of strength as compared with recent years. There is not a sign of any disarmament as against Germany; on the contrary, the illegitimate profits arising out of the Versailles Treaty (*Gewaltdiktat!*) force Denmark to a continual state of preparedness for war which should prepare for the little country much breaking of heads in the future.

M. Poincaré's repetition of the accusation of "disciplined barbarity" against the German troops, in his speech at Bar-le-Duc on 20th August, 1922, has drawn an official reply which is communicated to the *M.W.B.* and published in this number. It contains nothing of much interest; protest is made against making a whole army responsible for the deeds of a few, and the usual accusation of crimes committed by soldiers of the Entente is repeated. The writer concludes by saying that speeches such as M. Poincaré is continually making can only do harm at a moment when every effort is needed to prevent the economic break-up, not only of Germany, but of all the European States that stand in close relationship to her. The home-truths about the German war criminals have evidently an exasperating effect, which it is apparently sought to correct by violent counter-propaganda.

1st November, 1922.—The leading article of this number deals with the account of the landing at Suvla Bay in August, 1915, as culled from *The Times*. No comments are offered, though the account is given with a Turkish bias. "All the English attacks were shattered by the heroic resistance of the Turkish troops."

In a "military political" article on Denmark, Norway and Sweden, General von Winterfeldt points out that the redistribution of the Danish army has an offensive direction against Germany, the Danish minister president basing the reasons for the changes on Denmark's position in the League of Nations, which may force them to the defence of their neutrality and to eventual participation in international expeditions. To which the General provides a mark of exclamation. He notes in Denmark's external policy a certain *rapprochement* with France, though

no definite undertaking has been concluded. French capital is seeking to exploit Danish munitions industries and to fit these for the production of results which have hitherto been impossible.

Under the title *Night, Mist and War* a reserve lieutenant stresses the need for special training for night-work, particularly in the case of the town-bred soldier, whose ability to find his way about in the dark was proved in the war to be *nil*. He fell over stones and hollows which the countryman was able to perceive and feel. He fell into holes and ran up against standing wagons which the other was able to avoid. He adds even that the country-bred soldier lacked training in night-work. Difficulties by night were accentuated by rain or snow. He points out that this was bad enough when it was a matter of bringing up rations or ammunition, but disastrous in the case of telephone linemen or " runners." He cites, as the most striking case in the late war, the attempt at Brzeziny on 23rd November, 1914, to get the orders of the 25th Reserve Corps for the next day through to the 3rd (Guard) Infantry Division. A captain of the General Staff, a whole squadron and several dispatch-riders were tried in vain. To see in the dark, to be able to find one's way about the country, to find troops or villages, to carry orders through, these must be systematically practised. He concludes by urging that these aims may be contributed to by training the youths in their young men's clubs (*Jugendvereine*) to being accustomed to the dark, a proceeding which he claims in no way contravenes Art. 177 of the Peace Treaty!

11th November, 1922.—" Lucius Cincinnatus " contributes, in the leading article, a so-called " military political " review of the general world situation. With the exception of a few lines on Eastern Siberia, the article is devoted to European affairs and mainly to a violent tirade against the military commission of control. The iniquities of its president, General Nollet, are described with a wealth of epithet, the reason for the outburst being the suggested substitution of a " military guarantee committee " for the present commission.

After some comments on the introduction of 18 months' service in the French Army, he then turns to the change of government in England, which, he says, has been welcomed in French military circles. He quotes a severe criticism of Mr. Lloyd George by General Fouville, adding that whether Mr. Bonar Law will find more favour in this critic's eyes is yet to be seen, and only then, provided he will consent without conditions to every intransigent demand, of the French in particular, for the enslavement of Germany. The new Prime Minister's first speeches make the writer doubt whether the change will benefit Germany. He then goes on to say that the leading English Jingo paper, *The Times*, has just published a whole string of lies about the *Reichswehr* in order to prove that Germany is training more soldiers than they are allowed, and has only temporarily pensioned officers who are to be promptly reinstated, and so on. England's first task after the Turkish victory over the Greeks is to deal with the liquidation of the Near East question. Mr. Lloyd George backed the wrong horse, and obviously did not appreciate the military weakness of the Greeks, or he would have pursued a different plan on the Bosphorus. " The English plan of creating in the Eastern

