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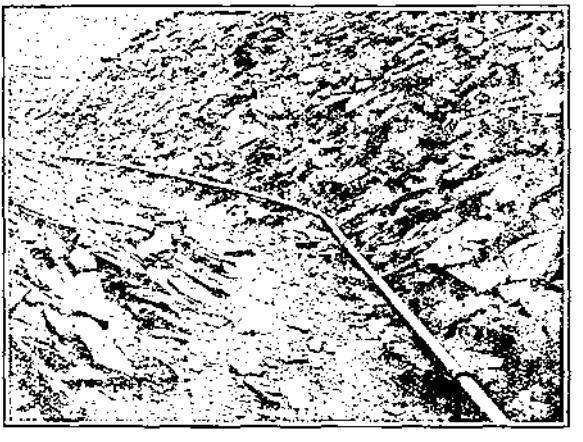

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THE DIRECTION OF NATIONAL EFFORT IN WAR.

A Lecture delivered at the S.M.E., Chatham, on February 23rd, 1928, by MAJOR G. N. MACREADY, D.S.O., O.B.E., M.C., R.E.

ALTHOUGH war has been the principal international pastime for a very long time, a national war—that is, a war involving the whole of a nation's effort—is a comparative novelty.

One hears of people living in the Highlands, or in remote country districts of England, who never heard of the Napoleonic wars until they had nearly ended, but I doubt whether any inhabitant of these Isles did not hear of and feel the effect of the Great War before a very few months had passed. At the front, of course, one often heard the remark that the people at home did not realize we were at war until the gin and bitters ran short, but such remarks were not meant to be taken seriously.

What is meant by the production and direction of National Effort.—As a result of our experiences in 1914–1918, our conception of war has had to be largely modified. As Sir William Robertson said recently at the Royal United Service Institution :—

> " War is not nearly so much a matter for soldiers and sailors alone, as soldiers and sailors sometimes think. On the contrary, it embraces all the activities of the nation."

It must also be borne in mind that, when a nation is fighting for its life, it is almost impossible to draw any hard-and-fast line between the imperious, and almost insatiable, requirements of the fighting services, and the essential needs of the non-fighting departments and the civil population.

The life and the enthusiasm of the whole people must be maintained ; the economic fabric of the nation must not be imperilled ; our relations with neutrals must be safeguarded.

A general view and a just apportionment are essential. It is, therefore, not merely a case of arranging to provide the fighting services with vast quantities of men and stores, most of which are of special design, and many of which are not produced commercially in time of peace—though that in itself is a gigantic undertaking. It is a case of foreseeing and providing for the whole vast total of the nation's requirements.

If we extend this to the Empire, we find that the problem

confronting us is nothing more nor less than the preparation of plans for the mobilization of the entire resources and industries of the Empire, and their employment in a unified and pre-determined manner.

Peace-time organization.—Now, whatever type of machinery may be evolved for directing national effort in war, the starting point of transition must be our peace-time administrative organization. Let us take a glance at this. We have a Cabinet, consisting of twenty-one ministers, including the Prime Minister. Each of the fighting services is controlled by its own minister, responsible only to the Cabinet. The Navy, Army, and Air Force recruit their own personnel, have their own supply departments, their own programmes, and their own contractors. Owing to their comparatively small requirements in peace-time, their recruiting and supply interests rarely clash, either with each other or with the civil community.

Again, while the Ministries of Health and Labour, and the Board of Trade regulate the life of the civil community to some extent, and the Chancellor of the Exchequer makes it his business to extract from us as large a proportion as possible of our hard-earned pay, the ordinary civilian can do pretty well what he likes in peace-time. We can all drink as much as we like, as long as the after-effects do not attract the attention of the police; we can eat as much meat, butter, and sugar as we like, without wondering whether there is likely to be a shortage of these commodities at any time.

In short, for all practical purposes, each service and each department functions in peace-time as a separate entity. Whether this should or should not be is beside the point. We must take the situation as it exists as our starting point for war preparation.

The first question that obviously arises, when one looks at the situation I have described, is: "How on earth can adequate plans for a national war be evolved, when in peace-time you have such a multiplicity of departments, working entirely separately from one another?"

Neither the principles, the policy, nor plans for defence can be dealt with by one service, or even by the three services together, for everywhere they are found to involve co-operation by other Departments or Governments, such as the Treasury or Foreign Office, by India, the Dominions, or Colonies.

Similarly, to give effect to the war plans of the services, ancillary preparation is required by many departments, and has to be concerted inter-departmentally in many matters, such as censorship, blockade, communications of all kinds, transport, supplies, man-power, and so forth.

In short, before we start thinking of how the national effort is to be directed in war, there must be some inter-departmental

organization to plan in peace-time how the national effort is to be produced.

Such an organization exists in the Committee of Imperial Defence.

The Committee of Imperial Defence.—In the time available, I can do no more than give you an outline of the composition of the Committee of Imperial Defence and how it works.

The Committee of Imperial Defence is a purely advisory and consultative body. It cannot decide, it only recommends. This does not, however, necessarily mean that all recommendations of the Committee go to the Cabinet. Large questions of policy are always referred to the Cabinet for approval. Recommendations on lesser questions, which, if they were purely departmental, would fall within the authority of a Minister, are dealt with under ministerial authority.

Composition of the Committee of Imperial Defence.—As regards its composition, the Committee consists technically of the Prime Minister and such persons as he may summon to consult with him. This elastic arrangement enables anyone who can contribute useful advice, or information, to be summoned to the Committee or its Sub-Committees. As a rule, however, among the Members who regularly attend meetings are the Secretary of State for Foreign Affairs, the Chancellor of the Exchequer, the Ministers of the three fighting departments, and the three Chiefs of Staffs.

The Chairman.—The Esher Committee, on whose recommendations Lord Balfour based the organization of the Committee of Imperial Defence in 1904, considered it a vital necessity to have as its invariable President the Prime Minister of the day, and although, for a few years immediately after the War, pressure of business prevented the Prime Minister from attending regularly, and necessitated the appointment of a Deputy Chairman, the general custom has always been for the Prime Minister to attend meetings in person. There are, obviously, considerable advantages in this. Firstly, the Prime Minister, as Chairman of the Cabinet, is better informed on defence matters if he is also Chairman of the Committee of Imperial Defence. Also, as I shall explain later, the higher control in time of war must inevitably be exercised by the Prime Minister. It is, therefore, advantageous if he has studied defence problems in some detail, and got to know the Service authorities beforehand, by presiding at the Committee and some of its more important Sub-Committees.

Sub-Committee organization.—The main work of the Committee of Imperial Defence is carried out by Sub-Committees, a very large number of which exists. Some of these Sub-Committees are permanent, and are constantly engaged in reviewing war requirements,

and keeping war preparations up to date. Others are merely *ad hoc* Committees set up to consider particular questions which arise from time to time. You will get some idea of the activities of the Committee of Imperial Defence and its Sub-Committees, when I tell you that, in 1926, 218 meetings were held, attended by about 430 people, including 19 out of the 20 Members of the Cabinet, 142 Service Officers, 157 Civil Servants, 6 representatives of the Overseas Empire, and 48 experts outside Government service.

I have no time, in this lecture, to describe the work of all the important Sub-Committees. All that I can tell you is that every possible aspect of war is studied, and, where necessary, schemes are prepared. For instance, the Supply and Man-power questions, trading and blockade, air raid precautions, censorship, imperial communications, oil fuel, and war emergency legislation, are all catered for. It would, however, be as well to tell you something of the three Committees perhaps most directly concerned with the production and direction of national effort. These are the Chiefs-of-Staff Sub-Committee, the Man-Power Committee, and the Principal Supply Officers' Committee.

Chiefs-of-Staff Sub-Committee.—The Chiefs-of-Staff Sub-Committee is under the direct control of the Prime Minister, who himself presides when political guidance is required; but when technical matters are discussed the senior Chief-of-Staff is Chairman. The functions of this Committee were set forth in the Report of Lord Salisbury's Committee in the following words :—

> " In addition to the functions of the Chiefs-of-Staff as advisers on questions of sea, land, or air policy respectively to their Board or Council, each of the three Chiefs-of-Staff will have an individual and collective responsibility for advising on defence policy as a whole, the three constituting, as it were, a Super-Chief of a War Staff in commission. In carrying out this function they will meet together for the discussion of questions which affect their joint responsibilities."

One advantage of the setting up of this Sub-Committee is that the Committee of Imperial Defence now receives collective advice, instead of separate and sometimes contradictory advice, from three separate sources. There are, of course, occasional differences of opinion when a question is first discussed by the Chiefs-of-Staff, but discussion almost invariably leads to a reconciliation of the various points of view.

Man-Power Committee —It is clear that, in preparing for the mobilization of the whole resources of the nation, nothing is more important than the organization of man-power. This is the task of the Man-Power Committee, which works through six Sub-Committees.

The present Chairman is the President of the Board of Trade, who was the right-hand man of the Director of National Service in the later stages of the War, with representatives of the Service Departments and other Departments concerned, such as the Ministry of Health and the Registrar-General. Great progress has been made in this matter, and should it again be necessary to set up a Ministry of National Service, this Committee should be in a position to provide, not only a nucleus staff, but complete plans and statistics which will enable general mobilization of the nation's man-power to be undertaken with the least possible delay.

Principal Supply Officers' Committee.—The tendency towards mechanization of modern warfare renders the production of war material one of the most important tasks in the organization of our defensive preparations. The co-ordination of this work is the task of the Principal Supply Officers' Committee. This Committee works through seven Supply Sub-Committees, each of which is responsible for investigating a particular portion of the vast field of war requirements. There is, in addition, a Contracts Co-ordinating Committee and a Supply Board, whose object is to ensure that the seven Supply Committees work on a uniform policy and in close co-operation with each other. The Board of Trade is responsible for tabulating and co-ordinating the statistics furnished by the various Supply Committees, and for exploring the field of availability for materials. If and when a Ministry of Supply became necessary, the Board of Trade officials engaged on this work would provide a trained nucleus. The necessity for a supply organization of this kind is clearly shown by the history of the late War. Before the War, each of the fighting departments—and, of course, in those days there were only two—was responsible for its own supply arrangements. Each had its own Supply Department, its own Factories, its own Contractors, and its own Programmes. There was no clashing of interests, and therefore no need for co-operation. In these circumstances, and the idea of a war of national effort never having been considered, supplies scarcely came within the orbit of the Committee of Imperial Defence. You all know that, during the War, this machinery soon proved inadequate to cope with the war problem of supplying an Empire in arms, to say nothing of assistance to our Allies. No system existed for the co-ordination of the various supply agencies; there were no arrangements for organizing the expansion of manufacture of the nation as a whole, which was left at first mainly to armament firms. There was no machinery for determining priority as between competing demands for strictly limited supplies. As a result, it was impossible to obtain a general view of national requirements, or to draw up comprehensive supply programmes. Manufacturing capacity was inadequately exploited, and the lion's share of our limited production went not necessarily to the most needy, but to the most importunate.

As early as May, 1915, a new departure became necessary, and all indications pointed to the advisability of entrusting the task of mobilizing the industrial resources of the country as a whole to a new and separate department.

The Ministry of Munitions was set up; it inevitably developed into the most enormous concern, and it successfully delivered the goods. But there are three points worthy of attention: firstly, this Ministry was only concerned with the engineering and allied industries, except ship-building; secondly, naval war material was never included within its orbit; and, thirdly, since all arrangements had to be made in a great hurry, the cost of munitions was probably infinitely greater than it would have been, had detailed preparations been made beforehand. *Now*, in peace-time, the Service Departments do their own shopping as before, but it is expected that, in the event of war, supply requirements will be co-ordinated by the Principal Supply Officers' Committee, and competition between the Services should be eliminated.

I hope that I have now convinced you that, in the first place, any efficient system for direction of our national effort in war must be based on the peace-time administrative organization, and, secondly, that we now possess adequate arrangements for preparing to produce our national effort. You will probably say, however, that what I have said tends rather to complicate the direction of our effort in war than to simplify it. We are starting in peace-time with a Cabinet consisting of the Prime Minister and twenty other ministers, and I have mentioned the possibility of at least two additional ministers, for Supply and Man-Power. Surely this makes the machine more unwieldy than ever! Would it not be possible to centralize the control of Departments that must work closely together? We have a Chiefs-of-Staff Committee for tendering joint advice. Why not go a step further, and have a Ministry of Defence? This is a question I should like to consider in some detail.

Ministry of Defence.—A Minister and a Ministry of Defence certainly have an attractive sound. The Services exist for a common purpose—war—and at first sight it seems logical that all the forces devoted to this object should be administered by one Minister and one Department with a view to complete co-ordination, avoidance of duplication and overlapping, and reduction in expenditure. With these objects everyone must be in accord, and it is a question of practicability and method. It is, therefore, no surprise that a Ministry of Defence became a kind of catch-word. It was advocated by the cheaper newspapers; even some of the more important organs of the Press have at one time or another toyed with the idea. A number of Members of Parliament, including officers of wide experience, have supported the plan. Why is it then that a scheme so attractive at first sight, and so warmly

supported, has not been adopted? A considerable stimulus was given to this idea by a notable speech made in the House of Commons by Mr. Churchill, in March, 1922. The key-note of this speech is contained in the following extract :—

> "The co-ordination of the three Services can only effectively be attained through a process of unification, of realization by all members of those Services that their business is to defend the country as a whole. Whether they serve in the air, or at sea, or on land, ought not to be a cause of differentiation any more than exists between the Cavalry, Artillery and Infantry, who are all gathered under the War Office. No solution of a harmonious or symmetrical character will be achieved in the co-ordination of the Services except through the agency of a Ministry of Defence, but it is not possible to create such a body at the present time, nor will it be possible for a considerable time. In the interim, the only steps which are open to us are to create machinery for pooling the administrative functions of the three arms, and to create a common staff brain, from whose exertions in the future the responsible advice given to the Cabinet of the day in regard to matters of defence must and can only effectively originate."

You will notice that Mr. Churchill indicated two preliminary steps. First, to create machinery for pooling the administrative functions of the three arms, and, secondly, to create a common staff brain. Effect has been given to the latter suggestion by the recent establishment of the Imperial Defence College. As regards the former, a Committee had already been set up in February, 1922, "To make definite proposals for safeguarding as far as possible the common Services of the Navy, Army, and Air Force, such as intelligence, supplies, transport, education, medical, chaplain, and any other overlapping departments, in order to reduce the cost of the present triplication."

This Committee worked for nearly a year and its Report, although completed in 1923, was only published in 1926. The first recommendation of this Report is as follows :—

> "We are of opinion that, in existing circumstances, the complete or partial amalgamation of the common services of the three fighting departments is not advisable, and we do not believe that any substantial economies would thereby be effected."

Instead, the Committee recommended the establishment of a whole series of co-ordinating Joint Committees, on such subjects as the medical, educational, intelligence, supply, transport, and works services. With the exception of the intelligence services, which

were found already to work in close contact, these Committees were all set up. Their reports are reviewed annually by the Committee of Imperial Defence. They have achieved very considerable results in the direction of economy by arrangements for the purchase and inspection of clothing, stores, mechanical transport, etc., by one department on behalf of another ; by the adoption of trade standards or patterns, and common specifications, by standardization, exchange of information in technical and other matters, making the hospitals of one service available to the other two, thus enabling certain hospitals to be closed, by the construction and maintenance of buildings by the department which can undertake it most economically, etc.

The Salisbury Committee.—Meanwhile, the agitation in favour of a Ministry of Defence had not abated, and in March 1923, a very strong Sub-Committee of the Committee of Imperial Defence was set up, with Lord Salisbury as Chairman, to enquire into the co-operation and correlation between the Navy, Army, and Air Force, including the question of establishing some co-ordinating authority, whether by a Ministry of Defence or otherwise. This Committee, after obtaining the views of the principal advocates of a Ministry of Defence, as well as of a number of persons of special experience, considered the criticisms to be overwhelming as against all proposals for setting up a Ministry of Defence or any Minister of Defence with authority overriding that of the Ministers at the head of the Service Departments or a combined Staff.

This account of the historical side of the question is not exhaustive, but is, perhaps, sufficient to show that, if a Ministry of Defence has not been adopted, it is not due to lack of examination. As a matter of fact, between 1921 and 1925, enquiries into our defensive system, beginning with the Geddes enquiry and ending with the Colwyn enquiry, occupied cumulatively no less than 47 months out of 53, with the ultimate result that the plan of a Ministry of Defence was definitely rejected.

What is meant by the term "Ministry of Defence?"—A point which came out strongly in the Salisbury enquiry, and which is noticeable in every Parliamentary debate on this question, is that each exponent of a Ministry of Defence has a different conception of what it should be. One plan involves the suppression of the existing Service Ministers and fusion of all the Service Departments under a single Minister. A variation of this is a plan for the maintenance of the present Departments, and their administration by a single Minister of Defence with the assistance of Parliamentary under-secretaries to take some of the work off his hands. A third scheme is that of a single Minister super-imposed upon the existing Service Ministers and their Departments. Proposals have also been

made for a joint staff and the amalgamation of administrative Services, though how this would be fitted into the organization has not been made clear. Finally, there have been proposals for the re-absorption of the Air Force into the older Services, but I shall not touch on that question, since successive Governments of all parties have taken definite decisions on the subject. Altogether, there seems to have been a certain amount of loose and woolly thinking about details, though the root idea of economy and co-ordination is one with which we can all agree.

Three Ministers essential in war.—All proposals involving the suppression of the existing Service Ministers and Departments appear to break down in the light of war experience. The problems liable to arise in a great war in connection with each Service are so vast and so novel that they require the whole attention of even the most gifted and industrious Ministers. Consider, for example, what was involved in the raising of Kitchener's armies, the officering, recruiting, clothing, armament, supply, transport of so huge a force. Imagine what is involved in administration, to say nothing of the Parliamentary side and the education of public opinion. Much can be done by previous organization, and in this respect we shall be better off than we were last time. Much can also be done by decentralization to subordinates. But even so, an immense number of unforeseen and unforeseeable difficulties and departmental controversies will arise at every turn, which the head of the department alone can settle. Many of these problems may affect Government policy, and have to go to the Cabinet, where the Minister must have every point at issue at his fingers ends.

Take another instance, the anti-submarine campaign, with its ramifications in shipping, shipping control, diversion of traffic to unaccustomed ports, restriction on imports, and a thousand detailed questions, on which the First Lord of the Admiralty had to be informed. Or, again, take the expansion of the Air Force in war, which is at least as important as that of the older Services, with its immense potentialities, raising at every turn the most complicated problems. It seems almost inconceivable that a single Minister of Defence could in a great war handle the problems of the sea, the land, and the air simultaneously. In fact, in the Great War, the task was soon too great even for the Service Ministers and their Departments. Other great Ministries had to be thrown off, a Ministry of Munitions, Ministry of National Service, Ministries of Shipping, Blockade, Information, and eventually an Air Ministry. This experience was shared by the other belligerents, and will, to a certain extent, be repeated in a great war in the future. For all we know, we may require new Ministries for, say, Gas Warfare or Air Raids. To expand, in addition, from a single Ministry of Defence into an Admiralty, War Office, and Air

Ministry, at a time when all branches of the fighting forces are actively engaged, would be worse than "swopping horses whilst crossing the stream"; it would be like giving birth to triplets while crossing a roaring torrent in full flood.

What is the right system?:—If then a Ministry of Defence is not practicable, what should our system be? The experience of the Great War gives us several to choose from. The German system seems to have been centred upon the Kaiser himself. It provided for the paramountcy of the military authorities without giving them complete control over all the resources of the Empire. While it no doubt produced a very high standard of military efficiency, it was distinctly weak on the civil side. The adoption of the unrestricted submarine campaign, for instance, led to the creation of a host of enemies, including the United States, and this resulted finally in the downfall of Germany. The support of the public opinion of the world was lost by this and other examples of frightfulness. Again, the civil authorities in Germany were so overshadowed by the military that they had not the prestige to maintain the national spirit. General Ludendorff writes in his war memories: "Our War Chancellors did nothing to repair the damage or enlighten the people. They had no creative ideas and did nothing to hold the people together and lead them, unlike the great Dictators, Clemenceau, Lloyd George, and Wilson."

But if, under the German system, the civilians did not enlighten the people, it was certainly beyond the capacity of the Generals to do so. In the very next sentence, Ludendorff says: "The attempts of General Headquarters to help the homeland by patriotic instruction and disseminating propaganda intended for foreign consumption within our own borders were mere crumbs to the hungry. The soul of the German people was without direction or leadership, a prey to every pernicious impression that came its way." In the following passages, also from Ludendorff's book, the German system of military predominance, which stopped short of real control, stands condemned. "Like Clemenceau and Lloyd George, I had wanted to call on the whole nation, but I was not a Dictator, as men were only too glad to repeat, false though it was. Lloyd George and Clemenceau had control of *their* Parliaments. At the same time, they stood at the heads of the entire administrative and executive authorities. I, on the other hand, had no constitutional power to influence the German Government, nor to enforce my views as to the steps necessary for the conduct of the War, and I was frequently confronted with the lack of understanding and energy of the Departments concerned."

I doubt whether a stronger indictment of the German system, or a more reassuring endorsement of the British and French systems could be found elsewhere than in this book of Ludendorff's, unless

in the even more severe stricture of Admiral Von Tirpitz, which there is no time now to quote.

The British system.—For the first three months of the War its general conduct was in the hands of the peace-time Cabinet. This system did not work well. The Cabinet was so large, its members so busy with their own departmental problems, that it could not be summoned sufficiently often or sufficiently rapidly to deal with the great mass of business involved in the higher control of war. Consequently, at the end of November, 1914, Mr. Asquith constituted the War Council. On the change of Government in May, 1915, the War Council was renamed the Dardanelles Committee. Originally created to deal with the Dardanelles, this body very soon became in fact a War Committee, and, in the autumn of 1915, it was rechristened accordingly. The War Council and War Committee were an application to war conditions of the Committee of Imperial Defence, the main difference being that, instead of being advisory, the War Council and War Committee had powers of decision, except in matters of the highest policy, which the Prime Minister reserved for approval by the Cabinet. On December 9th, 1916, Mr. Lloyd George formed his War Cabinet, which combined the powers of the Members of the Cabinet with the machinery of the Committee of Imperial Defence tuned up to war conditions.

The French system.—The French experience was somewhat similar to our own. At the outset, the general conduct of the War was in the hands of the ordinary peace-time Cabinet. Later, there was formed a War Committee, whose functions seem to have resembled our own. On December 12th, 1916, three days after the formation of our own War Cabinet, the French Government was reorganized, and M. Briand established a War Cabinet of five members. When M. Painlevé became Prime Minister, he remodelled his War Cabinet organization closely on our own. Later, when M. Clemenceau came into office, he adapted M. Painlevé's organization to his own particular views.

For the last year of the War, the higher control in Great Britain and France was exercised in the main by Mr. Lloyd George and M. Clemenceau, both men of tremendous character, both exercising immense influence over their colleagues, but both working with a Cabinet, and subject to their respective Parliaments.

The Prime Minister must take charge in war.—One feature of this arrangement, to which I would draw special attention, is that in Great Britain, France and Italy, every organization to which the direction of national effort was committed, was presided over by the Prime Minister in person. In a country with a Parliamentary system no other course appears feasible. The moment a big war breaks out, its prosecution becomes the main feature of Government

policy. The Prime Minister must be ready at any moment to expound that policy in Parliament. Moreover, under conditions of modern warfare, that policy is not merely a matter of naval, military, and air operations. Every resource possessed by the nation has to be organized behind the services. Every Cabinet Minister, every Department of State is concerned. In these circumstances, who can direct the policy, who can expound it as a whole, and who can insist on the decisions of the higher control being carried out, except the Prime Minister?

If, then, I am asked who is to exercise the general direction of the national effort in war, I would answer that, in a country governed as we are, only one man is possible, the Prime Minister of the day. No one else is in a sufficiently central position. No one else can exercise the required authority. The latter is probably far the most important point.

Organization of higher control.—The next point is, what form of body is to assist the Prime Minister to exercise this control? The type of body to be adopted must depend on circumstances, such as the personality of the Prime Minister and the magnitude and nature of the war.

For a small war, the present system.—For a very small war, the ordinary Cabinet, with the assistance of the Committee of Imperial Defence and the Chiefs-of-Staff Sub-Committee, would appear to be quite sufficient.

For a medium war, a War Committee.—For a medium-sized war, of the type of the Crimean War or South African War, a War Committee is required which can take prompt decisions on all matters where time is of vital importance, and on questions of a secondary order, although in such a war the larger policy would always require the approval of the Cabinet.

For a great war, a War Cabinet.—For a war of the first magnitude, like the last, which requires the Cabinet to be in continuous session to settle a mass of questions arising from day to day, as well as to formulate and direct the policy as a whole, the experience of the War went to show, I think, that the War Cabinet is the most satisfactory system. The essence of that system was a small Cabinet under the Prime Minister's presidency, with Members free from ministerial duties, in whom resided full powers of decision. The Ministers at the head of Departments, such as the War Office, Admiralty, Ministry of Munitions, etc., attended when questions affecting them were under consideration, but otherwise they were free to give their whole time to their Parliamentary and administrative duties. The Chiefs-of-Staff attended every meeting of the War Cabinet. It is a system that would only be tolerated in the gravest national emergency. The Prime Minister of the day must

be the judge of the moment at which the method must be changed, and it is quite possible that the War Cabinet system will again only be reached after the other systems have been tried and found inadequate.

There is much to be said for this elastic system, which leaves the precise form of the higher direction, which, I suggest, owing to our constitution and form of Government can only be one of the three I have mentioned, to be decided when the emergency arises.

Higher control of Empire Forces.—I have not dealt with the question of the direction of the Empire's effort. This raises constitutional issues of rather a difficult character, which are not ripe for solution. In the War, we solved the problem with a good deal of success by the emergency expedient of an Imperial War Cabinet. Whether that expedient would again prove acceptable to the Dominions, or whether some other system would have to be evolved, is at present rather a matter for speculation. One thing, however, seems clear, and that is that, when the ever-growing forces of the Dominions again fight side by side with our own, the Dominion Governments will have to be accorded a full share in the formulation of the war policy, and in the general organization of the Empire's war effort.

Perhaps, after this rather long and involved dissertation, it would be as well to summarize my conclusions, which are as follows :—

In order to arrive at an efficient system of controlling the direction of national effort in war, in the first place, dislocation of the normal peace-time system must be reduced to a minimum. Secondly, there must be in peace-time an advisory organization which can explore the whole field of war-time requirements, and draw up plans adaptable to every likely contingency. Such an organization exists in the Committee of Imperial Defence. Thirdly, a Ministry of Defence, either in peace-time or in war-time, does not appear to help towards war efficiency. Fourthly, the ultimate responsibility for controlling the national effort must pivot on the Prime Minister. And, lastly, to assist the Prime Minister to exercise the necessary control, there should be either the usual peace-time Cabinet and Committee of Imperial Defence, a War Committee, or a War Cabinet, according to the needs of the situation, but that it would be a mistake to lay down rigidly that any one system should apply to every eventuality.

SCIENTIFIC SOLDIERSHIP.

By COLONEL J. F. C. FULLER.

THE simplest definition of "science" is "knowledge," but, as knowledge so frequently signifies haphazard inference and unanalysed fact, a better definition is co-ordinated or systematized knowledge. There is nothing mysterious about this word, and it is not necessarily connected, as the common mind imagines, with grey beards and abstruse problems. For example, every gardener who aims at producing artistic effect must know something of the science of gardening. He must understand not only the soil, climate, and the seasons of the year, but when and when not to plant certain seeds, for they do not all germinate, or flower, at the same times. Without this science, this knowledge of the principles of gardening, his art will be of a very low order. Similarly with the soldier, his art of war will be primitive unless it is based on science, that is, on a true knowledge of war, in place of haphazard knowledge.

How does the man of science arrive at true knowledge? By observation, reflection, and experiment. Whatever his subject may be, he is always confronted by a variety of changes. Nothing which can be studied is absolutely simple, otherwise to the mind it would become a blank zero. It is complex and possesses variety. For instance, even so exact a science as mathematics is continually evolving and conquering new spaces and exploring new or little-known dimensions. Once, Euclid was the high prophet of geometry, now he is but one of a number of geometrical masters. In war, complexity is complicated in the extreme, and the study of war is rather like unravelling a mass of entangled spider's web. The task is so difficult that many soldiers affirm, not only that there is no science of war, but that there can be no science. Such a statement is manifestly absurd, since complexity is not the negation of science; in fact, the more complex a subject is, the more necessary is it to examine it scientifically; to discover one of the two ends of the web, and by degrees unravel it.

The science of war is not to be discovered on the battle-field, for there it can only be tested out as an art. The gardener does not discover the science of gardening in the garden, for there also is his science tested out as an art. He attains his knowledge primarily by study, or by tapping the knowledge of other gardeners who have arrived at it through a long process of trial and error. So also with

the soldier ; he has the whole history of war to observe and examine. It contains an enormous number of facts—true, half-true and false, and unless the soldier has sorted out the facts of history and discovered their value, his art on the battle-field will be chaotic.

The scientist, having discovered the nature of facts, next compares them. From comparison he discovers differences ; these may at first perplex him, but if they do he builds upon them a theory, and then starts to test his theory out. If, after a large number of tests, he can find no exception to his theory, he deduces a law, or governing principle. Thus, if, after throwing a great number of articles into the air, all fall to earth, this falling constitutes a general principle which governs all things material. To-day, this general principle is called the law of gravity, and it will hold good as long as no exception to it is found.

In war, there must also be some *one* governing principle, yet it must be recognized that the history of war clearly shows us that the average soldier has no conception of a law of war. Like the average man, he buys his experience, and frequently he is cheated. He sets out to fight his battles, if not actually believing in chance, very much entranced by this false goddess. In the world of science, chance does not exist. Chance is the partner of ignorance, and not of knowledge. A world ruled by chance would be a chaos and not a cosmos, and it is for this reason that so many wars in the past have been chaotic, not because they must be so, but because ignorance of the science of war has made them so.

Whether laws are defined or not, the man who would work scientifically must do so without favour or prejudice. He must be slave neither to opinion nor law. He accepts a law as long as no question is raised as to its validity, but, should doubt be cast upon it, he must re-examine it in the light of this doubt, and be ready to scrap the law if evidence proves that it is fallacious.

In the study of military history, and of history generally, the great difficulty is that the student is not examining inanimate objects but events once fashioned by human beings, and as no two men are alike, so also no two events are alike, or exactly alike. Consequently, the science of war is not an exact science. A chemist knows that two molecules of hydrogen and one of oxygen go to form water, but no soldier can definitely say, should two men fight over a jug of water, what the result will be. Yet he must know that in every fight there is a right and a wrong way of fighting. So, by either observing many fights, or by reflecting on them, by degrees he extracts what may be called the principles of fighting. Often, in his studies, he will be faced by a choice of two evils, then he must choose the lesser until further examination, or experiment, enables him to exchange an indifferent fact for a more certain one.

In war, the permanent yet the most uncertain facts are those

related to human nature. They are permanent, since human nature changes but slowly. In all essentials man, as man, is much as he was several thousand years ago. He is courageous or fearful, greedy or generous, selfish or grateful, kindly or cruel. But which is he at any moment, and what is his predominating virtue or vice, and what is the nature of the society he lives in? It is this doubt which makes the study of history so interesting and so difficult. To study the Thirty Years' War, or the Crusades, as if they had taken place in the twentieth century is to misread history altogether, for, though the men engaged in them were much the same as they are to-day, their social surroundings were entirely different, and until these differences can be grasped, history is apt to mislead us.

The changing factors are weapons, and the means of protection and movement made use of. In recent years, weapon improvement has been continuous. To-day, the power of the bullet, the most potent factor on the battlefield, is threatened by the re-introduction of armour. This has been rendered possible by a new motive power—petrol. If, in the last hundred years, weapon-power has been advanced by leaps and bounds, in the next hundred it is likely to be changed out of all recognition, for the change of motive power from muscle to petrol is radical in the extreme. For many years yet, the soldier will live in a rapidly changing period of transition, and unless he can catch hold of the sheet anchor of military science he is likely to become derelict to the storm.

Can such an anchor be fashioned? The answer is: Most certainly, if the soldier discovers that, though every new weapon, or improved weapon, changes the tactical use of all older weapons, yet behind all these changes there is an unchanging framework to tactics. As long as he is prejudiced in favour of a certain weapon, or arm, he will never make this discovery. He may be an infantryman, or a cavalryman, or a gunner, but he should only remain such in mind as long as these arms are useful. Not very long ago, there were no gunners; for a thousand years in Christian history, that is, over half its total period, infantry were of little use and cavalry were supreme, though to-day the tactical power of cavalry is negligible. There is nothing eternally essential in any arm save its functions; these, as controlling ideas, remain permanent, and during one period they find their expression in one series of arms, and during another in another, for arms of themselves are but the vehicles of ideas. For example: if my idea is to move from one town to another, I can go by train, car, aeroplane, horse, etc. Again, if my idea is to discover an enemy, I can use an infantry scout, a cavalryman, an armoured car, or an aeroplane. In both cases the idea remains the same, but the means of attaining it differs.

What are these functions? They are: finding, holding, hitting, and protecting. Whatever war is under consideration, whether the

last one or the most remote, one side has had to find the other. When found, the enemy has had to be held, that is, his freedom of movement has had to be restricted. When held, he has had to be hit, and as he will undoubtedly hit back, the hitter must be prepared to protect himself.

Now, if the past 3,000 years of known warfare show us that these four tactical functions have never changed in idea, we may accept them as four scientific facts, which in the future will hold good until an exception is discovered; then we must reconsider their validity.

A close study of history will show that the side which was so organized that it could find, hold, and hit its adversary the more easily, and protect itself the more effectively, always won; consequently we may deduce from this that the controlling law of war is that of economy of force. Finding economizes time, holding economizes mobility, since the holder can make better use of his power of movement; hitting economizes energy, since the side hit will become the more exhausted, and protection economizes all these three by shielding them against being found, held and hit. If this argument is logical, then a most significant discovery has been made, namely, that war, like any other subject, is based on a fundamental law—economy of force. Accepting this law, even if only provisionally, I will now turn to the future of war and see whether, by means of it, some of its secrets cannot be read.

All sciences aim at increasing knowledge, some are concerned purely with the past, unearthing what has long been forgotten, others mainly deal with the future, and never cease struggling with its secrets. The science of war is confronted by both these tasks. The military scientist delves into past history to discover facts, and from these facts he elaborates theories as regards future possibilities. Unlike in most sciences, he cannot completely prove these theories save in war itself, yet, through logic and reflection, provisional proofs of the greatest value can be obtained; consequently, our study of military history and present-day events should primarily be undertaken with this object in view.

Our starting-point is obviously the last war, our last great experience. Before the outbreak of this war, all armies were organized for mobile warfare, as they are to-day. The War, however, proved utterly static, which at once shows that the armies of 1914 were not suited to the conditions they were called upon to face. Either conditions had been misread, or no trouble had been taken to organize armies to fit them. We know that the greatest trouble and care were taken in preparing them for the last war, consequently it is in the misreading of conditions that the fault lies.

It was the bullet on the defensive which rendered the War static, and, from 1914 onwards, the War problem was how to conquer the bullet. The obvious answer was armour-plate; but as this form of

protection could not be carried by men, it was carried by machines, and as these machines had to move across country they were provided with caterpillar tracks. From these two facts—armour and cross-country movement—we may develop two hypotheses. The first is that unarmoured troops will prove of little use where armoured vehicles can move; and the second, that the age-old dependence of armies on roads, and later on railways, is likely to undergo radical modification, since, if one type of vehicle can move across country, there is no reason why all types should not do so. Out of this second hypothesis may be developed a third, which strategically and tactically is of the highest importance. This is: whilst in the past the decisive point of attack has normally been sought in the front of an army, in future it is likely to be found in its rear. If this is so, then our present conceptions of strategy and tactics will have to undergo a radical change. I will enquire into these three factors conjointly.

Why are infantry likely to disappear from the main theatre of war? The answer is: Because they cannot protect themselves against armoured machines. But cannot they be protected by other arms? Certainly, yet what use are they to the protecting arms? It is quite a simple operation to escort a squadron of wooden three-deckers by a fleet of modern warships, but in the eventual naval battle what use are these wooden ships?

To examine this question in greater detail: a field-gun can frequently destroy a tank, consequently field-guns can protect infantry. Now, since the bullet-swept zone compels the field-guns to come into action well in rear of the infantry they are supporting, therefore they are very badly placed to carry out this protection. Equip the infantry with portable anti-tank weapons, does not this solve the problem? No, because the tanks can stand off outside their effective range, and bring heavy fire to bear on them and the infantry they are protecting. Or they can ignore the infantry altogether and attack the guns which are covering them.

If these guns are attacked in flank or rear, they will be taken at a serious disadvantage, consequently they will require anti-tank weapons of their own. What can the tanks now do? They can ignore infantry and guns and move still further in rear and attack the supply services. These also will have to be protected by anti-tank weapons.

The problem of protection thus handled becomes an unending one, and why? *Because it is a static one.* Every unit, right back to the base, will have to be protected by anti-tank weapons, just as in the last war every unit was protected by trenches. In the War, trenches were constructed from flank to flank, and only when both flanks were blocked was complete protection established. But a trench is no great obstacle to a tank; consequently, anti-tank

protection, as long as it remains static, will not only have to be provided for the front of a force, but also for its flanks, and it will have to go right back to the base, and only when a tank-proof lane has been established will complete protection be attained.

Literally, thousands of these anti-tank weapons will be required; and what for? To protect arms which can do the tank little or no harm. Surely then it would be better to replace the existing arms by tanks. For tank can attack tank.

The difficulties connected with this problem arise out of a faulty appreciation of facts, coupled with the obsession that the arms we have must be permanently useful. If soldiers would only think out this problem scientifically, it would at once be realized that armoured mobility can develop higher offensive power, and armoured offensive power higher mobility than unarmoured. Once realizing this, they would see the folly of the "Great Wall of China" idea. It is no economy of force to protect what is useless, and if infantry still possess certain uses, then in place of "walling" them in against tank attack, as a few years ago they were walled in against infantry attack, they must be escorted by mobile armoured troops. In conception the correct answer to this problem becomes simplicity itself directly we begin to think scientifically. Our object in war is to apply the law of economy of force, and not necessarily to hold fast to everything we have.

From what I have now written may be deduced a new theory of war, which I will call the Area Theory. In the past, movements have been linear. Troops marched in column—a line. They deployed into line, and fought in line, or lines. Generally the front protected the rear, for to outflank an unbeaten line was both difficult and dangerous. In area warfare, there is only one fixed point—the permanent base. A column may advance from this base in any direction. It can manœuvre in any direction; consequently fronts may be anywhere, and normally they will not directly protect the base, as they do in present-day warfare.

If we examine the last war we shall find that everything is pointing to this change taking place. Aircraft are independent of fixed frontages. Aeroplanes can move in any third-dimensional direction, and can attack any area within their radius of action. If this is so for attack, then defence must follow suit, areas being protected in place of points, or positions. For such a purpose, persistent chemicals at once suggest themselves. Gas is not only an area hitter, but an area protector. It not only can attack any target, even unknown ones, in an area, but can, so to say, occupy an area for days on end and remain effective.

Two other recent inventions, namely, communication by wireless telephone and telegraph are intimately connected with this same idea. To-day, it is possible to communicate anywhere in a given

area with any other individual, in spite of the fact that his actual location may be unknown.

If the area idea is going to dominate the attack, defence and intercommunication, it follows that all the administrative services, supply vehicles, tool carts, field kitchens, ammunition wagons and ambulances must be able to move across country. When they are not immediately protected by the fighting troops they will have to be convoyed, and when distances are too long for this they will have to seek refuge in fortified depots. The picture we obtain of the future is as follows :—

A fortified base, and a series of fortified areas which are vital to the army, such as manufacturing centres. A series of fortified depots, not along the frontier, but from the frontier backwards. Escorted convoys of supply vehicles moving from depot to depot, and the fighting forces operating independently in the theatre of war. From this it will be seen how much easier it will be to fight in one's own country.

All these changes in strategy, tactics and administration, so I believe, can clearly be foreseen if present-day conditions are scientifically analysed. The law of economy of force is the controlling factor. Why be hit by a bullet if armour will protect you, and why be tied to a road if the track will enable you to move across country? For some time, no doubt, possibly a long time, if we refuse to think scientifically, infantry will be used in numbers. It may be urged, and for the time being correctly, that, as practically every theatre of war will contain areas unsuited to mechanical movement, infantry will be required. But, in wars between industrial nations, these areas, mountains and forest land, will be the least important economically. Great armoured battles will be fought on the plains, and, if won, the mountain fastnesses (under modern conditions) will soon surrender. In fact, by throttling the communications leading to them, they will be starved out. Little by little, as the true nature of conditions is laid bare, so it seems to me will armies armour themselves more and more until they are completely protected by steel. This change has occurred once before in European history, when the legions of Rome were replaced by the armoured knights of the Middle Ages. Then armies grew small, numbers of unarmoured infantry being replaced by a few armoured horsemen. This cycle, I think, is going to repeat itself, and will, so I believe, manifest when the soldier has trained his mind to think scientifically, that is when he has learnt how to apply the law of economy of force to scientific inventions and to the existing conditions of war.

THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART I. (AUGUST 4TH TO SEPTEMBER 5TH, 1914).

Battle Honours during the period—" Battle of Mons," " Retreat from Mons."

THE hot summer of 1914 was dragging sleepily along. Aldershot was mopping its brow in the toil of the usual summer training, the 23rd and 26th Field Companies had completed a very pleasant summer camp by the Thames at Wallingford, and as July neared its close, the field works season was almost over, and the possibilities of short leave before manœuvres were being canvassed. In connection with this field works season it is worth recalling that the problems connected with the passage of barbed-wire obstacles had been much discussed, and, one fine day on the Long Valley, might have been seen the spectacle of small parties of perspiring Sappers trundling before them massive shields on wheels, whence, on reaching the entanglements before the trenches, held by the gallant (skeleton) enemy, grappling irons were thrown attached to ropes that had been uncoiled from the stomachs of the monsters in their progress. Unfortunately the wheels were small and the bumps in the valley numerous and intricate, and more than one shield fell on its face before the wire, leaving the crew limp and exposed like an oyster on its shell. This was doubtless the germ of the tank.

The only cloud disturbing the horizon was the situation in Ireland, which created a feeling of restlessness at the possibility of an unpleasant job, and it came almost as a bolt from the blue when leave was stopped on July 30th, and the full meaning of events in Europe was realized. Ireland was forgotten, and, as events followed one another thick and fast on the Continent, it became apparent that the real thing was come at last, and, little realizing the anxious and critical decisions which were being debated in the highest circles, the units in Gibraltar Barracks began to prepare for the inevitable wire. All Saturday, Sunday and Monday, there was a scene of strenuous preparation, 33 1/3 % of the 23rd (Field) Company's officers got married, harness was taken from the mobilization stores and assembled, serving soldiers were medically examined and inoculated, and all preparations made for the starting pistol.

At 6.5 p.m. on August 4th, the order to mobilize was received, and we were already well ahead of schedule, tool carts nearly packed, harness ready for remounts, and so on. Very soon the reservists began to come in, and by the second day of mobilization every man except one had arrived, and he came a day or two later. It was not long before these men had fully shaken down ; a progressive course of route marching, beginning with 3 or 4 miles a day, and working up to 12 or 13, together with a short refresher in musketry, soon wore off the traces of reserve service, with the result that a fine, fit, hard-marching body of men marched off the Gibraltar Barracks parade ground to entrain at Farnborough on August 15th, 1914. Prior to departure, on August 11th, the Company had the honour, with other units, of being inspected by His Majesty the King.

The only absentee from the final parade was "Sunny Jim," a terribly tall yellow horse, belonging to the writer, who, having no stomach for battle, sprained a fetlock in his stable the previous day, and for the remainder of the War terrorized unfortunate recruits in the Depot. His place was taken by Peter, a well-mannered and friendly bay.

At last, 3.17 p.m., wagons and horses all packed aboard, the train steamed out, and the 23rd (Field) Company had started on its greatest adventure, conscious of the great record of service in past campaigns, the Mutiny, South Africa, every officer and man confident that that record would be maintained bright and secure in the future.

The order of battle is given in Appendix I.

The Company arrived at Southampton and detrained at 5.15 p.m., only to find that no ship was yet available, and it therefore marched to rest camp in Southampton Park. The following day, Sunday, August 16th, there was more than one false alarm that the ship was ready, but nothing happened. A church parade was held during the morning (thanks to the kindness of the Rev. H. Bown, of Southampton, who offered his services), and after parade service a very large number of all ranks of the Company attended the celebration of Holy Communion in the open air, under the tall trees of the Park ; an episode that one remembers with much gratitude.

At last, the Navy said they were ready ; but even so, to enable the most efficient use to be made of the ships, the Company had to go in two portions : Addison and four sections embarking in the s.s. *Melifont*, at 3 p.m., on August 17th ; Company H.Q. and H.Q. vehicles at 3 a.m., on August 18th, in s.s. *Basil*.

The weather was fine, but as we steamed out past the Isle of Wight, in the purple, orange and red of a wonderful sunset, there must have been a choppy sea, for in the writer's diary appears the significant entry : "The others went to dinner ! "

During the night, the sea smoothed, and at daybreak we were all on deck enjoying an unforgettable sight, a perfect summer sunrise, as we steamed slowly into the mouth of the Seine, the red and yellow of the first rays of the sun lighting, with rainbow colours, the slight morning mist that gave dignity and an air of mystery to the steep hills above Havre, and laying on the smooth water a long carpet of gold up which we sailed into the heart of our adventure.

The valley of the Seine is very beautiful, and that early morning, steaming up the snake-like coils of the river, between the steep and rugged cliffs dotted here and there with white chalet-like houses of unfamiliar design, set in wooded clefts, left an impression that one could never forget. Early as it was, many of the country people came down to the river banks and cheered us on our way.

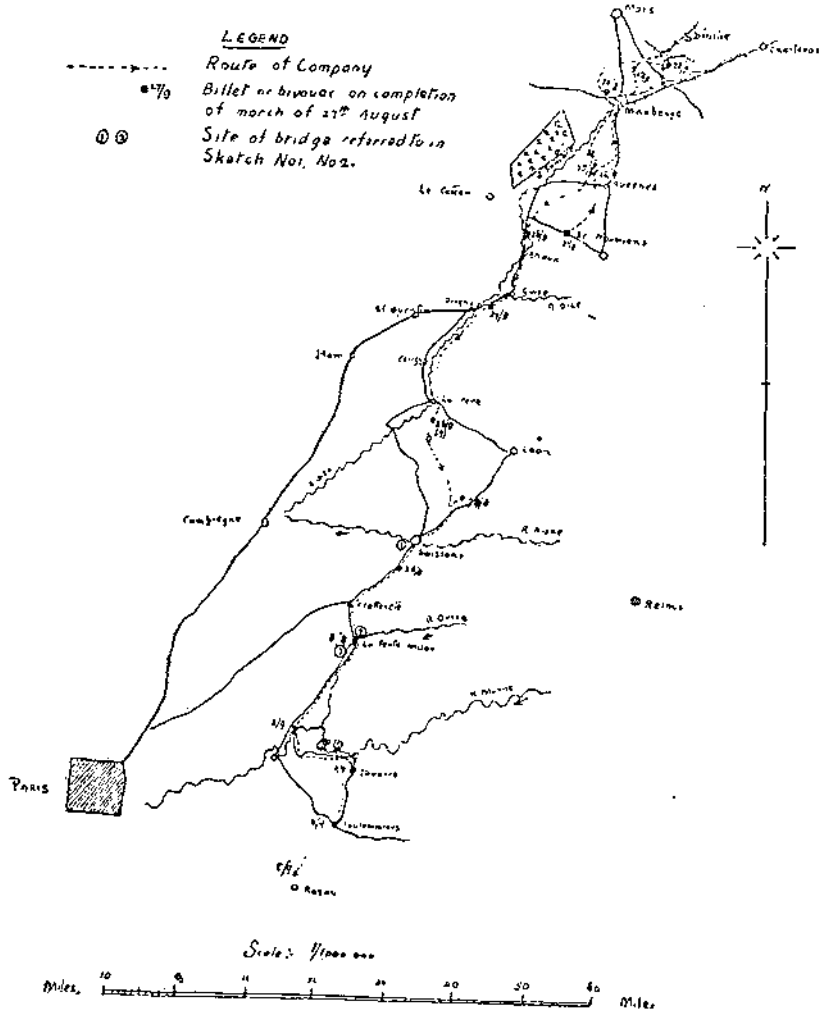
The *Melifont* arrived at Havre about mid-day, and moored alongside the quay, in the centre of the town. It was a blazing hot day, and the heat rose from the cobbles like a furnace, and we were not sorry when, after considerable delay for one reason and another, we eventually arrived in the rest-camp on the top of the hill, south of the town.

By 6 p.m., the H.Q. had also arrived in camp, and the Company was complete. We had been but a short time settled in, when it was discovered that a black draught-horse was missing, and a search party was sent out which after some trouble spotted the absentee tied to a gunner picket-line and enjoying a very fine gunner hay ration. Horse and ration were rapidly removed, without being spotted, which was looked on as a good evening's work by the search party.

At 9.30 the following morning, August 20th, the Company paraded in camp, and marched down to the Gare du Nord. It was a very hot day, and railway arrangements were not yet working in that smooth and timely fashion to which the B.E.F. was to become accustomed later on. There was, therefore, a long wait in the dusty vicinity of the station, and it was not until 3.45 p.m. that the train at last started on the northward journey. From time to time we stopped in wayside stations, everywhere greeted by enthusiastic inhabitants. Fair maidens filled the carriages with bouquets —Stafford, in particular, securing a fine specimen—though even the most forward bachelor of the party failed to achieve such merit as an officer of a famous regiment, who was handed a charmingly decorated card, inscribed, " Kiss me," by an attractive admirer. The nearest approach to any such stimulating greeting was a placard, held up to our carriage window by a remarkably dirty old man, accompanied by an even dirtier old lady : the legend on the placard ran, " I love you."

A sketch map is attached showing the movements of the Company during the ensuing operations.

About 4.30 a.m. on the 21st, in rather a chilly and foggy dawn, the Company detrained at Le Nouvion. After a halt in the neighbourhood of the station for a meal, orders were received to join the column at 12.0, and move to Dompierre, some 10 miles away. Here



the Company had its first experience of the typical farm billet : good barns ; a fine meadow for the horses ; rooms in the house sparsely furnished and slightly dejected in appearance ; the inevitable feather mattress and *pouf* above in the heavy old wooden bed, unhygienic and not above suspicion. The wallpaper in this particular room appeared to have been in existence since the Middle Ages. However, once rid of undue æstheticism, such quarters were wonder-

fully comfortable. Early the following morning, the 23rd (Field) Company joined in the column for its first real march of the campaign, a march forming a fitting introduction to the many succeeding strenuous days. The division moved north, along mile after mile of hard and foot-wearying *pavé* between the endless lines of poplar trees, and towards evening passed through the fortified town of Maubeuge, where the first signs of war were apparent. In the suburbs trees were being cut down, wire entanglements spread over the country on the open grass glacis before the conspicuous forts, and wire barricades were being erected on the roads. Darkness began to fall soon after passing through the line of forts, and then the first experience of night-marching in a long column. The constant halting, the pulling on another 300 yards; another halt. At each halt, marching in front of the section, one bumped into the tail of the limber of the section in front, whilst the smell of the new paint on the tarpaulin cover beat itself into the memory for ever.

At last, when the process had almost reached the limit in exhausting the troops, the Company turned in to a good orchard bivouac at Villers-sire-Nicole, at 1 a.m., having covered 21 miles. In spite of this exhausting start, there were no absentees from the ranks; a record which the unit maintained throughout the heavy marching still to come.

It had been suggested that there would be a rest next morning after the long march. Any such expectation was rudely shattered, for "R.B.," who had been to 2nd Brigade H.Q. to get news, returned later on with orders that we were to turn out again in 1½ hours' time. A somewhat hurried breakfast was achieved, and at 4 a.m. on the 23rd, the Company marched under orders of the 3rd Infantry Brigade to Rouveroy. Here instructions were received to move at once, under orders of the C.R.E., to Liseroeulx; and Bond went ahead with the C.R.E. and Adjutant (Lieut.-Colonel A. L. Schreiber, D.S.O., and Captain L. C. Jackson, C.M.G.), to reconnoitre for two strong points, facing north and north-west, in the neighbourhood of Peissant, about 4 miles south of Binche and 10 miles south-east of Mons. Two positions were selected; one about a level-crossing near Peissant station, firing north-west towards a large wood, some 1,600 yards away. This strong point included the station-master's house, which was put in a state of defence in spite of the excited opposition of the owner. The second strong point was constructed on rising ground on the east of a railway cutting, about 1,000 yards further to the south. Two sections were employed on each strong point; and trenches were dug to accommodate one or two platoons of infantry in each case. The field of fire was considerably hindered by nearly ripe standing corn, and men were employed with reaping hooks to clear it.

It may be mentioned here that there was a distinct shortage of

6-foot rods on this day, for in the darkness and hurry of the previous night's arrival in bivouac, no proper picket lines could be arranged for the horses which were simply tied to the tool carts and limbers. We soon learnt that the hairy looks on a 6-foot rod as good for the liver, and had eaten 18 inches or so off the rods which had been left in place on the carts.

About 2 p.m., there was an alarm, and a platoon of the 2nd Welch Regiment occupied the strong points; the section of the 23rd (Field) Company withdrawing into the shelter of the cutting, where a mid-day meal was taken, much assisted by presents of vegetables, butter and milk, from the open-handed inhabitants. One or two shots passed overhead, where from it was difficult to ascertain, and from the north the occasional dull boom of a gun could be heard; otherwise there was nothing to disturb the peace of this fine summer's day. Eventually the sections withdrew and rejoined the remainder of the Company near Rouveroy, where we expected to billet. Very shortly afterwards, orders were received to move at once to Grand Reng, where the Black Watch (1st Guards Brigade) were on outpost, and the situation was unsatisfactory owing to that flank being entirely in the air. It will be remembered that the withdrawal of the 5th French Army had left a very wide gap at this point between that Army and the B.E.F. Some assistance was given to the Black Watch in strengthening the outpost position; and the Company then went into billet at Grand Reng station, actually almost in the outpost line. Luckily, no alarm disturbed the night's rest.

Early the following morning, the 23rd (Field) Company moved from Grand Reng with the 1st Guards Brigade. West of Villers-sire-Nicole the Brigade, which was forming the rear-guard to the Division, commenced to take up a rear-guard position, and a very fine one it was too, with a long, open, glacis-like field of fire to the north-east, but although work was commenced on a couple of strong points, near the Ferme de Bettignes, there was no pressure from the enemy, and it was possible to take a mid-day meal in comfort. The day was intensely hot, the local inhabitants had by now taken alarm and had almost all disappeared; and "R.B." finding in the farm two excellent casks of beer (too good to leave to the enemy) the Company had a welcome ration all round.

This was the first occasion on which the troops encountered the afterwards familiar spectacle of unhappy refugees streaming southwards by every road, and it made a deep impression. Farm carts, donkey carts, dog-drawn barrows, hand-barrows laden with the most portable property; poor old men and women making their way stumblingly along, supported by boys and girls; sometimes an old lady would be seen, sunk in the familiar bed *pouf*, being wheeled along in a barrow by a great-grand-daughter. Where they all went; how many got clear away; how many of the old ones fell by the

way, victims at last of the aggressor whom they had faced or fled from perhaps 44 years before, who can say? It is certain that it was this scene that brought home to every man the nature of the enterprise in which we were engaged, and sowed the first seeds of that increasing bitter feeling against the wanton nation which, for the second time in 50 years, had deliberately thrust fire and sword into the peaceful homesteads of northern France. Not one of those whose hearts were wrung by that pitiful trek but can sympathize and understand when, amidst idealist cries of "Disarmament! disarmament! disarmament!" a deep strong voice from northern France replies: "No third time; security above all."

To return, however, to the story. All this long hot day, continual rumours were rife that it was going to be a near thing; that the enemy were not far off our flank, and so on; and it was obvious that the column was making a flank march across the face of the enemy. But at last, as dusk was coming on, the Company reached its billets in La Longueville Convent. Needless to say, the inmates had disappeared, and, dead to the world, tired men appreciated the comfortable quarters. The Company had now marched 20 miles on the 22nd, 12 miles on the 23rd, and 21 miles on the 24th, and dug on both the last two days. Belts were coming in hole by hole, but only one case of foot failure was to be recorded; in July, this unfortunate had been engaged in his normal duties in the Brighton Police Force.

On the morning of the 25th, a very early start was made, and just as the Company was getting on the move, orders were received for the pontoons to join the Divisional train, and for two sections to join the 3rd Infantry Brigade in the rear-guard. Numbers 1 and 2 sections were detailed for this duty, but the march produced no incident; and these sections, after becoming detached from the rear-guard and delayed by apparently endless French batteries, eventually found their way about 10 p.m., soaked and weary, to Dompierre, reporting to H.Q., 1st Guards Brigade. The remainder of the Company billeted at Houguemont, near Marbaix. On this day, the Company achieved its first casualty, for the pontoon wagons, moving with the Train, were attacked by German cavalry, and had a narrow escape. One man, probably our footsore ex-constable, was slightly wounded. The march this day was about 17 miles.

On the 26th, numbers 1 and 2 sections remained with the 1st Guards Brigade. Whilst the II Corps was fighting its great battle at Le Cateau, the 1st Division was slipping away, unmolested by the enemy. Everyone was beginning to feel the loss of sleep, and many of the unfortunate infantry, whose rest had been cut even shorter by outpost duties and night alarms, were almost marching in their sleep. Again the march of 15 miles to Petit Cambresis was carried out without molestation, though a long halt was made by the 1st

Brigade about mid-day. We little realized the delicate situation the 1st Division was actually in at this time, although it was apparent that a big battle was in progress to the west. Food, of the legitimate kind, was very short, for the situation was such that no proper issue of rations was possible. The train wagons dumped the food by the roadside, and troops drew as they passed by. It can be imagined that the rear party found little but empty biscuit boxes, but, all the inhabitants having fled, leaving their stock to the tender mercies of the enemy, it was found that a biscuit tin made a good milk pail, and eggs could easily be found by the experts, so that no one starved. Towards the end of the day, the Company reunited and moved into billets together with the 1st Brigade, just south of the Sambre-Oise Canal, a spot that was not to be visited again until the 4th November, 1918.

The following day, August 27th, it will be remembered that the Munster Fusiliers fought their flank and rear-guard battle between Fesmy and Etreux. The 23rd (Field) Company was again allotted to the rear-guard with the 1st Guards Brigade. The bridge over the canal at Petit Cambresis was prepared for demolition, and a foot-bridge constructed alongside for the use of the rear party, as it was thought the Munsters would be withdrawing by this route. A bridgehead position was also constructed for use by troops covering the withdrawal. Heavy firing was heard from the direction of Fesmy and the road to the north. About 3 p.m., orders were received to remove the charges from the bridge and retire, and this was done, the bridge being left intact. Two companies of the Coldstream Guards were the only troops remaining when the 23rd (Field) Company eventually commenced to move southwards, and there was considerable apprehension as to the situation of the Munsters, a motor cyclist, who had brought orders to the rear party, stating that he had been unable to get through to them. After assisting by digging trenches in the preparation of a position just north of Etreux, the Company moved southwards unescorted. After leaving Etreux, an open piece of road, with a wide strip of common on either side, had to be traversed. About 1,000 yards away to the east a village was in flames, and far ahead to the south-east the smoke of others could be seen. A few mounted men suddenly galloped from the burning village straight towards the rear of the Company, followed by shrapnell shells, one or two of which burst on the road a couple of hundred yards behind the H.Q. wagons, but for some inexplicable reason no attempt was made to benefit by the remarkable target the Company, in column of route with all its pontoon vehicles, must have presented. The march proceeded unmolested until the tail of the main column was encountered struggling through the congested streets of Guise. Here an argument developed with French Staff and Engineers who wished to "*Sauter le pont.*" Considerable

heat was generated, but the project was finally negatived, luckily for the 1st Brigade which had not yet arrived. It was not until about 11 p.m. that a bivouac at Jonqueuse was finally reached, a march of 15 miles since about 1.30 p.m.

The Company was again on the move before dawn, once more with the rear-guard. Many rumours were in the air: that the enemy were across the river, near Guise; that a great French counter-attack on the flank of the enemy, who were following up the B.E.F., was to take place; and so on. Some trenches for occupation as a rear-guard position were dug about a mile south-east of Mont d'Oriny, and successfully camouflaged with turnips. During the day, the enemy made a half-hearted effort to advance, and our guns came into action against what appeared to be cavalry on the high ground about Jonqueuse, but the advance died down. French troops appeared from the east, and after a considerable halt at a hospitable farm, where the good lady provided bacon and eggs, but suddenly decided in the middle of the frying to make a bolt for it, the rear-guard moved off. Numbers 1 and 2 sections again became detached in the course of carrying out digging work, with the result that they had a clear road for the greater part of the march, the sections marching in splendid style in spite of the heat and the fatigue of the last few days. As the Company was moving on the road east of the Oise, on the crest of a hill near Abincourt, the sound of guns was heard on the west of the river, and it appeared that a cavalry engagement was in progress, though it was difficult to see exactly what was taking place. This, we now know, was the affair of Cérizy, a red-letter day in the annals of the cavalry. The march was a long one, over 24 or 25 miles, and unfortunately, just at dusk, the rapidly marching sections caught up the tail of the main column, which had just commenced the desperately fatiguing process of stopping and starting, moving 200 yards, and on again. This was too much for the weary men who had been marching so well, and a number of sappers fell out, but all arrived in the bivouac at Bertaucourt, south of La Fère, within half an hour of the remainder; and this was the only occasion during the whole of the retreat or subsequent advance on which any men fell out. Bivouac was reached about 11 p.m.

The 29th was a welcome day of rest in a splendid barn, which accommodated the whole Company. A good wash, a long sleep, letters, a full ration for nearly the first time, and by evening the Company was again ready for anything. Orders were received to move about 8.30. Major Russell-Brown was put in command of the convoy of Divisional train vehicles, with the 23rd (Field) Company, 1 section R.F.A., and 1 company of infantry as escort. The column rendezvous was St. Gobain, and about 10.30 p.m. the whole moved off through the forest, a somewhat eerie move in a bright moonlight

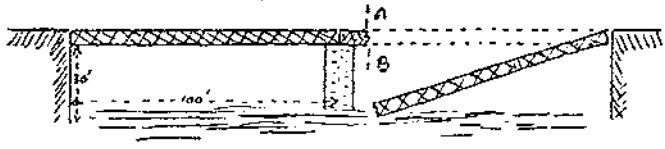
under the great beech trees. The column halted at midnight till 3 a.m. at a big convent in the heart of the forest; the night was cold, and the renewal of the march was welcome. The short rest in a wet courtyard was disturbed by occasional false alarms from the temporary outposts. Daylight found the Company marching through very beautiful wooded country. The march was uneventful, though at the end of this very hot day it was found that French troops were in occupation of the allotted billets at Margival, so that the Company moved to billets at Allemant instead, on its own initiative.

August 31st saw the Company again in the rear-guard and early

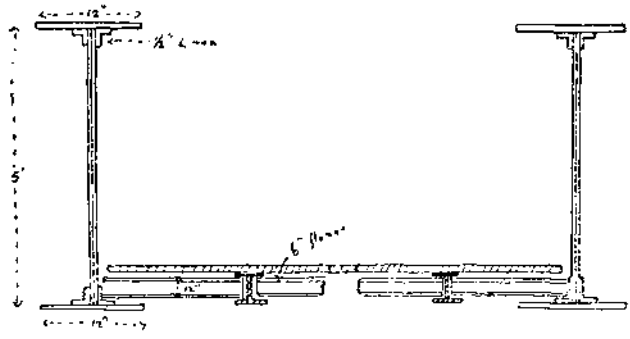
SKETCH NO. 1.

SOISSONS BRIDGE, DEMOLISHED BY NO. 4 SECTION, AUGUST 31st, 1914.

Side Elevation.



Section on AB.



Total Charge = 12 + 12 + 12 + 12 + 3 + 3 = 54 slabs gun-cotton.
Fired electrically, 6 detonators in series.
Completely successful.

on the move. The march was unmolested, and the Company bivouacked in the open at Misiy-aux-bois, six miles south of Soissons. Stafford was left behind in Soissons with No. 4 section to demolish the main-road bridge, a task which was successfully carried out without interference. Sketch No. 1 gives the details of the bridge and charge.

On September 1st, famous for the fight at Nery, the Company again found itself in the rear-guard; whilst moving through the Villers Cotteret Forest, heavy rifle fire was heard at no great distance, which proved to be the enemy attacking the 2nd Division; our own rear-guard was not involved and the march was carried out in peace to La Ferte Milon, where the 23rd (Field) Company went into bivouac

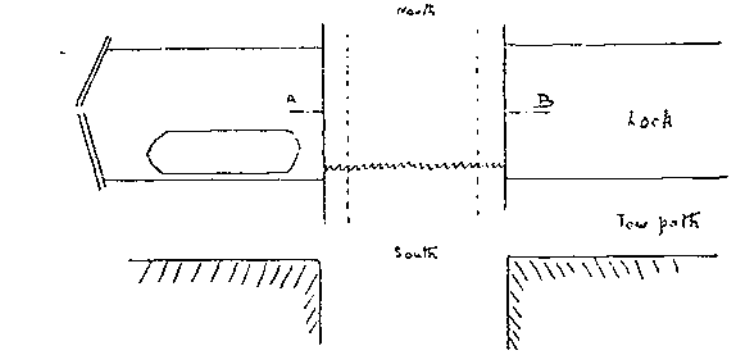
on the north side of the town with the 2nd Infantry Brigade, the remainder of the Division being south of the canal. A march of 16 miles. Shortly after reaching bivouac, the Company was ordered to assist in the preparation of the outpost position. A certain amount of digging, clearing the field of fire, and road-blocking was carried out.

It will be remembered that about 7 p.m., on the 1st September, Sir John French had decided to evade the new southerly movement of the enemy by making a night-march. As a result of this, the sections of the 23rd (Field) Company, R.E., had barely completed their

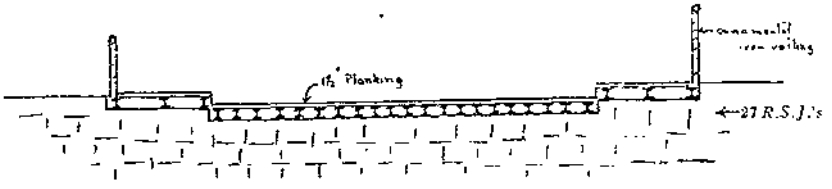
SKETCH NO. 2.

Plan.

BRIDGE OVER LOCK AT LA FERTE MILON. NO. 2 SECTION, SEPTEMBER 1st, 1914.



Section on AB.



Charge. 1 slab and detonator per R.S.J. Fired in two sets of 13 and 14 charges respectively. Completely successful.

outpost work, and were just having a hot meal before turning in, when orders were received for the continuation of the move. Bridges at La Ferte Milon and at Marolles were to be destroyed as soon as the rear-guard was clear. The main-road bridge over the lock in La Ferte (Sketch No. 2) was of curious construction and required two separate sets of charges to complete the demolition. After the first set of 13 R.S.J.s had been cut, the infantry platoon escort withdrew, leaving the section officer and cyclists to themselves, very much wondering whether the rumoured Boche in lorries would appear down the village street attracted by the noise. At the same time, an irascible old gentleman in a dressing-gown and nightcap, whose house adjoined the bridge, came out with a lantern and

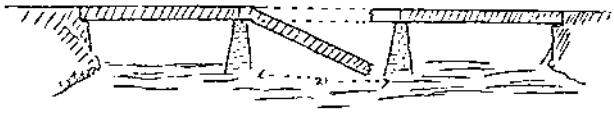
complained bitterly that his windows had been broken by the noise, and that it was most disgraceful. However, the lantern quickly went into the river, and the old man hurtled, protesting, into his house, and by 1 a.m. the destruction of the bridge was completed; a barge and some boats were sunk in the lock, spare R.S.J.s on the bank thrown into the water, but supply of explosive did not permit of damage being done to gates. The destruction of the bridge at Marolles was carried out, without interference, by No. 1 section at 11 p.m. (Sketch 3).

When the destruction parties caught up the tail of the column, some 3 or 4 miles south of La Ferte Milon, it was found that hustle was the order of the day, or night, rather. Units were decidedly mixed, the column was five or six deep, and from time to time Staff officers were passed shouting, "Keep moving! Keep moving!" No hourly halts, half asleep, mechanically plodding on, oblivious

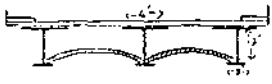
SKETCH NO. 3.

BRIDGE AT MAROLLES. NO. 1 SECTION, SEPTEMBER 1st, 1914.

Side Elevation.



Section.



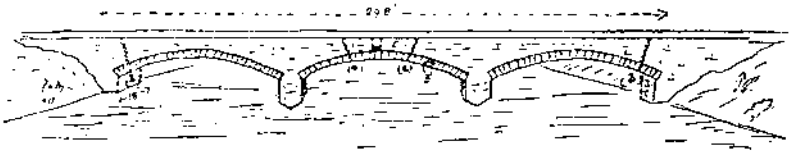
Charge = 20 lb. per girder. Total = 60 lb. Completely successful.

of anything but the effort to keep going somehow, somewhere; the serried mass moved along, until, as day broke, efforts were made to collect units together, regimental representatives standing by openings into fields, calling out names of units and assembling the personnel. A long halt was made at mid-day on the high ground near Beauval, when orders were received to prepare a rear-guard position, on which some digging was carried out, but no enemy appeared and by 3 p.m. the Company arrived in billets at Varreddes, on the north bank of the Marne. Here a good rest was obtained, and a bathe. The march recommenced at 3.30 the following morning, the 23rd (Field) Company (less No. 4 section) crossed the Marne with the advanced guard, No. 4 section moving with the rear-guard, the 1st Guards Brigade. Numbers 1 and 3 sections demolished the road bridges over the river at Sammeron and St. Jean respectively (Sketches 4 and 5). The bridge at Sammeron was a fine masonry bridge, of three arches, each nearly 100 feet span. The

original intention was to blow a gap in the centre span, sufficient to cause considerable delay to the enemy, but not to cause too much trouble to ourselves should we re-cross the river in the course of a day or two. However, when the charge was fired and the gap made, the piers on either side were seen to be slowly settling under the thrust of the outer spans until after about three minutes the whole bridge collapsed into the stream. The night (spent at Jouarre) was disturbed by various alarms, though no enemy actually appeared.

SKETCH No. 4.

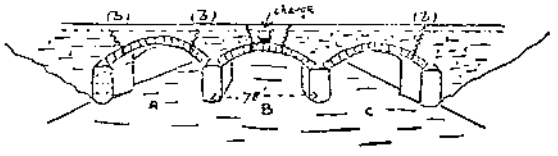
BRIDGE AT SAMMERON. NO. 1 SECTION. 6.30 P.M., SEPTEMBER 3rd, 1914.



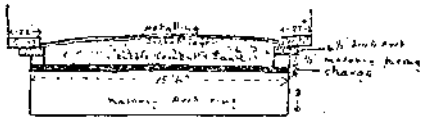
Charge = 110lb. laid in trench across roadway and tamped.
(*a*) (*a*) = limits of initial gap.
(*b*) (*b*) = subsequent break.

SKETCH No. 5.

BRIDGE AT ST. JEAN LES DEUX JUMEAUX. NO. 3 SECTION. 6.30 P.M., SEPTEMBER 3rd, 1914.



Section of roadway at charge.



Commenced at 8.30 a.m., ready at 1 p.m. Charge, 112 lb. tied to board and laid in trench. Fired electrically.

Result. Two-thirds of span B demolished; subsequently cracks developed at (*b*) (*b*) (*b*). Span C collapsed, but span A did not quite do so.

A short march, commencing very early next day, took the Company to Coulommiers. Here the Company carried out a considerable amount of work with the outposts. Numbers 1, 3 and 4 sections assisted the Black Watch on the Coulommiers-Chailly road; No. 2 section at the Pont du Moulin on the Boissy road. Here a somewhat unfortunate incident occurred. The road was blocked at the bridge over the Avenelle River by felling and entangling the branches of a fine beech tree. Unfortunately, the machine-gun, sited some 300 yards up the slope which led down to the bridge, failed to allow

for this tree, and, when a party of German cavalry approached in the night and were duly fired upon, the bullets all found their way into the tree trunk. A party of refugees, making full-speed for Coulommiers in a taxi, had to be rescued by No. 2 section from a ditch by the bridge, and were given a lift into the town, for which Bond and Serjeant Eyres reluctantly refused the proffered *pourboire*.

On returning to Company H.Q. about 2 a.m., No. 2 section cyclists were again turned out to guide the 2nd Brigade through the town, the march having already recommenced. The Company joined the main column at Mauperthuis and marched to bivouac, a short distance north of Rozoy, where once again wiring and trench-digging on a bright moonlight night to assist the outposts was carried on. Sections turned in about midnight.

Thus finished the great retreat. The 23rd (Field) Company had never been seriously involved in actual fighting, but long marches followed by nights of digging and wiring had put a heavy strain on all ranks, particularly the reservists. However, the intensive march training of the days of mobilization had produced admirable results, and the Company can look with pride on its high record of march discipline and fitness during those anxious days.

The morrow was to show that its spirit under fire was on as high a level.

APPENDIX A.

ORDER OF BATTLE, 23RD (FIELD) COMPANY, R.E., AUGUST 15th, 1914.

Headquarters.—Commanding Officer	...	Major C. Russell-Brown.
2nd in Command	...	Captain G. H. Addison (joined on mobilization).
C.S.M.	...	W. H. Hudson.
C.Q.M.S. ...	...	A. Griffin.
Mounted Serjeant	...	W. Rapson.
No. 1 Section	...	Lieut. E. L. Parkes (Special Reserve, joined on mobilization).
		Serjeant Dominey.
No. 2 Section	...	Lieut. R. L. Bond.
		Serjeant R. Eyres.
No. 3 Section	...	Lieut. J. W. D. Mallins (joined on mobilization).
		Serjeant H. Harwood.
No. 4 Section	...	Lieut. J. H. Stafford.
		Serjeant G. Jones.

(To be continued.)

WAZIRISTAN.

By MAJOR-GENERAL A. LE G. JACOB, C.B., C.M.G., C.I.E., C.B.E., D.S.O.

A Lecture delivered before the Central Asian Society on May 25th, 1927. Reprinted by permission from "The Journal of the Central Asian Society."

OUR FIRST CONTACT AND RELATIONS WITH THE INHABITANTS OF WAZIRISTAN.

BEFORE dealing with Waziristan as it is now, I propose to describe very briefly the country and our relations with its inhabitants from the time when we first came into contact with them.

To many of you here, who probably know the country as well as I do, this will not be necessary, but for those who have not been in those parts a reference to past events will make things clearer. We have here a map of the North-West Frontier Province (or at any rate of the greater part of it) which it will be as well to examine carefully.

It is merely an outline map, and does not show any of the physical features of the country, but it gives the names of the various places of importance and the communications, and also part of the Zhob district of the adjoining province of Baluchistan.

There are two lines marked on the map which are of importance, the Durand Line and the Administrative Border, which I will refer to presently.

The Administrative Border is in the plains, and practically corresponds with the foot of the hills.

The country between these two lines is a mass of mountains, not on the gigantic scale of the Himalayas, but of considerable size, many of the peaks running up to anything between 10,000 and 12,000 feet in height.

This chain of mountains runs all along the north-west frontier, through Baluchistan right down to the sea, some 2,000 miles, and is inhabited by some 300,000 well-armed tribesmen. The lower hills in Waziristan, up to a height of 4,000 feet, are very barren and desolate-looking, but the higher hills are well wooded with oak, pine, and fir trees.

The inhabitants of Waziristan consist of two main tribes, the Wazirs, or Darwesh Khel, and the Mahsuds. Although undoubtedly having a common ancestor, these two tribes are distinct.

The Wazirs, who are the stronger numerically, inhabit roughly the

upper part of the Tochi valley, Shawal, and the country round Wana and Spin, while the Mahsuds occupy the centre.

Through this mass of mountains there are five important passes from Afghanistan into India. Commencing from the north:

1. The Khyber.
2. The Peiwar Khotal.
3. The Tochi.
4. The Gomal.
5. The Bolan.

The Khyber and the Bolan are the two most important, and have been used by armies for the invasion of India for some thousands of years, and there is now a railway through each of them.

The Peiwar Khotal came into prominence during the second Afghan War, when Lord Roberts advanced by it into Kabul after the massacre of our envoy, Sir L. Cavagnari, and his escort.

The Tochi has not been used by any modern army, either from or into Afghanistan, but it was traversed several times by Mahmud of Ghazni in his various invasions of India in the eleventh century. It is not a very difficult route. It leads to Ghazni.

The Gomal Pass, which follows the Gomal river, is fairly easy so far as the actual track is concerned, but the country through which it goes is about the worst on the frontier. This route also leads to Ghazni, but has not been used by armies for some centuries.

Both these passes, especially the Gomal, are used every year by the Ghilzai Powindahs during their migration into India in the autumn and their return to Afghanistan in the spring. They move with their wives and families and all their camels, sheep, etc.—about 70,000 human beings, and about the same number of camels, through the Gomal Pass above—and this migration takes about two months each way.

Before we came into these parts, the Powindahs had often to fight their way through the pass.

THE ADMINISTRATIVE BORDER AND THE DURAND LINE.

When we annexed the Punjab in 1849–1850, we took over all the countries which had been under the rule of the Sikhs, and, as regards the frontier, this extended only to the foot of the hills. In some places, notably the Bannu district, their rule was only nominal.

Their only method of collecting any revenue from it was by sending periodically a small army there, which looted and destroyed, but it ended generally in their being chased out of the country by the exasperated inhabitants without any revenue.

In the district further south, now the Dera Ismail Khan district, their rule was less shadowy. Raiding by the tribesmen from the hills was constant, but the Sikhs only once attempted to enter the hills and were only too glad to come out again.

After annexation, we took over charge and established garrisons and administered the country right up to the foot of the hills—taking revenue from the people—and this is, practically speaking, our administrative border now. Although we have garrisons in the hills and in many places beyond it, we do not "administer" or take revenue beyond it.

Most of you know what the Durand Line is, but, for the benefit of those who do not, I will explain it very shortly.

The mountains all along the frontier are inhabited by various tribesmen, such as Mohmands, Swatis, Bajauris, Afridis, Orakzais, Wazirs, Mahsuds, etc., who have always been immensely proud of their independence, and acknowledged neither the Amir of Afghanistan nor the British as their rulers, and who look upon the various phases of frontier fighting as their normal existence.

Although all alike in their spirit of independence, they are not alike in their tribal constitution and idiosyncrasies. They are all Pathans, and are allied in language and religion to the Afghans, but not in race affinity, except, perhaps, the Mohmands.

They have not the faintest race sympathy with India or the ruling people of India, but all of them would appeal to the Amir of Afghanistan as adviser and supporter. If he has not been their king, he has been their religious chief and their political referee.

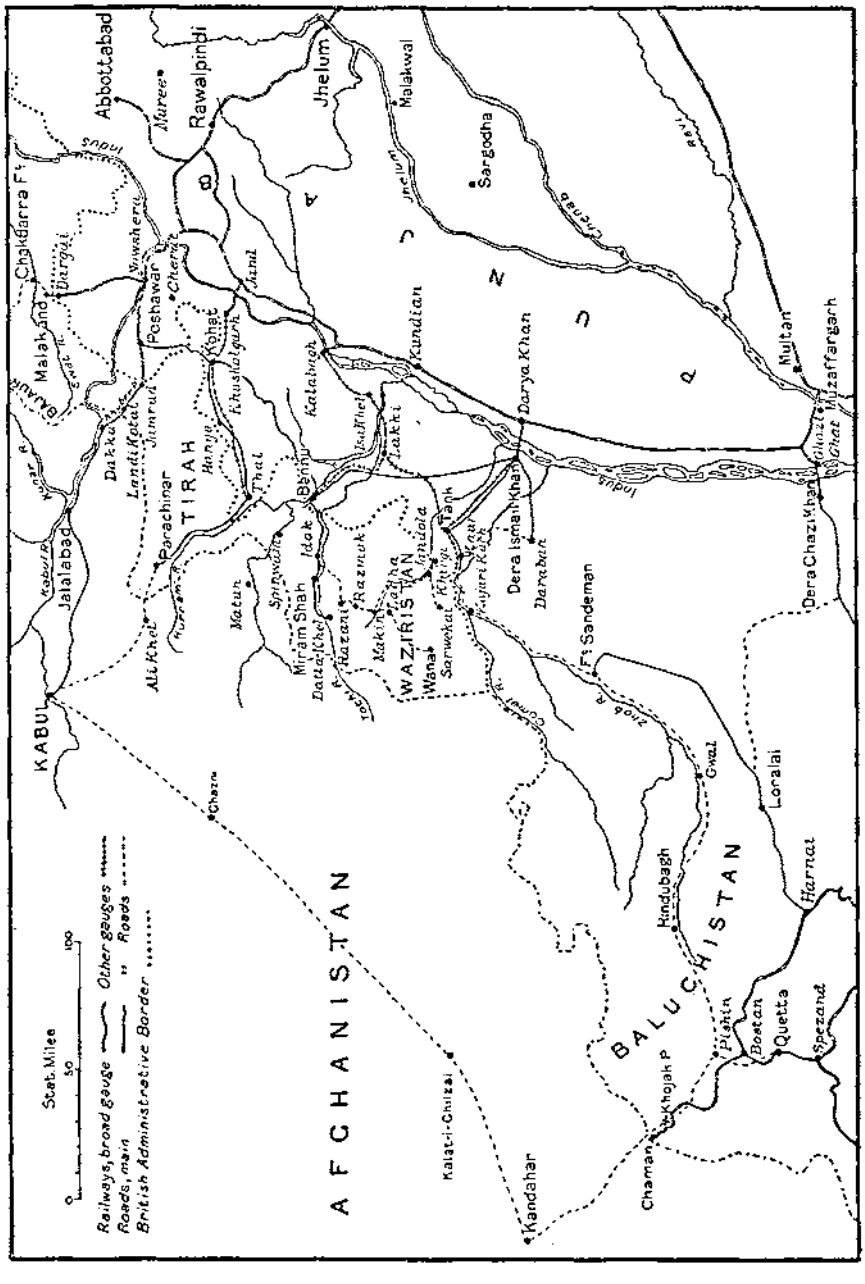
It was extremely easy, therefore, for the Amir to stir up these tribesmen against us if ever he wished to make himself unpleasant and to give us trouble.

In 1893, relations with the Amir had been strained for some time. Among other reasons he was very sore about our selection of New Chaman as the site of the railway terminus on the far side of the Khojak. He considered that we had gone too far down into the plain, and had violated the Treaty of Gandamak. On the other hand, we had various complaints against him for aggression, so negotiations were made for a mission to proceed to Kabul and definitely fix with the Amir our respective spheres of influence. Sir Mortimer Durand, at that time Foreign Secretary to the Government of India, was our envoy, and after some months succeeded in getting the Amir to sign the agreement. The line you see on the map was agreed to, and it has been called the Durand Line after Sir Mortimer Durand. Except in a few places, which it was impossible for our parties to visit, the whole of this line has been marked out by pillars.

Expeditions into Waziristan.

I will now mention very briefly the various expeditions which we have had to carry out from time to time against the tribesmen in Waziristan. Raiding has always been looked upon by the trans-border tribesmen as a normal condition of existence, and as a legiti-

mate source of income. In this respect, raiding, temptation with these border people lies all on the side of India. Their own lands are



barren and rough, and cultivation is confined to the narrowest strips of alluvial soil which may be found alongside their mountain streams. In fact, their own country is not self-supporting, and up to recent

times they looked to raiding and looting the plainsmen to increase their means of subsistence. They are born with the instincts of the old Scottish Border robber in them, and the fat plains of the Punjab were their traditional hunting grounds. After taking over from the Sikhs, we very soon came into conflict with both the Mahsuds and Wazirs. The result was our first expedition against the Mahsuds, in 1860, under General Sir Neville Chamberlain. Those were the days of muzzle-loaders, and the Mahsuds trusted chiefly to shock tactics, especially attacks on a camp just before dawn. They made one of these on our camp at Palosin, near Jandola, and managed to get in, but were beaten off with considerable loss on both sides. There was also some severe fighting at the Barari Tangi, but our force went through the country, brought the Mahsuds to terms, and then withdrew from the hills.

Except for occasional raiding, matters remained comparatively quiet for some years, but, towards the end of the second Afghan War, in 1880, the Mahsuds and Wazirs came out of their hills in strength and sacked Tank (about nine miles from the nearest hills), and, in the spring of 1881, an expedition under General Kennedy started in two columns, one up the Takki Zam from Tank to Kaniguram, and the other up the Khaisora valley, with Razmak as its objective. There was some desultory fighting, and various villages and towers were destroyed. The Mahsuds and Wazirs came to terms, and the force again retired from the hills to their cantonments in the plains.

The next expedition, the third, was in 1894–1895. Shortly after the Durand Line had been agreed to, the Government of India decided to form a military post at Wana. The Amir had built a post there shortly before this, but had been obliged to withdraw the garrison in accordance with the Durand agreement.

Wana is some twenty miles from the Durand Line on our side of it, and its strategical importance had been recognized by both our political and military authorities for the following reasons:

A military force established at Wana is in a position (*a*) to stop Afghan emissaries and troops from entering that area from Birmal; (*b*) to dominate the Sulaiman Khel and other Ghilzai tribes who enter our territory every year by the Gomal river route; (*c*) to check both Mahsuds and Wazirs from raiding in the Zhob district.

It was decided to occupy the place with a brigade of all arms, and incidentally to use this force as a support, which was considered essential to the actual demarcation of the Durand Line west of Waziristan.

This brigade arrived at Wana in 1894, and encamped in the open plain. Here they were attacked by a combination of the Mahsuds and Wazirs just before dawn. The enemy managed to penetrate the camp, and a fierce hand-to-hand fight took place in the dark. They were eventually driven out by the bayonet with heavy loss, and as soon as it was light enough to see, the cavalry were let loose,

followed by infantry and guns, and the tribesmen disappeared into the hills.

This led to the expedition of 1894–1895 under General Sir William Lockhart. Again our troops went right through the country, and the Mahsuds came to terms. Then was our opportunity to occupy Mahsud country, and the Mahsuds were prepared to accept it. There was at that time scarcely a single breech-loader in the country, and occupation could have been followed by gradual disarmament without much difficulty, but again we cleared out.

However, we occupied Wana in Wazir country, and its effect was very soon apparent. Raiding into the Zhob district of Baluchistan almost ceased, and it was found possible to reduce the strength of the garrisons and outlying detachments by nearly one-half.

The force eventually kept at Wana after the demarcation of the Durand Line was one battalion of infantry, one section of mountain artillery (two guns), and one squadron of cavalry.