Mediterranean a Greek *mare clausum* under British control has been demolished for the time being," but he thinks that we have not finished with it, as witnessed by the stubbornness with which we stick to our intentions and the means we have got at our disposal there. "Great Britain has still some trumps in her hand, not only her influence in Greece, but also her position in Crete." He finishes by eulogizing Mustapha Kemal, who has played the decisive rôle in the conflict.

A review of the ex-Kaiser's book of experiences, 1878–1918, affords an excuse for asserting Germany's innocence for starting the Great War. This review is followed by a report of evidence given before the Commission appointed by the *Reichstag* to investigate the causes of the German collapse in 1918, at the beginning of which we find that the first witness proves that the ex-Kaiser must bear not only the formal but the actual responsibility for the offensive of 1918. The third witness, Prof. Delbrück, considers that the fatherland was sacrificed to Ludendorff's ambition. Rathenau, though criticizing Ludendorff, condemns the system and not men. The article summarizing the disclosures says that Ludendorff was not opposed to a so-called "peace by consent," if only there was the slightest prospect for it. As no such prospect was apparent, at least to him, he had no other course but to appeal to the fortune of war. He believed in victory, in his star. It ends by quoting Prof. Delbrück himself: "Did Hannibal lose one whit of his greatness because at the end the forces of the Romans were greater than he had calculated and the Carthaginians were defeated?"

"The Problem of the Professional Army" is the title of an article which sets out to answer the question of maintaining efficiency in the rank and file during the long period of colour service; "twelve years of 'slope arms' and 'order arms' pass the limit of bearable boredom." The experiences of other countries are only of value up to a certain point; colonial service affords the necessary change for the English soldier. The methods of the Foreign Legion are not such as the German would apply(?). The writer then goes on to advocate the abolition of all duties and parades which a long-service man does not need; for instance, no reveille on Sundays, half-holidays from time to time, and to slacken rein between two strenuous parades. He then sketches in outline a suggested course for the infantry-man, the main points of which appear to be to train all men to the light machine-gun, a large proportion as machine-gunners and trench-mortar experts, and the whole as potential N.C.O.'s. As regards this last point, the attitude is curious, though perhaps natural in an army with their traditions: the man promoted, as suggested, at the end of his fourth year of service to be a N.C.O. is suddenly placed over the comrades of his own year and over those of longer service who have not received promotion. "These will, at first, submit themselves only reluctantly to his orders." It will be even more difficult for anyone promoted Company Serjeant-Major while young. "Theoretically, change of Company on promotion would be the best solution. But then no Company Commander would take any interest in pushing on his best men." The most difficult question is regarded as that of soldiers' marriages. He does not want to see a force, the greater half of which consists of conscientious fathers of

families, but, on the other hand, the State cannot prevent the soldier from marrying throughout his service. Young and efficient soldiers are apparently already seeking their discharge on account of the impossibility of marrying, and such cases will increase as time goes on. Why marriage "off the strength" is not possible is not explained. After mentioning a few more apparent difficulties, he concludes by urging the Corps of officers to tackle the question in detail.

21st November, 1922.—The leading article consists of a reply by General Ludendorff to the criticism of "double vision" levelled against him in the evidence given before the *Reichstag* commission. The charge against him was that outwardly, from various motives, he pursued different aims to what he considered possible of attainment, and had been more prepared for making peace than he showed. A further deduction is made that he regarded the situation as desperate, continually "trembled for peace" and only continued to prosecute the war out of personal ambition. Against this he asserts that he was always in agreement with the policy of seeking a reasonable peace if it was attainable, but he never believed in its possibility, yet was in duty bound not to hinder the Chancellor from pursuing it if the latter thought it within reach. As long as there was no peace, they had to fight on for a victory if that was possible. The conditions in the autumn of 1918 he promises to deal with later.

"In the summer of 1917 England was said to have been ready for peace, that is to say, to feel herself too weak to continue the war with the prospect of attaining her goal, the destruction of Germany, and to fear that she herself might be beaten. I welcomed the corresponding communication concerning England's peace move most gladly, though with doubt." He saw that it was hopeless, under the then conditions, to secure by this peace the establishment of their position on the Flanders coast, but thought they could establish themselves on the Meuse by Liége, which did not vitally affect England's interests, supposing she was really ready for peace, that is to say, weaker than they assumed. At the Council of 11th September, 1917, the Emperor opposed the proposal concerning the Meuse, and gave the Secretary of State, von Kühlmann, full authority to guarantee the sovereignty and full restoration of Belgium in case peace was concluded in 1917. For the rest, the Secretary of State was given a free hand for his activities. In Berlin circles there was the belief that an open declaration concerning Belgium, in the sense of the Imperial decision, might be the key to peace. There then follows a long story of the action of General von Haeften, Ludendorff's representative in Berlin on many questions, in proposing to von Kühlmann that the declaration about Belgium should be published; the proposal was rejected. Ludendorff says he refrained from blaming the general for thus acting off his own bat, as the only result of it had been to show the Secretary of State that, in conformity with the Imperial decision, German G.H.Q. left him free to pursue any course which he found convenient. German G.H.Q. was not in a position to influence directly the action of the Secretary of State; its job was to win the possibility of peace by fighting, knowing nothing of its details. For it the knowledge sufficed that, so far as depended on

G.H.Q., it had removed every difficulty from the Foreign Office in this matter. He defends the bringing up again of the question on the 14th September by saying that G.H.Q., as there was no protocol, considered it necessary to lay down clearly its views for the probable case of there being no peace concluded in 1917, and the Secretary of State's full powers in this matter being withdrawn. G.H.Q. was clear that speeches about war aims had only the object of finding a basis of negotiation in the given military situation. What would be achieved depended, apart from the military situation, upon the strength of the German representatives at the conference table. "The confidence of G.H.Q. in this strength was uncommonly small." There follows a paragraph dealing with "the weak government," "its internal defeatist policy," "party business," ending "for the war aims, like everything with us, had become a question of internal politics, whereby the conduct of war and its essential meaning were forgotten, until, by the dagger-blow and revolution, the collapse arrived."

In the position German G.H.Q. took up with regard to the so-called English peace-feeler no other considerations played any part, not even the feeling in the higher staffs, which for the most part was very yielding; on this Ludendorff says he had no doubt as a result of his many journeys to the front.

"It is clear that in this general situation the war was to be pushed on with energy and pursued without interruption." Ludendorff thus claims this to have been his "double vision" in the autumn of 1917. The position taken up by G.H.Q., he says, is simple, clear and logical, free of prepossessions and contradictions.

1st December, 1922.—Ludendorff continues his reply to the accusation of "double vision," in a long article dealing with the situation in the spring of '18, which he begins by saying was such that they could assume the offensive in the west with a prospect of success. He condemns the diplomats for their weak and undecided attitude at Brest-Litovsk and Bucharest, which had not helped the military leaders, and for their failure to get into touch with the western powers. G.H.Q. was only aware of preposterous peace conditions which could not be accepted except by a defeated Germany. Of other unacceptable offers, like Clemenceau's to Count Czernin, G.H.Q. heard no word; the continuation of the war was all that remained. After another dig at the diplomats over their hesitating attitude in the East, the obscure conditions there and the Ukraine enterprise, he says that G.H.Q. was well aware of the extent and difficulty of its task in attacking in the western theatre, and had paid due regard to it by preparation and training of the troops. Report was made to the ex-Kaiser that the army was well equipped and prepared for the greatest task of its history. "An elevated, moral earnestness inflamed G.H.Q."