Before this occupation of Wana, the route through the Gomal Pass, from Kajuri Kach to Murtaza, had been opened in 1891 by Sir Robert Sandeman, A.G.G., Baluchistan.

There was thus communication to Wana through this pass from the plains and also communication with Zhob along the Zhob river from Khajuri Kach.

About the same time, the Tochi valley had been occupied, our most advanced post being at Datta Khel at the head of the valley.

Except for occasional raids, the country was more or less quiet for a few years. Then came the treacherous attack on our troops at Maizar, about ten miles beyond Datta Khel, in 1897, resulting in the expedition against the Wazirs, but with very little actual fighting.

THE WAZIRISTAN MILITIA CORPS.

In 1900, the Government of India decided to raise two local militia corps in Waziristan, to take the place eventually of the regular troops located there. One, the North Waziristan Militia, to be located in the Tochi valley, and the other, the South Waziristan Militia, at Wana and along the Gomal route. Local militia had been tried with success elsewhere along the frontier, notably in the Kurram valley, but the position there was very different from that in Waziristan.

The inhabitants of the Kurram valley, the Turis, were only too glad of our presence and support in their valley, as they were surrounded on three sides by hostile tribesmen, so they joined the militia freely and worked with us.

That corps, the Kurram Militia, was in actual fact what it was intended to be—a corps locally recruited and for local service, and it answered admirably. In Waziristan, on the other hand, it was extremely risky to enlist Mahsuds in large numbers; we were not

occupying a single yard of their country, and had therefore very little control over them. Moreover, one of the main duties of the militia would be to intercept raiders, and most of the raiders were bound to be Mahsuds. The case of the Wazirs was slightly different; we were occupying a good deal of their country in the Tochi and at Wana, and we had therefore some hold over them. A good number of them were enlisted and did well.

We tried the experiment of enlisting Mahsuds at Wana, the headquarters of the South Waziristan Militia, and at one time we had about 500 of them—about one-third of the strength of the corps—but it was not a success. They got out of hand, made a plan to seize the headquarters post at Wana, which very nearly succeeded, and they incidentally murdered the commanding officer, so they were all discharged. With the exception of a small number of Wazirs, the corps eventually consisted of other border tribesmen, such as Afridis, Orakzais, Khattaks, etc., and was not locally recruited.

Shortly after the raising of these two militia corps had commenced, the Mahsuds, whose offences in the way of raiding and other outrages had been mounting up, were fined, as a tribe, a lakh of rupees. They were given a month in which to pay up, failing which they were to be blockaded. Needless to say they didn't pay up, and the blockade started in December, 1900. This lasted nearly a year, was not successful in bringing them to book, and another expedition—the fourth—was carried out against them. This was in the winter of 1901–1902, and again we went through their country.

The fighting was not severe, and a lot of destruction of villages and towns was carried out as before.

Here again was our opportunity to occupy their country, and again we declined to take it and cleared out. Meanwhile, the Mahsuds had become very much better armed. More than one-third of their fighting men had breech-loaders by this time.

In 1904, the two Waziristan militia corps relieved most of the regular troops in Waziristan, and the situation remained more or less quiet until the outbreak of the Great War.

Our position then in Waziristan was this: We occupied the whole of the Tochi valley on the north, and the Gomal route up to Wana on the south side. The east side had always been held by us, but the west towards the Durand Line was entirely open, and both Mahsuds and Wazirs had free communication with Afghanistan whenever they chose. Not a single part of Mahsud country was occupied by us.

Enlistment of Mahsuds in the Indian Army.

In the early 'nineties, Mahsuds had been enlisted in one of our Indian regiments, the 124th Baluchis, up to the strength of one company

—114 men—and about ten years later, in 1903, a company of Mahsuds was raised in the 130th Baluchis.

Both these experiments proved successful, and in 1910 it was decided to raise two additional companies in the 130th, and three companies in each of the 127th and 129th Baluchis. There were thus at the outbreak of the Great War, in 1914, ten companies of Mahsuds altogether in these four Baluch regiments—about 1,050 men.

Many of these Mahsuds served in France and East Africa during the Great War and did extremely well.

As was the case among other trans-border tribesmen enlisted in our Indian Army, notably the Afridis, disinclination to serve (to put it mildly) became apparent, and it ended in the discharge of practically every trans-border Pathan in our Indian Army; up to then the situation in Waziristan was more or less normal, but, in 1916 and 1917, serious trouble broke out—and we had few reliable troops with frontier experience to cope effectually with it. In 1919, the crash came.

When the two Waziristan militia corps were first raised in 1900—I happened to be one of the officers first appointed—it was always impressed upon us that we should never be left in the lurch, and that we could always count on support by regular troops in time of trouble.

RETREAT FROM WANA, 1919.

However, in 1919, when real and very serious trouble occurred, no support was forthcoming.

The commandant of the South-West Militia at Wana, Major Russell, a very gallant officer, received instructions by telegram that he could not receive any support, and that he could hang on to Wana or clear out as he thought best. I cannot imagine any officer being placed in a more unfortunate position. He could have hung on to Wana for possibly a month until his supplies gave out—water would not have been any difficulty, as there was a well in the fort—but, by that time, the whole country would have been up, and retreat would have been almost impossible. He wisely decided to clear out while there was still time. He had no transport, and he and his officers and men had nothing but what they stood up in. He decided to retire quietly during the night, and his only line of retreat was to Toi Khullah, twenty-eight miles, and thence into Zhob. Some 200 Afridis of the Corps, who happened to form part of the garrison at headquarters at Wana at the time, turned traitors and fired on the others. So the retirement was hampered from the very start. To cut a long story short, the unfortunate remnants of the Corps, some 300 or 400, eventually straggled into Fort Sandeman, having had to

fight their way down for about fifty miles before they got clear. Major Russell himself was badly wounded, and nearly all his British officers were killed.

Effect of Evacuation.

You can imagine the effect of this evacuation of Wana in the country round.

Afghan emissaries and troops almost at once came in from the Birmal direction. The Wazirs joined in with the Mahsuds, and practically the whole of Waziristan was up.

I have already mentioned the strategical importance of Wana, and our abandonment of the place at once had its effect.

Strong parties of raiders, both Mahsuds and Wazirs, at once started operations in Zhob, and at one time Fort Sandeman itself, the head-quarters of the Zhob district and about a hundred miles from Wana, was besieged for some days. The troops in these parts had to be reinforced—to about double their former strength—and all their work had to be carried out as on active service in an enemy's country, where formerly all had been quiet and comparatively peaceful.

We were then compelled to carry out operations against the Mahsuds at a most inconvenient time. The Great War was just over, most of our regiments in the Indian Army consisted of mere recruits with no frontier training and experience, and their British officers, with a few exceptions, were much the same.

We organized what in former years would have been considered a very large force, and more than adequate to deal with the situation, but, before the Great War, we had many very fine regiments thoroughly well trained in frontier warfare, both officers and men, and up to all the tricks of the game. Now, in 1919, we had to rely on quantity, not quality, and, to add to our difficulties, there must have been something like 2,000 Mahsuds against us, who had been trained by us—about one-fifth or one-sixth of the fighting strength of the tribe. Nearly every Mahsud had a modern rifle and knew how to use it, and he was on his own ground, with every inch of which he was familiar; whereas in the expedition of 1901–1902 our troops, well trained and able to shoot well, plastered the Mahsuds with lead up to 800 yards every time they showed themselves, now the boot was on the other leg. Many of our troops had not even fired a recruits' course with their rifles, and it was *our* men who got the plastering; the result was the biggest butcher's bill on the frontier, our casualties being over 2,000.

Re-occupation.

However, we won in the end, and this time we fortunately did not clear out of the country. We occupied strongly with troops the line up the Takki Zam to Ladha, close to Kaniguram, and proper road con-

struction for motor transport was carried out. The South Waziristan Militia was reorganized at Jandola, and renamed the South Waziristan Scouts.

I may mention that the withdrawal from Wana also entailed the evacuation of all the other posts held at that time by the South-Waziristan Militia and the complete abandonment of the Gomal Pass, which we had held for nearly thirty years.

It was a very heavy blow to our prestige, from which we have not completely recovered. At the same time as the withdrawal from Wana took place, the commandant of the North Waziristan Militia was ordered to abandon Datta Khel and the other posts in the Tochi valley above Miram Shah held by the militia, and actually also to burn them on retirement. Imagine the effect of this on the local tribesmen of the country round and on those enlisted in the Corps. They could only think one thing—and that was that we were "down and out." Things were comparatively quiet for some time after the expedition of 1919–1920, chiefly because we were in occupation of the country or, at any rate, of part of it—but there was a distinct feeling of unrest, owing to the delay in the decision of the Government of India as to whether we intended definitely to remain or to clear out. Fortunately, Government decided to retain troops in the country; and then came the question of the best place for locating these troops in order to dominate the Mahsuds. Razmak was the place decided upon.

Razmak Field Force.

In the autumn of 1922, the Razmak Field Force was formed from the troops of the Kohat district, with orders to occupy Razmak and form a strong movable column capable of operating in any direction from there.

Frontier Roads.

This operation was duly carried out, and the Razmak plateau was occupied in January, 1923, in a blinding snow-storm; at the same time, a good metalled road fit for heavy mechanical transport was constructed, branching off from the existing road up the Tochi at Isha and thence all the way to Razmak.*

From Razmak this road has been continued, and now joins up with the road from Jandola up the Takki Zam, so that you have a circular motor road now running from Bannu up the Tochi, right through the heart of Waziristan, down to Jandola, and then on to Dera Ismail Khan in one direction, and to Sarwekai to the west.

* For an account of the construction of this road, see *R.E. Journal*, September, 1925, pp. 361–379. The road as far as Razani was constructed ahead of the regular troops, under the protection of *Khassadars* only.—*Ed., R.E.J.*

Razmak itself is an excellent place for a cantonment—6,500 feet in height and a good climate, about five miles from Makin. The garrison is a large one, consisting of three pack batteries, one section medium artillery (6-inch howitzer), one company, S. and M., six battalions of infantry, and one battalion pioneers; and the movable column from this force consists of two pack batteries, four battalions infantry, one battalion pioneers, and one company S. and M. I will now deal with the present situation and our future policy in Waziristan.

Policy and Present Situation.

The present situation is this: we have a large force at Razmak with a strong movable column, which dominates the Mahsuds to a great extent; but there are certain sections of the tribe which this column cannot reach at present without a lot of additional pack transport. It is equipped with M.T., A.T. carts, and a certain amount of pack-mule transport, and it can move anywhere along the circular road and up to Sarwekai, and it can also move to Wana when necessary, as it did last year, and in the opposite direction from Razmak into the Tochi up to Datta Khel. It can also strike at any tribesmen within a day's march of the metalled road; but there are two important parts of the country which it cannot reach without pack transport —*i.e.*, camels—and they are (*a*) the Shaktu valley, and (*b*) towards Kaniguram and the Khaisara valley.

The road itself, from Bannu right round through Razmak and Jandola and thence to Manzai in the one direction, and to Sarwekai in the other, is strongly held by regulars, scouts, and *Khassadars*.

The present policy is, in my opinion, thoroughly sound, but it must be continuous and progressive.

What we have suffered from in the past is a lack of continuity in our policy, or rather a lack of any policy at all. We blew hot and cold alternately, with no practical result so far as the pacification of the country was concerned.

We should, therefore, continue our present policy steadily and progressively, and the next step in our progress should be the reoccupation of Wana, and the sooner this is done the better.

On a frontier which consists of a chain of mountainous country like our north-west frontier, one of the most essential and important things is good lateral communications, so that troops and supplies can be moved without difficulty where and when required. At present, there is no lateral communication by road between Waziristan and the Zhob district of Baluchistan, although the two districts are adjoining: there used to be, before we withdrew from Wana.

In this connection there is already a narrow-gauge railway from Khanai (about thirty miles north of Quetta) to Hindu Bagh, and I have reason to believe that an extension of this railway from Hindu

Bagh, down the Zhob valley to Fort Sandeman, has now been sanctioned. It seems natural and obvious, therefore, that this railway should eventually be continued down the Gomal valley to Tank, where there is a similar narrow-gauge railway.

I have already mentioned the strategical importance of Wana and the effect of its occupation.

Now, since our withdrawal, there is a big gap in our line of about forty or fifty miles, exposing the Zhob district from the north and west, and communication by road has ceased to exist.

The reoccupation of Wana would at once close this gap, and automatically cause a reduction in the number of troops which it is now found necessary to keep in the Zhob district for its protection. In fact, that fatal withdrawal in 1919 has put us back thirty years in that part of the country.

Our next obvious step, therefore, it seems to me, should be (*a*) the occupation of Wana; (*b*) construction of a metalled road fit for mechanical transport from Razmak to Wana; (*c*) extension of the road from Sarwekai to Wana; (*d*) a branch from this road to Khajuri Kach and thence to Fort Sandeman.

If the above be carried out, our hold on Waziristan would be complete: Wana should be held by regulars.

It would not mean any addition to the troops now in the country. The garrison I recommend is one squadron of cavalry, three battalions of infantry, and one pack battery, all from the Manzai Brigade. We are not committed to any serious building programme yet at Manzai, and the troops could be hutted at Wana just as easily as at Manzai, and in a far better climate.

The regular troops in Waziristan would then be concentrated in the two most important places for dominating and holding the country as regards both Mahsuds and Wazirs.

The soundness of our present policy is to my mind apparent. It has resulted in peace and quiet during the past two years, such as was unknown before, and if we continue this policy steadily and progressively on the lines suggested, the gradual disarmament of the tribesmen will most assuredly follow. It is merely a question of time.

The Mahsuds are undoubtedly settling down, and are recognizing and reconciling themselves to the fact that we mean to stay.

There will be no opposition to our reoccupation of Wana from the Wana Wazirs, and as regards a road from Razmak to Wana *via* Kaniguram, the Mahsuds are already beginning to ask about contracts for work on the road, as they are convinced that this is bound to come.

The civilizing effect of good roads is apt sometimes to be lost sight of.

What we are doing now in Waziristan is exactly what was done in the Highlands of Scotland nearly two hundred years ago by General Wade when he made a road right through them, and the effect will be the same.

The pity of it is that it was not done thirty years ago, when we had the chance, and when the tribesmen were badly armed. We should have saved ourselves a vast amount of blood and money.

Additional Notes up to March, 1928.

During October, 1927, the Manzai Column marched to Wana, where it halted for three days, during which tribal allowances were paid by the local Political Officer. It then returned to Sarwekai, and the Razmak Column, which during the same period had marched to Dargai Oba, returned to Razmak. The whole operation was carried through without any tribal opposition, and the serene atmosphere throughout Waziristan continues to vindicate the present policy of peaceful penetration and road construction.

As regards the road programme, the Razmak–Jandola road is being improved by the substitution of permanent for temporary bridges and the Sarwekai–Wana road is now being constructed by tribesmen under contract. In addition, work on the Tochi–Thal (Kurram) road is in progress, and the Kaitu River is being bridged at Spinwam.

Last cold weather, there were several incidents between the Powindahs and the Wana Wazirs during the former's migrations, and the Wazir villages on Spin were burnt. This year, the Sulaiman Khels passed down to British India without any trouble at all. The Dotannis started to graze on Spin, and a party of Scouts was sent out to deal with them, which it managed most successfully.

The situation has been very quiet during the last year, only a few minor incidents having occurred. Meanwhile, the tribesmen are becoming more and more amenable. In September, 1927, the Political Agent, South Waziristan, escorted by a number of Mahsud *maliks* and *Khassadars*, climbed Pir Ghal, the highest mountain in Waziristan. It is believed that this is the first time a European has reached the top.—Editor, *R.E. Journal*.

THE NEXT GREAT RAILWAY.

By LIEUT. C. A. DE LINDE, R.E.

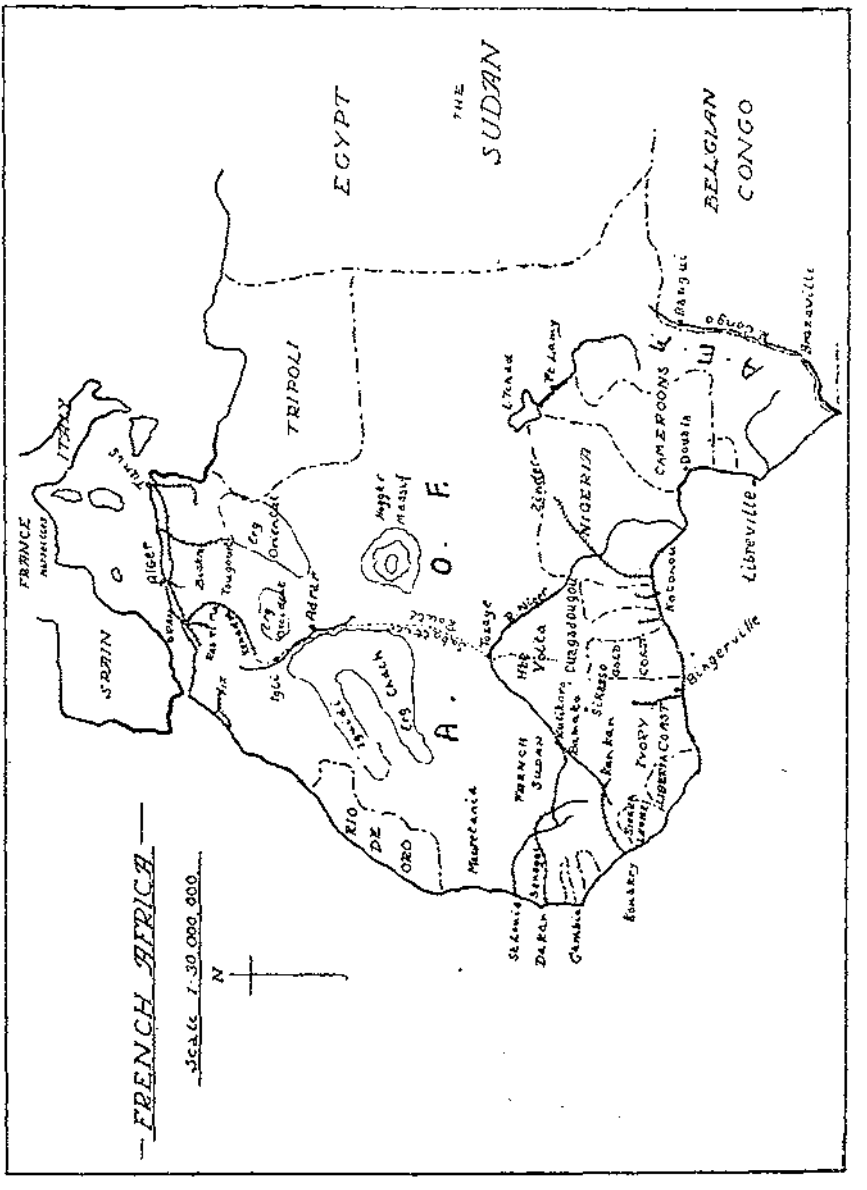
Note.—On January 11th, 1928, the French Minister of Public Works wrote a circular letter to the interested parties stating that the Prime Minister had approved the formation of a Trans-Saharan Committee; that this committee would have a sum of £100,000 allotted to it, wherewith to carry out the survey of the line. A third of this sum will be found by the State and the rest by the Colonies and Private Railway Companies concerned. Parliament will be asked to pass a Trans-Saharan Bill this session. The survey should be completed by April, 1929.

THE Great War, with its Armies' ever-increasing cries for more soldiers, more labour and more material, has given the French people a new idea of the value, actual and potential, of their colonial empire. What before the War was only known to a few far-sighted travelled Frenchmen, such as Marchand, Gallieni, Archinard, Mangin and Lyautey, is now known to many a man in the street. As Britons, we generally use atlases published in London or Edinburgh, and our eyes are naturally taken by the large areas coloured red, rather to the exclusion of other less brilliant colours. But a glance at a French atlas will show that there is another colonial empire besides our own; an empire not so large, not so populous, not so rich, not so temperately placed, not so fully developed nor so colonially minded. Still Indo-China, Madagascar, North Africa, West Africa and Equatorial Africa make France the second colonial power of the world.

It is with the object of welding the last three into one strong whole that the world's next great railway will be built. Since the Treaty of Versailles restored to France a slice of Central Africa behind the Cameroons, these three great areas have been contiguous, but have had no real unity. And the two last, West and Equatorial Africa, are not the pillars of strength they should be. France sees the remedy in a Trans-Saharan Railway, to which in time will be added a great limb, growing eastwards and southwards round Nigeria to the Congo basin. With the advances, made and still continuing, in North Africa, the French are well and justly content; the flag has already been followed by trade, and civilization comes hot-footed.

The Geography of French Africa.

A study of the map is essential to a right understanding of the matter. French North Africa (Afrique du Nord) consists of the



Colony of Algeria and the Protectorates of Tunisia and Morocco. The pacification of Morocco is almost complete. French West Africa (A.O.F. or Afrique Occidentale Française) consists of four coastal colonies—Senegal, Guinea, Ivory Coast and Dahomey, all separated each from the other by foreign territory, but with a common

hinterland in the colonies of Mauretania, French Sudan, Niger and the Upper Volta. French Equatorial Africa (A.E.F. or Afrique Equatoriale Française) stretches along the north-west banks of the Congo and the Oubangui from the sea to Lake Tchad, from the Chari to our Sudan. Togoland and the Cameroons are administered by France under a League of Nations mandate. The existing railways are all of the sort that run inland from the coast without any lateral connection.

THE TRANS-SAHARAN AS A MILITARY NECESSITY.

The project of building a Trans-Saharan Railway is no new one. Money was first voted for a reconnaissance nearly fifty years ago. The first mission was assassinated by the Touaregs in 1881. Many reconnaissances have been made since, but no railway has been built, as it was considered desirable to concentrate first on the development of the more valuable lands under the Atlas Mountains. The camel caravan was given a little longer to live. The War over, desert-crossing became little more than a week-end pastime for properly organized parties. The most popular vehicles were Citroën-Kégresse tracked cars, six-wheelers and aeroplanes. But none of these can take the place of the railway train for the purposes of commerce. In 1923, the " Conseil de la Défense Nationale " declared the early construction of this railway essential to the security of the French nation. This declaration has become an article of faith with French soldiers. France's first necessity is peace; she feels she can only have peace while she remains strong. She is now yearly weakening in manpower and she can expect no more than 160,000 recruits to come up in 1935, at a time when the Rhineland will have been finally evacuated and some 500,000 young Germans will come of military age each year. Hope as she may for peace, she must be in a position to call in Africa to redress the balance. Without the Trans-Saharan, all efforts spent on organizing an African army might be wasted. With submarines and aeroplanes, the French Navy is tolerably confident of being able to keep a way open for her transports across the Western Mediterranean—from Oran to Marseilles it is less than 600 miles. But, without the help of the Royal Navy, it is by no means sure of securing the passage from the Gulf of Guinea to the Bay of Biscay, or even from the Senegal Coast to the Gulf of Lyons. And by land the journey would not only be safer, but quite possibly quicker. From Tosaye on the middle Niger it takes from three to five weeks—according to season—to Marseilles. By railway it should take less than a week—at all seasons. Though, perhaps, large forces could not be transported at this rate, it is hoped that with a clear run across the desert and good operation, a steady schedule speed of thirty miles an hour will be possible for every type of train. This would mean an enormous

increase of capacity over what has been hitherto found possible on single lines with expresses averaging forty miles per hour and mineral trains just managing to average ten. It remains to be seen, however, how far it will be possible to work one-speed trains in practice.

Economic and Political Advantages of a Trans-Saharan.

Further, it is economically important to France, as to any other Power, to be in the greatest possible measure self-supplying, in peace as in war. In war, because Mars has found to-day a new appetite, an insatiable hunger for dishes made up of rubber and oil, cotton and wood. Only the nation well equipped with factories and well supplied with raw materials from the tropics can hope to satisfy this hunger. In peace, because industrial countries can only balance their accounts and thus maintain their standards of life—when their foreign imports are a minimum, that is when they can supply themselves with a greater part of their raw materials. And the nearer the raw materials are to the factories, the cheaper and more saleable are the finished articles. It is this last that will make French Africa, when adequately endowed with railways, more important to the mother country than Indo-China or Madagascar.

There is the political and social importance of the line also to be considered. Rightly or wrongly, the French favour a centralized system of government. This can only succeed where communications are good; as yet they are poor in French Africa, in that they have no effective continuity. It is felt, too, that the construction of a great trunk line will increase French prestige, in Europe as in Africa; so far the building of such has all been carried out by the British Empire, by the United States and by Russia. Its social importance will be rather indirect, but none the less real; railways have always brought with them peace, peace has generally in its retinue prosperity. Again the railway will make more frequent visits to France possible for the utter exile that almost every Frenchman feels himself when living overseas. With it he may be the more easily encouraged to go out to make a new France in Africa. Lastly, the Trans-Saharan will be the northern third of the Trans-African; already the southern third is completed between the Cape and Bukama, and the Belgians have begun work on the central portion between Luebo and Leopoldville. British interest in such a line is obvious.

The Proposed Route.

At least half a dozen routes have been carefully reconnoitred between the Niger and Algeria, and it is now generally agreed that that of Sabattier will be best. It makes Oran the northern terminus and Ouagadougou (*anglice* Wagadugu) the southern, and takes the line through Kenadsa and Adrar to cross the Niger at Tosaye. It is to be

noted that there is already a line from Oran to Colomb-Béchar near Kenadsa, but it is narrow-gauge and has very sharp curves that would make conversion difficult. From the present broad-gauge railhead at Ras-el-Ma, south of Oran, it would go fairly straight through easier country to the coalmines of Kenadsa. Then by following the Souara valley it would avoid the Erg Occidental—a sterile sandy desert—on one side, and the dunes of the Iguidi and of the Erg Chach on the other side. Beyond the Touat oases, it will follow a tolerably straight course, leaving the Hoggar mountains well to the East. At Tosaye the Niger runs between rocky banks, and is no more than six hundred feet wide. In the more distant future, the great limb to A.E.F. and the Cape is expected to leave the Trans-Saharan here and to go round Nigeria (through Zinder and Fort Lamy) to Bangui, which would be the natural terminus of the Congo system. From Tosaye to Ouaga-dougou it is less than four hundred miles across the potentially rich region enclosed in the great sweeping bend of the Niger. Ouaga-dougou may expect to become the Clapham Junction of West Africa, whose coast is convex to the sea and whose existing railways run perpendicular to the coast in such a way that their natural extensions will lead to this, the capital of the Upper Volta. Indeed, these lines have been laid with a view to ultimate through-connection to the Mediterranean. They will become feeders to the Trans-Saharan as well as the bonds that will make, one day, a genuine entity of A.O.F. The hinterland in that day will no longer be a hinterland, but a centre of production and commerce, looking as much to the north as to the south or west. There are many sections remaining to be completed —the task is ambitious, but scarcely Utopian. In Senegal, the main line has to be taken from its present rail-head at Koulikoro *via* Sikasso to Ouagadougou. The Guinea railway will have to be continued from Kankan to either Sikasso or Bamako, the Ivory Coast Railway from Niangbo to Bobo. Finally, there will be the terminus of the Dahomey line at Savé to join to the rest of the system at Ouagadou-gou. It must be understood that there is no chance of all these missing links being forged much, if at all, before the Trans-Saharan itself reaches the Upper Volta ; work on them, though fairly constant, is slow. They are all metre gauge.

In A.E.F., lines are eventually likely to run from Bangui to Douala (the Cameroons), Libreville (Gabon) and Brazzaville (Middle Congo). Belgian Congo and A.E.F. lines are all three-foot six-inch gauge to match the South African Railways.

INTERNAL SECURITY.

The Sabattier route has, moreover, this to recommend it, that it is the safest. It avoids, more successfully than any other suggested, those areas which remain the domain of the robber chiefs. The two worst of these regions are the Rio de Oro hinterland and the Tripolitan

marches; both being under foreign control, France can do no more than piously hope that Spain and Italy will put their colonial houses in order as soon as possible. But the Sabattier route lies over five hundred miles from either district. The nearest danger area is the Tafilalet in south-west Morocco; but France is confident in her ability to tame the bandit tribes of this region in ample time. Over the Central Sahara, order is maintained quite effectively by military camel companies. And in the end, this railway, like every other built in wild countries, will be its own agent of pacification. It is well known how quickly savage tribes are softened by the regular passage of the iron horse. Indeed, they often provide the labour for further construction, and then spend a part of their earnings on cheap week-end excursions.

Engineering Problems.

Few major works are called for on this route. Between Ras-el-Ma and Kenadsa advantage can be taken of the break between the Grand Atlas of Morocco and the Saharan Atlas of Algeria to cross the rugged backbone of North Africa. A long viaduct would seem necessary to take the line across the Guir valley. The next and only other important bridge will be that of Tosaye. The most serious obstacle is the waterless Sahara itself, with its moving sands. But the ergs and their shifting dunes can be avoided; and that mere sand can prevent the coming and going of trains has been disproved in a dozen places, in Arizona, in Sinai, in Australia and, in fact, in this very colony of Algeria, between Biskra and Tougourt. For the rest, the desert is "reg"—level plains of sand and gravel so compact that a camel's foot only makes a light imprint—or "hammada"—plateaux, level enough, but covered with limestone boulders. In either type of country the track can be laid almost directly on the ground, the earthwork necessary will be a minimum. Maintenance of way will call for special organization; it will be impossible to keep tiny gangs stationed at four or five-mile intervals along the whole length of the road. Gangs will have to be stronger and concentrated at water points, going out to work daily in motor trolleys. It is unlikely that this would be more expensive than the use of camel or motor transport for these parties. It is hoped that deep-bored wells will be able to supply these water points, as water tank trains would add considerably to the operating costs.

The water problem is so serious as to require a bold and original solution. Nearly seven hundred miles of bone-dry desert lie between Adrar and the Timetrin; north of Adrar the waters of the Souara and the Touat oases should suffice up to Igli; from Igli to Oran there is ample water, from the Timetrin district southwards no difficulties are anticipated. The steam locomotive is a thirsty machine, and over a distance of seven hundred miles will evaporate not less than

160 tons of water; it is clearly impracticable to take such a quantity with the train. A pipe-line worked well enough in Sinai, but here the distance is much greater and the terminal supply conditions different; in times of peace, consideration of cost is decisive. Electric traction is peculiarly open to attack and, further, is only economical where water-power abounds or when traffic is both fast and heavy. The condensing turbine locomotive has been suggested as one way out of the difficulty, but the best hope lies in the Semi-Diesel locomotive; its water consumption is negligible, it requires only a fifth of the weight of fuel per horse-power hour necessary to the steam locomotive, and it is a far hardier prime-mover than the petrol motor. Best of all, if present hopes are realized, it will run on the vegetable oil which the Niger region can and does produce in abundance. Then, indeed, will the humble peanut come into its own.

Cost and Finances.

The cost is estimated at £12,000 per mile, or a total of £22,000,000. With interest at 8% to allow for amortization, the annual amount to be found by the State will be about £1,750,000 less profit made. This profit is very difficult to estimate, but one authority maintains that it may be expected to grow from nothing during the first year of operations to £750,000 in the tenth year. Account must be taken, in considering the finances of the project, of the indirect return which may be anticipated and of which the State can take monetary advantage. French administration and railway building have, in Morocco, taken the value of land up from a few shillings an acre to something between one and two pounds sterling an acre. In the Niger region, the area of land, now unsaleable but of similar potential value, amounts to not less than a hundred million acres. The State will have a just claim to a share of the enrichment to be expected. A concession for the construction and operation of the line will probably be given to the P.L.M. Company, the capital being raised by public subscription. The Government may be disposed to help with some part of the Reparations deliveries-in-kind, which it receives under the Dawes Plan.

Commercial Possibilities.

There are two main obstacles to the successful exploitation of A.O.F.; one is the climate and the other the innate laziness of the native. The white man may curse both, but can scarcely, in reason, blame either. The effects of the first are being, to some extent, ameliorated; suitable education and time may overcome the latter. Indeed it has already been noticed that the native is becoming susceptible to the lure of wages, and one tribe in particular, to the number of a quarter-of-a-million, makes an annual visit to the Gold Coast, where they work on the plantations, and whence they bring back the much-prized kola nut as the reward of their labours. The French hope

that a remedy may be found in planting the kola in their own territory, in land grants and in making communications easier between the Upper Volta and the rest of A.O.F. than between the former and the British colonies. They hope, too, to increase the population by reducing the high rate of infant mortality (60%) and by fighting, with every weapon of medicine and hygiene, the armies of disease. Further, the railway may bring with it a new immigration of Berbers from the north, a race of many qualities. Lastly, machinery may, even here, take the place of some sorts of manual labour, and so reduce the apparent shortage.

That the country is not poor and may become exceedingly rich is admitted by all. The total value of exports in 1926 amounted to £12,000,000. At present, the country takes a great part of its wealth from the production of vegetable oil and from the head of live stock which is estimated at seven millions. Other products are cotton, sisal, hemp, kapok, indigo, rubber, gum, tobacco, manioc, millet and timber. Many districts are suitable for maize, rice and even wheat. To get the best out of the soil, irrigation works will be necessary, but these need not be on the titanic scale of the Nile barrages; for instance, the Niger almost dams itself at the Tosaye defile. But the railway must come first; once it has come, it can be assured of steadily growing reward; a reward sufficiently encouraging, it is hoped, to justify the construction of the great Congo extension. The pessimists may contend that the sea route will continue to take all the traffic. This is unlikely; in the dry season, river navigation is slow and uncertain, at all seasons the harbours of St. Louis, Dakar, Konakry, Bingerville and Kotonou are expensive in operation owing to bars. They lack natural facilities. And it is as far from Tosaye to Dakar as it is to Oran, which is less than two days' sail from Marseilles as against Dakar's ten. One estimate puts the saving in cost from Tosaye (*via* the Trans-Saharan as against the Dakar route) as high as £1 a ton. The two ways should not, in general, compete with, but should complement each other.

Passenger traffic is expected to be profitable and large. The travel habit has spread far since the War, and Dark Africa is coming into the fields of activity of Thomas Cook. The Trans-Saharan connected to the Nigerian Railways will provide a fair imitation of an Overland route to the Cape, and connected to the Senegal line should attract a good proportion of the passengers between Europe and South America. To sum up the financial aspects, one may say that here is a work of national defence that ultimately will, like no other, pay for itself in times of peace.

Comparison with some other Trunk Lines.

It may be of interest to compare this railway with some of the other great lines that have been pushed out across continents. The most

obvious of such is the Canadian Pacific, but it is perhaps the least like ; it certainly has joined two oceans, but then, almost immediately the similarity ends. It was in no sense military—though it did secure for us British Columbia ; it took its way through what was admittedly a white man's country ; if anything, cold was the enemy, not heat ; instead of deserts it crossed mountains, and having crossed them found no railways already stretching out from the coast to meet it. It has been a success and has made a nation. The South Australian Railway does cross a desert to link up two existing systems, and has helped to give added political unity to what geography has made one ; also it does compete—and that fairly successfully—with a sea route. It was not built at the behest of a general staff. It gives an encouraging example to the builders of the Trans-Saharan. The Siberian Railway is in its objects—or at least was—the most similar to the Trans-Saharan. Russia built it to carry troops as much as to open up a new country ; it has scarcely had a fair chance and it can in no sense be taken as a guide. Looking at the Trans-Caspian, the French are heartened when they see how this line, even under Russian mismanagement, has been the means of creating a great cotton-growing industry in Ferghana, thousands of miles from anywhere. At present, France has to buy 300,000 tons of cotton a year abroad, producing in her own colonies only 10,000 tons ; she intends to make serious efforts in A.O.F. to reverse these figures.

As the world grows older, clearer and clearer does it become that every nation has need of every other nation, that none can prosper by his neighbour's troubles, that the disaster of one is the disaster of all in their varying degrees. At the same time, it were foolish to expect all nations in all their variety to act up to the implications of this axiom at once. Great ideas may move surely, but they move exceeding slow. In the interval, it behoves every people to look to its own security ; what way less offensive than that of striving to become as self-contained, as united as possible ? The peoples of Europe look across the ocean and see a young people, "an eagle mewing her mighty youth, and kindling her undazzled eyes at the full mid-day beam." They look more closely and they see this people, rich and strong, holding land that seems to contain every need except one, a land that is crossed and crossed again by more miles of railway than all Europe can boast, a land that seems less likely to be ravaged by war than any other in the world. The moral is patent. It is to achieve some semblance of American compactness that France will build the Trans-Saharan Railway, to avoid paying a heavy tribute to foreign nations that she will develop to the utmost French Africa. France hopes that this great Railway will prove an instrument of peace and an agent of civilization ; of the civilization of which she is so proud as being the oldest in Europe and not the least active.

LIFE ON THE FRONTIER.

By CAPT. R. E. WOOD, R.E.

PERHAPS a short account of a frontier station at the moment might be of interest to those expecting to go to India in the near future. The writer has spent the last 15 months with a Sapper and Miner Company in Razmak, one of our newest outposts, and although conditions there are better than in some other stations, life is much the same on the whole.

To begin with climate, as is usual when discussing India, Razmak has the advantage of a moderate summer temperature, and real cold weather in the winter. The latter may not be considered an advantage, but it is at least healthy. In the summer, the thermometer rarely reaches 90°, nights are always cool, and a breeze usually springs up at mid-day. January and February bring snow, a foot or so, but seldom lying for more than a few days. From December till March there is frost nightly, reaching last year a maximum (or should I say minimum) of 16°.

Quarters are stone huts with corrugated iron roofs, with " pukkha " doors and windows, concrete floors, fireplaces, bathroom, and verandah, cool in the summer, but uncommonly draughty in the winter. Service conditions prevail, with such concessions as free rations for British officers, special messing allowance for the men, and separation allowance for married officers. The nearest female is at Bannu, over 70 miles away, so Razmak is an ideal place for the strong silent man. This cold weather, a camp has been established at Bannu for the families of officers at Razmak and on the L. of C., and " week-ending" has begun. There is considerable motor transport, both civil and military, and a return passage on the mail, for instance, only costs Rs. 10.

Soldiering occupies quite a lot of one's time. Three times a year or so the Razmak column, a mixed brigade of all arms, goes on tour for a week or two. These have been comparatively peaceful of late, but, of course, all military precautions have to be taken at all times. The lot of the Sappers is chiefly the inevitable water-supply, which in the majority of camps is taken direct from the nearest stream. Five thousand men and 1,600 animals, after a hot march, drink incredible quantities of water. Animals can occasionally be allowed in the

stream, but frequently troughs, which we carry for the brigade, have to be erected owing to the bed being muddy or the supply limited. With apologies to the author of the *Manual of Field Works (All Arms)* I will quote some of our records. On one march the mules on arrival in camp averaged over six gallons each—not surprising, as for many of them it was their first drink of the day. It is usually impossible to water all animals before the march begins, and the poor old frontier mule must hate columns. Another day, the brigade, only 4,000 strong, took 16,000 gallons from the drinking-water point in five hours! It must be remembered that everything has to shut down, and all men and tanks, etc., must be inside the perimeter before dark. Other jobs which occasionally arise are the roping of fords, when rivers are in spate, and improvements to roads. These latter obviously cannot be extensive, but a corner where A.T. carts have to reverse demands attention. Camp approaches and assistance to the infantry in the construction of the perimeter defences are normally the task of the pioneer battalion, which forms part of the brigade.

Next to work, I am sure the most interesting subject is recreation. We cater for most games in Razmak. Hockey, soccer, and squash are in full swing all the year round. Grounds for the two former are highly dangerous at present, but a new pattern, of sifted and rammed earth, involving considerable time and labour, was proving a success when I left. The problem, of course, is to get rid of the stone menace. Four squash courts are "pukkha" concrete affairs. In the summer, there are cricket, tennis and polo. A concrete cricket pitch has been made, but the outfield is best described as sporting. A ball with an eye for country starts towards third man and finishes by blacking mid-on's eye. Tennis is conducted on normal lines. Polo takes place on what is known as the aeroplane landing-ground, as occasionally an unfortunate 'plane has had to land there. The ground has a transverse slope of about 1 in 20, and is full of delightful surprises. There is also a 9-hole golf course. As the stones grow (or seem to) like daisies, a local rule allows the ball to be "placed" for each stroke. Artificial hazards have been found unnecessary so far, and golfers with clubs they value try to borrow someone else's.

The country is unsuitable for riding, and a valuable pony undesirable. There is gradually forming a type of horse best described as a "frontier charger." Small-game shooting is run by the Brigade, areas being allotted to syndicates of 8 to 10 guns, but birds are not too plentiful. The Gurkhas specialize in bringing down pig with a ·303 in. rifle. In the summer, climbing expeditions are very popular, mountains of over 10,000 feet being only a few miles away. Officers are granted three months' privilege leave annually in Waziristan, which brings Himalayan shooting within easy reach. Kashmir can be reached in two days.

Razmak, 6,500 feet above sea-level, with its moderate climate, allows training to be carried out under ideal conditions, and normal English hours are observed. Sapper and Miner units are chiefly concerned with operations, but in Waziristan work in close touch with the M.E.S., and a good deal of valuable experience in heavy bridging, road-work, and similar jobs is obtained. M.E.S. officers also get direct acquaintance with the organization and capabilities of the S. and M. units they may be posted to in war. A glance at the *Quarterly List* will show that a large number of junior Sapper officers are employed in Waziristan, and there is no doubt that, with the large programme of road construction now under way, service there should be attractive for many years to come.

It will be as well to mention one or two other stations not so favourably situated as Razmak, otherwise an unfortunate fellow in Manzai, for instance, may speak reproachfully. Dera Ismail Khan (D.I.K. as it is affectionately known) and Bannu, though disgustingly hot in the summer, are at least civilized cantonments, with little of the barbed-wire atmosphere. Manzai has not even this recommendation, but, as its Brigade is due to move to Wana shortly, it will cease to be a Sapper station. Jandola and Sorarogha, in the Takki Zam valley, and Miranshah, in the Tochi, are Scouts' posts, renowned for their hospitality, as the touring Sapper officer will soon find. Officers are encouraged to see as much of Waziristan as they can, and those stations in the more unpleasant places usually take advantage of free transport to visit Razmak in the hot weather. The scenery in many places is very picturesque, especially in the upper stretches of the Takki Zam valley, and has afforded the writer some quite artistic photographs. Former battle-grounds, like the Ahnai Tangi, Palosina or Makin, are of interest to the student of frontier warfare.

The circular road from Bannu *via* Razmak to Dera Ismail Khan is open for traffic from sunrise to sunset without escort, protection being afforded by local " Khassadars," a sort of irregular police, on whom considerable reliance can now be placed. It is hoped to extend our control by establishing a garrison and movable column at Wana in the next few months, and this should go a long way to the pacification and civilization of the country.

THE NEW HARBOUR AT TANGIER.

By LIEUT. G. V. MICKLAM, R.E.

INTRODUCTORY.

THE following notes on the new harbour works at Tangier do not claim to be complete. Circumstances limited the period of inspection to half a day, and consequently much information of interest to engineers has been omitted. Further, it is only the officer with experience of harbour work who can discriminate between normal and abnormal practice in new construction.

It is, however, unlikely that such officers will have the opportunity of inspecting progress at Tangier, and therefore these plans and notes may not be out of place.

PRESENT CONDITIONS.

The strategical importance of Tangier is a subject of frequent debate in Naval and Military journals, and calls for no further comment.

Tangier Bay is silted, and ocean-going vessels anchor a mile from the existing landing stage (marked B in the Plan). Passengers and merchandise are transferred to motor boats or lighters. A low tide in conjunction with a rough sea outside the mole (marked A in the Plan) often entails another transfer into still smaller craft. The inconvenience of night landing, or embarkation, with the clamorous assistance of excited Moorish boatmen, has to be experienced to be fully appreciated. In very bad weather the Port is officially closed, and the ships pass by to their next point of call.