Their idea was to reach a decision by a "tactical victory," if not at the first, then at the second attack, in the course of which the Entente, before the arrival of the Americans in decisive numbers, was to be brought to the position of seeking peace, and thus to save Germany; delay would spoil everything. For such a tactical victory the enemy's front must be penetrated so far that a break-through must result, giving

them freedom of operation against the exposed hostile wing. The first thing then was to find a weak spot in the enemy's front which promised such a success. "This was found south of Arras on both sides of St. Quentin, offering an attack in the direction of Amiens, that is to say, separating the French and British forces."

An attack in Flanders was also contemplated, and in the plain of the Lys. "To roll up the enemy's front from the north, after the style of the 1914 operations, was attractive." These operations, with their own right wing supported on the sea, was, he says, much easier than that towards Amiens. "But in view of the distribution of the enemy's troops the tactical success of the attack seemed by no means probable"; conditions in Flanders were "still more unfavourable" than they were at the attack of the 17th Army on 21st March, and the latter had but little success, though outside circumstances may have had something to do with it. It is difficult to draw comparisons, especially between tactical situations, but still one can get at essential facts which deserve a certain consideration.—(*To be continued.*)

E.G.W.

CORRESPONDENCE.

THE DRAYSON FALLACY.

SIR,

In the last number of the *Royal Engineers Journal* you printed a review, by Colonel B. R. Ward, of a pamphlet entitled "The Drayson Problem. His Important Astronomical Discovery." By chance I have had the opportunity of reading the pamphlet, and I find that the author avows himself to be an astrologer, or, in his own words, "attached" to astrology. He doubts whether the earth is really an oblate spheroid, and says that "the settling of this question is not easy, since the equatorial protuberance (if any) is so slight." He states that the proper motions of the stars, "at present assigned, do not result from any motion of the stars, but from a motion of the earth improperly conceived." He is of opinion that the motions in the line of sight, derived from spectroscopic investigations, should not be accepted, since they are really due to the prepossessions of astronomers. And so on, and so on.

On first reading Colonel Ward's review one might, perhaps, get the impression that he approves of the fallacy and of the conclusions of the author. But probably a juster view is that Colonel Ward is indulging in what is familiarly known as a "leg pull."

F.R.A.S.

THE EMPLOYMENT OF DIVISIONAL ENGINEERS IN CONJUNCTION WITH OTHER ARMS IN WAR.

SCHOOL OF MILITARY ENGINEERING, CHATHAM.
14th April, 1923.

SIR,

In the March number of the *R.E. Journal* you published a letter from Brevet Major H. C. B. Wemyss, Royal Corps of Signals, in which he disagrees with my contention that an independent system of engineer communications is essential to the efficient working of the system of Divisional Control of Engineer Work as enunciated in *Engineer Training*, 1922 (*Provisional*). May I be permitted to say a few words in self-defence?