When the new Tangier Zone Administration was established, it realized that early action was necessary in this connection if the port were ever to develop. Tenders were therefore invited for the construction of a new harbour. The contract was given to a French firm, and the work was set in progress in 1924. It is hoped that it will be completed in 1930.

ORIGINAL SCHEME.

Plate I gives a general plan of the port, as originally designed, with the exception of the curve which now replaces the angle at the point K. The existing mole and landing stages are shown at A and B respectively. New work under the present contract is shown in

solid black. Proposed ultimate extensions are in disconnected lines. These will not be undertaken until the financial position of Tangier is such as to justify the added expenditure. The figures in circles refer to the sections, with corresponding numbers, in *Plates 2 et seq.*

For reasons which are set out later, it is hard to foretell accurately the final area of the enclosed harbour, but it can be safely estimated at between 150 and 200 acres.

Details of the South-East Mole, and of the quay −4m, were not available at the time of writing.

It would appear curious that the outermost dredged area should be marked down to −9m, when the sounding lines indicate depths of −10m, but as this is shown on the contractor's plan it is retained in the *Plate.* Further examples of inaccuracy in paper work are quoted in a later paragraph. It will be noticed that the 4m, 6m, and 7m depth lines have been omitted, presumably for clearness.

Classification of Stone.

The stone used at the various points of the cross-sections is grouped as follows :—

Class 1. Blocks of 50 to 1,000 kilogrammes each.
Class 2. Blocks of 1,000 to 3,000 kilogrammes each.
Class 3. Blocks of 3,000 to 10,000 kilogrammes each.
Class 4 (special). Above 10,000 kilogrammes each.

Photographs.

Fig. 1 represents a very early stage in the work. Figs. 2, 3 and 4 were taken in September, 1927, and correspond to progress shown on the Plan. Fig. 5 is a photograph of the power house, near the quarries, which are shown in Fig. 6.

Notes on the Contract.

The contract is divided into two sections :—

A. *Infrastructure.* This includes :—

1. A breakwater 960 m. long, of which the shore section is 560 m. long, and the outer section 400 m.
2. An arm, known as the "Intermediate Traverse," 300 m. long, extending South-West from a point 100 m. from the further end of the breakwater.
3. A yard for coal and fuel oils, 60 hectares in area, in the angle between the breakwater and the existing mole, bounded on the South-East side by a 6-metre quay wall, (between levels −2m and +4·00 m.) for 170 metres, and on the North-East by a masonry embankment.

4. A protective mole 150 m. long, known as the North-West Mole.
5. A quay 100 m. long, with a 5-metre vertical face between levels −4·00 m. and +4·00 m.
6. A quay of four lengths, totalling 305 m., with a 6-metre wall between levels −2·00 m and +4·00 m.
7. A quay 100 m. long, with an 8-metre vertical wall between levels −4·00 m. and +4·00 m.
8. A mole, known as the South-East Mole, with an elbow, in continuation of the above, of total length 180 m.
9. Within the coastal basin, limited by the existing works and by the works proposed above—
   A. A dredged area 3·5 m. deep, of mean width 150m., the whole length of the quay at −4·00 m.
   B. A dredged area 2 m. deep, west of the preceding, and of mean width 100 m.
10. Outside the coastal basin, and within the outer harbour, dredging and blasting, up to a total cost of 1,000,000 francs. These operations to be carried out in such a way as to form—
   A. An anchorage of about 14 hectares, 8 m. deep at low tide, and 200 m. wide.
   B. A channel of access to the anchorage, 9 m. deep at low tide, and 200 m. wide.
11. Filling, estimated at 410,000 cubic metres, of which 240,000 cubic metres are for the coal and fuel oil depôt, and 170,000 for the quays and their connections.
12. Protective masonry for the quay platforms and communications.
13. 4,000 square metres of paving, and 10,000 square metres of metalling.
14. The drainage scheme of the town.
15. Water and electricity mains for the harbour works.
16. The fencing of the harbour area.
17. Port lights and buoyage.

B. *Superstructure.* The following are included in the finished programme of the work :—

1. A warehouse 50 × 20 metres, consisting of a steel framework filled in with brick, with a tiled roof, and equipped with Decauville track and hoisting and travelling gear.
2. An open shed 50 × 20 metres, in wood or corrugated iron.
3. Two cranes, one 3-ton, and one 5-ton.
4. A 20-ton derrick crane.
5. 450 metres of track for cranes.
6. A 250 H.P. winch.
7. A motor water barge.

8. Administrative offices for harbour authorities, including, on the ground floor, two rooms for the *Service de Contrôle*, two rooms for the Harbourmaster, and one for the Pilot Administration.

9. A permanent building to include—

Passenger waiting-room.
Sanitary services.
Postal and Telegraph Offices.

10. The contractor will erect a disinfecting station at the expense of the Tangier Zone Administration, on a site chosen by it.

Note.—Railway Tracks.—The track for harbour communications and developments, with the exception of crane track, will be laid by the *Compagnie Concessionnaire du Chemin de Fer de Tanger à Fez*, at its own expense, in compliance with the existing regulations of that Company.

Labour.

Labour is cheap and plentiful. A mason is paid 10d. a day, and an ordinary unskilled labourer 3d., in present-day equivalents.

Power for Quarries.

Two 80 H.P. National gas-engines are used, one driving an air compressor, and the other a D.C. dynamo for lighting. The generators, scrubbers, and receivers are housed in one end of the main building, adjoining a large sliding-door giving access to the open air (*see* Fig. 5). No stand-by plant is provided, and it is therefore presumably considered unnecessary. The compressed air is transmitted to the tools in the quarry through a 3-inch pipe line. This is made up of 5-metre lengths of steel piping with flexible joints. The line lies out in the open on unprepared ground beside the light railway, and is capable of taking steep curves satisfactorily. Fig. 5 shows the pipe line to the right of the right-hand track. To the left and beyond the power-house can be seen the electric overhead monorail sand hoist overhanging the beach, which lies to the left of the picture. The control cabin is hidden by the gable.

Repairs.

There is a large workshop, sparsely equipped, near the starting point of the new work. It is chiefly employed on repairs to locomotives, rolling stock, and cranes.

Methods.

The stone is blasted from the cliffs which line the coast to the west. It is brought some four kilometres along the water's edge by light

railway. Some is required to form the aggregate for the 35-ton blocks which are made up near the site. The stone passes through crushers to a steam-driven mixing plant. Other stone is dropped where required to form the breakwaters, etc., and is there packed by natives with crowbars, assisted by the small steam-cranes.

The concrete blocks are left out in the open for three months before use. They are placed in position by the "Titan" crane shown in Fig. 1, at the head of the work. The photograph also shows four rows of blocks waiting their turn for use, and three of the small cranes employed on lighter work. Fig. 4 shows two of the blocks, each approximately 2 × 2 × 3 metres, in position. The two slinging grooves on each side of a block can be distinctly seen.

REMARKS.

There are one or two points about the harbour scheme that call for comment. The first is that, although the work is now in a fairly advanced stage, the plan and sections are still under discussion, with a view to alterations in design. The curve was substituted for the angle at the point K when work on that part of the breakwater was imminent. Again, Section 5 has just been completely redesigned, with a considerable increase of cross-sectional area. Altogether there is a vagueness and lack of finality about the scheme, which may, or may not, lead to improvement on the original project as submitted to the Tangier public works engineers for approval.

A second point is that the provisions of the agreement allow for payment to the contractors at monthly intervals, such payment being based on the amount of mole that has been completed to full section. This means that the work is growing outwards from the shore, instead of upwards from the sea bottom. No sooner is a short length of foundation dumped, than the blocks are laid in position, and the filling is hastily completed up to the level of the finished work. Very little time is allowed for the inevitable settlement of the rubble and hand-packed blocks. It may, however, have been impracticable to organize the work otherwise.

The third point is, on the face of it, trivial, but it is understood that much trouble and waste of time was caused by it. In bills of quantities, estimates, etc., the decimal point was represented by an ordinary comma. As the figures used exceeded a million in most cases, it was found that it was not easy to differentiate between the commas separating the thousands digits, and the decimal points. It is said that the French engineers themselves were led into errors in this manner; errors which were only discovered when the engineer of the Tangier Zone checked the figures. This is a striking example of the necessity for the most minute and careful scrutiny of all Tables of figures which have been typed out from a correct manuscript.

FIG. 1.

Tangier Harbour.

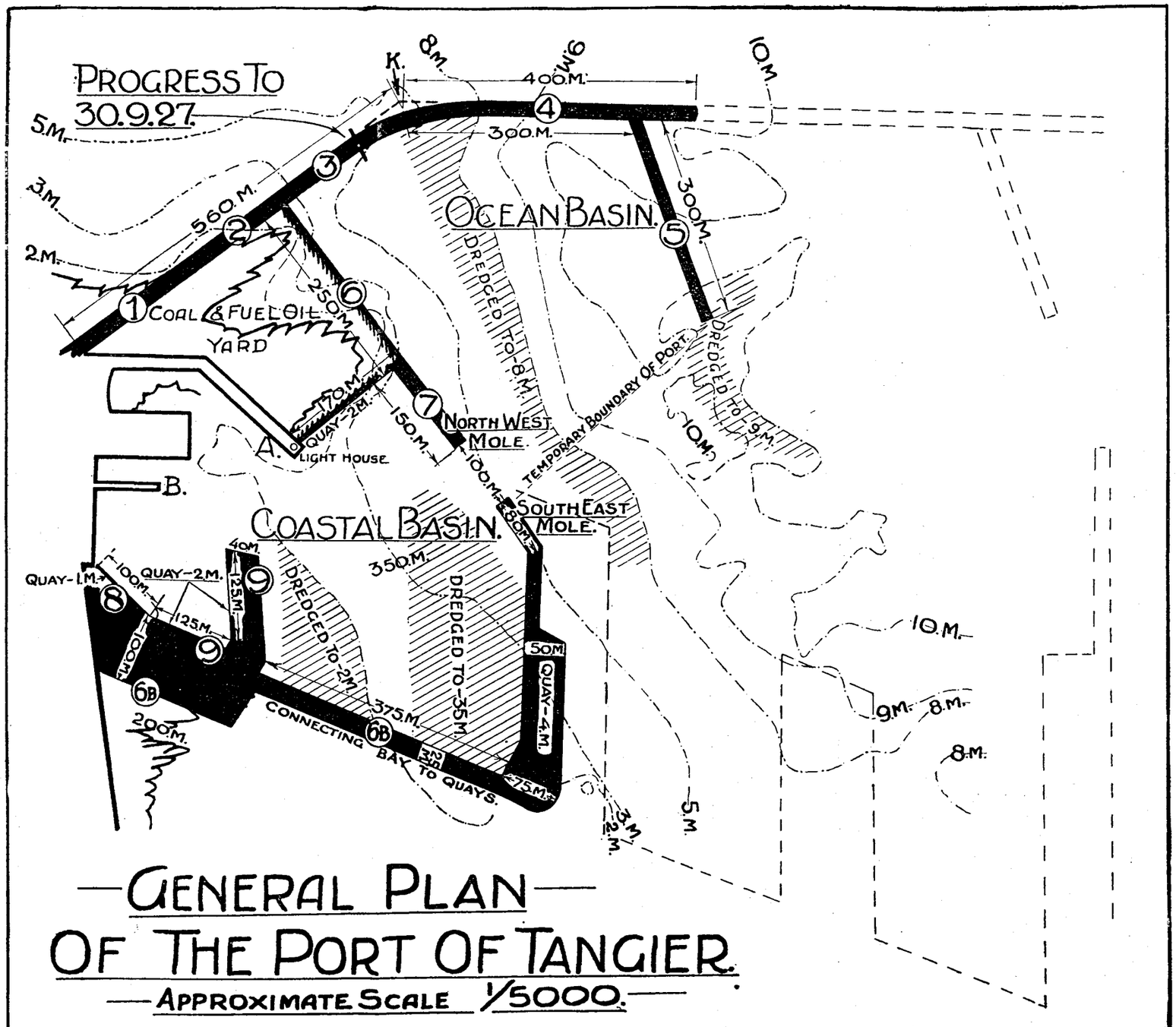
FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

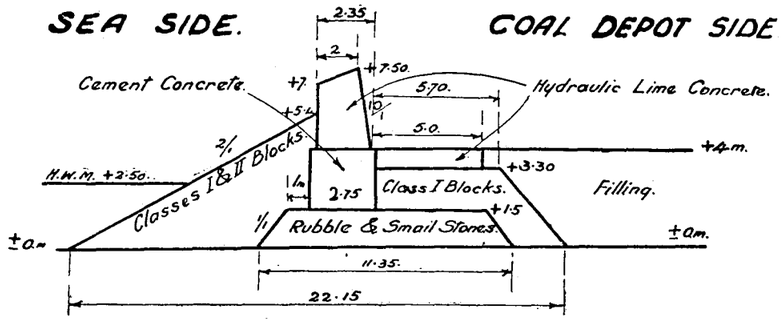
Railways



GENERAL PLAN OF THE PORT OF TANGIER.

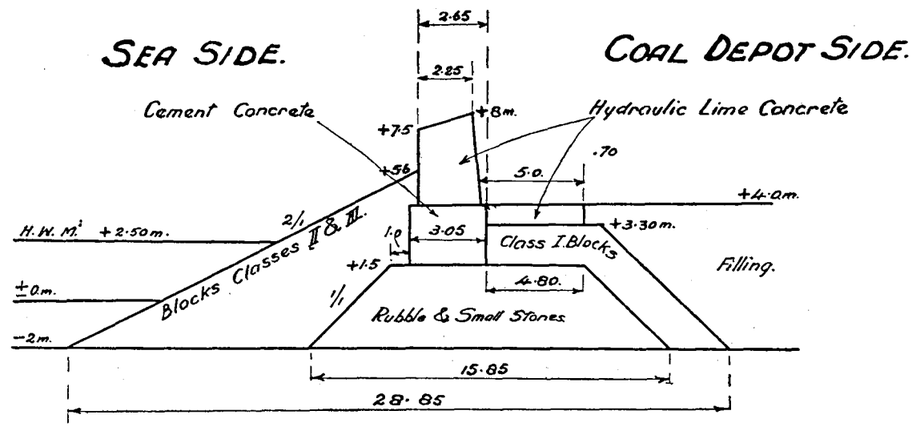
APPROXIMATE SCALE 1/5000.

(1.)



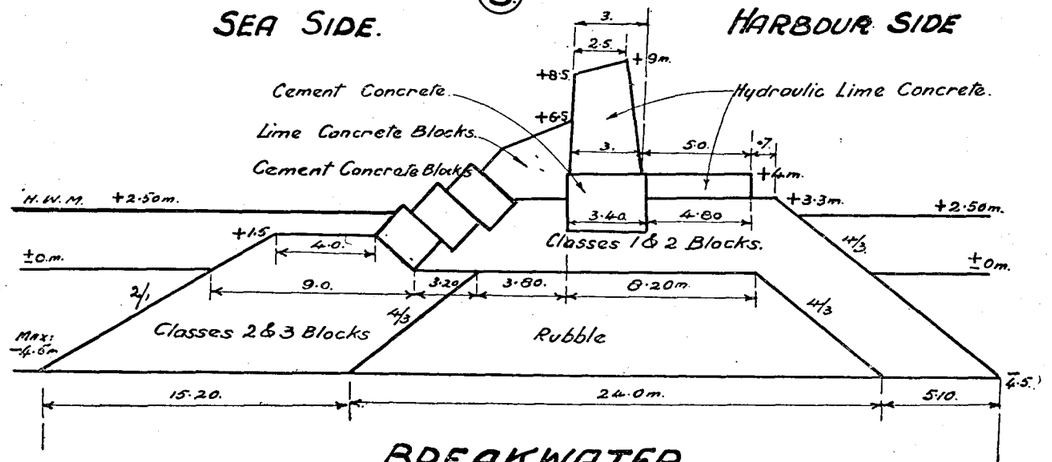
BREAKWATER.
EXTENDING 180 M.

(2.)



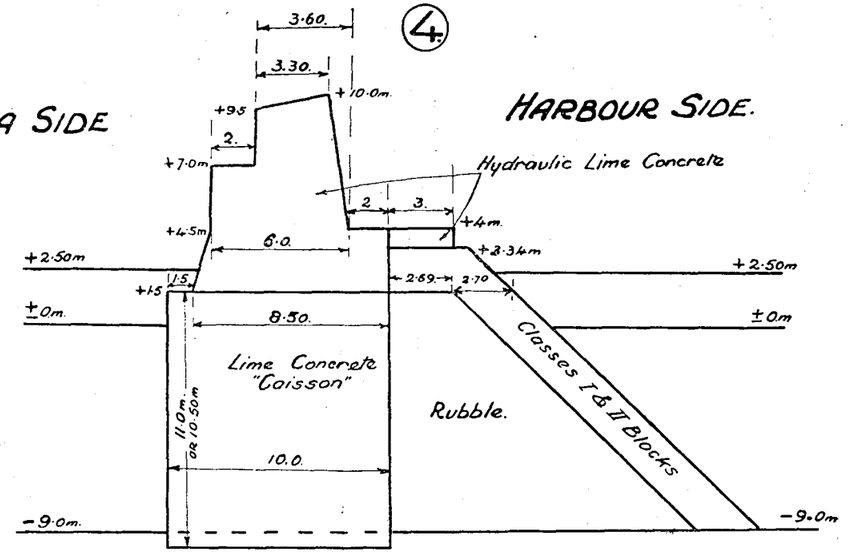
BREAKWATER
EXTENDING 100 METRES.

(3.)



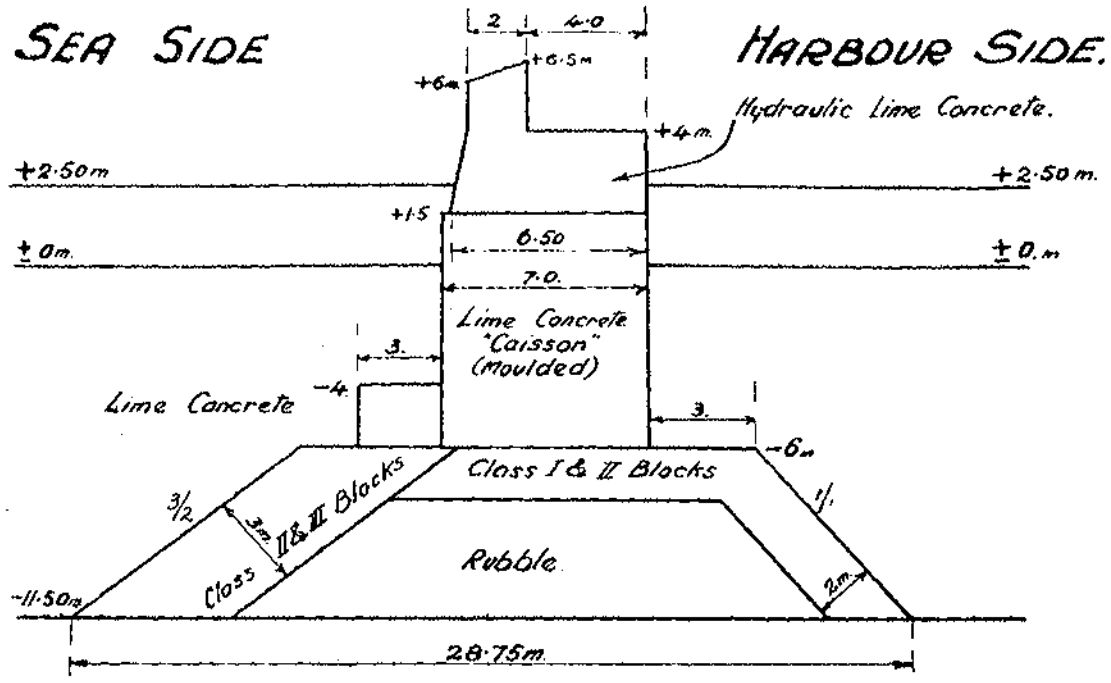
BREAKWATER.
EXTENDING 200 METRES.
DEPTH VARIES FROM -3.70 TO -4.50 METRES BELOW DATUM.

(4.)



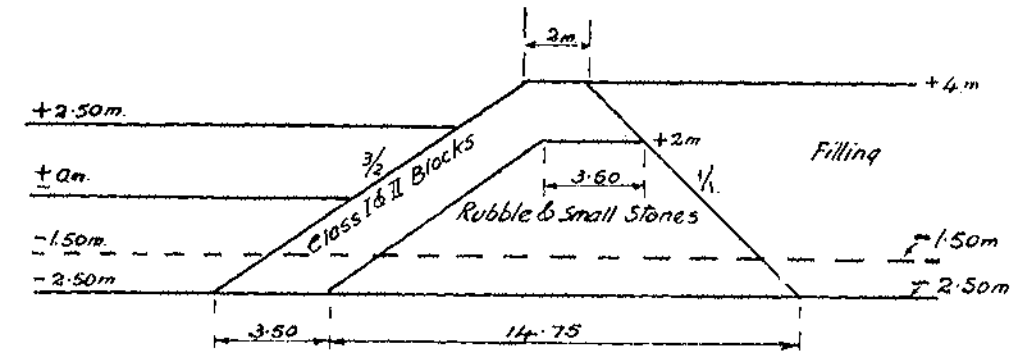
SEA BRANCH OF THE BREAKWATER
EXTENDING 400 METRES

(5.)



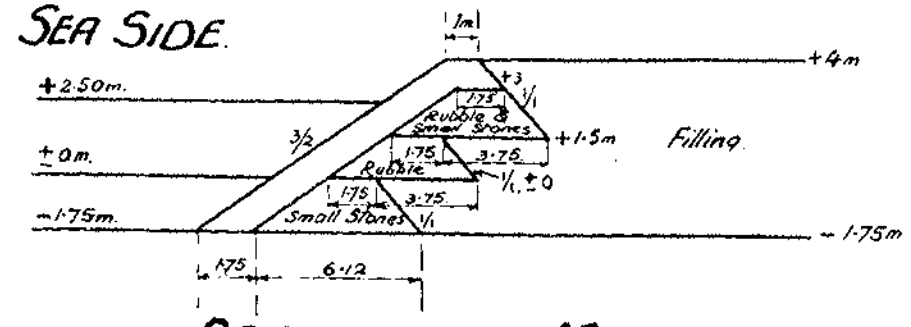
(ORIGINAL) INTERMEDIATE TRAVERSE.
EXTENDING 300 METRES
(NOW RE DESIGNED)

(6.)



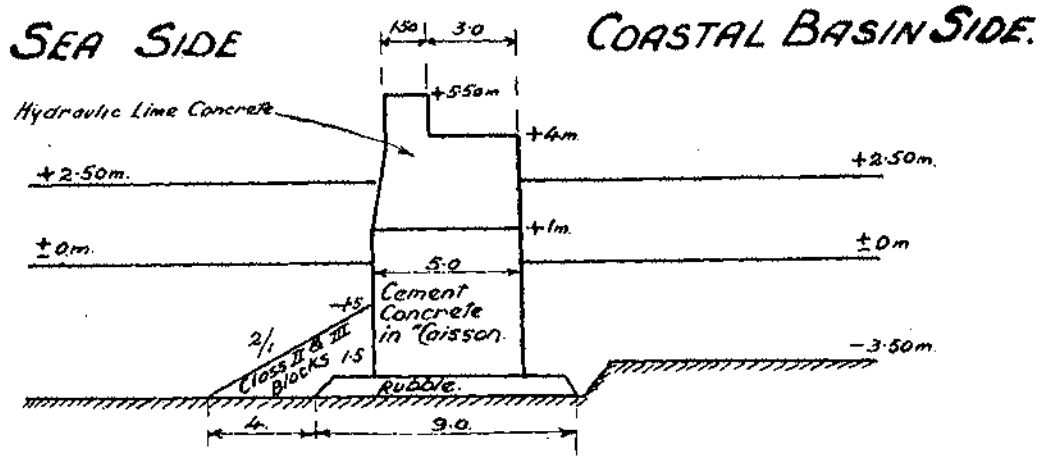
PROTECTIVE MASONRY.
250 M. Of Coal Yard (East Side) — Mean Depth (-2·50) &
240 M. Of The Return Mole (East Side) — Mean Depth (-1·50)

(6.b)



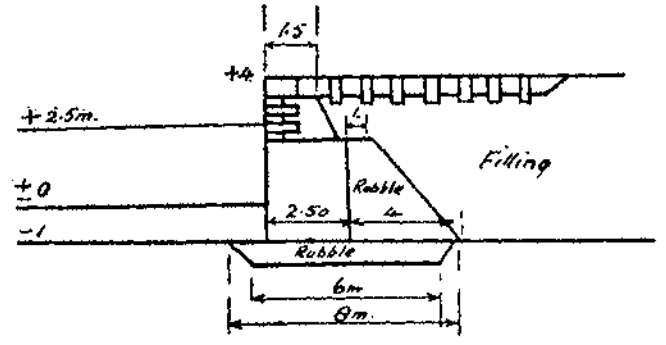
PROTECTIVE MASONRY
EXTENDING 200 METRES
For Quays Between -1 & -2, And For The Connecting Link Between These Quays To The Quay At -4 -(South Side)-

(7.)



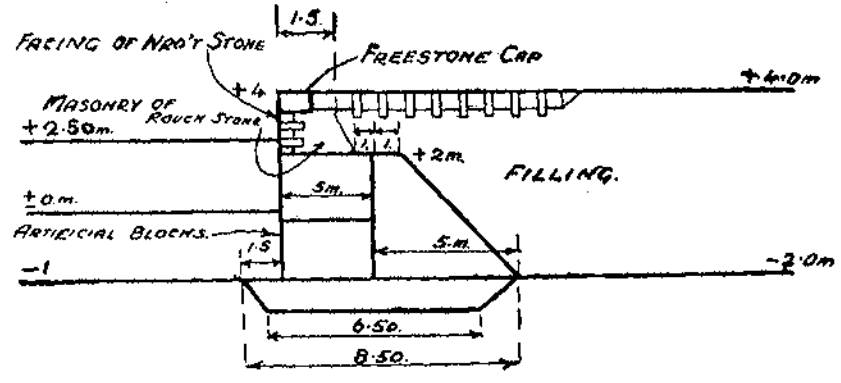
NORTH WEST MOLE.
EXTENDING 150 METRES MEAN DEPTH -3·50

(8.)



QUAY WALL AT -1m.
EXTENDING 100 METRES.

(9.)



QUAY WALL AT -2m.
EXTENDING 475 METRES

TRANSPORTATION, AND THE LAY-OUT OF AN OVERSEAS BASE.

A Lecture delivered to the Officers of the Garrison at Bombay on August 10th, 1927, by Bt. Lieut.-Colonel W. G. Tyrrell, D.S.O., R.E

1.—General Considerations.

Under the present organization of the Army for War, the Director of Transportation deals with Ports, Railways and Inland Water Transport. This involves the construction of new work and the maintenance and operation of both new and existing work. In order to ensure success in War, one of the essential factors is that the fighting troops should be provided with a sufficient quantity of stores of all sorts, at the right place and at the right time. The Transportation service is largely concerned in this, particularly if the line of communication is long.

The Transportation service undertakes the movement of men, animals and materials. Whether units and formations will be moved up to the front by rail will depend on distance, urgency, commitments as to movements of stores and the total capacity of the railways. In any case, the railways never undertake their movement through the whole of the base area. Troops after disembarking will proceed by road to the rest and reinforcement camps, which should be situated outside the seaport town. A station within a few miles of the camp can usually be set apart as a troop entraining station. As this station will not be required for other purposes, every facility can be provided to ensure comfortable and rapid entertainment of all classes of troops. The *Field Service Pocket Book* gives the number of trains required for the higher formations as 78 for an Infantry Division, and 69 for a Cavalry Division. Each of these, roughly, demands three days' full capacity of a single line, and a whole day's capacity of a double line, the best conditions being assumed in each case. It will thus be seen that the movement of troops by rail will make serious inroads on the capacity of the railways.

Stores *must* be moved by rail, and it is of primary importance to know the total requirements of any force. The requirements of the two principal higher formations are shown in Table I.

The lower figures for Ammunition and R.E. Stores are for a war of movement, while the higher ones are for stationary or trench warfare.

The total requirements of the whole force can be based on the number of Infantry Divisions, if a proper allowance is made for other formations. The allowances to be made are :—

For Corps Troops	25%
For G.H.Q. Army and L. of C. Troops (includes Cavalry Division)	20%

We will not be far wrong if we add 50% to the requirements of the Infantry Divisions.

TABLE I. DAILY REQUIREMENTS IN TONS.

Commodity.	*Infantry Division.*	*Cavalry Division.*
Supplies and Forage	100	132
Petrol and Oil	6	3
Coal and Other Fuel	26	14
General Ordnance Stores	45	25
Ammunition	50—80	30—60
R.E. Stores	40—80	15—30
Mails, M.F.O. and Canteen Stores ..	8	5
	275—345	224—269

In addition to the daily requirements of the force, a considerable reserve must be maintained in order to guard against interruption of communications and fluctuation in demand. The amount of the reserve to be maintained may vary with the distance of the overseas base from home. It need never exceed 30 days' requirements, and should never be less than 15 days' requirements. When the reserve is less than 30 days, the balance to make up the 30 days' reserve should be immediately available within a short distance of the shipping port at home. In effect, this means that a 30 days' reserve is always maintained within a reasonable distance of the overseas base.

2.—THE PORT.

No arrangements for dealing with stores at a port can be made unless we have some idea of the quantities which will arrive in each ship.

These figures are of considerable importance, as such things as depth of entrance channel, depth of harbour, and amount of manœuv-

ring space may limit the size of ship which can be received. The programme for dealing with ships will be considerably affected by the rise and fall of the tide, as some ships may be able to come in at any time, while others must wait for high water.

TABLE II. DETAILS OF SIZES AND LOADS.

Length, feet.	*Loaded draft, feet.*	*Average tons of Army Stores.*
200	15	800
300	20	2,400
400	25	4,800
500	30	8,000
600	35	12,000

The rate at which ships can be unloaded bears a simple ratio to the length of quay which they occupy. The rate of unloading is considerably affected by the mechanical equipment, *i.e.*, power cranes, on the quay front. Quays are considered to be well-equipped if there is, on the average, one crane for each 90 ft. of quay frontage. In well-equipped ports, the average rate of unloading of all classes of stores is about one ton per foot of quay front per shift (a shift is taken as eight hours). Where there is no mechanical equipment on shore and only the ship's winches are available, a rate of half-ton per shift is all that can be expected. For calculating unloading rates, the length of quay occupied by a ship can be taken as the ship's length plus 75 feet. Owing to losses which must occur, due to succeeding ships being of different lengths and to the space required for mooring-cables, a length of 150 feet should be added to the ship's length for each berth occupied. So, in order to find the number of berths which will normally be occupied, divide the total quay frontage by the average length of ship plus 150 feet. Then the number of berths multiplied by the average length of ship, plus 75 feet, and again multiplied by the unloading rate, will give the unloading capacity in tons.

The possibility of constructing additional quays without interfering with the free use of the port should be examined in detail. Where increased facilities are required, new construction work should be undertaken. New quays of a temporary nature will require at least one ton of material per foot run of quay, and a rate of construction in excess of 1,000 feet per month should not be counted on, unless a very large construction force is available. We can then forecast the maximum capacity of the fully developed port, and the date on which it will be available.

All materials which are unloaded from ships should be removed immediately by rail to the various depots established to receive them. The retention of stores in the docks will eventually lead to congestion and reduced output. An apparent exception to this rule is when the existing dock facilities are in excess of what is required by the force to be maintained during the period when the main depots are being constructed. The storage space opposite such excess quay frontage can be conveniently used for temporary depots, if adequate road access is available. In order to avoid delay in the unloading of ships, loaded wagons should be removed promptly and a plentiful supply of empties should be available. An ordinary 10-ton wagon will contain an average load of seven tons when carefully loaded at a depot for shipment to the front. With the more rapid and less careful loading necessary to prevent delays to ships, it is improbable that an average load in excess of five tons will be obtained. As such a wagon will account for about 25 feet of quay frontage, it will be necessary to change the wagons five times during each eight-hour shift. This entails considerable railway activity.

For the discharge of ordinary cargo, cranes of 3-tons capacity have been found to be the most suitable. Cranes up to 10-tons capacity will be required for lorries and guns, and up to 30-tons capacity for tanks, while lifting equipment with a capacity up to 100 tons may be required for locomotives.

Before finally deciding what port capacity is available for the maintenance of the army, adequate provision should be made for the needs of the civil population. It is difficult to lay down any rules for this, as conditions are so variable. Exports and imports are likely to be less than in peace time. Fifteen per cent. of the capacity of the fully developed port is suggested as a *minimum* figure

3.—DEPOTS.

Stores depots may be classed as Major and Minor, as follows :—

The figures in brackets under the major items represent storage capacity in tons per acre, including spaces and gangways required in connection with the working of the depot, except in the case of item (*c*), which is based on gross area. Total tonnage divided by these figures will give net stacking space.

Major Store Depots :—(*a*) Supplies, forage, petrol, oil and fuel for troops (2,800). (*b*) General Ordnance Stores (1,100). (*c*) Ammunition (30–45). (*d*) R.E. Stores (1,000). (*e*) Transportation Stores (1,500). (*f*) Coal (2,000).

Minor Store Depots :—(*g*) Mails. (*h*) M.F.O. Consignments. (*i*) Canteen Stores. (*j*) M.T. Stores. (*k*) Medical Stores. (*l*) Veterinary Stores.

Ordnance workshops will always be adjacent to the general Ordnance Depot. Allow the same space as for general Ordnance Stores.

In addition to these areas, space will be required for railway sidings for loading and unloading, sidings to facilitate the operation of the depot and connecting lines. To take in all these railway lines, a gross area of four times the net area will be required in the case of depots (*b*), (*d*) and (*e*). On account of the highly inflammable nature of some of the stores, the gross area for depot (*a*) is eight times the net area. The figure for depot (*c*) is based on gross area, so that no multiplication is necessary. The gross area of depot (*f*) is twice the net area. No figures are given for depots (*g*) to (*l*), as the total quantities are quite small, and considerations of situation are usually more important than area. Whatever area is found to be necessary for each depot, one should not lose sight of the fact that future expansion will probably be required.

The siting of the various depots is usually a cause of controversy between the various departments concerned. In the first place, the General Staff will probably lay down two principles to be followed which are mutually antagonistic (these two principles have always been laid down at any exercise on this subject attended by the lecturer). They are :—

(*a*) The sites of the depots must be sufficiently dispersed to considerably reduce the risk attendant on aerial attack.

(*b*) The depots and the base regulating station must be sufficiently concentrated to facilitate anti-aircraft defence.

This question will usually be settled by the topography of the locality.

A tendency always exists in some quarters to earmark the best piece of level and unobstructed ground as an aerodrome. This is quite wrong for reasons that will soon become apparent.

Aeroplanes can quite easily and safely take off from and land on gently undulating ground, and it is no detriment if a sufficient area of such ground is situated on the top of a hill. For use as depots served by railways, such ground would be useless on account of its configuration and its situation. Ground for the major depots, except that for ammunition, should be of uniform slope (or easily made so). The slope in the direction of loading and of unloading sidings should not exceed 1/250, as this is the steepest slope on which an unbraked wagon will cease running after having been put in motion at a low speed. The transverse slope may be greater. In the region of seaports, the greatest areas of flat ground will usually be at low elevations. The reasons for reserving such areas for railway-served depots will become readily apparent as the result of a short calculation. In the circumstances assumed, the gradient of a main-line railway should

not exceed 1/200. The loads which could be hauled by a 60-ton shunting engine are :—

On 1/200 grade	..	..	..	..	1,020	tons.
„ 1/100 „	..	..	..	..	580	„
„ 1/50 „	..	..	..	..	300	„

This shows the difficulties which are to be encountered if we attempt to run railways up hills.

No attempt should be made to site the major depots (except that for coal) in or adjacent to the seaport town. The less the disturbance of the ordinary life of the town, the easier will be its control and administration by the Base Commandant. Railway operation will be greatly facilitated if the depots for supplies, general ordnance stores, R.E. stores and transportation stores are as close together as possible. Otherwise, supplies and ordnance should be near one another, as both consign goods direct to units, whereas R.E. and transportation stores are usually sent forward in bulk. Ammunition must be well removed from all other depots, and, if possible, should be served by some little-used branch railway line. Spurs for unloading can be run up small valleys with considerable addition to the safety of the lay-out. Coal, which is a comparatively fragile material, should be subjected to as few handlings as possible. For this reason, the coal depot should be in the docks, and a portion of the quay front should be set apart as a coal dock, so that the dump may be made immediately behind it.

Distance from the port is not a disadvantage, as the main consideration in siting the depots is suitable ground. As long as the stores are moving forward in the right direction, and the base regulating station is in advance of the depots, there is no loss of movement.

Minor depots may be placed in the town if suitable sites can be found. The M.T. depot and repair shop should, however, be on the outskirts, so as to allow for future expansion. This depot must have both road and rail access.

During the construction of the main depots, temporary arrangements must be made for the maintenance of the force. For this purpose, any suitable vacant pieces of ground and buildings may be taken into service. The reserves to be maintained during this period need not exceed one week's supply. Most of the ordinary rules regarding depots generally may be broken during this period, as it will be very much a time of give and take. As portions of the main depots are completed and declared ready for occupation, they may be made use of, particularly for the building-up of the necessary reserves, and the temporary depots may be gradually closed if convenient.

Considerable quantities of R.E. Stores will be required for construction of buildings, etc., in the various depots. As the amount is

large, due regard must be given to it when allocating the total port capacity. The proportion of the net stacking space of each depot which requires covered accommodation may be taken as follows:—

Supplies, 20%; Ordnance Stores and Workshops, 40%; R.E. Stores, 10%; Transportation Stores, 8%.

The weight of the materials for one acre of buildings may be taken as 300 tons.

For camps and various other items of base development, the covered area required may be taken as half an acre per division in the field.

The number of construction units and the rate of arrival of the materials required will determine the date on which the fully-developed base will be available for use. A reasonable proportion of such units will enable the work to be carried out in three or four months. Four months should be looked upon as a maximum.

4.—Railway Stores.

The calculation of the amount of railway material and stores required is an intricate business. However, a few simple rules will enable quite useful preliminary estimates to be prepared. For the construction of the depots, the calculation must be based on two factors. The lines serving the stacking spaces depend for length on the reserves maintained. For every acre of net stacking space 1,200 feet of track will be required. The main ammunition depot will require one mile of track for every 3,000 tons stored. The sorting sidings for serving the store grid must deal with the daily traffic. The track required will depend on the number of divisions served, the rate being $3\frac{1}{2}$ miles of track per division. Some track will be required for development and improvement of the dock area. Coal and other railway operating stores depend for quantity on the length of line of communication. An approximate figure is 10 tons per 100 miles of railway per division in the field.

For new railway construction in the forward area assume 1/4 mile of track per day per division in the field. The weight of a mile of track with bridging material and other accessories may be taken as 360 tons.

Railway tracks will be required on any new quays which are constructed, the length required being five times the quay frontage. Some extra track will also be required for additional sidings in the dock area.

5.—Force which Port will Support.

With all the previously noted facts in our possession, we are in a position to work out the size of the force which can be maintained through the port in question. The method of producing the results can best be explained by working out an imaginary example.

Assume a port possessing well-equipped quays with a total frontage of 8,000-feet run, with the possibility of 2,000 feet additional being provided by development. The largest ships which can be taken into the harbour have a draft of 25 feet. A few months after active operations start, the railway L. of C. is expected to be 300 miles long. Reserves of stores for 20 days will be held.

The ultimate total length of quay will be 10,000 feet, so that at 550 feet per berth there will be 18 berths. Three of these should be allotted to the civil population, leaving 15 for army use. The unloading rate for each berth will be 475 tons per shift. We will assume only one shift per day, during the development period, and two shifts per day after its completion. This is possible on account of the release of the unskilled labour from the development works. The total tonnage which can be landed from 15 berths will be 14,250 tons per day after development is completed.

The daily requirements of a division will be taken at the higher figure given in Table I.

General Stores	345 tons
50% for ancillary troops	172 ,,
Railway track	90 ,,
Railway operation	30 ,,
	637 ,,

The total force which can be maintained is therefore 22 divisions. Let us assume that development can be completed in four months, and that after 2½ months 1,000 feet of the new quays can be taken into use fully equipped. We may take it that the original 8,000 feet of quay will provide 14 berths, of which three are for civil use, and that each 1,000 of new quay will provide two berths. The number of berths available and the total unloading rates per day will then be :—

Period.	*Berths available.*	*Shifts per day.*	*Tons per day.*
1st 2½ months	11	1	5,225
Next 1½ months	13	1	6,175
After 4 months	15	2	14,250

We must now work out the areas of the various depots. This is best done in the form of a Table. Table III gives the details. From this Table we can work out the weight of stores required for development. The railway grids in the depots at 1,200 ft. per acre of net stacking space will require 178 × 1,200 feet of track, which is 38 miles. The ammunition depot at one mile per 3,000 tons stacked will require 18 miles. New quays and additional works in the dock area may be taken as seven miles. The total railway track for development is therefore 130 miles, weighing 50,400 tons.

TABLE III.

AREAS OF DEPOTS, ETC., FOR 22 DIVISIONS AND 20 DAYS' RESERVE.

Item.	Daily requirements.		20 days' reserve for 22 divisions.	Tons per acre in depot.	Net stacking space.	Gross depot area.	Covered area.
	Per division.	Plus 50%.					
	Tons.	Tons.	Tons.		Acres.	Acres.	Acres.
Supplies	100						
Petrol and Oil	6 } 132	198	87,120	2,800	31	248	6·2
Fuel	26						
Ordnance Stores	45	67½	29,700	1,100	28 } 56	224	22·4
Ordnance Workshops ..	—	—	—	—	28		
Ammunition	80	120	52,800	45	—		
R.E. Stores	80	120	52,800	1,000	53	212	5·3
Transportation materials ..	—	90	39,600	1,500	27	108	2·2
Coal	—	30	13,200	2,000	7	14	—
Canteen Stores	6	9	3,960	1,000	4	16	—
Totals		634½ (excludes mails and M.F.O.).	279,180		178	822	36·1

The 2,000 feet of new quays will require 2,000 tons of materials. The depots require 36·1 acres of covered area, and other development works at half acre per division will require 11 acres, a total of 47·1 acres. At 300 tons per acre the weight will be 14,130 tons.

The summary of materials for development is :—

Railway track	50,400 tons.
Quays	2,000 ,,
Other development	14,130 ,,
	66,530 ,,

Of this, one-half should arrive during the first month, and the balance during the succeeding two months, so that all the materials will be on hand by the end of the third month. This gives a daily rate of arrival of development stores of 1,110 tons per day for the first month and 555 tons per day for the next two months.

The final calculation, showing the use of the available port capacity, is also best worked out in tabular form, as shown in Table IV. There are, of course, many other ways of dividing up the daily capacity of the port between maintenance and reserves. If a larger force is required during the development period the building up of reserves will be slower, and hence the date at which the full force can be maintained will be more remote. Two shifts per day have been assumed for unloading in the docks. If enemy air action prohibits night work as a regular practice, it may be necessary to assume an average of 1½ shifts or perhaps only one, in which case the strength of the final force would be 17 and 11 divisions respectively. There would also be a corresponding reduction in the sizes of the depots and the quantities of stores required for development purposes.

It is considered that the largest force which can be maintained economically and conveniently through one port is 30 divisions.

The ideal arrangement is to maintain the covering force through a small port, which can be used as it is found, while the development of the main port and the depots is carried out elsewhere.

TABLE IV

USE OF PORT CAPACITY.

Period.		Daily capacity, tons.	Development stores daily tons.	Balance for maintenance and reserves.		Divisions maintained	Reserves at end of period in Div. days	Reserves available for	
Months.	Days.			Tons	Divisions.			Division.	Days.
1	11	5,225	1,110	4,115	6½	4	28	4	7
	19	5,225	1,110	4,115	6½	4	74	6	12
1½	45	5,225	555	4,675	7	6	119	22	5·4
½	15	6,175	555	5,620	9	6	164	22	7·4
½	15	6,175	—	6,175	9½	6	216	22	9·8
½	15	6,175	—	6,715	9½	8	238	22	10·9
1	29	14,250	—	14,250	22	Average 15	440	22	20
After 5 months.		14,250	—	14,250	22	22	440	22	20

THE BOMBAY ENGINEER OFFICER OF 1800.

By ARTHUR VINCENT.

[NOTE.—In this article, the old-style long "s" is printed as an "f," due to the limitations of modern type.—EDITOR.]

BY the courtesy of Lieutenant-Colonel L. F. G. S. Wylde, O.B.E., of the Military Accounts Department, I have recently enjoyed the opportunity of perusing a particularly interesting book which cannot be commonly known, and of making some extracts which may be of interest to the Corps. The title of the book occupies most of its front page; its essential part is :—" A compilation of all the Government and General, Government, General, Brigade and Garrison Orders, Minutes of Council, Commands of the Hon. Company, or regulations, from whatever authority promulgated, from the year 1750 to the 31ft of July 1801, that are now in force and operating on the Discipline or Expenditure of the BOMBAY ARMY." The compiler was Captain Edward Moor, and the publishers the " Courier and Gazette Presses " in 1801.

The book is fairly large, and is a perfect mine of information which throws light on all sorts and kinds of rules and amenities of the Service a hundred and twenty-five years and more ago, and is, at times, by no means devoid of unconscious humour. For instance, making allowance for the different outlook of somewhat coarser days, it is interesting to find in a General Order of 1770 a sentence which still holds good, though in politer and more moral terms to-day: " A foldier fhould be as attached to, and careful of, his musket, as his miftress."

To review the book even on broad lines would be impossible in a restricted space, it covers such a multitude of issues, and gives such general and accurate pictures of contemporary life and work through the medium of dry governmental detail. Only the main aspects of Sapper life will therefore be touched upon, which I have taken as military status, works, and the ever pertinent subject of pay and allowances.

In those days of yesterday, the military position of Engineer officers appears already as a matter for discussion. After all, up to a very short time ago, one occasionally met misguided A.C.R.E.s, as they were then, who allowed the temporary command of their stations to devolve on officers of other arms junior in army rank, because " they had no time to do it." The question is partially

discussed in 1796, in respect of touring engineer officers. In those days, touring was naturally a different affair from its counterpart to-day; without trains and cars it was a slow and long business, which must have involved the presence of senior Sappers for considerable periods in stations commanded by their cavalry, artillery or infantry juniors. Such inspecting officers are tactfully warned off the ground of local administration and discipline, as also of the command which in present-day short visits they would never dream of asserting, but the officer actually named is informed that he " will alfo, if he pleafes, give out the parole and counterfign," an important recognition of status in those days. As the individual officer in question was Lieutenant-Colonel Sartorious, that family may add to its brilliant military record the useful achievement of having been very early in the field to secure their right status to the Corps officers.

In 1797, a command of John Company's, applying thus presumably to all India, goes into the question in much detail. The Engineers are to receive the full honours of their rank, whilst command and administration remains with the permanent commander, who is responsible for it at all times, a very just decision, since this part of the order relates only to Sappers on temporary or inspection duty in those days. Apparently some or others of them had tended towards interference, for we read the following paragraph, which will be snorted at duly by the hardworking infantryman of to-day, to say nothing of the cavalry and artillery, who are not deemed worthy of so much as mention :—

> " No perfon entertains a more refpectable opinion of the profeffional importance of the corps of engineers, than the commander in chief, but it is evident that an officer employed in repairing or conftructing works, cannot afford the requifite attention to the duties of detail and difcipline, which is undoubtedly the peculiar province of the infantry officer, whofe leisure (*sic*) and education beft qualify him to conduct this part of the fervice ; as on the other hand, an engineer is, indifputably, the fitteft judge in matters relating to his own department."

Officers and officials of more than one kind might with profit take notice of the concluding sentence of this Order, which is now one hundred and thirty-one years old !

At the same time, be it particularly noted, the same order vests the command of the station definitely in the engineer officer, if he is the senior officer permanently stationed in the garrison.

The question of command during attack by an enemy, whilst the senior officer momentarily present is an inspecting Sapper, is delicately avoided ; but it is laid down that only an attack by an enemy justifies the station commander in ordering junior inspecting Sappers on any but their own work.

Nowadays, matters are far more cut and dried; but it is not without interest to find, as early as 1797, the implicit admission of the tenet that Sappers are soldiers first and engineers afterwards.

Next, one may pass to the subject of works.

It would seem that in 1800, officers were not automatically looked upon as being of the fibre of to-day! Upon the completion of a contract work the engineer officer, not excluding a Chief Engineer, had to sign and deposit very formally a "written affirmation upon honor, that he has not directly or indirectly had or will have any participation or concern in the providing or fale of the materials, nor derived nor will derive any benefit or emolument whatever from the work carried on under his infpection, over and above the ftated allowances affigned to him by government."

Furthermore, "The chief engineer muft be acquainted that he is to have nothing to do with the execution of public works except as an officer of controul (*sic*)"; and, "in confideration of the allowances granted to him, he is to be reftricted from having any concern whatever on public buildings or works, or in the materials ufed therein." Chief Engineers must have had a jolly junketing time before 1795, the date of these orders.

For the execution of work there was apparently a standing "Agent for buildings and repairs," to whom new works costing less than ten thousand rupees could be given without tender by Government if it saw fit. Larger works had to be done by contract, and "offered to the loweft bidder"; with a curious rule whereby on big repairs a contractor could draw two-thirds of the cost in advance. Bombay had apparently yet to meet the worthless native who submits an impossibly low tender in order to get the contract, simply as a means of raising his bazaar credit where he has no capital; and then either tries to cover his impending losses (including huge interest to moneylenders) by inferior and faked work, or, as has been known, bolts into the blue after he has squandered the borrowed money, and leaves a very nasty mess for the unfortunate engineers to sort out. We are wiser in these days, when not a penny of advance is permissible, and acceptance of the "lowest reliable tender" is a general rule.

In slightly older days, one recollects grouses at the multiplicity of periodical reports required upon works in progress, which, after all, are or ought to be as useful to the officer who makes them as they are important to his superiors. It may thus be of interest to note that the monthly progress report was apparently born officially on the 18th of December, 1796, and had to be prepared in considerable detail.

For very many years now, insistence on a proper knowledge of Indian languages has been almost a stronger tenet in the Corps than in the army as a whole. Before the war, one recollects C.R.E.s and Commandants of Sapper and Miner Corps who rightly used all

legitimate means to prevent their young officers from resting content with the minimum statutory qualification of the old Lower Standard examination. In 1800, however, times were apparently easier, for a chief engineer's establishment paid for by government included an interpreter, at the then liberal rate of twelve rupees a month. Furthermore, it included sixty rupees, a comfortable wad of money in those days, each month for "palanquin and conveyance." Happy days! One can fairly see that interpreter perspiringly accompanying the lordly palanquin.

The important question of pay and allowances is gone into at great length. Curiously enough, with one notable exception, the emoluments of the engineer officers seem to have differed in no way from those of the other arms. The ordinary regimental tables may be of interest; emoluments were composed of pay and "batta," only half-batta being drawn in peace. The rates were as follows:—

		"In garrison."	*In the field.*
For a 30-day month:	Lieut.-Colonel	630	1,009
	Major ..	495	799
	Captain ..	296	436
	Capt.-Lieut.	266	406
	Lieutenant	168	254
	Ensign ..	129	200

They seem, of course, very small, but the relatively enormous purchasing power of the rupee in 1800 must be given full weight. Exactly how it compared with the depreciated article of to-day it is difficult to say. The writer can testify from family records that a married officer with children forty years ago had as comfortable a time as a similar family now enjoys on just four times the pay; and it may be presumed that, eighty years earlier still, money went proportionately further still.

It is curious to note the old coinage; the tables are made out in rupees, quarters, and "reas," the latter presumably a hardy survivor of the days of Portuguese rule in Bombay. The tables thus read "Rs-q-re," as compared with the Rs-a--p of to-day. It took four hundred reas to make a rupee, so that the fact of the detailed inclusion of reas in rates, even to half a reas in one case, makes one suspect that the purchasing power of money must have been high indeed. The reas was an almost universal insect, cropping up everywhere. Eighty of them, *i.e.*, one-fifth of a rupee, were solemnly tacked on to the princely salary of a chief engineer in the field, to cover what contingency this deponent knoweth not.

The exception noted to the similarity of pay between all arms was the "Colonel, chief engineer." His was eminently the post to hold. From the Rs. 630 of a Lieutenant-Colonel in garrison, his salary soared straightway to the heights of Rs. 2,340 for a 30-day month;

and in the field he drew Rs. 2,419, to which were added eleven rupees a day "table money," and the allowance for two horses which was open to all commandants of engineers in the field, if field officers.

Of his princely pay, whether in garrison or in the field, Rs. 1,200 per month was an "Establishment in lieu of commission on public works and of all contingencies"; an amusing indication of what must have been one of the earlier attempts to give responsible but comparatively lesser military officers emoluments which would place them beyond temptation. It is not clear from the volume how much of the Rs. 1,200 was destined straightway for the Colonel's pocket, and how much might have to be disbursed on contingencies. As, however, his government-paid establishments included office rent, clerks, lights, stationary (*sic*) and other details which were all specifically legislated for outside the pay table, and it seems likely also that he got either a Company's house or house-rent, there is a strong presumption that all of the Rs. 1,200 was the equivalent of modern charge pay.

It is thus interesting to compare his Rs. 2,355 average monthly pay with that of his latter-day successor, the C.R.E. 2nd Class of the Bombay District, who gets Rs. 2,010 if a lieutenant-colonel, and Rs. 1,750 if a major, with the general purchasing power of the rupee probably at one-tenth or less of what it was in 1800. Even the Chief Engineer of the Southern Command, who is chief engineer of both the Bombay and Madras Presidencies, beats the old Colonel by a beggarly 145 cheap modern rupees!

It must be admitted that chief engineers sometimes suffered a sly dig from behind, as witness the following (24-9-1799):—

> "As the practice of allowing any defcription of officers to draw full field allowances, whofe duties are ftationary, is contrary to the original and real intention of that indulgence, which is granted with a view to enable an officer to fupport the extraordinary expences of equipment, neceffary either for a ftate of actual movement, or when the circumftances of his fituation require him to be prepared for this event. It is accordingly refolved, that when thefe circumftances do not exift, officers, fhall not in future be entitled to full field allowances; which applies to the fuperintending engineer at the prefidency, Cananore, Paulghatcherry, and Cochin."

Which rather looks as though four senior Sappers were the only poor fish in that pool.

The following General Order, dated 17th March, 1795, has quite a modern tang about it:—

> "When officers conceive they are entitled to any allowances not granted to them by the pay table or any fpecific regulation, they

are not to bring the matter forward by an indent to the paymafter, but muft make application to government through the commanding officer of the forces, obferving the regular channel."

In other words, " Never waste your breath in arguing with a C.M.A., who has no discretion with the rules of his Department ; but put the case up straightway to your commanding officer, for consideration through the channels of military command "—one of the golden rules of a quiet life in India, which applies equally to all questions of your own and of government finance.

A couple of other rules of detail, common to all arms, are worthy of note. Just as laid down in our Post Office notices of to-day, any officer or other rank who suspected a bad coin in his pay, could have it examined and replaced if necessary before leaving the pay office, but not a bean of help, if he had once gone outside the door with it ! In a very different sphere, the loss of a leg on service brought with it a monthly allowance of thirty rupees for the maintenance of a palanquin ; with presumably not a penny after retirement. As the " Colonel, chief engineer," drew at all times just twice that sum for a palanquin " and conveyance," there seems a tacit suspicion that chief engineers of 1800, like the Queen of Spain, had no legs.

A pertinent allowance was that for the purchase of camp equipment. The sums varied from Rs. 400 for a subaltern to Rs. 1,600 for field officer, the equipment being expected to last for two years. This cannot, of course, be compared with the much smaller expense of nowadays, when officers move about on service with far less kit and far greater fighting efficiency.

So much for the outstanding items of pay and allowances. There remain a few other details worthy of notice. The first of these is dress. The Sappers are dealt with in a single paragraph, dated 1800, being the most recent order prior to the publication of the book. It may be given verbatim :—

" The officers of the engineer corps to wear jackets with black velvet facings, cuffs and collar—the ftrap of the epaulette to have a black ground—in every other refpect the jackets are to be made and embroidered, and the appointments of the officers of this corps to be the fame as thofe of the artillery, except that they are to wear round hats, inftead of caps, plain black ; with the cockade on the left fide of the crown, and a button of the fame kind as thofe of the jacket."

The artillery dress quoted is given at great length, of which the broad details are :—

Jacket : blue, with red facings, cuffs and collar, and some plain gold embroidery.

Epaulettes: straps two inches broad, red ground, with 8 embroidered stripes of gold: the bullion plain, three inches long and 24 in number with a proportionate quantity of fringe.
Buttons: three-quarters of an inch in diameter, with the Company's crest engraved on them.
Waistcoat: plain white, single-breasted.
Pantaloons: plain white.
Stocks: black leather, without false collars.
Boots: half boots cut round at the top.
Sashes: crimson silk, with a rose, worn at the left side.
Gloves: buff leather.
Breast-plate: oval, not exceeding the breadth of the belt (*sic*) with the honourable company's crest engraved on it.

In all, probably a pretty uncomfortable outfit for the Bombay Presidency climate, and not very conducive to health.

The badges of rank are interesting, they are given only in connection with the epaulettes, viz.:—

Subalterns and Captains:—One epaulette on the right shoulder.
Field Officers:—An epaulette on each shoulder.
Lieutenant-Colonels:—One spangled star of six points in the centre of the strap of both epaulettes.
Colonels:—Two such stars on each epaulette, one at the centre of the strap, the other at its lower end near the bullion.

Generals and Staff Officers must have been regular peacocks, from the paragraphs-full of decorative stuff which they were to wear.

Whilst on the subject of dress, there is an amusing reference to Indian officers. Nowadays, being sophisticated, we say for instance "Ankle boots and putties will be worn with service dress," a nice and specific instruction. Not so the old Bombay Ducks of 1769. They laid down, on the 3rd January of that year, that:—"The black (*sic*) officers are to wear boots, and constantly appear on duty in them." Anyway, it must have kept the black officers cool.

Eight years later, the order that "Safhes are to be worn uniformly round the middle," conveys the irresistible suggestion that a qualified field officer or two had found them slipping naturally upwards.

As perhaps the winning curiosity of spelling, and incidentally the historic initiation of proper commissioned rank to Indians, we read that:—

> "The hon'ble the Governor confents to the fubahdars and jumbledaurs of the fepoy corps having commiffions, agreeable to their general requeft."

Let us hope they got them somewhat cheaper than the British officers of those days, amongst whom even a captain was fleeced for

£8 15s. as the price of his commission. No wonder that, as late as my year of joining the Corps, there was a current yarn that the formal deposit of one's commission with Cox & Co. stood good for an overdraft of a fiver when desired.

Finally, reverting for a moment to the subject of works, we find in 1796 the official birth of the "hoonwallah." He is not called that. The order runs :—

> "They (the board of Governors presumably) recommend, as an encouragement that the Muccadams who are inftrumental in collecting Coolies, fhould be received with them, and retained if capable."

Nearly a hundred and twenty years later, I once objected to paying rather enhanced coolies' wages to the gangman bossing each small gang, his contribution in actual work being *nil*, since he merely ejaculated a very loud and nasal "Hoon, hoon," each time the gang pulled on a rope or shifted a load. I was told to let be, as the "hoonwallah" was one of the oldest and most respectable institutions in India. I now see that under, to my mind, a much less picturesque and descriptive name, he was governmentally baptized in 1796. What a pity that he has no counterpart in the officer cadre !

ADDISCOMBE.
From an old engraving.

WORK OF THE R.E. WITH THE SHANGHAI DEFENCE FORCE.

PART I.

INTRODUCTION.

THIS Report has been prepared for the following purposes :—

(*a*) As a record of the work done.
(*b*) For the benefit of a future Shanghai Defence Force, should a similar emergency arise in, say, 10 or 20 years' time.
(*c*) For the benefit of any similar force sent off to any other city at a moment's notice.

It deals chiefly with the work in connection with defences, accommodation and stores. To make it complete as regards all aspects of R.E. work, short accounts of the activities of the Litho-Printing Section, and Army Postal Service, have been added.

PART II.

DEFENCES AND WORK OF THE 10TH FIELD COMPANY, Q.V.O., MADRAS SAPPERS AND MINERS, 1927.

Situation in February, 1927.—On 17th February, the British Force in Shanghai, most of which had arrived the previous week, consisted of Headquarters 20th Indian Infantry Brigade, two British and three Indian Infantry Battalions, one Company Sappers and Miners, and certain administrative units.

The Shanghai Municipal Council maintains a Volunteer Corps for Internal Security, and at this time it was composed of :—

Cavalry ..	..	2 troops.
Artillery ..	..	1·4 gun battery 4·5″ howitzer.
		1·4 gun battery 2·75″ howitzer.
Engineers	..	1 troop.
Armoured cars	..	1 company of 8 cars.
Infantry ..	..	800 (in national companies).

It was anticipated that, when the Chinese armies, engaged in civil war, arrived at Shanghai, there would be an outbreak of mob violence within the Settlement, which would be aggravated if Chinese troops were permitted to cross the Settlement boundary. A further consideration was the possibility of one or other of the Chinese armies attempting to rush into the Settlement and take over control, perhaps using the Chinese city as a line of approach.

Political situation on 17th February, 1927.—The International

Settlement, administered by the Shanghai Municipal Council, adjoins the French Settlement and is only separated from the Chinese city by a thin strip of town.

The British Force had no international standing and could be quartered on British-owned property only. With the consent of landlords, occupation of other property was possible.

On the declaration of a state of emergency by the S.M.C., difficulties caused by this restriction ceased as the British Force assumed an international standing.

Not, however, until the situation had become so critical that tactical considerations overruled all others, could defensive measures be carried out unhindered by any restrictions.

Roads both inside and outside the Settlement were usually owned by the S.M.C., and could be used by the Defence Force.

The Railway was the property of the Chinese Government, while the Soochow Creek was ruled to be an international waterway.

No help, in their official capacities, could be expected from members of the S.M C.

Rôle of the S.D.F.—The Provisional Defence Scheme, issued by H.Q. 20th I.I. Brigade, laid down the *rôle* of the British Force as being :—

1. To suppress violence within the Settlement if called upon by the Shanghai Municipal Council.
2. To prevent destruction of foreign property. (A foreigner being anyone not Chinese.)
3. To take up a defensive position to prevent mob or troops entering the Settlement.

Duties of Field Company S. and M.—The duties allotted to the S. and M. Field Company were described in the Defence Scheme as being :—

1. Preparation of materials for, and design of, defences.
2. Location of materials in suitable dumps and distribution thence to required sites.
3. Supervision of the construction of the defences.
4. Execution of special R.E. tasks required by O.C. sectors.
5. Arrangements for armouring lorries if required.
6. Arrangements for searchlights as required.
7. Arrangements for cutting railway if required.

Provisional Defence Scheme.—The scheme allowed for alternative defensive lines, subdividing the front into eight sectors, of which numbers one and five were considered of major importance.

With slight modifications, the actual line first taken up has always been adhered to, though alterations in unit and brigade boundaries and frontages have taken place with the variations in strength of S.D.F.

In February, the frontage, approximately 15 miles, was so long, with respect to the troops available, that the system of defence was based on :—

1. Section posts on the passive-defensive, crossing the front of the position, and sited so as to avoid a mob being able to brush them aside.
2. Infantry patrols (with a possibility of armoured lorries for use in the streets).

Nature of perimeter.—Apart from grave mounds up to nine feet in height, the country is uniformly flat and much intersected by creeks. Lines of approach to Shanghai are the Soochow Creek, Whangpoo River, the railway, and roads which cease a few miles from the city.

At depths from two feet to four feet, the ground is water-logged, the soil being of fine alluvial deposit.

In winter, everything is bare, while at other seasons foliage and crops obstruct the view.

No. 1 sector :—For the most part through open country and presented no difficulty.

No. 2 sector :—Through town area, which is very closely built and cut up by innumerable alleyways. The salient of Hongkew Park was eventually taken over by the Japanese, who had material interests there, but two companies of the S.D.F. remained in billets in the Public School for Boys, for which defences were put up.

No. 3 sector :—The line ran through the town, and was a difficult one to deal with. Just across Boundary Road was the North Railway Station, which Chinese troops were utilizing. The Chapei District, considered to be an area of potential trouble, where gunmen and strikers foregathered, was also the width of one street away from the line.

No. 4 sector :—Contained the mill area along the Soochow Creek, the mill hands being peculiarly susceptible to disaffection.

No. 5 sector :—Traversed open country with good fields of fire.

No. 6 sector :—The dividing line between the International and French Settlements, and was considered of a secondary importance.

No. 7 sector :—The Pootung area on the east of the Whangpoo River.

No. 8 sector :—A modification of the western defensive line marked on the map, being practically the Western Settlement boundary as far as Robison Road, and then east to left flank of No. 4 sector. This was an alternative line which was never adopted.

Policy affecting choice of line.—1. Outside the boundary of International Settlement, except for municipal roads, the country is under the Chinese Government. It was desirable that no offence should be given by any act of occupation by the British.

2. The policy that the normal life inside the Settlement should proceed without interference meant that roads, waterways, etc., should be left as unobstructed as possible.

3. The greatest care had to be exercised to avoid giving offence to property-owners of other nationalities, whose land could only be used with their consent.

General.—The French had their own defence scheme and works were executed in accordance with this, while, prior to the arrival of the S.D.F., the S.M.C. had also had carried out a good deal of work, primarily of the nature of wiring and barricades.

Factors Affecting Design of Works.

1. The anticipated trouble was more from strikers, mobs, and gunmen than from an attack by armed and well-organized Chinese forces.

Artillery fire was not considered likely, and the defences were primarily constructed to give protection against intermittent rifle or M.G. fire, and bombing.

It was considered likely that the effect of a Chinese bullet might be less than that of one of ours, as ever since 1925 occasions had arisen when war had been waged in China with varnished paper bullets.

2. All-round defence was aimed at. Small posts were built complete, larger ones, front first and rear added afterwards, or were raised in height as opportunity arose.

3. In February, one brigade held the whole front, necessitating a large number of small scattered section posts. Later, in No. 5 sector, on the arrival of more troops, selected posts were enlarged as platoon posts and the remainder abandoned.

4. Owing to the water-logged nature of the country, breastworks or a combination of trench and breastwork were built. Very occasionally a rise in the ground (grave mounds being avoided) permitted of normal trench work being carried out.

5. In the town, all posts are completely overlooked by houses. As far as considered essential, posts were eventually roofed with ⅜" M.S. sheets, concrete pavement slabs, or road metal to render them bomb-proof. Some houses were earmarked for defence purposes in case of trouble and, later, several were occupied.

6. To avoid dislocation of normal life in the Settlement, posts in the streets were sometimes sited and built to permit the use of roads and shops, to the detriment of their protective value. Wire entanglements to some extent also conformed to this policy.

7. In the town areas, the earlier posts were built of sandbags containing sand or road metal, or of C.G.I. revetment, filled with road metal.

8. In open country C.G.I. revetment, sandbags and bamboo hurdles were used.

Employment of the Field Company, S. and M.—The Unit arrived from India on mobilization scale of equipment, clothing, etc., on 17th February, disembarked on 19th under urgent orders, and moved to Thorburn Road into tents.

Until the arrival of the C.R.E. on 28th, there were no other R.E. representatives in Shanghai. For three weeks from the date of arrival, one officer acted as Garrison Engineer, assisting the Staff Captain in his work of billeting, and also was *liaison* officer with the Italian Landing Party.

The remaining three subaltern officers were detailed to work with officers commanding the sectors of the defensive lines, being employed on numbers 1 and 2, 3 and 4, 5 and 6, sectors respectively.

Reconnaissances had been commenced on arrival of H.Q. 20th I.I. Brigade, and were carried on with by the Field Company Officers, in conjunction with the infantry.

On the information obtained, materials were ordered and delivered at sector dumps, to be available when needed.

The principal requirements were stores for entanglements, and corrugated iron and sandbags for revetment, a stock of which was gathered together at Ward Road Camp, in which the Field Company was located from 24th February.

For some days there was a continuous delivery of material by P.W.D. and civil lorries, while, when the " flap " was on, stores were off-loaded and distributed immediately by our own lorries to the sites of the work. The men available for this loading work were usually the drivers, the guard occasionally lending a hand, as the demand for stores was insistent and seemingly insatiable, and all Sappers were out on works.

22nd February.—In the evening, a Commanding Officers' Conference dissolved on receiving news that shells were falling in the French Settlement and that refugees were coming into the city. The shelling proved to be that of a Chinese gunboat shelling the Kiangnan Arsenal, and late at night one battalion was moved into the line.

25th February.—Provisional Defence Scheme came into force. Acting on sanction received the previous day, wiring was commenced on numbers 1 and 2 sectors. This was considered to be urgent, and Chinese coolies were obtained to assist. Japanese forces occupied the Hongkew area.

26th February.—The Italian detachment took over one mile of front on number 2 sector. They showed themselves to be extremely

keen and willing to co-operate in every way. One section of Sappers moved out to number 4 sector. Defences on sectors 2–5 were commenced.

27th February.—Wiring was in hand in sectors 1 to 5, and certain roads were barricaded.

1st March.—Four searchlights (flood lights) were arranged for at certain points on the Soochow Creek. These were installed by the Electrical Department, and operated by the infantry.

2nd March.—A second section of Sappers moved to number 5 sector on detached duty.

3rd March.—Priority work was ordered on 2nd line opposite Chapei.

4th March.—Another section went into billets in number 2 sector. Up to this time lorries had been used to take Sappers out to work.

6th March.—Erection of second line wire on numbers 3, 4, and 2 sectors, in that priority, was ordered.

10th March.—Four R.E. Serjeants from England reported for duty with the Company.

20th March.—Priority work was ordered on the previous day on number 1 sector, and 10 C.G.I. revetted breastwork positions, to hold from 1 to 2 rifle sections each, were prepared. Those on the road were made with road metal, the remainder being filled with earth

21st March.—"State of emergency" declared and S.V.C. called out. Civil war was carried on in Chapei all day and during the night. All entrances to the Settlement were barricaded, and troops occupied the line.

At 8 p.m., Headquarters Section was ordered to Hongkew Park to assist in the construction of additional defences for the Public School for Boys, where two companies of infantry were billeted. Two sandbag posts were built, and another one made of kerb-stones and pavement slabs taken out of the footpaths.

At 10 p.m., the remaining two sections (now at Company H.Q.) were called out, and proceeded to various places opposite the Chapei area and the railway station, where they constructed a number of posts and obstacles, and returned between 6 a.m. and 9 a.m. the next day.

From 24th to the end of March, defences opposite Chapei were developed.

Additional posts were erected, while heavy gates and improvised concrete blockhouses were brought into use. Many posts were provided with bomb-proof roofs, while others were either made weather-proof or given sectional huts for the use of the garrison.

This work continued in April, which proved a quiet month.

On May 9th, the barriers leading into the Settlement were opened, and on the following day curfew was abolished. From then on, the

policy was to maintain only such posts as were considered essential, or to replace them by a more permanent article, such as concrete, when they had deteriorated and become unserviceable.

Early difficulties.—February and early March were wet and cold. Troops were accommodated in tents, hutments or billeted in godowns and mills, and the Race Course, and some units from India, having been mobilized, were equipped with only one pair of boots, one suit of thick and one suit of thin clothes per man.

When work was ordered, it was usually of an urgent nature, and necessitated long hours of work carried out in the rain, with no facilities at the end of the day for drying and changing boots and clothes.

With a front of 15 miles, distances to be covered were considerable and work fell heavily on R.E. officers.

The greatest difficulty was experienced in the crowded town areas, where alleyways are very numerous, and where the policy of allowing normal life to proceed unhindered produced many worries for all concerned. This latter difficulty was later on very largely done away with, when the " state of emergency " was declared.

Wilful damage to sandbag posts and the stealing of pickets from entanglements, even though frequent patrolling was resorted to, was another source of trouble.

SUPPLY OF R.E. STORES.

Authority was delegated by H.Q. 20th I.I. Brigade to O.C. Field Company S. and M. to deal direct with P.W.D. as regards the purchase of material required. This authority was confirmed by C.R.E. on his arrival on 28th February, and held good until 31st March.

Without the assistance given by P.W.D. the work carried out in the early days of the British Force would not have been possible. At very short notice any kind of material was produced and delivered at selected sites, while the officials were prepared to give their help at any time.

Barbed Wire.—Eventually 800 tons were purchased and brought across the Whangpoo River. Quantities were dumped at the sector R.E. dumps, for use on the line, the bulk being unloaded at Ward Road Camp, which later became the R.E. stores.

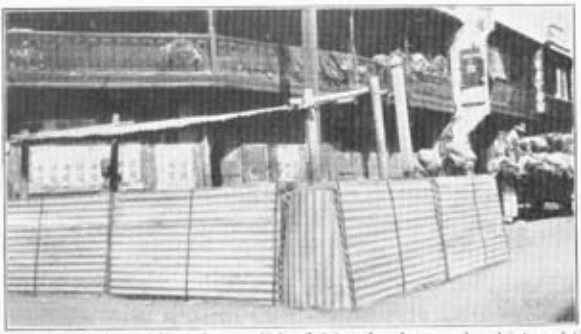
Timber.—Posts for entanglements were distributed similarly, usually being 12-foot Foochow poles suitably cut.

Planking and scantling for other works could also be procured at short notice.

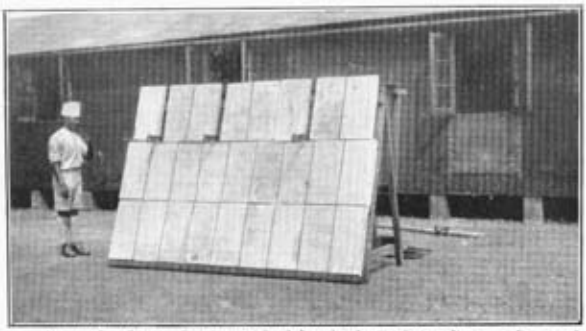
Sand and road metal.—Available at various P.W.D. depots in the Settlement. The normal procedure was either to send sandbags in lorries to the depots, with working parties to fill them there for onward dispatch to the site of the work, or for P.W.D. to deliver where required.

WORK OF THE R.E. WITH THE SHANGHAI DEFENCE FORCE.

No. 1.—C.G.I. revetment with earth filling completed to give all-round fire. Type used in No. 1 sector.



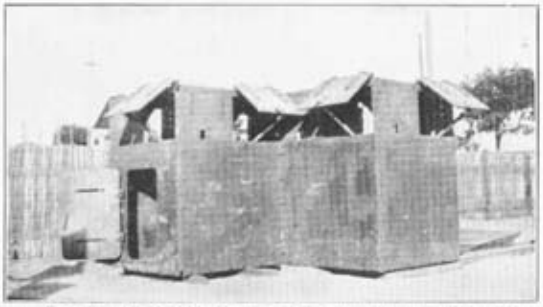
No. 2.—C.G.I. boxes with 3/4 in. × 1/8 in. flat iron bands around and internal ties, to hold sand. Used by Italians to replace sandbag posts when the latter had deteriorated.



No. 3.—Example of use of extemporized barricades, using 2 ft. × 1 ft. × 2½ in. concrete paving slabs on frame.

Barricades

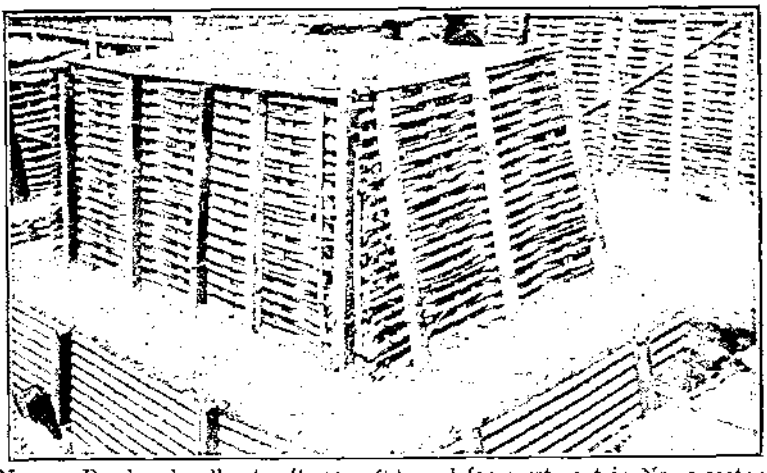
No. 10.—Shows method of mounting large gates on crown of bridge where excavation into roadway was not permitted.



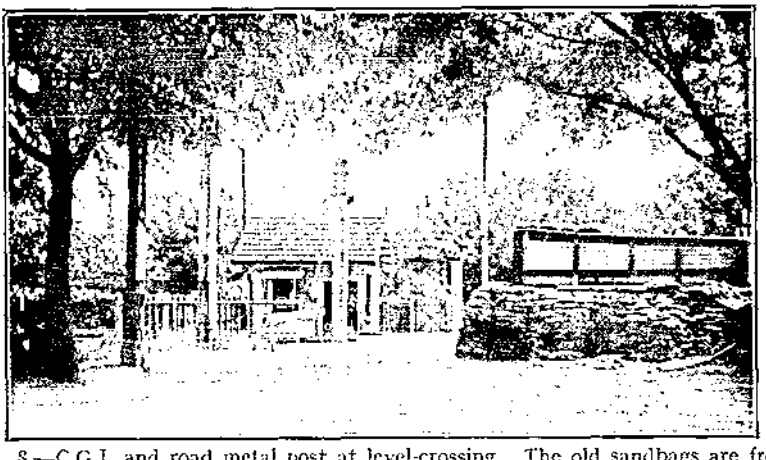
No. 11.—Experimental M.S. blockhouse. Sufficient parts were ordered to make
(a) two 10 ft. × 5 ft. blockhouses,
(b) one 10 ft. × 10 ft.
(c) one L shaped 10-ft. frontage as in picture.
Made in 5 ft. panels, two thicknesses of 3/8 in. M.S. sheets being used. Loophole plates 3/4 in. M.S. hinged for coolness in summer. Roof single 3/8 in. M.S. Erection of 10 ft. × 5 ft., seven men 4½ hours.

No. 12.—Concrete blockhouses; loopholes cut as required for M.G. and L.G. 4 ft. × 1 ft. × 4 in. slabs with double X.I.*M. reinforcement. Erection, 12 men from 6 to 8 hours; digging holes for posts, additional 3 to 9 hours, dependent on quality of road; a pneumatic drill was sometimes available for this and for making holes for entang'ement pickets.

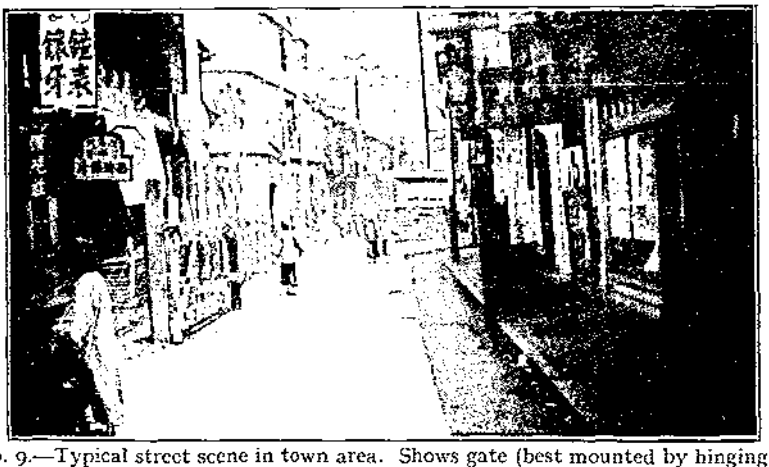
Blockhouses



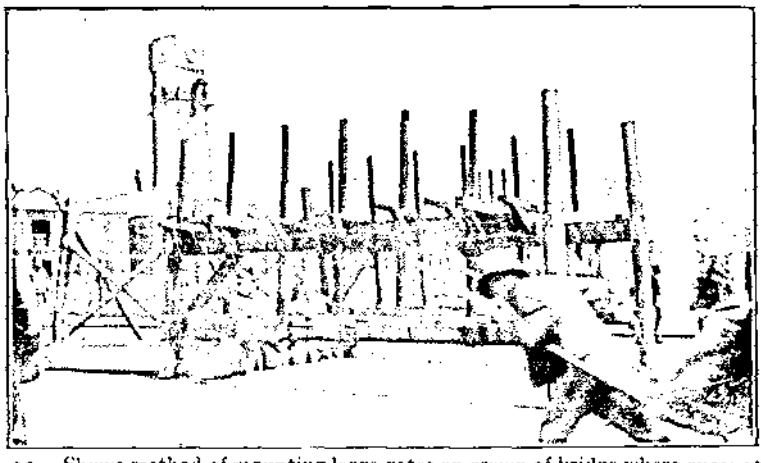
No. 7.—Bamboo hurdles (10 ft. × 5 ft.) used for revetment in No. 5 sector.



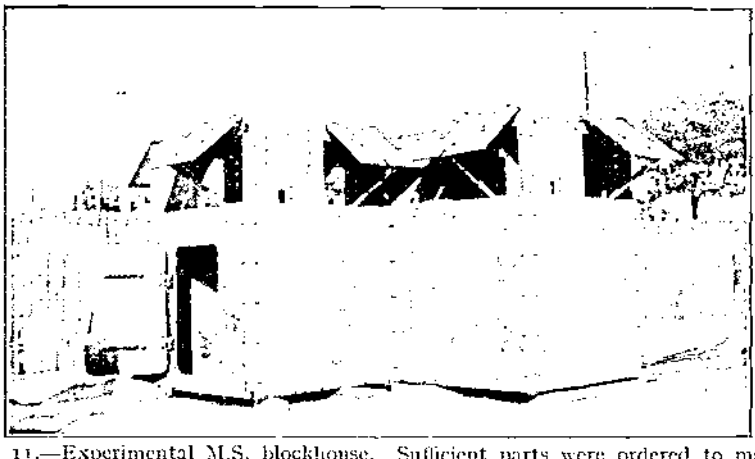
No. 8.—C.G.I. and road metal post at level-crossing. The old sandbags are from original post.



No. 9.—Typical street scene in town area. Shows gate (best mounted by hinging to post by use of 1-in. thickness iron collar) pivoted on stone slabs with outer end running on a solid wheel roller. Secured, when shut, with padlock and chain. Concrete post at street corner.



No. 10.— Shows method of mounting large gates on crown of bridge where excavation into roadway was not permitted.



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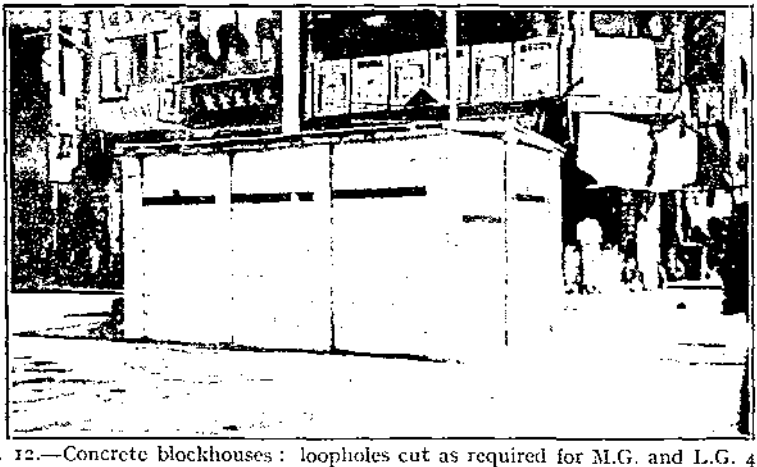

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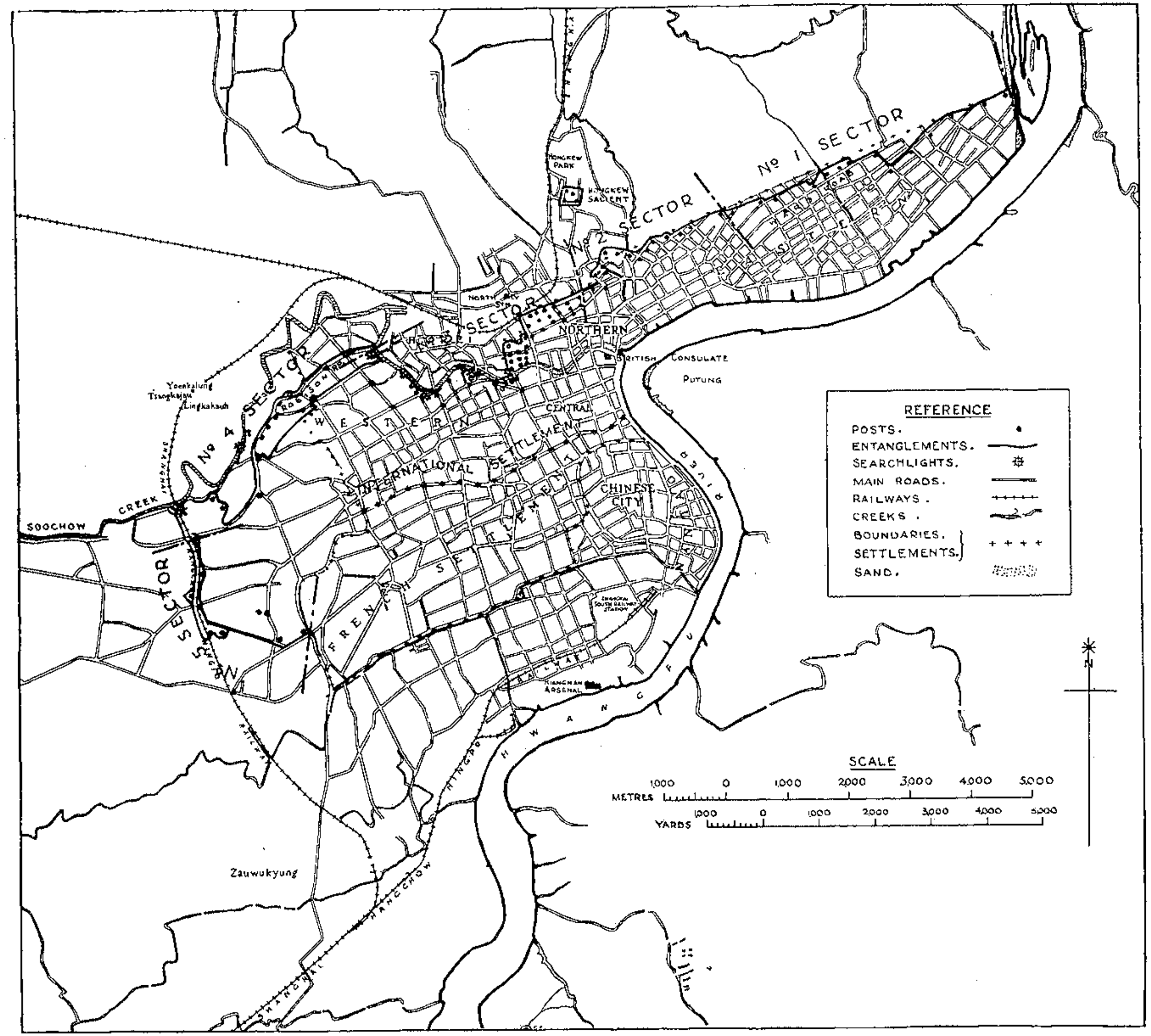
SHANGHAI.