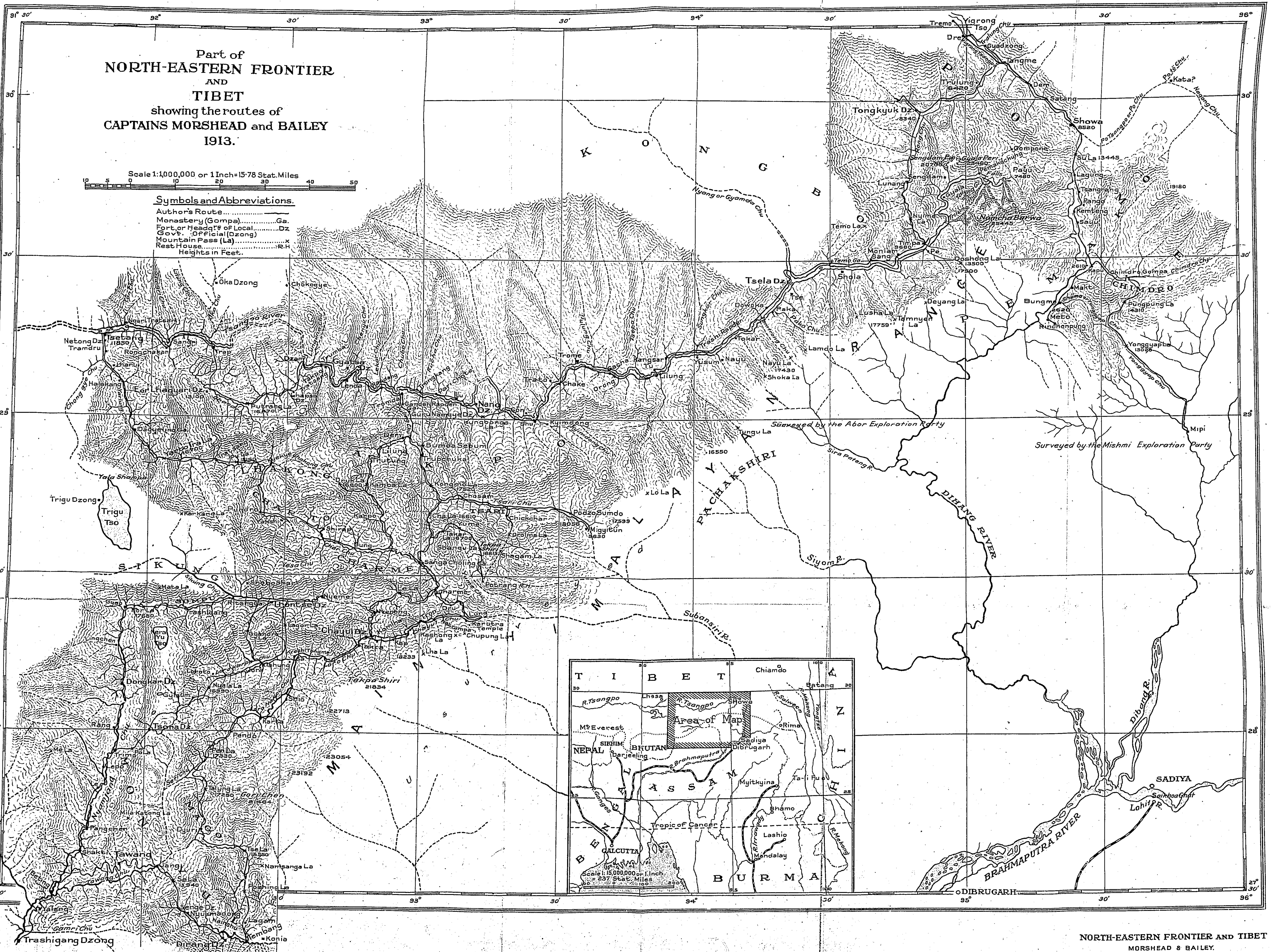
Everybody now agrees, I think, that all communications *except within units* should be in the hands of the Divisional Signal Company. But he goes on to say that the "unit," in the case of the engineers, is the Company. There I disagree with him. Under the Brigade Group System the Company was the unit. Under the Divisional System the "unit," so far as tactical control is concerned, is the divisional engineers, *commanded* by the C.R.E. If you deny to a commander of a unit his own means of communicating his orders to his sub-units he cannot efficiently command them, nor can he be held responsible for any failure due to non-receipt of orders. The motor-cyclists of the field companies and the C.R.E. correspond to the runners and signallers of an infantry battalion. Without them the battalion commander cannot exercise his functions of command, nor are they provided by the Royal Corps of Signals. The C.R.E. is in the same position. The argument of Major Wemyss, therefore, though sound in itself, is based on a false hypothesis which vitiates his conclusions.

The Rawlinson Committee on the organization of the engineers of the Army allowed the following motor-cycles for intercommunication purposes in the units of divisional engineers in the establishments it recommended:—

Headquarters Divisional Engineers and Headquarters Company	2
3 Headquarters Double Field Company (2 each)	6
6 Headquarters Field Company (1 each)	6
Total for Divisional Engineers	14

Yours faithfully,
G. E. H. SIM, *Brevet Major*.

The Editor, *R.E. Journal*



NORTH-EASTERN FRONTIER AND TIBET
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