REFERENCE
POSTS.
ENTANGLEMENTS.
SEARCHLIGHTS.
MAIN ROADS.
RAILWAYS.
CREEKS.
BOUNDARIES.
SETTLEMENTS.
SAND.
SCALE
METRES 1000 0 1000 2000 3000 4000 5000
YARDS 1000 0 1000 2000 3000 4000 5000
No 1 SECTOR
No 2 SECTOR
SECTOR
No 4 SECTOR
No 5 SECTOR
HONGKEW PARK
HONGKEW SALIENT
NORTHERN
CENTRAL
WESTERN
INTERNATIONAL SETTLEMENT
CHINESE CITY
FRENCH SETTLEMENT
BRITISH CONSULATE
PUTUNG
RIVER
HWANG PU
SOOCHOW CREEK
Yoenkalung
Tsangkajau
Lingkakauh
Zauwukyung
KIANGNAN ARSENAL
SHANGHAI HANGCHOW RAILWAY

Concrete.—The P.W.D. concrete-ware yard had in stock a quantity of grooved posts and 6-foot slabs (3 inches thick) for the building of compound walls by the unit construction method.

On 28th March, these were taken into use and erected as block-houses at several places opposite the Chapei area, while special members (including roof-tiles) were being cast to a new design, on the same principle, for blockhouses. This experimental type was modified later.

Other stores.—All other material, stores and tools were obtainable through the P.W.D. who arranged a prompt supply.

Sandbags.—Ordnance had 300,000 sandbags brought from India, and a few tools.

Transport.—In February and early March, seven lorries and four motor cars were allotted to the Field Company.

Conclusion.—The map shows the Settlement boundary, without making clear that on the Chinese side of it there is a town as closely built as that on the Settlement side.

It is also on too small a scale to indicate the obstacles and gates enclosing posts. It was laid down as a matter of policy that, as far as possible, all posts should be wired round and sometimes have double gates. In the town, in important areas, four gates were necessary for each position on cross roads. The large gates were made in P.W.D. workshops, whose facilities were greater than ours.

"Concertinas" were found to be unsatisfactory for blocking streets.

The elapse of some days between the arrival of troops and the commencement of work was due to the fact, already noted, that nothing could be done without sanction from the S.M.C., which was the authority responsible for gauging how serious the state of affairs had become.

This period was filled in by carrying out reconnaissances and preparing stores in readiness for any eventuality.

Internal Security troops held positions on bridges and important points within the Settlement, and patrolled day and night during period of trouble.

The experiences of taking part in the defence of the city under abnormal conditions has been of considerable interest and has proved valuable training to the Field Company.

Sections were often billeted away from Company H.Q., with section officers in close co-operation with battalion commanders, while the O.C. Unit was dealing with headquarters of brigades and the Public Works Department, until the arrival of the S.O.R.E. on 9th March, when the latter duties were taken over by him.

Co-operation between the R.E. and infantry was always on the friendliest basis, the extreme keenness of the infantry being remarkable.

(To be continued.)

ENGINEERING MODELS.

By LIEUT.-COLONEL E. W. C. SANDES, D.S.O., M.C., R.E.

THE vast scope of modern Civil Engineering should lead an instructor to adopt any methods which will save time and impress engineering forms and details indelibly on the minds of his pupils. There is little doubt that imagination, by which I mean the ability to think in three dimensions, is of supreme importance in engineering. It is a gift which some possess from childhood, but in most people its development must be assisted. To these less fortunate ones a concrete illustration of theory is of great help and saves them many hours of poring over diagrams which convey little to them and are soon forgotten. If an instructor can show an actual structure to his pupils they will derive twice as much benefit from his lecture, and will remember it ten times as long, as if his remarks are illustrated only by blackboard drawings or printed diagrams. In lectures to men who have already developed the imaginative faculty the use of diagrams may suffice; models are to them merely the confirmation of what they have already imagined. My remarks do not refer to such instruction, but to that of comparative beginners, and particularly those who have never built ramshackle houses of wooden bricks, or dissected the nursery clock with a nail, in their childhood.

An engineer once told me that he thought that instruction with models was actually harmful. His view was that it destroyed originality and retarded the development of the ability to read and understand engineering drawings. He said that men instructed with models slavishly copied the details of those models when making their own designs, instead of examining and adapting the drawings of similar structures, and that, without their models, they were lost. There might be something in these opinions if engineering models were so numerous that all types and details of structures could be shown and were always accessible to students; but the variety of structures being so great, life so short, and funds so scarce, this heavenly model room remains a dream, and no student will find in his earthly model room more than one or two of the examples which he needs. The remainder he must get from diagrams of works, and palpably he will read those diagrams more easily and quickly if he has already studied others with the assistance of models. A student of engineering must be encouraged to exercise his ingenuity, but the presence at the back of his mind of a clear picture, formed from a model, of how certain difficulties in design are overcome in practice

will keep him on the right lines when his inexperience might otherwise send him off the rails.

Unfortunately, as the science of engineering advances, models become out of date and may then lead students astray. This objection, however, applies to all engineering structures, and a model can be altered or replaced cheaply, while a full-size structure cannot. It is easy to attach to any model, in addition to a printed description, a note showing how it differs from the most recent practice in general design or detail—in fact to indicate errors—and when it becomes obsolete it can be relegated to an engineering museum if it has any historical interest.

Instruction given on an engineering work in progress is preferable to instruction on that work after its completion ; and instruction even on a completed work is usually better than instruction with a model. But it is difficult to locate an engineering college where there are structures illustrating *all* branches of civil engineering within easy reach. In, or near, manufacturing centres in England examples of many branches of engineering may be studied, though at the cost of considerable time spent in travelling ; but, in India or the Colonies few such facilities exist, and it is there that models become so valuable. Methods of construction cannot be shown in a model, though progressive stages can be depicted, and hence the superiority of periodical visits to actual works in progress. The model scores, however, in that it is always available for examination ; a student can return to it again and again to see some point of interest or detail which he needs for his design work in college. The model fails to show the organization of labour, the methods of the supply of materials, and the preparation of the site, though these can be dealt with in a printed description. To reap the full benefit of instruction with a model, the class should be formed of not more than six or eight students, so that all may have access to the model and can ask questions—intelligent or otherwise. If they ask questions it shows at least that they are observing the model, and if they are observing it they are learning from it.

The conclusion at which we arrive is that, if modern engineering works of all kinds exist and are increasing in number close to an engineering college, a civil engineering model room is a luxury ; but that, if such works are not easily accessible, a model room is invaluable to facilitate and expedite training, and to save expense in travelling.

An engineering model room should be attractive, though it need not be artistic. The models are meant primarily for instruction, but if painted in bright colours they will be more likely to catch the eye. The repetition of identical features should be avoided if possible, and at many places (*e.g.*, at joints in steel work) portions should be cut away to show interior details. The scale will depend on the size of the smallest detail which must be shown. For steel bridges, 1/6th

or 1/8th full size will usually be found suitable, but models of details may be on a scale of 1/2 or 1/3 and occasionally the scale for a complete structure may be as small as 1/60. A model should preferably be small and portable, though this is not essential if there is ample space for students in the model room. The model of a portion of a large Baltimore Truss-type girder-bridge with overhead bracing, illustrated in this article, is an example of a fixed model large enough to show the necessary details on a suitable scale.

Every model, unless of the simplest type, should have printed, framed and glazed descriptions and diagrams (and for bridges, calculations also) mounted on an iron stand attached to it, or near it, so that the presence of an instructor is not essential. If a student does not know what the model represents, and what it is intended to teach, it is of little value except as an ornament. In the case of bridge models, if there is space to show the calculations and stress diagrams of the full-size bridge, so much the better. The framed plan, sections and elevations should show the dimensions of the full-size bridge and not the model dimensions, which can be obtained easily by measurement. The diagrams should also show the scale of the model, in addition to their own scales, with reference to the full-size bridge. It is rarely possible to provide diagrams on so large a scale as the model, as there will then probably be no space for the description, calculations and stress diagrams, if these are to be mounted close to the model for easy reference. If the model shows a bridge which actually exists, photographs of the structure should be included, together with a note by the engineer who built it, explaining his difficulties and his methods of overcoming them. A small model can be mounted on a wooden base, which, when varnished, makes a convenient platform for showing the title in white lettering. A vertical framework of 1 in. x 1 in. x 1/8 in. angle iron, attached to the base and stayed with flat iron, can support the wooden frames holding the diagrams, etc., and should be of such a height that the frames are immediately above and behind the model. The diagrams should be coloured. If the model is large, and has a separate framework or stand for the diagrams, the framework should be so designed that it can be fitted closely to the model. All the diagram frames must be glazed, and, if the glasses are large, they must be thick to avoid breakage from distortion when the iron framework is moved. The frames should fit exactly within the angle iron to which they can be screwed, and the scales of the diagrams and sizes of the frames should be arranged accordingly.

Curiosity being a marked characteristic of youth, it will be found that any model with movable parts will soon be put out of order unless specially designed to be "foolproof." If it is not so designed, it must be kept under a locked glass case and operated only in the presence of an instructor. Much of its value for instruction is then

lost. Accordingly, if there are any delicate working models in a model room (*e.g.*, signal apparatus) it is worth while to make foolproof editions of them, magnifying the delicate parts. As an example I may draw attention to the photograph of the foolproof model showing the slotting of Outer and Warner signal arms; the relative dimensions of the various parts are wrong, but a hammer would be needed to put the model out of action. It supplements and illustrates one part of a model of a complete mechanical interlocking system of railway signalling kept under glass protection in the model room at the Thomason College, Roorkee—a detail which is most difficult to explain by a diagram or verbally. It may be asked why it is necessary, or even advisable, to spend time in illustrating so small a point. To this I would reply that, though civil engineering instruction in a college must be mainly theoretical—time does not allow otherwise—a few examples showing the practical application of theory are valuable to *interest* a student and induce him to notice engineering details when he visits actual works, in fact to increase his powers of observation so that he will take nothing on trust, but will insist on understanding the why and wherefore of everything. In that frame of mind he will never forget what he has seen, and his design work will benefit accordingly.

Various materials can be used in the construction of models, but undoubtedly steel or brass are the best, though expensive. Concrete is heavy, rough and easily chipped. Wood is suitable for some models and is cheap and light, but in hot climates it warps, cracks, and is attacked by insects, and small projecting parts of wooden models are often broken. Model lashings, made of whipcord, should be glued in position and varnished. Road metal can be represented by very fine gravel or coarse sand consolidated with glue or size. Steel models requiring miniature rivets and angles must necessarily be expensive and difficult to manufacture. The steel Plate Girder model shown in one of the illustrations cost nearly £100; it was made by Messrs. Burn & Co., Howrah, Calcutta, who generously presented it to the Thomason College. The very large steel model of part of a Baltimore Truss road bridge with overhead bracing—also made by Messrs. Burn & Co.—cost about £250, including its metal pier and diagram stand, and the reproduction and framing of its diagrams and calculations, and its construction occupied more than one year. The cost of the average model, however, is fortunately much less than the figures I have quoted, and many wooden models cost little except in labour.

Brief descriptions of some of the civil engineering models in the Thomason College, Roorkee, as illustrated in this article, may be of interest. I have tried to show as many types as possible, but have had to omit several which are equally instructive.

(1) *160 ft. Span Baltimore Truss Bridge for Two Lines of Road Traffic (3 bays only).*

Scale 1/6.

Manufactured in 1927 by Messrs. Burn & Co., Howrah, Calcutta, and embodying the latest ideas in large steel bridging. One completed end of the bridge is shown, including its expansion bearings and pier and rocker bearings for the next span. The incomplete end of the model is supported on an iron frame. The best material for the model pier—five feet long—was difficult to decide. Brick, or plastered brick, would soon become chipped and ugly, and the fine corbelling would be difficult to cast in concrete; also none of these materials would provide a movable pier. Wood might have been used, but a huge block of perfectly seasoned wood without cracks or flaws was very difficult to get, and if the pier was built up with several blocks these would separate in the hot weather. Eventually the pier was made in cast iron with a steel plate screwed on to form the top, the walls being cast in two halves from one mould. This hollow and portable pier was then painted red and the brickwork lined in white. As the design of the bridge is complicated, only three bays are shown in the model, so that the details may be sufficiently large. The roadway is supposed to be of roadmetal on concrete resting on steel trough flooring, but the model roadmetal is actually made of Portland cement and coarse sand. A short length of completed roadway appears in the model. The separate angle iron stand carries wooden frames on both sides —on one side the elevation, plan and cross section of the full-size bridge, and on the other the stress diagrams for dead and live loads and complete data and calculations. On the model itself is a small frame containing a brief general description. The greatest care was taken to make this elaborate and expensive model complete in every respect and quite up to date. Its cost, and the labour involved in its manufacture, were fully justified by the fact that no large steel road bridges of modern type exist near Roorkee.

(2) *60 ft. Span Plate Girder Bridge for a Single Line of 5 ft. 6 in. Gauge Railway.*

Scale 1/6.

Manufactured by Messrs. Burn & Co., Howrah, Calcutta, and presented to the Thomason College by that firm. The complete structure is shown, excluding the permanent way. All the dimensions are to scale, and every joint is properly constructed and fully riveted. Sleepers and rails are omitted, as these appear in a model of one end of a similar bridge which can be seen in the illustration beyond the large model. The piers, being of medium

size, were each cut from a single block of seasoned wood and hollowed for lightness. A separate iron stand behind the model carries the coloured diagrams, calculations, description, and photographs a of similar existing bridge constructed, in 1921, about 12 miles from Roorkee. The illustration also shows in the background a very large wood and wire model of one cantilever span of the Lansdowne Railway Bridge over the Indus at Sukkur. This is an old model and not used for instruction, but it adds greatly to the appearance of the model room without occupying any floor space, and hence it is allowed to remain.

(3) *200 ft. Span Reinforced Concrete Arch Road Bridge with Suspended Single Roadway.*

Scale 1/60.

This model shows a road bridge constructed, in 1914, in the Terai District below the Himalayas—a wild tract with few roads and much jungle. The model is small and portable, so the framed diagrams, description and photographs are mounted on an iron stand attached to the wooden base. Bridges of this type have proved satisfactory and cheap under the special local conditions, *i.e.*, where a single span is essential, a narrow roadway under moderate loading suffices, expert supervision is constantly available during concreting, and the transportation of heavy steel sections is difficult. Under more ordinary conditions a steel girder bridge might be preferable. The model is made in brass, painted to represent concrete; a skilled fitter completed it in three months, and, excepting his pay, the cost of the model was small. It would be more valuable for instruction if its scale was rather larger, when portions of one arch and an abutment could be cut away to show the reinforcement and anchorage.

(4) *Reinforced Concrete Slab Floor on Pillars.*

Scale 1/8.

A small and portable model showing construction in various stages. One column is complete with its concrete foundation exposed; in another the steel reinforcement alone is shown, together with the reinforcement of the foundation, the main and subsidiary beams which are monolithic with the floor, and a part of the floor itself; a third column, and the beams and floor above it, are shown with the boxing in position. The description above the model explains the materials employed, the use and design of the boxing, the precautions and methods of work during construction, and other similar matters—in fact, the model gives a

short lesson in elementary reinforced concrete work. The reinforcement is plated to prevent rust, since painting would have given a wrong impression that reinforcement should be so treated in actual work.

(5) *Slotting of Outer and Warner Railway Signals (List and Morse Type).*

Scale 1/3.

A working model which is specially designed to be "foolproof." The diagrams behind the model show the mechanism to scale, and any part of the model which may be damaged by rough usage is enlarged or replaced by something stronger. For instance, the signal wires attached to the higher ends of the slotting levers are replaced by two suspended brass links which can be pulled down and fastened to hooks on the wooden base; actual wires, pulled by model signal levers, would be broken in a few minutes. It will be noticed also that the signal post is very massive and dwarfed, and that the signal arms (of solid brass) are narrow and thick. If the model was made to scale it would have to be kept under a locked glass case, where it could not be worked by students alone, and its value for instruction would then be lessened.

(6) *Boat, and Barrel Raft, in a Bridge.*

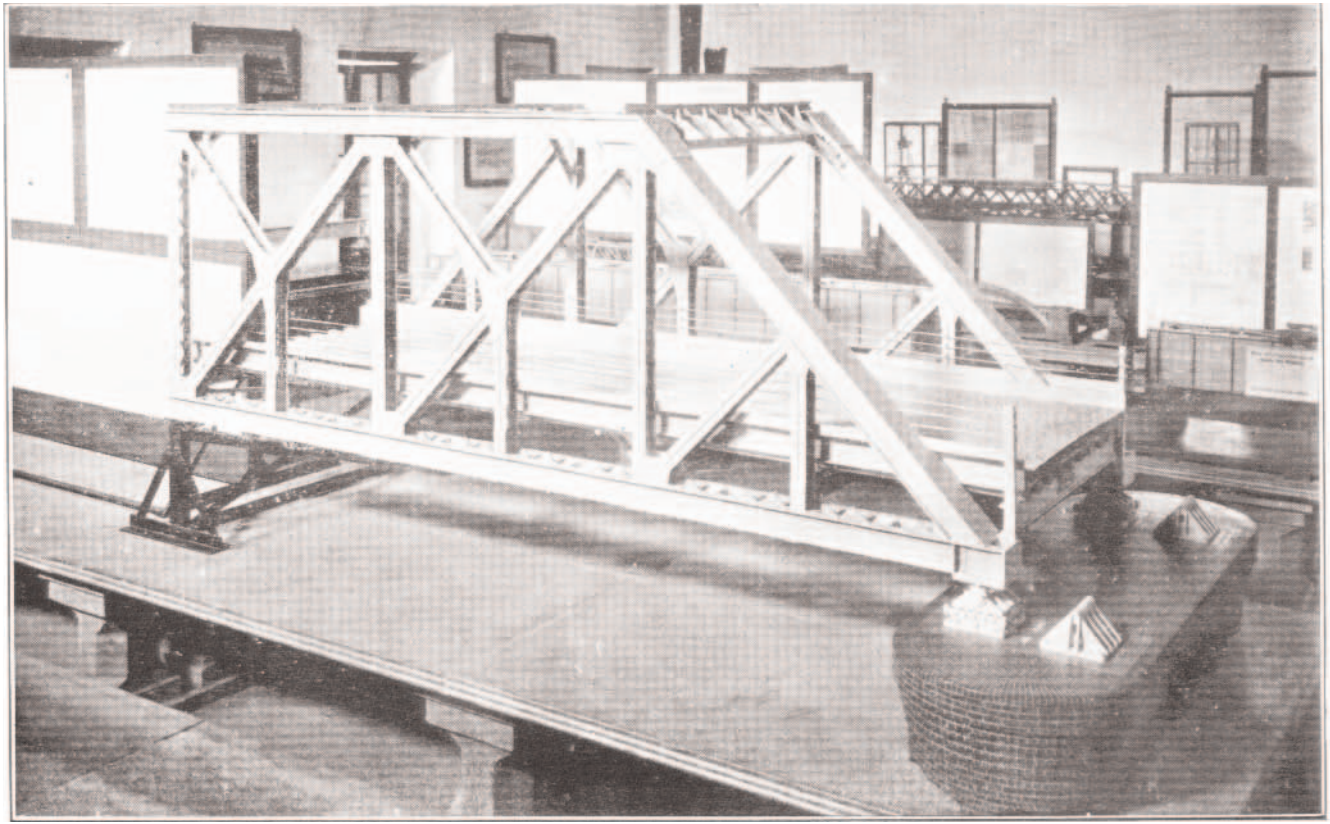
Scale 1/8.

To show how a rowing boat should be strutted for bridge work, the design of a barrel raft using angle iron, the usual type of roadway for a light floating bridge, and the names of the various parts. A very portable and cheap model made from an old model boat and some waste material from an obsolete model of a roof. Before inclusion in the model, the boat was merely a pretty toy. Everyone knows what a boat is like, but everyone does not understand how a boat should be treated for bridge work.

(7) *Barrel Raft.*

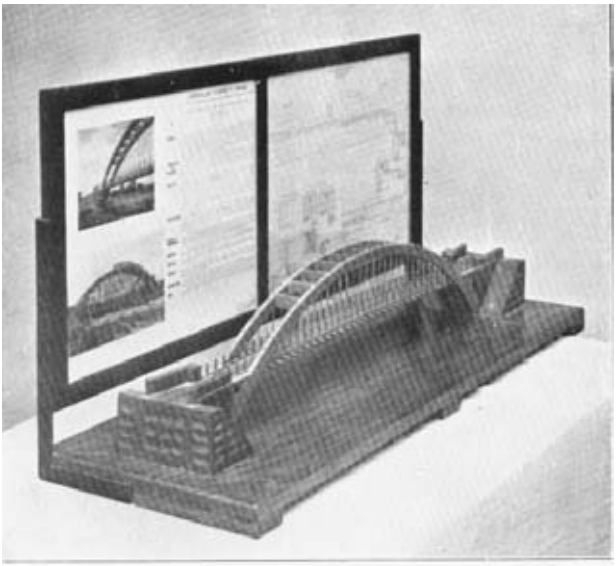
Scale 1/12.

Another small model to show the lashings and design of an ordinary barrel raft, which are rather difficult to explain with diagrams. The model, of course, is not intended as a substitute for the construction of an actual barrel raft, but merely as a means of refreshing a student's memory after he has helped to make a barrel raft. I would emphasize again that instruction on a work is preferable to instruction with a model.

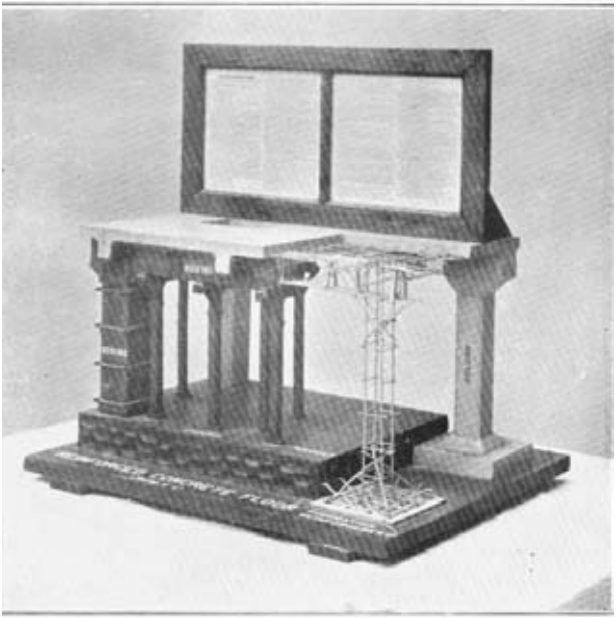


Model Bridge

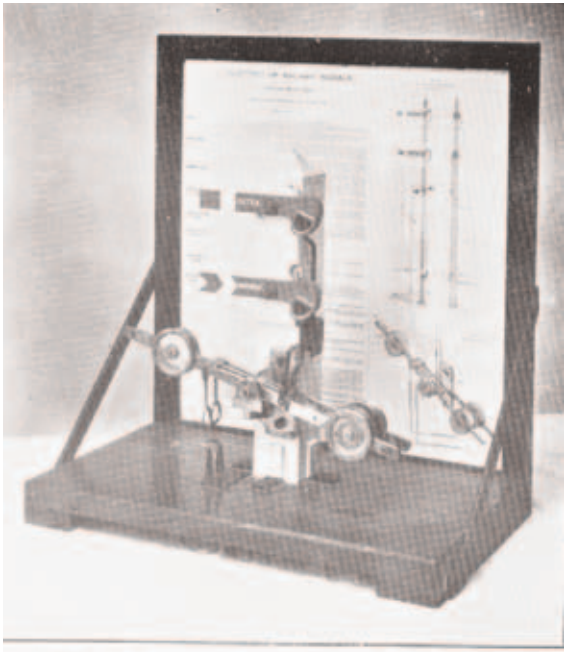
Girder Bridge



No. 3.—200' Span Reinforced Concrete Arch Road Bridge with Suspended Roadway.



Reinforced concrete slab

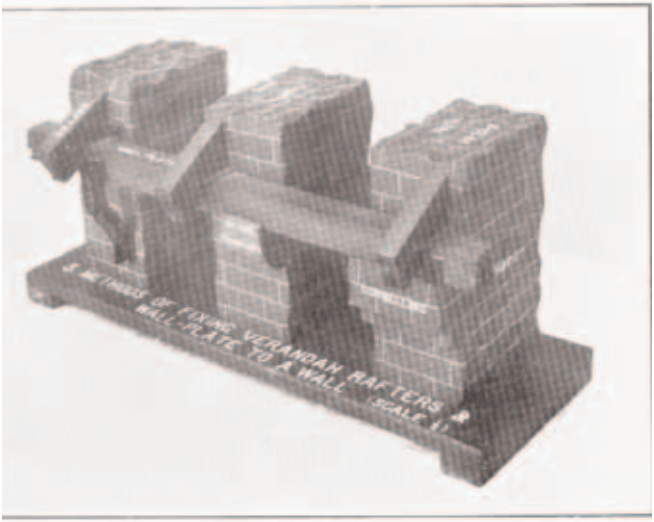


No. 5.—Slotting of Outer and Warner Railway Signals.

No. 6.—Boat, and Barrel Raft, in a Bridge.

Boat and Barrel Raft

No. 7.—Barrel Raft.



No. 8.—Fixing Verandah Rafters and Wall Plate to a Wall.

Fixing verandah rafters


KNOTS
THUMB
FIGURE OF 8
REEF
GRANNY
CLOVE HITCH
HAWSER BEND
TIMBER HITCH
SINGLE
DOUBLE
SHEET BEND
BOWLINE
BOWLINE ON A BIGHT
MAN'S HARNESS HITCH
2 HALF HITCHES
ROUND TURN & 2 HALF HITCHES
FISHERMAN'S BEND

Knots

(8) *Fixing Verandah Rafters and Wall Plate to a Wall.*

Scale 1/2.

A simple wooden model showing three sections of wall with different bonds of brickwork, and three common methods (in India) of securing the rafters and wall plate in a verandah. Bonding of brickwork is easy to follow in a model, but much more difficult in a diagram.

(9) *Knots.*

Examples of knots made with thin line. The knots are varnished and screwed on to a varnished board, which can be taken wherever required for the practical instruction of students in knotting and lashing.

I have tried to give some examples of all types of civil engineering models, from the most expensive and elaborate to the most elementary and cheap. All those illustrated, except the first two, were made during the last few years at the Thomason College, where there are many others of all types. To a beginner, Engineering must often seem the dullest and driest of professions. He tires his brain in chasing the elusive x and in horrible and puzzling stress diagrams. He needs change and relaxation—something to look at without puzzling, something to encourage him to resume his chase or dive again into his diagrams, something which shows him in a concrete and pleasing form what his wearisome pursuits may achieve. He strolls into the model room, and finds the encouragement required to keep alive his interest in his future profession, so that one day he may perhaps hope to emulate the accomplishments of those great engineers who have left behind them so many proofs of their genius.

A RAILWAY RAID.

A SIDE-SHOW ON THE FRONTIER—OF THE ALDERSHOT COMMAND.

By MAJOR I. SIMSON, R.E.

THE SCHEME.

1. Certain operations were carried out on 6th and 7th July, 1927, on the Woolmer Instructional Military Railway, at Longmoor Camp. The Units engaged were :—

1st Field Squadron, R.E., Aldershot.
8th (Railway) Company, R.E., Longmoor Camp.
4th Army Co-operation Squadron, R.A.F., South Farnborough.

As a result of this combined exercise certain points emerged, and a short description of events may prove of interest.

2. A sketch map of the area is given. The 8th (Railway) Company, R.E., were responsible for operating and maintaining the W.I.M. Railway, Bordon–Whitehill–Longmoor Camp–Liss Forest, with a branch up to Weavers Down. This unit was "billeted" at Longmoor Camp.

The operations fell into three main heads :—

(*a*) *6th July*, 8.00 *hours till finished* (*about* 16.00 *hours*).

Relaying of half-mile track near Whitehill by 8th (Railway) Company, R.E., during which they were attacked by No. 4 Army Co-operation Squadron from the air with bombs (flour bags) and machine-gun fire.

The work itself consisted of substituting new 75 lb. F.F. rail and new sleepers for old 60 lb. F.F. rail and old sleepers in the W.I.M. Railway main line. This calls for no further comment.

(*b*) *Night of 6th/7th July.*

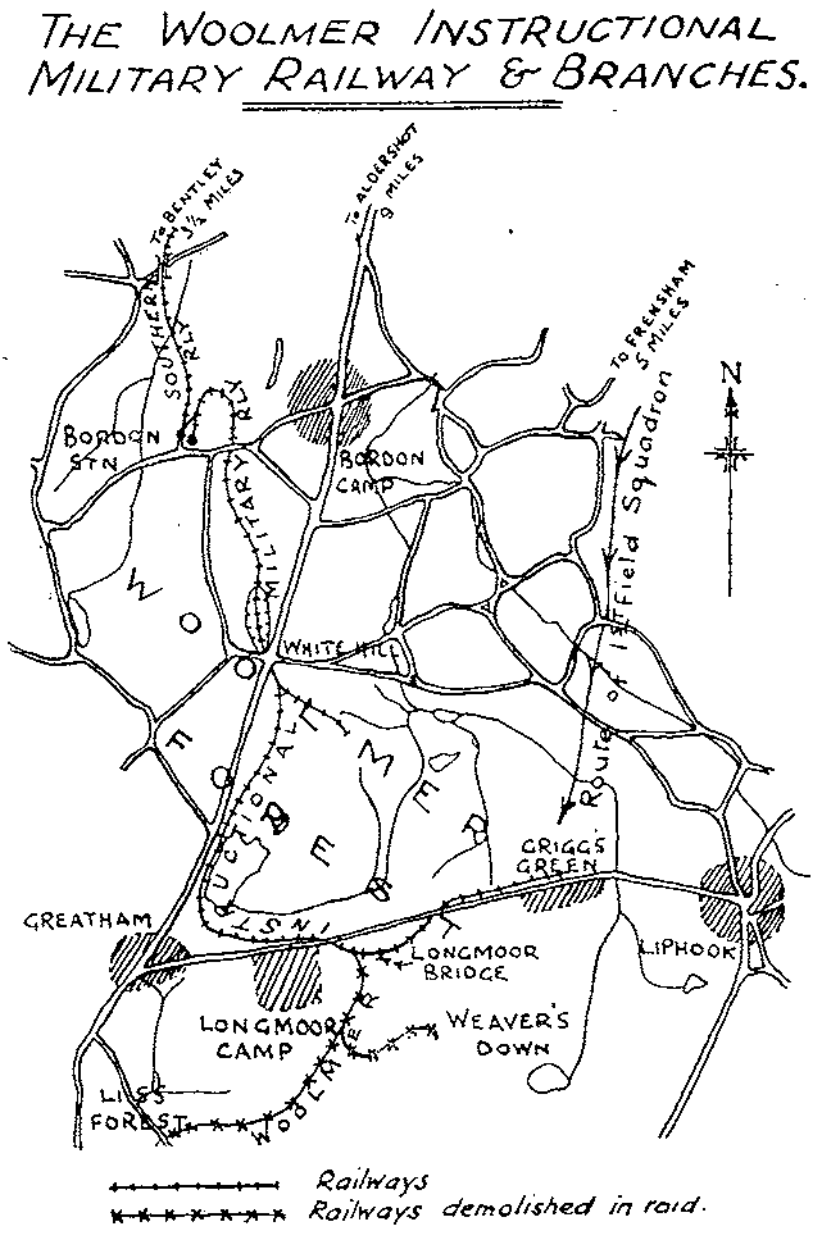
Raid on the W.I.M. Railway and demolitions by 1st Field Squadron, R.E.

(*c*) *7th July*, 7.00 *hours till finished.*

Repair by 8th (Railway) Company, R.E., of damage to railway, as soon as the area had been reported clear of the enemy (1st Field Squadron) by aeroplane. Later in the day the aeroplanes "changed sides" and again attacked the railway troops while carrying out repairs

ATTACK ON RAILWAY TROOPS BY AEROPLANE, 6TH JULY.

3. The site where track re-laying was in progress was Whitehill railway cutting. This cutting is about 300 yards long, some 20 feet deep, and with high fir trees growing up to the edge of the cutting on both sides of the line. At the lower end of this cutting the main road passes over the railway by a bridge, which is almost a short tunnel.



The locality is " blind " and entirely favourable to surprise attack by aeroplane.

The first attack (6 aeroplanes) occurred at 10 a.m. and was a distinct success for No. 4 Army Co-operation Squadron. The aeroplanes approached low down over the forest, and at right angles to the railway. They were unseen and unheard till within a few seconds of their starting to drop bombs. The surprise was practically complete. Of 46 men working in the cutting, 50% were adjudged casualties from bombs alone in the first few seconds. Any man within five yards of a flour-bag bomb was counted as a casualty. Many men were caught working too far away from their rifles; others crowded under Whitehill Bridge. Three direct hits on the bridge itself, and the several bombs which fell into the cutting, immediately each side of the bridge, would probably have made casualties of most of the men sheltering there.

4. Three more aeroplane attacks were made later in the day. There was no further surprise, however, mainly owing to look-out men being now posted in the tops of two or three high fir trees. The two A.A. Lewis guns were better sited. They could see their targets for a longer period of time and in more favourable circumstances. Individual rifle fire was also better, and it is certain that on these last three occasions the aeroplanes would by no means have had matters all their own way, as they did on the first occasion. Blank ammunition was used by the troops on the ground.

In view of the extremely slow speed of these aeroplanes compared with those from which attack may be expected in war, it is probable that approach at right angles to the railway and at a height only just above the forest was the only possible means of achieving surprise.

THE NIGHT RAID.

5. The section of railway from Longmoor Camp to Liss Forest, the Weavers Down Branch and Longmoor Bridge (near Longmoor Railway Yard), were placed at the disposal of O.C., 1st Field Squadron, R.E., for demolition purposes.

Practically all of this three miles of railway was laid in very old 60-lb. rail and very old sleepers, so that the value of actual damage done to material was not great. The O.C., 1st Field Squadron, received a rough sketch, showing the position of Longmoor Bridge, Weavers Down Junction and Longmoor Camp, where the " enemy " (8th (Railway) Company, R.E.) were billeted. This sketch represented the work of an Intelligence Agent. The raiders' problem was therefore, to march some 16 miles from Aldershot to Longmoor with the explosives considered necessary for the night's work, to deal with enemy patrols along the railway if any were met, not to attract the attention of the enemy's main force in the camp (which is about 500 yards away from the railway), to cause maximum damage to the railway in the time available during darkness, and to get away back

to Aldershot before the enemy investigated as a result of the explosions.

6. No previous reconnaissance of the area was allowed. The railway and the country generally was entirely unknown to the raiders until they reached it after dark on the night in question. The conditions and the whole "atmosphere" in which the men worked were thus probably as near the real thing as can be arranged in peace-time. Actually no 8th (Railway) Company patrols were on the railway, as the risk of casualties occurring in the dark owing to actual fighting developing, or to exploding charges, was considered too great. Their inclusion in the scheme had, however, the desired effect on the 1st Field Squadron personnel. The danger area was protected by a ring of sentries. These men, together with sentries in the camp itself, had orders to report all lights and noises noticed by them during the night, before the series of explosions later informed the whole neighbourhood of what was happening.

Time Table of Raid.

7. An assembly point was chosen by the raiders from the map. At this point limbers were unpacked and stores transferred to pack-horses and the men. This assembly point varied from 1½ to 2½ miles from any point on the railway. This distance was generally considered excessive by most critics, as the men were heavily laden, and from there onwards valuable time was occupied in reaching the railway across unknown country in the dark. The assembly point was 14 miles from Aldershot. This distance occupied 2½ hours, of which 20 minutes were wasted as a result of trying the inevitable short cut by night through unknown forest country, without a local guide and without previous reconnaissance by daylight.

The distances and actual time-table were as follows:—

From Start, miles.	Detail.	Troops.		
		1st.	2nd.	H.Q.
0	Rendezvous (near Aldershot) dep.	9.00 p.m.	9.00 p.m.	9.00 p.m.
14	Assembly Point (Griggs Green) ... ... arr.	11.30 p.m.	11.30 p.m.	11.30 p.m.
	dep.	12.10 a.m.	12.15 a.m.	12.10 a.m.
15½ to 16½	Started work on Railway:			
	First party	01.00 a.m.	02.00 a.m.	01.15 a.m.
	Last party	01.45 a.m.	02.15 a.m.	01.45 a.m.
	Charges fired at	03.05	03.05	03.05
	Bridge fired at	03.15	—	—
About 18	Assembly Point:			
	Arrival (on return journey)	04.00	04.00	04.00
	Departure, ditto	04.30	04.30	04.30
About 32	Arrival at Rendezvous (Aldershot)	06.45	06.45	06.45

The total distance covered by the Field Squadron was thus 32 miles, of which 28 miles were by road and from 3 to 5 miles (according to the troops concerned) were across country, coming up to and away from the railway.

TASKS PERFORMED.

8. The distribution of tasks to the three Troops was as follows :—

Party No.	N.C.O.s	Men	Task	No. of charges	Total gun-cotton	No. of failures	Fired by
				1st Troop (2 *Officers*)			
					lb.		
1	2	5	Wooden trestle bridge ...	6 (with 8 detonators)	112	3(A)	Electricity
2	1	5	Points and track ...	18	27	5	Safety Fuze
3	1	2	Small bridge of steel rails ...	2	56	1	Ditto
4	2	9	Track and small mine	8	58	—	Ditto
				2nd Troop (2 *Officers*)			
5	1	8	Track and points	38	70	10	Ditto
6	1	5		6	28	2	Ditto
7	2	9		12	54	4	Ditto
				H.Q. Troop (2 *Officers*)			
8	1	4	Mines ...	1	29(B)	—	Ditto
				1	28		Ditto
9	1	5	Mines ...	1	40	—	Ditto
				1	28		Ditto
10	1	4	Mine ...	1	60	1(C)	Ditto
			Track ...	9	20	2	
Grand Total	13	56	—	104	612	28	—

Notes.—(A) Three charges misfired entirely, and others failed to explode the complete charge—*see* para. 15 later.

(B) The only charge of ammonal, all other charges were gun-cotton.

(C) For safety this mine was fired later by daylight.

The raiders had no knowledge of the best points to attack, other than the bridge.

The demolitions in all thus occupied about 170 men-hours of work actually on the site.

Results on the Track.

9. A consideration of the above Table brings out certain points. The number of charges which failed to explode was 24% of the total; of those charges actually cutting rails, the failures were 30%. This proportion at first sight seems high, but is to be expected in the conditions. Most failures were due to fuzes not being properly lighted. This is easy to understand because of darkness, no lamps being used, and the men being hurried by the fact that they had just lighted another fuze only a few yards away. The charges for rail cutting, turnouts, and culverts, and the resulting damage, are shown in various photographs at the end of this article. It should be noted that the rail was 60 lb. and had been under traffic for some 20 to 30 years. As a result the rail was more brittle than the average, and the photographs show that pieces were blown out clean with extremely little bending of the rail. Generally speaking, a single slab of gun-cotton blew a hole in the web without damaging the head or flange of rail, which was therefore still usable at slow speeds. Two slabs were sufficient at rail joints for 60-lb. rail; but three are required for 75-lb. rail joints.

The Mines.

10. The illustrations show the mine craters photographed from the air, and from ground level. These were all in an unconsolidated sand embankment about 12 feet high.

The charges and results were as follows, the mines being numbered from the Longmoor end, *i.e.*, from the right of the aeroplane photographs :—

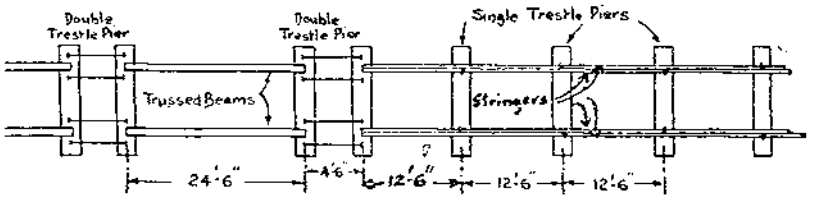
Mine Number.	Charge.	Resulting Crater.	
		Diameter.	Depth.
1	29 lb. Ammonal	28 ft.	7 ft.
2	28 lb. Guncotton	28 ft.	6 ft.
3	40 lb. ,, ...	20 ft.	7 ft.
4	28 lb. ,, ...	18 ft.	7 ft.
5	60 lb. ,, ...	Misfire	

It will be noticed that ammonal had considerably more effect than gun-cotton. All the above mines were in trenches, 6 ft. long by 2 ft. wide by 6 ft. deep, dug without removing sleepers. Sandbags were used for tamping. Except for No. 5, the mines were fixed in pairs.

Each charge had two separate fuzes, one with 8 feet of safety fuze, the other with 3 feet of safety fuze, to *cordeau détonant* connecting the mines in pairs. Mine No. 5 failed because the safety fuze had gone out after burning a few inches. The alternative fuze had never been lighted.

THE BRIDGE.

11. The bridge was a timber one across dry land and of 12 in. by 12 in. trestles on concrete foundations, with two timber stringers under each rail. The single trestles were of normal construction, supporting spans of 12 ft. 6 in. The double trestles were of similar construction, placed at 4 ft. 6 in. centres. These double-trestle piers supported trussed spans of 24 ft. 6 in. The whole bridge was extremely solidly constructed, well braced, and capable of carrying the heaviest locomotives. The two stringers under each rail were continuous over two spans, but joints were staggered thus :—



A bridge of this sort is extremely difficult to bring down properly, particularly as regards untrussed spans, owing to the short spans and the fact that the railway track *or* bracing *or* stringers are each sufficient in themselves to keep the whole structure up unless *several* consecutive piers are cut completely. This, in fact, was exactly what occurred, as will be seen.

12. Certain restrictions were placed on demolition :—

(*a*) The abutments were sleeper cribs filled with ballast. Attacking them with explosives was forbidden because of the danger from flying stones. The bridge was within 60 yards of a main road and 200 yards of houses.

(*b*) The concrete foundations to the trestles were not allowed to be attacked for similar reasons.

(*c*) Burning the bridge was not allowed. Fire is usually the most effective way of dealing with timber structures, providing the fire has time to do its work before the enemy can put it out.

13. The bridge had not been reconnoitred by day and reconnaissance in complete darkness without lights apparently did not elicit the fact that stringers were continuous over two spans. The raiders decided to cut by explosive one single-trestle pier, and one double-trestle pier. These piers were situated four spans apart. This was a mistake in the circumstances—not to attack neighbouring trestles. Each trestle was to be cut at its base and close to the bottom sill. Even if every vertical and raker of two or three trestles

had been cut, the bridge would probably only have dropped a little before the shortened trestles touched the sill or the ground, and stopped further settlement of the superstructure. This permits jacking up for repair and represents the second mistake. The legs should have been cut about half-way up so as to give a maximum drop before support to the structure could occur. In the case of the single trestle, the fact that the stringers were continuous over two spans entirely prevented any settlement whatever of the superstructure. The trestles themselves were about 14 ft. to 16 ft. high. To fix charges half-way up would thus have been more awkward than fixing them at the foot.

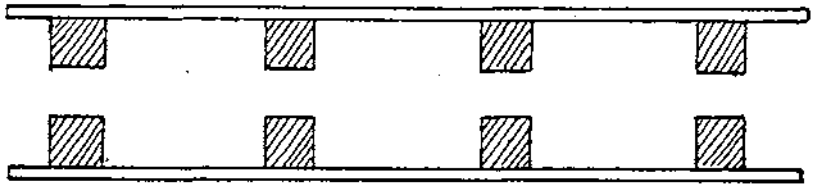
14. The fixing of charges on the bridge was as follows, the method adopted being due partly to a shortage of primers.

Single-Trestle Pier.

Plan.

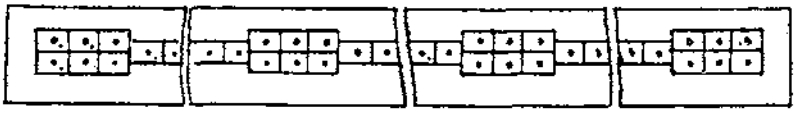
Six slabs of gun-cotton were arranged, as shown, against each 12 in. by 12 in. This occupied 30 minutes.

Double-Trestle Pier.



Each trestle of the double pier had a continuous charge of 44 slabs, arranged so that 6 slabs came opposite each 12 in. by 12 in. thus :—

Side View of Long Charges on Double-Trestle Piers.



The board to which this continuous charge was fixed was 12 in. by 3 in., cut from the cross bracing of the bridge. The double-trestle pier took one and three-quarter hours to prepare.

One detonator was fixed in each of the four charges on the single trestle, and two detonators in each of the long charges on boards on the double trestle. There were, therefore, eight detonators, and these were connected up in series and fired electrically.

RESULTS OF DEMOLITION ON BRIDGE.

15. The results are clearly shown in the photographs. It will be noticed in the single-trestle pier only one raker and the sill were damaged, while in the double-trestle pier four out of the eight legs only were cut.

It appears that three detonators on the single pier and possibly two on the double-trestle pier failed, and these long charges failed to explode completely. Two detonators were recovered undamaged, and sent for test. As a result of investigation later, it was discovered that this type of detonator was obsolescent and faulty, and had been issued by mistake.

It has been suggested that it was a mistake to try and fire that number of charges simultaneously, and that it would have been preferable to fire the charges in small groups. This reduces the risk of misfires, but, when time presses, the obvious danger in this proposal is that, as no charges can be fired till the signal, all charges will usually have to be placed ready *in situ* and the detonation of the first group may possibly displace the second. In this particular case, the charges had to be close, and it is considered that simultaneous firing was the only possibility. Eight detonators is well within the capabilities of the exploder.

The essential point is, therefore, to ensure that the detonators are not faulty. They can all be tested for continuity before use, and a proportion from each tin could be tested for sensitiveness by firing in groups. It is considered that the fault was in this case due to variable sensitiveness in the detonators.

Each troop of a field squadron carries only one exploder and a limited amount of cable, and this further restricts the possibilities of group firing.

It is interesting to note that, shortly after the charges were fired, some empty railway trucks, weighing six tons each, were pushed on to the damaged section of the bridge in order to cause it to collapse. These trucks had no effect, and caused no visible settlement even.

OTHER POINTS OF THE RAID.

16. All the charges were timed to be ready for firing at 3 a.m. The raiders were, however, spread out over three miles, and the actual time for starting to fire the charges was given by firing a Very light. Further secrecy was then impossible, and each troop of the Field Squadron fired its own charges as quickly as possible and fell back on the Assembly Point, being guided back by further Very lights. From paragraph 7 above, it will be noted that the charges at the bridge were not ready when the Very light went up, and the bridge was not fired till ten minutes later. This delay

might have proved serious in war, being so near the enemy's camp.

Great credit was due to the raiders for the extremely quiet manner in which they reached the railway and for the way they worked on the railway without attracting attention.

The night was dark and dry. Reaching the objective and feeling for enemy patrols was particularly well done. Many senior officers witnessed this. The Inspector of Royal Engineers was present, and at one period had been standing still for several minutes on the high embankment near the bridge, watching and listening. Other watchers at the foot of the bank presently saw against the sky-line three shadows closing in on what they must have taken to be an 8th Company patrol. These "shadows" got within five yards of their man and were preparing for the final rush, before the General saw or heard them and spoke—very much to the relief of the watchers at the foot of the bank!

The work of preparing the charges was also done extremely quietly. Slight noises and three flashlights for a few seconds were reported by the protecting ring of 8th Company sentries, between mid-night and 3 a.m. These sentries were on a hill overlooking the railway, where no enemy troops, however, would normally have been likely to be.

No lights and only one small noise of metal to metal was reported by sentries in the camp itself. These men were specially ordered to look and listen. The raiders may thus be considered to have done their work without having aroused enemy suspicions as to anything unusual taking place, until the first Very light gave the signal for a series of explosions.

A small mine in the Weavers Down Line (not one of those mentioned above), went up some 45 minutes after the fuze had been lighted and the raiders had all gone. The cause of the delay action effect is not known. The delay was, however, so great that it nearly caused an accident. The 8th (Railway) Company sentries protecting the danger area had been called in by then by locomotive whistle, and two of these men coming in across country were uncomfortably close when this mine exploded.

Aeroplane Reports of Raid.

17. At dawn, on 7th July, three aeroplanes of No. 4 Co-operation Squadron, R.A.F., flew over the area, with a view to reporting :—

(*a*) What damage could be seen from the air, and

(*b*) if the area was clear of the raiders, and their line of retirement.

With regard to the former, although the aeroplanes came down to about 300 feet, they could see no damage other than the mine craters. The bridge was stated to be undamaged.

The track was reported to have been " removed " in three places, one of which proved to be the small rail bridge, of which photographs are given. Map references of the other two points were given, but no damage had been done there. It looks, therefore, as if aeroplanes cannot see damage to railways, except where it covers a large area —such as a mine crater or a thorough bridge demolition.

Three 8th Company officers were kindly allowed to go up in the aeroplanes, but rejoined their unit before 7.00 hours, *i.e.*, when 8th Company started repairs to the railway.

A dropping station for aeroplane messages was manned by 8th Company personnel; and at 5.13 hours a message was received to the effect that the area was clear of raiders who were retiring on Frensham.

At about 7.00 hours (*i.e.*, when there was sufficient daylight) another aeroplane took a series of photographs of the railway. One showing mine craters is reproduced; the remainder showed no damage. These photographs were taken by air to South Farnborough for developing, and prints were dropped at Longmoor within two hours.

REPAIRS BY 8TH (RAILWAY) COMPANY, R.E.

18. Owing to the absence of their officers, who were in the aeroplanes, the 8th Company did not parade till 7.00 hours. Although Longmoor Bridge is not situated on the direct Longmoor-Liss Forest line, it was assumed to be so for purposes of this scheme, and had to be repaired before track material could be brought up by rail for repairs further up the line.

The bridge was repaired, and a 53-ton locomotive passed over it within five hours, including loading and delivering material. This time includes delays due to three attacks by aeroplanes, and could undoubtedly have been lessened considerably. In the circumstances there was no need for it, as the men were mostly working further up the line. Repairs consisted essentially of cutting off horizontally the jagged ends of the damaged legs and packing up with horizontal baulks of timber.

A photograph shows the locomotive standing on the bridge. Bracing was not replaced on the piers as repaired, and this can be seen from the photograph.

The repair to the damaged track further along the line calls for little comment, and was quickly executed. The whole of the damage done by the raiders, including Longmoor Bridge, was repaired by 60 men in 22 hours, in spite of aeroplane attacks. This gives about

1,320 men-hours or about eight times the number it took to cause the destruction. The nine craters were in an embankment, with a wide formation, *i.e.*, an excess of earth, and the craters were thus filled by borrowing from the embankment itself. On a really narrow bank this might not have been possible. The volume required was sufficient to cause considerable delay if it had had to be transported to the site—and this might also have involved filling up one crater only at a time.

While the 8th Company were carrying out repairs, four more attacks were made on them by aeroplanes. This, however, calls for no further comment, except that the time lost (in all about two hours) is included in the figures quoted above.

Conclusions.

19. Some of the important conclusions on various points have already been mentioned. Other points worth mention are as follows, and were brought up at a conference held afterwards between the various officers concerned :—

(*a*) For a given expenditure of time and explosive, the delay caused by the destruction of a bridge, or other major work, usually greatly exceeds that due to destruction of track. For this reason, a bridge is more likely to be protected by sentries or visiting patrols and will, therefore, be more difficult of access. Nevertheless, it is generally worth the effort of demolition.

(*b*) If a "key" point (such as a bridge) exists on the section of railway, and is to be attacked, every effort must be concentrated on it to the exclusion of all else, if necessary. In other words, the dictum of concentrating on the decisive point, and to the exclusion of unimportant side-shows, still holds good—as it always does, in every walk of life, and not only in things military.

(*c*) While men are working at an important point, such as a bridge, which is likely to have a visit from enemy patrols during the night, they should be protected by outlying pickets who can deal quietly with enemy patrols approaching *and before their suspicions are aroused.* This is doubly important when working within 500 yards of a considerable enemy force, as in this case.

(*d*) In a raid of this sort, the time of firing all charges should have been dependent on the decisive point—the bridge—being ready. The fact that this was late would certainly have caused trouble in war, and was a source of danger to the raiders.

(*e*) Attacking rails at alternate joints so that every rail is damaged (and particularly points and crossings) may have additional value to that of delay only, if it is known that the enemy is short of track material, *e.g.*, the Turks during the last War. The General Staff will presumably give a pointer as to this.

(*f*) The effect of various charges on rail cutting should be tried out prior to a raid. It depends on weight of rail, type of fishplate, etc. If this is not done, there is a risk of insufficient damage being done or at least a great waste of explosive.

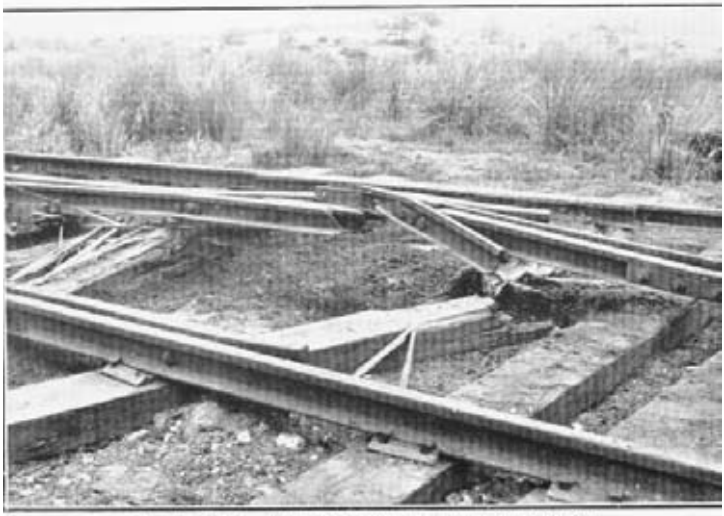
(*g*) The number of charges that one man can be expected to fire should be kept low. It should never exceed four, while two or three is better. The lower it is, the less should be the percentage of failures.

Besides the Inspector of Royal Engineers, the Chief Engineer Aldershot Command, the Asst. Director of Transportation, War Office, several other senior officers, who were present at night or saw the damage next day, considered the raid was a real success in all respects, except as regards the bridge demolition. Experience in South Africa, 1899–1902, and in every theatre of the Great War, 1914–1918, has invariably shown that a well-built timber bridge of this sort is almost impossible to demolish thoroughly by explosives in quick time, particularly under the conditions in which this raid was carried out. Timber and reinforced concrete structures are in this respect a very great deal more difficult to bring down completely than steel or masonry structures and require more thorough reconnaissance and thought.

A RAILWAY RAID.

A Side-Show on the Frontier of the Aldershot Command.

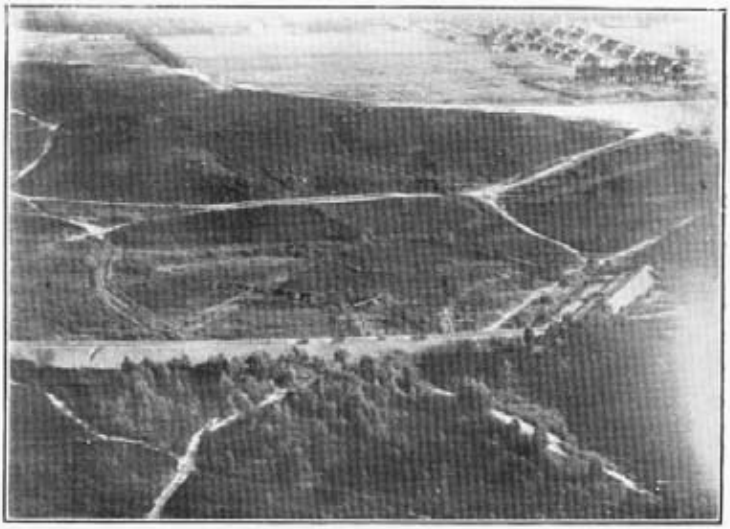
60-LB. RAIL.—Six slabs gun-cotton at the crossing.



60-LB. RAIL.—Two slabs gun-cotton at the switches.

slabs gun-cotton

The effect of two 5-lb. charges of gun-cotton in a culvert in a 2-ft. bank. Only one charge exploded.



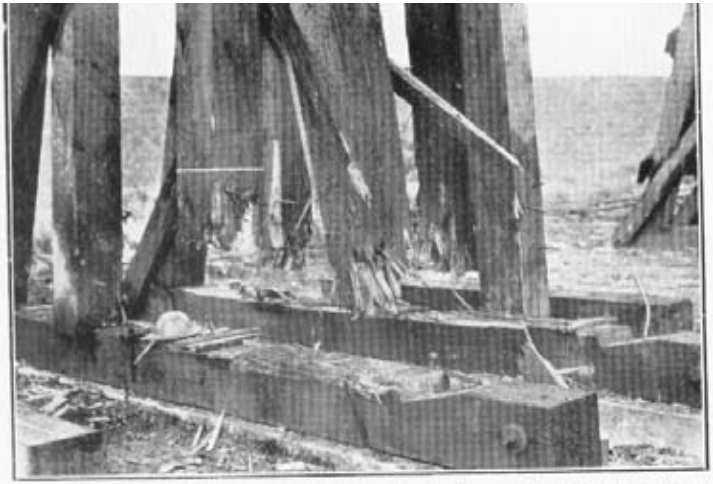
AEROPLANE PHOTOGRAPH OF MINE CRATERS.—No. 1 (ammonal) is on the right. No. 5 (to the left) misfired. In the background, the enemy camp at Longmoor. The embankment is 12 ft. high.

Aeroplane Photographs of Craters

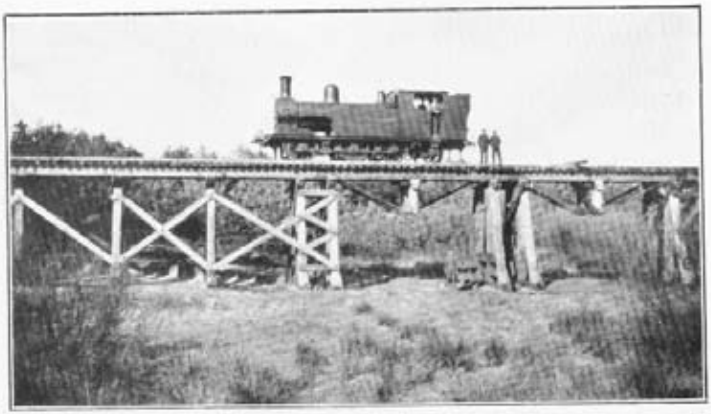
No. 1 Crater.—29-lb. ammonal. Diameter, 28 ft. Depth, 7 ft. Craters Nos. 2, 3 and 4 are in background.

Damage to the Single Trestle.—Right-hand, raker and bottom sill damaged. Left-hand, raker and both verticals undamaged.

Damage to trestle



DAMAGE TO THE DOUBLE TRESTLE.—Both left-hand rakers, and both bottom sills are intact. Left-hand, near vertical, moved 3 inches, otherwise intact. Right-hand, far raker blown off its seating and hanging from superstructure, otherwise undamaged. Three verticals and one raker only were cut, out of the eight timbers concerned.



THE BRIDGE.—After repair, with 53-ton locomotive. The single trestle is on the extreme left of photograph. The double trestle is between the two trussed spans. Repairs are visible near the man on the ground

Bridge after repair

DISTRIBUTION OF LOAD TO ROADBEARERS IN MILITARY BRIDGES.

By CAPTAIN H. A. BAKER, M.C., R.E.

IN *The R.E. Journal* for September, 1926,* an endeavour was made to show by a theoretical treatment that a vehicle crossing a bridge, consisting of several roadbearers and timber decking, produces stresses in the roadbearers considerably greater than that obtained by merely dividing the total load by the number of roadbearers. It was shown that the subject was, theoretically, considerably involved, but certain figures for the maximum percentage of axle load which could come on to one roadbearer, with a definite thickness of decking, were deduced from the theory.

It has now been possible to test these theoretical results in practice, and the attached Tables show the results obtained from the various tests carried out, and how they compare with theory and previous assumptions.

The tests were carried out with a 3-ton lorry on a 10-ft. roadway, with the lorry wheels right against one kerb.

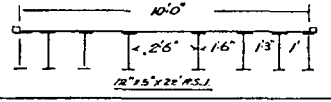
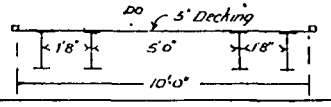
The deflections of the roadbearers or girders were taken and the maximum percentage of live load on one bearer calculated. The results shown are the average of several tests. The decking was changed between tests, and all precautions were taken to get good average results.

The diagram shows how the results obtained from the test can be used to determine the loading conditions on the decking, and also shows the full distribution of live load to roadbearers for one experiment.

The results are perhaps interesting, as they bear out the theoretical treatment very well in the one case where the full calculation was done, and show the necessity for considering this question carefully when designing a bridge.

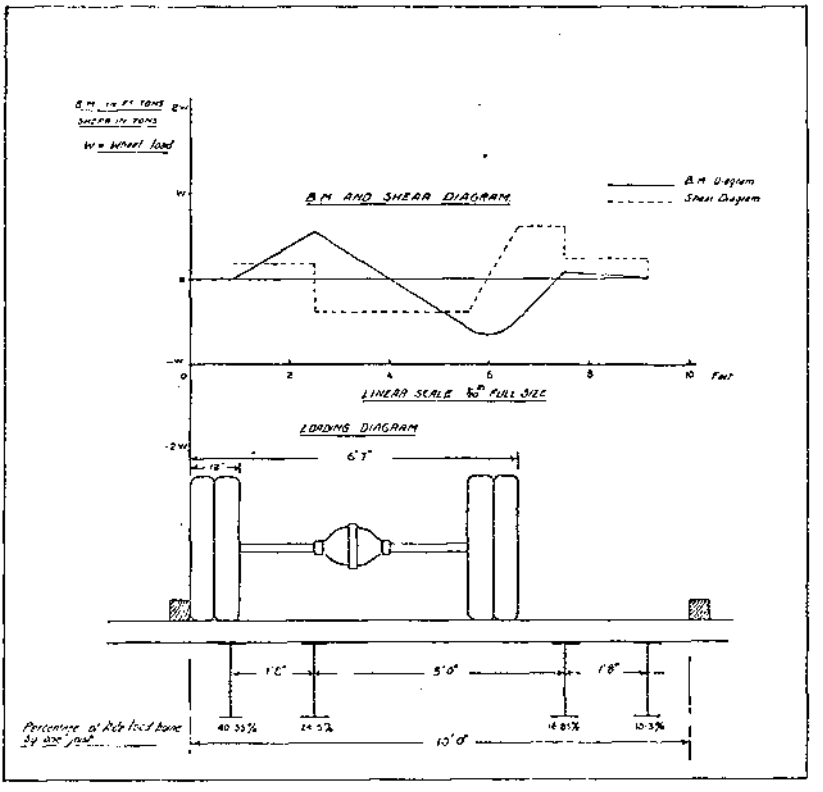
* "The Relation between Decking and Roadbearers in Military Bridges."

TABLE SHOWING RESULTS OF TESTS TO FIND DISTRIBUTION OF LIVE LOAD TO ROADBEARERS ON A BRIDGE

TEST No	ARRANGEMENT OF ROADBEARERS & DECKING.	LOADING CONDITIONS	MAX PERCENTAGE OF LIVE LOAD ON ONE R.S.J. OR GIRDER		REMARKS
			FROM EXPERIMENT	PREVIOUSLY CALCULATED OR ASSUMED	
1		MK.V TANK (30Tons) Central	13·72	8·5 Assumed	Usually assumed to be evenly distributed. Not calculated. Tank can only be central owing to width.
2	DO	3 TON LORRY CENTRAL	17·4	NOT CONSIDERED	
3	DO	3 TON LORRY AGAINST one Kerb	23·2	18. assumed from calculations on other bridges	The difference is probably accounted for partly by the inaccuracies obtained from reading small deflections and to the fact that the R.S.J. were rather old. The original figure of 18 was only assumed as calculation is too involved.
4	30' MK II Bridge as below	MK V Tank (central)	28·4.	25 assumed	
5	DO	3Ton Lorry (Central)	27·3	—	Not previously considered as not being the worse case.
6		3Ton lorry against one Kerb	40·35.	41 Calculated	This was the actual calculation carried out previously & which it was desired to test.
7	Box Girder Bridge } Two Girder. 4' Decking -do- Three -do- Four	3Ton Lorry against one Kerb -do- -do	69·7 42·6 39·58	Assumed 50 " 37 " 33	Tanks were tested on a Girder Bridge and gave 25.2% They can thus be treated as evenly distributed for practical purposes on 4 Girder Bridge on a 3 Girder Bridge% for a Tank would probably be about the same as for the lorry against one Kerb. This could not be tested.

EXPERIMENTAL DETERMINATION OF DISTRIBUTION OF LOAD IN R.S.J. BRIDGE.

GRAPHICAL REPRESENTATION.



THE BRUSTON PATENT AUTO-PNEUMATIC SYSTEM OF WATER SUPPLY.

By LIEUT. A. D. CAMPBELL, M.C., R.E.

AN installation of this type was inspected recently at Princes Risborough (Bucks) where it had worked, with apparent satisfaction, for about eighteen months.

The main features of the system are as follows :—

(*a*) The necessity for reservoirs or water-towers is obviated by the installation of a pair of steel cylinders acting as pneumatic tanks on the delivery-pipes from the pumps.

(*b*) The necessity for full-time attendance at the pump-house is obviated by automatic switch-board control, actuated by the air-pressure recorded in the pneumatic cylinder.

PROCESS.

Consider a case where a head of 250 feet is required at the delivery side of the pumps. Water is pumped into the steel cylinders, compressing the air content until the pressure meter on the switch-board registers say 110 lb. to the sq. in.

At this juncture, the pointer of the meter makes contact with one of two adjustable terminals, completing a circuit, which shuts down the pump.

As water is drawn off by the consumers, the air expands in the cylinders, reducing the pressure on the water until the pointer at, say, 100 lb. per sq. in., makes contact with the second terminal, and the pump is automatically restarted.

Where two or more pump units are installed, a separate pressure-gauge is connected to each one, the upper and lower terminals being adjusted so that they are brought successively into action, to cope with large demands, and shut down in turn again as the pressure mounts.

PLANT.

The plant is composed as follows :—

Pumping units.
Pneumatic tanks or cylinders.
Switchboard and connections.
Starting batteries
Air compressors.

Pumping units.—At Princes Risborough there were two units, consisting of two three-throw pumps, capacity 3,000 g.p.h. each. No. 1 pump is driven by a two-cylinder 10 H.P. "Lister" petrol-engine, coupled to an electric starter and generator with a 110-volt set of starting batteries.

On starting, the generator acts as a motor, rotating the engine with the exhaust-valves kept open by a solenoid starter. When sufficient speed is attained, the valves are released, and a centrifugal clutch brings the pumps into action, at the same time cutting out the motor, which returns to its normal function of a generator.

No. 2 pump is driven by a three-phase motor, current being supplied at 380 volts from the local power station.

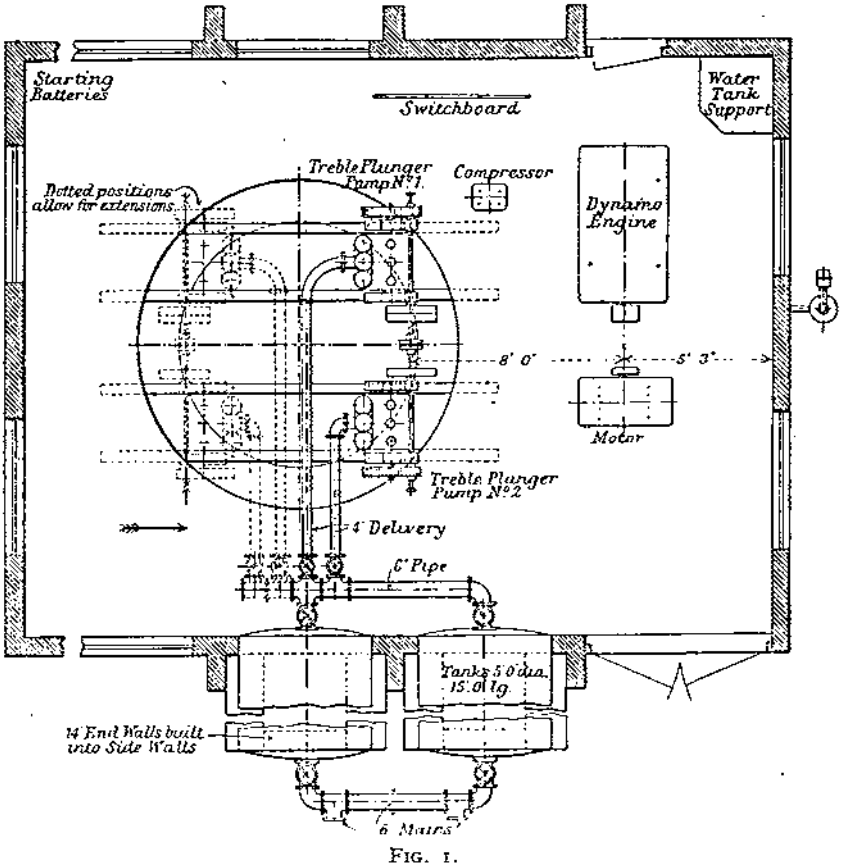


FIG. 1.

The plant is so arranged that, in the event of a breakdown, either pump can be driven by either prime-mover, and further, if the petrol supply fails during the time No. 1 pump is running (or the electric current for No. 2 pump), the other unit is automatically started up through the functioning of a form of governor control on the switchboard.

Pneumatic tanks.—The dimensions of these obviously depend upon the nature and quantity of the supply required. As a rough guide, two thirds of their volume should give a water content equal to half-an-hour's output from the pumps at the requisite air-pressure. They are so connected to the delivery-pipes that each pump can deliver into either or both tanks, and are connected at the further end direct to the delivery-main.

Switchboard.—This is covered by a patent by G. C. Pillinger & Co. Its functions have been referred to above.

Starting batteries.—These are used for lighting the pumping station and for starting purposes, being recharged by the generator while the petrol-engine is in action.

Air-compressor.—Any leakage of air from the cylinders is made good at regular intervals by operating the compressor.

In the event of very large demands over short periods, *e.g.*, for fire-fighting purposes, an artificial pressure can also be built up in the cylinders by this means.

GENERAL USES OF THE SYSTEM.

The advantages claimed are as follows :—

(1) Abolition of rising mains, reservoirs and water-towers.

(2) Reduction of attendance costs, owing to the automatic nature of the control, one man being easily capable of looking after two or three stations.

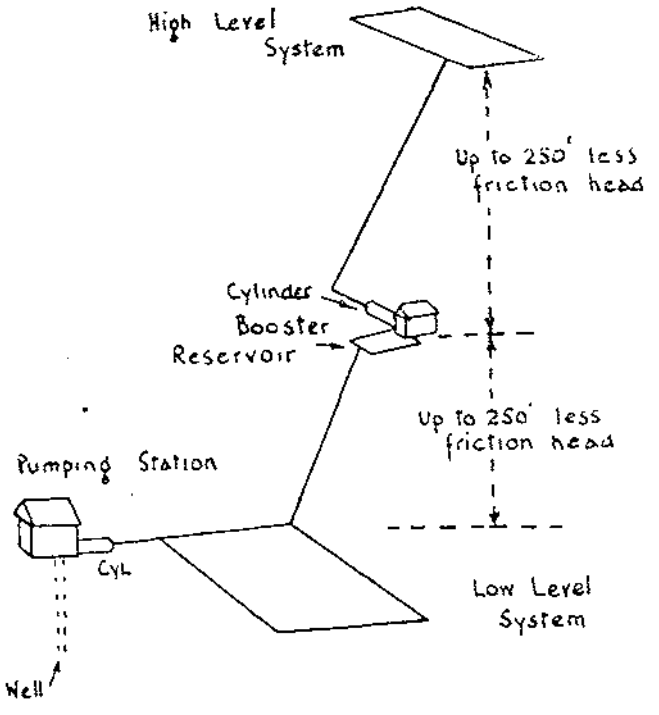
(3) Reduced necessity for stand-by plant. This is particularly the case where a number of pumping stations are connected to the same supply system, as the failure of one unit will automatically start up another in any of the connected stations, the order of starting being regulated by the setting of the switchboard terminals.

(4) High efficiency in working, as the water is only pumped through the mains as and when required.

(5) Possibility in a large system of exploiting a number of small capacity sources, which are more easily found than one large one, capable of competing alone with the total requirements.

(6) Possibilities as a boosting plant, which may be fitted at any point in any supply system. This is particularly useful in cases where a small portion of the system is at a height appreciably in excess of the remainder (*see* Fig. 2). In normal supply systems the worst-placed tap is the controlling factor, but by installing a boosting unit to deal with the higher levels, the head in the remainder of the circuit can be correspondingly decreased.

(7) General flexibility and possibilities for expansion.



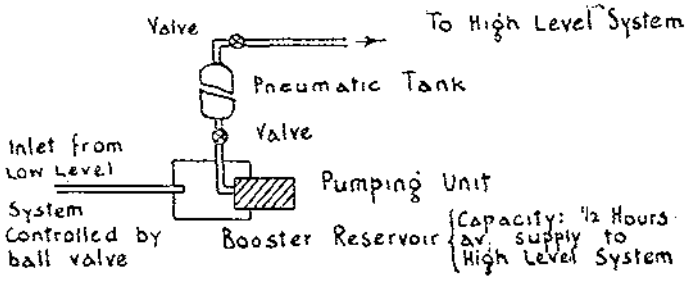


Diagram illustrating the uses of the "Bruston" System for Boosting.

FIG. 2.

(8) Economy. It is claimed, and the figures available tend to support the claim, that economies up to 40 per cent. of the cost of equivalent centralized installations can be obtained, by using this decentralized system.

There would appear to be distinct possibilities in the system from the military point of view, *e.g.* :—

(1) *Peace.*—Small military communities with no civilian supply systems in the immediate vicinity. For numbers under two thousand, the saving in an installation of this type, in reservoirs and rising mains alone, would be proportionately high, without considering the reduction in attendant costs.

(2) *War.*—Bases and points on the L. of C. where the duration period is sufficiently long to justify a piped supply, and where no civilian systems can be adapted. In this connection, it should be noted that, for fire-fighting purposes, a considerable volume of water is available, for short periods, at a head sufficient to obviate the necessity for manuals or fire-engines.

CALCULATIONS.

Pumps.

(1) For purposes of standardization, it should be assumed that there are three sizes of pumping unit available in the capacities of 3,000, 6,000, and 10,000 g.p.h. respectively.

(2) Calculate, in the normal way, the quantity of water required per day in the summer months, *i.e.*, including watering of recreation grounds, etc.

(3) Reducing this figure to gallons per hour, select the standard unit next above it. It has been found in civilian practice that a unit rated to deliver 20 per cent. more than the average requirements is capable of dealing adequately with the fluctuations in demand throughout the 24 hours.

In military communities the enhanced regularity of routine would presumably entail a somewhat higher percentage, as demands for certain purposes, *e.g.*, ablutions, washing up, etc., are more highly concentrated at certain definite hours.

It is suggested, therefore, that a reasonable basis for calculating the capacity of the pumping unit, for a purely military system, is attained by assuming that the daily requirements are consumed in twelve hours, and allowing 20 per cent. excess capacity to cover the fluctuation between average and maximum rates of flow during this time. This is equivalent to saying that the capacity of the pumping units in gallons per hour should be 10 per cent. of the daily requirements.

Thus, a daily consumption of 90,000 gallons would necessitate the installation of either :—

(1) One pumping unit of capacity 10,000 g.p.h.
(2) One " " " " 6,000 " } One " " " " 3,000 " }
(3) Three " " " " 3,000 "

The choice between these alternatives must be decided on the individual merits of each case, particularly on the possible advantages accruing from decentralization.

The following Table gives a very approximate idea of the relative prices :—

Gallons of water per hour.	Approximate Price with automatically-started internal-combustion engines.	Price with electric motors.
3,000	£1,900	£1,350
6,000	£2,200	£1,600
10,000	£3,000	£2,500

Stand-by plant.—There should be in every case a connection at some point between the fire-fighting and domestic supply systems. This connection can usually be most easily attained by having a common main from the pump-house, branching off later into separate ring mains for each supply system.

The advantages accruing from this process will be :—

(1) Reduction in size of stand-by plant.

(2) Greater facility for shutting down domestic supply in case of fire.

Assuming this to be the case, the plant required for each system of supply can be separately calculated, and it will normally be found, in the case of small communities, that the excess plant required for fire-fighting purposes, over that for domestic supply, will be amply sufficient to act as a stand-by plant for the latter.

The provision of stand-by plant for fire-fighting purposes, although eminently desirable, is not always economically possible, and may on occasion be dispensed with.

Cylinders.—There are normally two cylinders for each pumping station, of which two-thirds of the capacity is available for water storage at the standard head of pressure. This volume of water should be equivalent to half-an-hour's average supply in each cylinder.

Where the domestic and fire-fighting supply systems are combined, the pressure head in the cylinders should be that required for fire-fighting purposes, the excess head in the domestic system being eliminated by smaller branches from the mains.

The limiting head recommended by the patentees of this system is 250 feet for each lift, although for new works special plant can be designed to suit the conditions of the site.

Mains, branches, etc.—As for normal distribution systems, the level of the hydraulic gradient at the pumping-station being fixed by the pressure head in the cylinders.

EXAMPLE.

Consider the case of a community for whom the maximum daily domestic supply is calculated to be 60,000-gallons. If the method, advanced above, of calculating the capacity of the pumping units, is accepted, one 6,000-gallon per hour unit would suffice for the domestic supply.

Fire-fighting supply.—Assuming the nature of the buildings concerned is such, that a supply of at least 240 gallons per minute is required, for periods up to half-an-hour at a time, the quantity of water required will be 7,200 gallons, to be delivered in 30 minutes.

This is supplied from two sources :—(*a*) the pneumatic tanks or cylinders and (*b*) the pumping units.

The total quantity available in the cylinders will be equivalent to half-an-hour's average supply each, or, in the case where two cylinders are installed, to 5,000 gallons.

Assume as a first approximation that at the end of half-an-hour's fire-fighting this storage can be reduced by one-quarter. The quantity of water available from the cylinders alone will be 1,250 gallons, leaving 5,950 gallons to be supplied by the pumping units in half-an-hour.

Two units will, therefore, have to be installed of at least 6,000 g.p.h. capacity each.

Working on this assumption, we have 6,000 gallons supplied, during the period required, by the pumps, and the storage in the cylinders depleted by a further 1,200 gallons, or 600 gallons per cylinder.

It must now be considered how this depletion will affect the pressure head.

Using the formulæ $\frac{PV}{T}$ = constant, and assuming that the temperature remains unchanged, we have

$$P_1V_1 = P_2V_2; \text{ or } P_1 = \frac{V_2}{V_1} \cdot P_2$$

for the air content of the cylinders.

We know that one-third of the total cylinder volume contains air, and that the remaining two-thirds is equivalent in each case to approximately 2,500 gallons of water :—

$\therefore$ V_1 for each cylinder

$$= \frac{2500}{6{\cdot}25 \times 2} \text{ cub. ft.} = 200 \text{ cub. ft. of air.}$$

$$V_2 = 200 \text{ cub. ft.} + \frac{600}{6{\cdot}25} \text{ cub. ft.} = (200 + 96) \text{ cub. ft.} = 296 \text{ cub. ft.}$$

$$\therefore \qquad P_1 = \frac{296}{200} \cdot P_2 = 1{\cdot}48\ P_2.$$

P_2 must, when reckoned in feet head, be equal to the total of the following :—

(1) Difference in G.L. between hydrant and pump-house.
(2) Friction loss in the mains between these points.
(3) Head required at the hydrant for the building concerned, *e.g.* :—

three-storey	building	..	100 ft.
two	,,	..	80 ft.
one	,,	..	60 ft.

The value of P_1 can then be calculated, and this figure will give the standard pressure head required in the pneumatic cylinders, which, as previously stated, should not normally exceed 250 feet per lift.

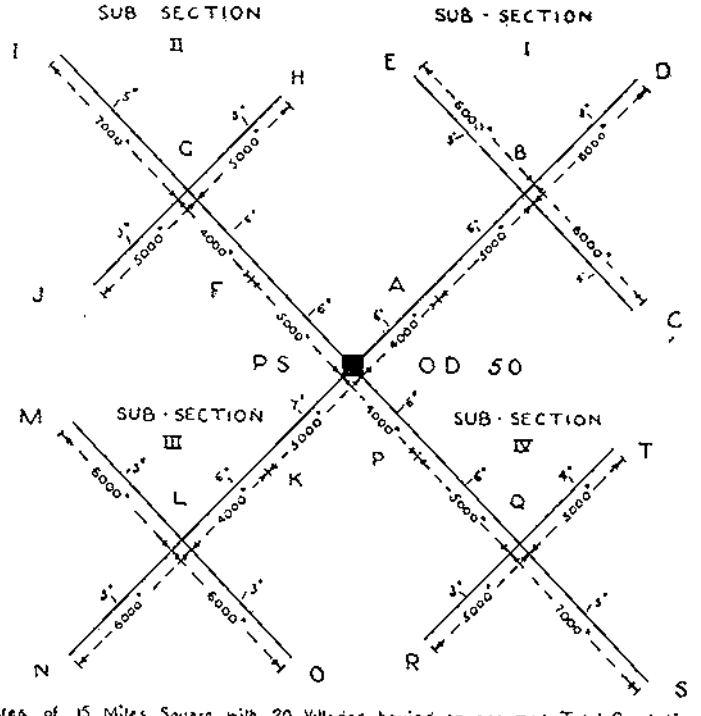
Sizes of plant required :—

(*a*) Two 6,000 g.p.h. units will, therefore, be installed, allowing a stand-by of 100 per cent. for the domestic supply, and adequate, apart from breakdowns, for fire-fighting purposes.

(*b*) Two pneumatic cylinders, each of approximately 600 cubic feet volume, will also be required.

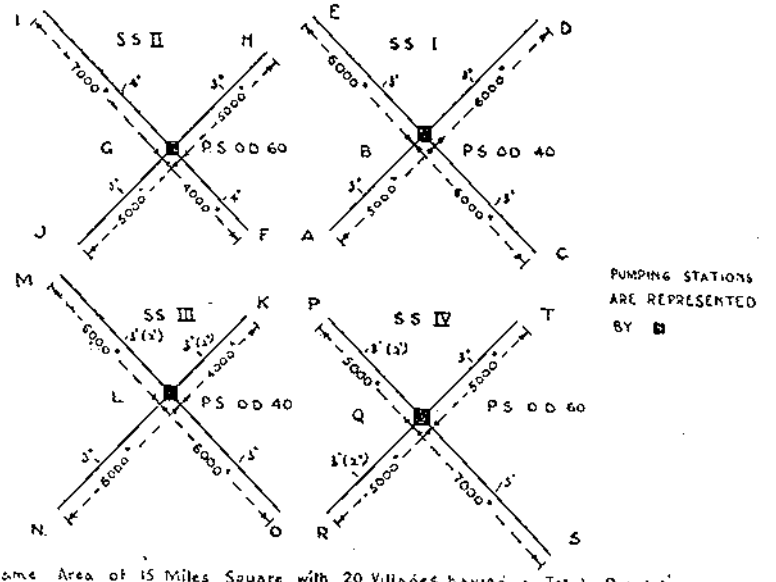
As a point of interest it may be noted that, for the ordinary system of supply, a pumping unit of at least 3,200 g.p.h. would have to be installed in this case, with 100 per cent. stand-by, or two units of 3,200 g.p.h. minimum capacity each. As an offset, however, against the increased cost of the pumping plant, we have the elimination of a 180,000-gallon reservoir, with a rising main thereto, and possibly either staging for the reservoir or increased length in the supply mains from the reservoir to the ring

CENTRALISED



Area of 15 Miles Square with 20 Villages having an assumed Total Population of 16,600 supplied by one Central Pumping Station
Total Cost of Mains £ 65,700.

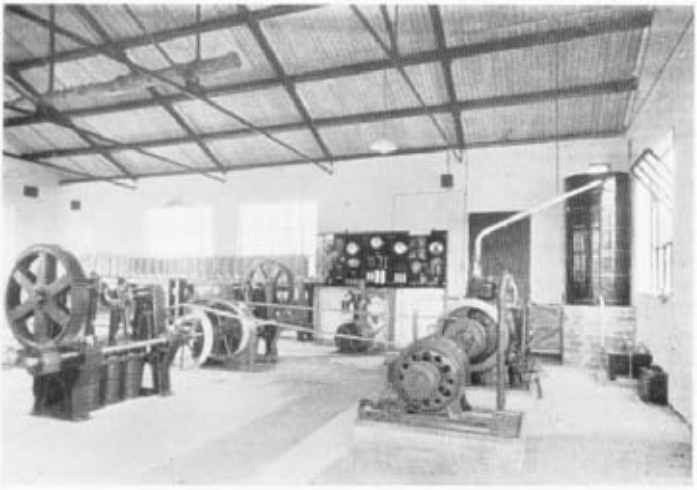
DECENTRALISED.

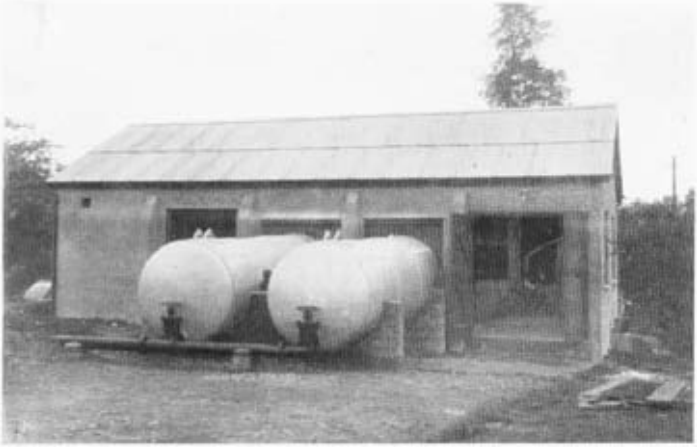


Same Area of 15 Miles Square with 20 Villages having a Total Population of 16,600 supplied by 4 Decentralised Pumping Stations at Villages B, G, L, Q
Total Cost of Mains £ 42,625.

FIG. 3.

THE BRUSTON PATENT AUTO-PNEUMATIC SYSTEM OF WATER SUPPLY.





Bruston patent

Decentralization.

The effect of decentralization on the reduction in the sizes of the mains may be seen in the diagram (Fig. 3), taken from the paper read before the Public Works, Roads and Transport Congress (1927), by Mr. D. F. Worger, M.INST.C.E., M.I.MECH.E., to whom I am indebted for the majority of the information contained in this article.

Here, twenty villages are shown, supplied in the first instance from a centralized pumping-station, and in the second from four small " Bruston " stations. The saving in the mains is calculated in the latter case to be £18,075. In attendance costs there is also an appreciable saving, in spite of the fact that there are now four pumping-stations as opposed to one previously installed. In the former case, however, three attendants were necessary, working on eight-hour shifts, and being paid at approximately £150 per annum each. In the case of the Bruston automatic system, it would normally be possible for one man to superintend all four stations, but even allowing two attendants with motor bicycles to supervise two stations each, the saving obtained amounts to £150 per annum.

As the villages extend, it would be feasible to connect the four isolated systems up, firstly into two pairs and later into one system, thereby enabling the stand-by plant to be very materially reduced, as each station would then act automatically as a stand-by for any of the remainder.

In conclusion, I should like to acknowledge the further assistance given to me in the preparation of this article by Messrs. G. C. Pillinger & Co., in kindly permitting the reprinting of the information contained in their pamphlet, and by the loan of their plates for three of the illustration figures.

DEVICES FOR CURING DAMP WALLS.

By COLONEL D. M. F. HOYSTED, D.S.O.

THE existence of damp patches in the walls of dwelling houses is normally the result of one or other of four principal causes.

These patches may owe their origin, firstly to the permeability of an outer wall to the percolation of moisture from rain driven against it, or secondly to the continued condensation of dew on the interior face, and thirdly to a leaky roof. But the fourth and most frequent cause of all is the rise of water from the foundation soil due to the absence of a protective device over the area of ground below the floor, or of a damp-proof course in the base of the walls themselves, or of both, and shows itself near ground level.

The first trouble should yield to a suitable treatment of the exterior with a coating of cement, rough cast, bitumen paint or petrifying liquid. The last-named, however, must be renewed every couple of years to afford continued protection.

The second is caused by the absence of a non-conducting coat on the inside of the walls and the consequent effect of a cold non-absorbent facing. This lack of covering offers a chilled surface for the convenient deposition of moisture from the warmer damp-laden inner air. The settlement of dew, by this operation, on walls of rooms and passages, is much more common in the North and West of England than it is elsewhere, and causes great inconvenience in many Depot Messes. It can generally be cured by a covering of non-conducting plaster on the interior surfaces involved. Common lime and hair plaster forms the best non-conductor; sirapite or any cement tends to destroy this quality.

In the third case, when dampness is evident in rooms above the ground floor, the trouble may be due to a leak in the roof covering: this can often be found by an investigation of the upper side of the roof from outside, and will generally be traced to a broken piece of the covering or a crack in a flashing. If the upper side gives no evidence, the under side should be examined where possible, during, or just after a rainstorm: the drip will probably be detected and can then be traced to its source. If the dampness has appeared above a fireplace or in a wall containing a chimney flue, it is probably caused by the passage of rain through a defective joint at the base of the chimney pot, or in the stack above roof level, or by the absence of a damp-proof course at the base of the chimney stack. For water finds

its way down through the material of a wall as quickly as it finds its way up from below. This nuisance can be remedied by the renewal of the flaunching or by a protecting coat of cement, bitumen paint or petrifying liquid, as the case may be, applied to the chimney. The last-named does not interfere with the æsthetic appearance of the material to any appreciable extent.

The fourth case, however, is the most complex, and should be very carefully investigated before any action is taken, as there are several paths by which the water may reach the point at which it manifests its presence.

When the dampness appears in the lower portion of ground-floor walls, the object of primary investigation should be to ascertain whether the building was provided with an adequate horizontal damp-proof course at the base of every wall, just above ground level. The want of such a protection forms the most fruitful origin of all.

If such there be, the search must be conducted to the conditions below the floor itself. For under the floor there should be a concrete seal or adequate air space, and in it there may be a fault. For instance, on a wet site the damp may come through a carelessly or faultily laid under-floor seal and be able to work its way round the damp-proof course, *via* the accumulation of rubbish, and thereby reach the wall above, whence capillary attraction would be sufficient to take it to a height of three feet or so above the floor-level. If no such protection is present, it will have to be provided, either by excavating an efficiently ventilated air space below the level of existing damp-proof course and not less than 12 in. clear, between the ground surface and the under side of the floor joist, or by the provision of a 4 in. concrete spread below floor and damp-proof course.

The damp-proof course is sometimes loosely misnamed a damp course, but, obviously, its whole action depends upon its imperviousness.

Should there be no horizontal damp-proof course in the building, however, some means will have to be taken to provide protection from the effect of the rise of moisture upwards from the damp soil of the foundation through the material of the walls. It is useful to remember that the rise of such moisture by capillary attraction through the interstices of the wall material hardly ever manifests itself beyond 3 ft. or 4 ft. above the ground-level or points of entry, as long as the wall is not specially waterproofed on both faces.

It may also be borne in mind that, if a wall is well built in sound cement mortar, every joint will act more or less as a damp-proof course, and therefore the maladies under consideration should not affect it. They are generally confined to walls built in lime. The insertion of a horizontal damp-proof course in an existing wall thicker than $4\frac{1}{2}$ in. is impracticable, except at a prohibitive cost, but in the case of thin partition walls of a horizontally bonded

nature, such as brick, it can be carried out by cutting or even sawing a horizontal joint in lengths of about 3 ft. through the wall. This hollow is then well wetted and filled in with a waterproofed cement mortar, slate, bitumen, or other suitable material. When it has set thoroughly hard, the intervening portions are similarly dealt with, eventually forming in this way a continuous horizontal damp-proof course which will confine the moisture to the area below it. Such treatment might be undertaken in the case of a building in which the damp has appeared only near the bottom of a thin partition wall, but has not caused trouble elsewhere. Then, if the provision of such a damp-proof course above the damp patch is followed by rendering both faces of the partition below it with a suitable waterproof coat, the visible effect of the damp will be overcome. As long as this surface seal remains intact no harm occurs, and it will probably be unnecessary to continue the horizontal damp-proof course vertically down to the foundations. In most ordinary cases it will be unnecessary to go to the labour of making this horizontal damp-proof course through the thickness of the wall, as the trouble can generally be stopped by just using a vertical waterproof covering over the face of the wall itself as described below.

But if an efficient damp-proof course exists in all but a thin wall, which happens to be affected by the damp, it may be possible to insert one in that wall, at the same level as the existing damp-proof course elsewhere, by the method mentioned. It would then be necessary to join up the new damp-proof course with the other so as to maintain continuity. When that is done, the damp patch will dry out after the rise of water has been cut off.

In the case of thicker walls, the best remedy is to apply a waterproof cover either to the inner face or both faces of the wall to such a height that the force of capillary attraction cannot compete.

In the case of an external wall, when the site of the building is such that it is likely that moisture may dry outwards by natural evaporation into the atmosphere from the external surface, treatment of the inner face alone will suffice.

This waterproofing of interiors can be carried out by covering them with ½-in. waterproofed cement mortar, or a bitumen paint of some reputed make, to a height of 2 ft. or 3 ft. above the damp patch. Two coats of the paint are advisable, allowing the first to dry thoroughly before applying the second. The internal decoration can then proceed normally without further fear.

This bitumen paint is black, for which reason it might not be so applicable to external use owing to its appearance, as it would be to an internal face, which will probably be covered with paper or plaster.

But if efficient evaporation from the outside of the wall is unlikely, owing to surrounding trees or other preventive causes, then both external and internal surfaces must be protected In this event it

should be remembered that the force of capillary attraction will be enhanced when both sides are sealed, and this fact may increase the height to which the moisture may rise, to some 6 ft. above the points of entry. Consequently it would be safer to carry the interior rendering up to the ceiling when both faces of a wall are dealt with.

There are one or two efficient makes of waterproof bitumen paint on the market, and at least one of these (Protex, by Callender & Co.) will adhere firmly to almost any surface, while having the further advantage of holding plaster without any additional key than its own adhesive property, provided the first coat of plaster is applied very thinly while the second application of the paint is still in a tacky condition.

There is also a Dutch method which is said to be effective for external walls, but which the writer has not actually examined. It has the great advantage, however, that it can be applied entirely from outside without disturbing the interior of the building, and should not be expensive. It consists of inserting 1½ in. diameter agricultural pipes in a line, about 3 ft. 6 in. apart and just above ground level, so as to extend some 7 ft. clear horizontally on either side of the damp area. A second course of pipes should then be inserted about 12 in. above the first and staggered. Each hole to be a good fit for the pipe, which must be in close contact with the wall material, but inserted without cement or fastening other than friction. Each pipe should extend from the outside of the wall to within 3 in. of the interior face of the wall, and should have a fall of ½ in. downwards and outwards. The lip of the pipe to project about ¼ in. beyond the exterior face of the wall. These pipes set up a circulation of air and draw out the moisture, thus enabling evaporation to complete the process and get rid of the water before it can rise above the upper row. They would thus fulfil the functions of an ordinary damp-proof course, and would be possible to apply to walls of any thickness.

Waterproof Cement.

When it is not possible to cover the construction with some suitable protection such as bitumen sheeting, bitumen or other paint, tar, etc., cement concrete may be more or less waterproofed either by making the mass itself more impervious to the passage of water, or by the application of some proofing substance after the concrete has set. At present these results are not absolutely satisfactory in all cases, though they will often fulfil limited requirements. The former method consists of filling up the interstices of the mass and lessening the voids in the concrete while it is being made, either by mechanical means or by the addition of small quantities of some insoluble substance in finely divided particles. It may similarly be applied to the rendering of the surface coat.

The mechanical means include grading of the aggregate, vibration, or the use of finer sand. Vibration should be effected when the

mass is in position, such as in the case of piles, slabs, etc. If fine sand, is used it should be between thirty and forty mesh.

A waterproof effect can also be produced by rendering the surface of the concrete, while yet green, with fine stuff consisting of one part P.C. to two or even one of sand, and using a steel trowel to float the surface. This produces a smooth, glossy finish, thus indicating that there are practically no surface pores for the passage of water. But the disadvantage of this method, if used for the face of interior walls, is that it forms a surface which will facilitate the deposition of dew, so must not be used where such may be reasonably expected. Neat cement should not be used, as it tends to contract on drying and make haircracks.

In the second category may be reckoned the admixture of certain specific materials such as sodium silicate, or use may be made of the affinity of alum and soap to form an insoluble precipitate of hydrate of alumina. This can be brought about by mixing 21 lbs. of soft soap and 12 lbs. of alum in 30 gallons of water, and using the liquor for gauging the concrete. Another recipe gives powdered alum equal to 1% of the combined weights of sand and cement in the first half of the water used for the mix, and after that has been used, a similar weight of yellow soap in the second half. When soap is used, frothing must be prevented. Powdered sand, hydrated lime, powdered slate waste, up to 50% of the cement content, are sometimes used, but allowances must be made, as they tend to weaken the concrete.

There are many patent materials on the market which rely for their waterproof effect on the same agency: of these Pudlo is one of the chief. It is a fine white powder resembling finely-ground glass, which should be mixed with the neat cement, then added dry to the sand or aggregate and finally treated and wetted in the usual way. About 5% by weight of the pure cement is the measure of the Pudlo claimed to produce absolute impermeability. Ferrocrete is a prepared cement making the same claim.

In the case of an existing concrete mass, clean the hardened surface and then wash over with a solution of 2 oz. alum dissolved in a gallon of water at 60° to 70° Fahr; brush it well in with a hard brush and allow to dry for 24 hours. Then apply a second wash of $\frac{3}{4}$ lb. castile soap to the gallon of water, and allow to dry for a similar period. This should be done four times. In the case of an existing tank, fill it with lime and water and keep it well stirred, so that the lime may fill the pores and close them. These treatments may have the necessary effect and save further expenditure.

BOOKS.

NAPIER'S "PENINSULAR WAR."

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The English, as Lord Balfour said some years ago, are a fighting but not a military race. Glory is not a word that appeals to them. They underwent once, indeed, a military schooling which left its mark even on the work of such men as John Milton and Andrew Marvell; but it endured not long, nor has the like of it ever recurred. Fighting, on the other hand, has been widespread and continuous to a degree that is suspected by only about one Englishman in ten thousand; and, singularly enough, there is hardly an expedition, however insignificant, since 1660, of which there does not remain some printed contemporary record, if only in a pamphlet of a few pages. If the adventure issued in victory, some officer was generally found to vaunt it; if in failure, the commander himself would write, or inspire some other to write, the story in his own vindication. In early days, it frequently fell to a chaplain to set down the chronicle of a great war, as did D'Auvergne for William III., though Marlborough's chaplain, Hare, left only a manuscript journal instead of a printed volume behind him. The last of these historian chaplains was he who accompanied General Grey to Martinique in 1794, for after that year it must be regretfully confessed that the British became for a time something of a godless Army. Many expeditions left England without any chaplain at all, and at one moment there was only a single solitary divine to be found with Wellington's army in the Peninsula. However, failing the parson, some other chronicler generally presented himself, and did the work no worse and no better.

Once only, during the eighteenth century, did a real man of letters touch on military history, and then only through the strange chance that Tobias Smollett was serving on the fleet as a surgeon. But for him, the ghastly story of Cartagena in 1741 would be unknown. Marlborough found no historian worthy of his genius, and has not to this day. We make strangely little of Marlborough, the greatest soldier and one of the greatest men that we have ever produced. There is no statue of him in London or in Washington, though but for him England might have sunk to a dependency of France, and French would now be the language of North America. How different would his fame be if, instead of a Kane, a Millner and a Parker, there had been a William Napier in his army! Still he lives at least as a hero of Uncle Toby and Corporal Trim. Clive was more fortunate; and we should be inclined to reckon Orme's *Military Transactions in Hindostan* as our first military history worthy of the name. Colonel Newcome, as we know, delighted in it and would quote with gusto sonorous passages which are still worth reading. But outlandish names and strange words forbid Orme's work to be popular; and it is one of those classics more talked of than read.

Orme set a fashion, however, and serious Indian campaigns until 1820 gave birth fairly regularly to more stately quartos, of which Colonel Mark Wilks' *History of Mysore* has most merit. Lord Mornington, mindful of the late Warren Hastings, took care to have a more or less official account of his Mahratta wars prepared, to ensure that his version of affairs should be the first before the public. Thus India may claim priority in producing what might almost be called a school of military history.

But who, except special students of the subject, could name any contemporary accounts of our long and almost unintermitted struggle with France, between 1742 and 1808? All that we know of the conquest of Canada we derive from the admirable works of Francis Parkman. For any account of Dettingen, Fontenoy and Minden we were dependent for years upon Carlyle's *Frederick the Great*. We have gathered from the pages of *Pickwick* that the Marquis of Granby was a hero, but it is chiefly from the German, Tempelhof, that we learn of his heroism. The finest incident in the dreary war of American Independence is unappreciated in the deadly pages of Steadman. In the bitter contest with Revolutionary France the years 1793–1801, being for the most part a tale of failure and disaster, found few and insignificant chroniclers, though three indifferent writers came forward to tell the story of the successful Egyptian campaign. Nor was it until after Waterloo that English military history at last took its place in English literature.

Southey was the first distinguished man of letters to take a military history in hand; but his volumes on the Peninsular War were promptly extinguished by those of the little-known soldier, William Napier, and that in virtue not of greater military knowledge, but, as shall presently be seen, of superior literary power. But curiously enough there was another soldier, Henry Bunbury, contemporary with Napier, and closely connected with him by marriage, who possessed striking literary gifts. He had set down his experiences from 1799 to 1810 for his own amusement and, though he had printed them privately for behoof of his friends, only published them in 1854 under the title of *The Great War with France*. Unfortunately, his active service was confined chiefly to the Mediterranean; but his masterly summary of the Army's work from 1795 onwards, and, above all, his account of the action of Maida, sufficiently show how great was his ability as a writer. It is, historically, a most valuable, as well as a most entertaining, work, but naturally secured comparatively little attention from a generation brought up on Napier.

It seems to have been mainly by chance that William Napier became a historian, for he was one of those rare men who would have distinguished himself in any profession. Physically, he was a magnificent animal, tall, deep-chested, active, with a dignity of gait which his soldiers never forgot, and a strikingly handsome face. Moreover, he had quick brains, a marvellous memory, and indomitable industry in exploring the whole field of literature. His brother officers, when he was a subaltern, believed that he could repeat by heart the whole of Pope's *Iliad* and *Odyssey*, to say nothing of other poems, which sufficiently accounts for his mastery of words, both with tongue and

with pen. However, being the son of a soldier and brought up upon Plutarch's *Lives*, he received a commission in 1800, when he was barely fifteen, and, falling under the spell of Sir John Moore a few years later, became earnest in the study of the military profession. He had the campaigns of Hannibal, Scipio, Cæsar and Alexander at his fingers' ends, for those were the happy days when a soldier's training was still modelled upon classical example. He then served for several campaigns in the Peninsula, with great eminence for personal gallantry and tactical ability, but with no very good fortune, his best service being overlooked and his career frequently interrupted by wounds and sickness. Finally, he retired in 1820 on the half-pay of a lieutenant-colonel—£171 a year—having already a wife and a growing family, and having also a bullet lodged near his spine, which kept him always in pain and frequently in excruciating agony. The prospect was not very bright for beginning a new life at the age of thirty-five. He resorted first to painting and sculpture, giving much time to the Elgin marbles and to the study of anatomy; and he actually produced a statuette which gained commendation from Chantrey. Then Southey brought out his history of the Peninsular War; and Lord Langdale, hearing Napier's criticism thereupon, urged him to write the history of the war himself. So far, Napier had published nothing but an article on Jomini's "Principes de la Guerre," in the *Edinburgh Review*; but the fire was kindled within him, and he resolved to commence historian. This was in the year 1823.

Chantrey had predicted success for Napier as a sculptor because of his perseverance; and Napier turned with devouring eagerness to the historian's first business—drudgery. The idea was that he should write a single volume only, carrying the story to the death of Sir John Moore; but already in 1827, before he had published a line, he was warning John Murray that the work would exceed three volumes, though it would be concluded in four. Such have been the hopes and fears of many historians. The Peninsular War filled ultimately six volumes. Meanwhile, there were books to be bought, and Napier was poor; there were visits to Paris, visits to London, conversations with Soult, conversations with Wellington, endless correspondence, and finally mountains of original documents not only in English, but in French, Spanish and Portuguese. Let no man who can read these languages comfortably in print imagine that he is thereby equipped to cope with them in manuscript. Bad writing, faint ink, colloquialisms, provincialisms, solecisms and mis-spellings will soon convince him to the contrary. With all these difficulties Napier grappled manfully; and his accomplished wife not only helped him, in the leisure which she could spare from her eight children, but actually puzzled out for herself the cipher of King Joseph's letters and drew up a key to it. Wellington, when he heard of this, declared that he would have given £20,000 for such a key at his headquarters. So the two toiled on; and only those who have gone through the like labour themselves can have any idea what it means—nor can even they imagine the burden of it when aggravated by that of constant physical pain. William Napier has two distinct scripts—so distinct that they would deceive the inexpert—which tell a

sad tale. The one is an ordinary hand, sloping to the right, as was the rule in those days, and this (to judge from internal evidence) is that which he employed when sitting at his table in comparative ease and comfort. The other is nearly vertical, a striking, peculiar, not uncomely and almost "precious" hand, which he used when lying on his back and battling against pain; and even in brief letters, written in this vertical hand, there appear the stinging epigrammatic sentences which are found so frequently in the history. It is, so to speak, his controversial or fighting script.

Six times was the first volume written and re-written before Napier's artistic sense was satisfied, and in the spring of 1828, just a century ago, it at last appeared in print. Napier's first draft apparently no longer exists, and the manuscript which went to printer (most kindly shown to the writer by Sir John Murray) is a transcription by several copyists, with corrections in Napier's vertical script; only on the first page are three drafts of the dedication, from which it seems that the characteristic allusion to Cæsar and the Tenth Legion was an afterthought. However, there the volume was, completed at last, and in a moment the work of Southey and of all other competitors was swept away from the field. No one but Napier could write the history of that war; and, encouraged by his success, he wrestled the more eagerly with his task. None who have not attempted it can conceive of the difficulty of setting down clearly and succinctly the operations of a dozen different armies and of as many guerrilla bands, and of appraising aright their significance and their bearing upon the main combatant bodies. And, quite apart from these, there were the vagaries of diverse Portuguese and Spanish factions to be followed, and the general course of military and political action to be traced and summarized, not only in England and France but all over Europe. Still, these latter came as a relief to purely military narrative, for the vocabulary of military operations is jejune and is not easily varied. It is easy to see that Napier rejoices in his freedom when he turns from military to more general topics. Nevertheless, he stands almost, if not quite, alone in the skill wherewith by sheer wealth and power of language he bursts through all the trammels of military conventional terms and carries the reader into the heart of march or combat. There is also in his narrative a tempestuous vehemence, which banishes all suspicion of labour and study painfully prolonged, of contradictory statements carefully weighed, of contending probabilities delicately balanced. All difficulty is masked by the ease of performance. He has assimilated his material and made it his own. He has shaped it to his mind, and he displays it with an Olympian majesty which takes for granted the wonder of creation. And this is great art.

A century of experience and research has corrected many mistakes in Napier's narrative, and mere time has turned the most violent of his prejudices for and against certain individuals into something very like absurdity. As to the mistakes, Napier's heart misgave him long before his death that his history was full of what he crudely called lies, but which deserve no harsher appellation than errors. He would be a bold historian who did not share Napier's despondency. But, none

the less, it was a dangerous thing to differ from Napier, for he was as combative as William Cobbett himself, and would bring all his powers of invective and scorn to bear upon the unhappy dissentient. He appears to have been quite unaware of the injustice that he did or of the wounds that he inflicted, for he would "throw himself on the ground, bathed in tears, when he thought he had done an injury." The truth seems to be that incessant pain, reacting upon an emotional nature, produced in him almost insane extremes of fury and of grief. He collapsed in helpless weeping when his hero Napoleon died; he nearly fainted when he heard of the death of his hero Wellington; but he boiled with eagerness to defend his damnation of his villains either with pen or with pistol. His later volumes passed more or less unchallenged because (as a passage among the Gurwood Papers shows) people thought it useless, if not wrong, to argue with one who could hardly be held responsible for his words.

That torturing bullet near the spine has, therefore, much to answer for; yet it may be that it was in part responsible for some of his most brilliant passages. The most famous of all—the attack of the Fusilier Brigade at Albuera—follows immediately upon a scathing criticism of Beresford, which had wrought up the author to excitement. The description of the battle is full of mistakes. Napier was not present and had never gone over the ground; but no one will ever care to read any other. The literary art of it is marvellous. The opening words —"Such a gallant line"—are almost light-hearted, but grimness closes in upon them immediately, and deepens and thickens in a superb *crescendo* till we reach the climax:—"The rain flowed after in streams discoloured by blood, and fifteen hundred unwounded men, the remnant of six thousand unconquerable British soldiers, stood triumphant on the fatal hill." The battle is not over; there is still much to be told. But Napier, giving a final touch of art, closes his chapter with those words and leaves us gasping, unable to bear more.

Take, again, the solemn prelude to the storm of Badajoz:—

> "The night was dry but clouded, the air thick with watery exhalations from the rivers, the ramparts and the trenches unusually still; yet a low murmur pervaded the latter; and in the former lights were seen to flit here and there, while the deep voices of the sentinels at times proclaimed that all was well in Badajoz."

Napier himself was not present, and, as a matter of fact, the French sentries shouted half-hourly, "*Sentinelles! garde à vous!*" which the British soldier translated into "All's well in Bada*hoo*"; but Napier would not sacrifice a wonderful conclusion to a wonderful sentence for any such trifle as that. Curiously enough, the scenes which he had not himself beheld often called forth some of the noblest of his imagery:—

> "The walls of Zaragoza thus went to the ground, but Zaragoza herself remained erect, and, as the broken girdle fell from the heroic city, the besiegers started at the view of her naked strength."

Again, at the opening of the French attack at Talavera :—

"The Duke of Belluno gave the signal for battle, and eighty pieces of artillery immediately sent a tempest of bullets before the light Troops, who, coming on with the swiftness and violence of a hailstorm, were closely followed by the broad black columns, in all the majesty of war."

Again, of the advance of the Spaniards to their doom at Ocana, "they had come down from the Morena like a stream of lava, and burst into La Mancha with a rapidity that scarcely gave time for rumour to precede them. But this swiftness of execution, generally so valuable in war, was here but an outbreak of folly. Without any knowledge of the French numbers or positions, without any plan of action, Areizaga rushed like a maniac into the midst of his foes and then suddenly stood still, trembling and bewildered."

Nor can the description of the Spanish insurrection be omitted :—

"Manifestos, decrees, and lofty boasts, like a cloud of canvas covering a rotten hull, made a gallant appearance, when real strength and firmness were nowhere to be found."

Now let us take Napier speaking as an eye-witness on the day before the battle of Salamanca :—

". . . the night came suddenly down with more than common darkness, for a storm, that common precursor of a battle in the Peninsula, was at hand. Torrents of rain deepened the ford, the water foamed and dashed with increasing violence, the thunder was frequent and deafening, and the lightning passed in sheets of fire close over the column, or played upon the points of the bayonets. One flash falling among the 5th Dragoon Guards killed many men and horses, while hundreds of frightened animals, breaking loose from their piquet ropes and galloping wildly about, were supposed to be the enemy's cavalry charging in the darkness ; but to a military eye there was nothing more imposing than the close and beautiful order in which the soldiers of that noble light division were seen by the fiery gleams to step from the river to the bank and pursue their march amidst this astonishing turmoil, defying the storm and the enemy."

Last, let us read once more the tribute to Edward Freer, of the 43rd, after his death at the battle of the Nivelle :—

"Of two who fell in this battle I will speak. The first, low in rank, for he was but a lieutenant, rich in honour, for he bore many scars, was young in days. He was only nineteen. But he had seen more combats and sieges than he could count years. So slight in person and of such surpassing and delicate beauty that the Spaniards often thought him a girl disguised in man's clothing, he was yet so vigorous, so active, so brave, that the most daring and experienced veterans watched his looks on the field of battle, and implicitly following where he led, would like children obey his slightest sign in the most difficult situations. His education was incomplete, yet were his natural powers so happy, that the keenest and best furnished intellects shrunk from an encounter of wit, and every aspiration was proud and noble, indicating future greatness if destiny had so willed it."

Indeed, whether William Napier writes from his brain or from his heart, he is incomparable. It is easy to point out the blemishes in his work, the controversial and aggressive tone, the frequent cumbrous quotations, the extravagant partiality of some personal opinions, whether for or against; but the *History of the Peninsular War* is one of the military histories of all time. He had fought through it as a regimental officer and knew it, so to speak, as a pawn. He had so deeply studied his profession that he could judge of it also as a player, and indeed was sometimes treated as such by Wellington himself. He knew private soldiers and he knew strategists, and realized that both alike were men and playthings of fortune, not the arbiters of their own destinies. Outside his military experience he was endowed in the highest degree with the historian's most precious gift—imagination—and he had strengthened it by wide and deep historical reading. Like Leonardo da Vinci, who was only incidentally a painter, however great, Napier was only incidentally a soldier. He loved his humbler companions in the service passionately, and never lost his interest in military questions, but the range of his intellect spread far beyond such bounds. Had he entered political life, he would have made his mark; for he could speak as eloquently as he could write, and would have left behind him epigrams akin to those which are so frequent in his history. "Men and not mountains decide the fate of a battle." "The bustle of confusion is easily mistaken for the activity of business." "The indecision from which none but great men and fools are free." "A memorable tale and a ruined city," and the like. But happily he resisted all pressure to stand for Parliament. Eloquence is but a branch of the dramatic—an interpretative art; and Napier was born to be a great creative artist. Whatever the passions which may have inspired him to resort to the pen for self-expression, he was too conscientious not to search earnestly for the truth and to set it forth becomingly as in his heart he believed it to be. Seventeen years of drudgery and grinding toil, with the bullet near the spine never resting in its work of anguish, went to the making of the six volumes. He knew all the troubles of an artist.

"Easy ys myne boke to rede and telleth of moche fyte,
But then your easy rede is damned hard to wryte,"

he wrote, in parody of Chaucer, when the work was done. But he has left us an everlasting possession.

THE STORY OF THE ROYAL REGIMENT OF ARTILLERY.

By Lieut.-Col. C. A. L. Graham, D.S.O., R.A., *p.s.c.* Assisted by Officers of the Regiment. Royal Artillery Institution, Woolwich, 1928. (Price, 8d. post free.)

This handy and well-illustrated little book of about 100 pages, bound in thick paper covers and priced at eightpence, post free, is designed for soldiers preparing for the Second Class Certificate of Education; material on which instruction for Third Class Certificates can be based being marked by a line in the margin. The cover design includes the Regimental badge and mottoes, and the zig-zag red and blue colours of the Royal Artillery. The book is divided into ten sections, the first

being devoted to the history of Artillery before the formation of the Regiment in 1716. The Campaign of Waterloo, the Indian Mutiny, the South African War, and the Great War, have a complete section devoted to each campaign.

General Sir George F. Milne, Colonel Commandant, R.A., contributes a foreword in which he stresses the importance of battery histories. "In this book," he writes, "nothing more than a general survey has been attempted; the real regimental history of the Royal Artillery is the history of the battery. This story has been written to provide batteries with a setting for their own exploits and to enable the more recently raised batteries to study the deeds of the Regiment in those countries in which they are serving or have served."

We have nothing quite like this book in the R.E. *The Deeds of the Royal Engineers*, compiled in the Record Office during the War, might usefully be revised and brought up-to-date on the lines of this attractively got-up short history of the Royal Artillery.

B.R.W.

THE SHAKESPEARE MYSTERY.

By GEORGES CONNES, Professor of (English) Literature at the University of Dijon. Abridged and translated into English by a member of the Shakespeare Fellowship.

(Cecil Palmer). Price 7s. 6d.

The Shakespeare Fellowship, of which Colonel B. R. Ward, C.M.G., is Honorary Secretary, a "brotherhood of all lovers of Shakespeare who are dissatisfied with the prevailing Stratfordian orthodoxy," has translated and published, with an original Preface, ten out of twelve lectures delivered by Professor Connes in 1925, in which he reviewed the various opinions held in the present day on the authorship of the works attributed to Shakespeare. After a brief historical sketch of the days of Elizabeth, the Professor describes in full the claims of orthodox Stratfordians, and of those who ascribe the works to Francis Bacon, Viscount St. Albans, to Roger Manners, Fifth Earl of Rutland, to William Stanley, Sixth Earl of Derby, and to Edward de Vere, Seventeenth Earl of Oxford. In each case he writes as a convinced advocate of the claim under discussion, so that a reader who may approach to the subject with an unbiased mind may here find an introduction to the arguments maintained by each party, and draw his own conclusions. In his concluding chapter the Professor gives it as his opinion that Shakespeare himself is the author . . . . "as Bacon said, if a little knowledge takes man away from God, a deeper knowledge brings him back to Him. And similarly, if a superficial study of the Shakespeare problem takes one away from Shakespeare, an extended study brings us back to him." The writer of the Preface claims that Professor Connes' summing up is far more than a mere echo of the earlier Stratfordian apologists. "By admitting the relations between William Shakspere of Stratford with Oxford, Derby and Rutland, he has placed an entirely new complexion on the Stratfordian case." Those who turn to the book to discover what this is will be well rewarded, for there is not a dull page in it. Few translators have been more successful in concealing their art than this "Member of the Shakespeare Fellowship."

F.E.G.S.

THE WORLD CRISIS. BY WINSTON CHURCHILL: A CRITICISM.

By LORD SYDENHAM, of Coombe, ADMIRAL SIR REGINALD BACON, MAJOR-GENERAL SIR FREDERICK MAURICE, MAJOR-GENERAL SIR W. D. BIRD and SIR CHARLES OMAN. (Hutchinson & Co., Ltd. 10s. 6d. 1927.)

This book should be read by all those who have read Mr. Winston Churchill's *The World Crisis*. In a review in the *R.E. Journal* by the present writer, it was pointed out that readers of those volumes should not permit themselves to be carried away by the literary gifts of Mr. Churchill, or be deceived by the specious arguments of that illustrious politician. Mr. Churchill no doubt takes pains to obtain correct facts and correct figures, but it is the way in which he uses those facts and figures to serve his purpose that vitiates the value of his chronicle of the War. Colonel Lord Sydenham (Sir George Clarke, late R.E.) discusses "Mr. Churchill as Historian." Sir Charles Oman, late Chichele Professor of Modern History at Oxford, and during the War in charge of the Department that dealt with German losses, disputes the figures on which Mr. Churchill based his arguments in the chapters of his book, entitled, "The Blood Test," and "The Battle of the Somme." Major-General Sir W. D. Bird puts forward some opinions from other points of view than Mr. Churchill's as to the strategy of the War, especially with regard to the initial plans of concentration, and also discusses the question of losses. He quotes Ludendorff's opinion that:—"The "modern defensive battle is more costly than the attack, one reason "more in favour of the latter . . . losses (in attack) consisted mainly "of slightly wounded men who came back. The prisoners we lost in "the defence had to be struck off for good." Mr. Churchill, it will be remembered, wrote:—"In all the British offensives (founding his "conclusions on official figures), the British casualties were never less "than 3–2, and often nearly double the corresponding German losses. ". . . Whereas while the British suffered heavier losses in all offensives "they exacted more than their own losses when attacked by the Germans "in 1918." Mr. Churchill's deduction is the opposite of General Ludendorff's! He advocated withdrawal and defence, and tried to show that every attack was bound to fail, until, of course, his Ministry of Munitions had time to provide us with an overwhelming superiority of tanks in 1919. Major-General Sir Frederick Maurice discusses Joffre, Gallieni and the Marne, and shows how Mr. Churchill based his praise of Gallieni entirely on a fiction. He champions Marshal Joffre, and shows how he, and not Gallieni both planned and won the Battle of the Marne. The final and the most interesting chapter is that on Jutland by Admiral Sir R. Bacon. It may not be "the last word" on Jutland, but it shows that Mr. Churchill based his conclusions on facts that were not all facts, and how unfair those conclusions were to the Commander-in-Chief of the Battle Fleet, and to the Admiral commanding the 5th Battle Squadron. "It is often difficult," he says, "to follow Mr. Churchill's arguments because of the inaccuracies they contain." In discussing Mr. Churchill's views of what Admiral Jellicoe should have done, he points out "three inaccuracies—the speed of the armoured cruisers is "incorrect, the number of *Carolines* with the C.-in-C. is mis-stated, the

" time at which the armoured cruisers were sent forward was not 'at " the first alarm,' but fifty minutes after the first alarm. But the " really important point that emerges, is that the whole of Mr. Churchill's " elaborate argument, as to what the C.-in-C. should have done, is " based on an inaccurate estimate of the speed of the armoured cruisers, " and an oversight as to the position of the 3rd Battle Squadron " at 3.10 p.m." This is only one instance; Sir R. Bacon gives several others, and he provides excellent sketch maps to show the position of the fleets at the crucial moments.

It is fortunate that this " criticism " of Mr. Churchill's book has been written, and by such distinguished writers. Untold injustice has been done by *The World Crisis*. That can now never be undone, but it is well for history that the facts should be recorded before all those who took part in the battle have passed away.

H.B-W.

CALLINICUS: A DEFENCE OF CHEMICAL WARFARE.

By J. B. S. HALDANE.

(Price, 2s. 6d.)

The author, who was Reader in Bio-chemistry at Cambridge, develops the two conclusions, that use will be made of chemical weapons in future large wars despite or because of existing agreements on the subject, and that such means will not make the results of fighting any more painful or cruel than the more usual methods which for years have passed the censorship of decent behaviour.

Indeed, the use of lachrymatory gas may be said to be the gentlest way of waging war that has ever been thought of. Though mustard gas caused about 150,000 casualties in the British Army alone, less than 4,000 (say 1 in 40) died, and only about 700 (say 1 in 200) became permanently unfit. Mustard gas, therefore, kills one man for every forty it puts out of action, while gunfire kills one for every ten.

Moreover the type of wound caused by a shell is far more distressing than the worst type of gas pneumonia.

The writer, or rather lecturer—for the origin of the little book was a lecture given at Mürren—claims that the use of mustard gas in war on the largest possible scale would render it less expensive of life and property, as well as shorter and more dependent on brains than on mere numbers. The most effective defence against gas is education, the education of all classes of our population.

Amongst all humanity there is a very definite natural terror of the unknown, and it is greater in inverse proportion to the current standard of education. The thought of poison gas produces one of the most alarming of these phobias.

During the Great War, large numbers of unnecessary casualties were caused during the early stages of gas attack, because trust was placed in certain so-called protectors sent out to soldiers by their friends at home, rather than in the more effective but less satisfactory-looking masks issued by the Army authorities.

A further terror was added by a widely-accepted rumour, that the survivors of lung-irritant gases would get consumption, while those burned by mustard gas would develop cancer; these predictions have not proved true, but the proof could not be broadcast at the time.

Such warfare can only be combated by a scientific study of causes, and a special type of accurate thinking.

"During the Great War, twenty-five different poisonous weapons "were employed; of these, three are gases at ordinary temperatures "and can be discharged from cylinders in which they are stored under "pressure. The remainder are liquids which gradually evaporate, "yielding a poisonous vapour or solids which are poisonous in the form "of smoke.

"The wonderful gas, which would put the enemy to sleep and allow "him to be taken prisoner comfortably, does exist, but is not a working "proposition, because the concentration has to be too exact for practical "possibility. One has only to think of the familiar case of chloroform "vapour and the skill required to give neither too much nor too little."

Discussing the possibility of an aerial gas bombardment of London, the writer considers that the effect in civilian casualties, provided the civilians had previously been educated in the mysteries of gas warfare and were provided with protectors, would be almost infinitesimal, compared to a bombardment with explosives by a similar fleet. Besides which, the material damage of the former is practically nil. Its real danger would arise from the effects of panic.

The author then presents a thesis for the tactical use of chemical weapons in the future. "The main efforts of the soldier who uses "them will be devoted, first, to blistering his enemy, and secondly, to "tiring him out by forcing him to wear a respirator continuously, "which, of course, enormously hampers him for doing anything else."

Mustard gas was used to make large areas absolutely untenable by the defenders, though it had the disadvantage that the attackers could not enter the forbidden zone either. It persists as a great danger for about a fortnight. But it is such an effective and reliable weapon that the difficulty will be evaded by some means. The attackers will either be immune by nature or be rendered immune by covering and they could be assisted by air-tight tanks. Either the effect will be avoided by clothing the attackers with a complete air-tight outfit, together with gas mask, or use will be made of men who are physiologically immune to its effects. One attack of gas poisoning does not, unfortunately, confer immunity against a second dose.

That some are immune by nature was made patent in the trials and tests carried out by the American Army. This resistant class comprised some 20 per cent. of the white men tested, but no less than 80 per cent. of the negroes. In explanation of this interesting fact, he shows that the blistering effects of mustard gas and the sun are very similar, and the negro is known to be practically immune to the latter. Probably by the same reasoning, Indian troops would be as immune as negroes. It would seem, therefore, that enough coloured troops could always be obtained to provide a sufficient and efficient shock formation, together with enough resistant whites to officer them.

One sees, then, the possibility of warfare somewhat on the following lines:—

"Heavy concentrations of artillery would keep an area, say, thirty "miles in length and ten in depth, continuously sprayed with mustard "gas. After allowing, say, two days for the development of blisters, "the gassing of the positions within two or three miles of the first "line is discontinued, but a long range bombardment, especially of "roads, goes on. Suddenly, behind the barrage appears a line of tanks "supported by negroes in gas masks. They meet with little opposition "in the area still reeking with gas, and occupy the hostile lines to a "depth of two or three miles. A counter-attack, even if successful, "involves concentration in an area under gas bombardment and enor-"mous casualties from blistering. The only satisfactory counter-attack "would be from the air. In this way, the side possessing a big superior-"ity of mustard gas and immune troops should be in a position to "advance two or three miles a day."

These methods introduce more strategic and administrative complications, but would establish and maintain a war of movement leading to more rapid decisions with far fewer casualties on either side.

It is to be remarked, at present, that Germany is devoid of coloured troops.

Gas warfare thus seems to be more humanitarian than the other forms. It may be asked, however, whether gases of the future may not be more cruel than those of the past. "Only a limited number of "chemical substances are appreciably volatile, and of their vapours "only a small proportion are poisonous. Now, every chemical sub-"stance has a definite molecular weight. Those with small molecular "weight are on the whole the most volatile. Now, the large majority "of the possible volatile chemical substances of small molecular weights, "and therefore relatively simple chemical composition, are already "known. Mustard gas, for example, was discovered and its properties "described in 1886. There are probably substances of high molecular "weight, whose dense vapour is even more poisonous than mustard "gas. But the charcoal of our respirators has the property of absorbing "heavy molecules of vapour quite independently of their chemical "composition. It is, therefore, somewhat unlikely, though not of "course impossible, that any very poisonous vapour will ever be found "which will go through a mask impermeable to mustard gas or chlorine. "It is, to my mind, far more probable that skin irritants may be dis-"covered, which are even more unpleasant than mustard gas."

Chemical weapons are roughly divided into four distinct classes. First come gases and vapours which are poisonous when breathed, but which have no ill effect on the skin and only affect eyes and nose when present in concentration heavy enough to be harmful to the lungs. Such are chlorine and phosgene. A second group, the lachrymatory gases, are deadly only in very high concentrations, but have an intense irritant effect on the eyes even in minute quantities. It is believed that this group caused no deaths or permanent blindness. Both these groups can be kept out by respirators.

The third group consists of the blistering gases, of which dichlorethyl

sulphide or mustard gas is the type. It is really a slowly volatile liquid and is extremely effective. "A drop of the liquid was put on a piece "of paper and left for five minutes on a man's sleeve. The vapour "penetrated his coat and woollen shirt, causing a blister, the effects of "which lasted six weeks."

The fourth series consists of poisonous smokes, mostly arsenic compounds, and were little used, though they were being developed for the 1919 campaign. They are extremely distressing temporarily, yet the large majority of casualties would recover in two or three days, and none who were previously fit would become permanent invalids.

"It is not unlikely that concentrations of smoke will be produced in "the future which will penetrate our present masks. If our anti-gas "measures are sufficiently neglected, the consequences may be serious."

Smoke particles are moving many thousand times less quickly than the molecules of gas; the former are, therefore, more likely to be drawn through the narrow passages in the filter without colliding with the absorbent walls. It will be easily realized that to make these passages more restricted still, would make such a resistance to breathing that the protector would become impracticable. For this reason, smokes may become more dangerous than the blistering gases.

It is of interest that the author's opinion as to the comparatively humane results of gas warfare are borne out by a President Physician-in-Chief of the large American gas hospital at Toul, during the Great War (*vide R.E. Journal* of March, 1924, p. 178).

D.M.F.H.

THE AUSTRALIANS AT RABAUL.

The Capture and Administration of the German Possessions in the Southern Pacific. By LIEUT.-COL. S. S. MACKENZIE. (Sydney: Angus & Robertson. 30s. net. 1927.)

Rabaul, on the shores of Blanche Bay at the north-eastern extremity of the large island of New Britain in the Bismarck Archipelago to the north of Australia, is the British, as it was the German, seat of Government of the mandated territories, formerly known as the "old Protectorate," which include German New Guinea. It is destined to be a pivotal point in the Pacific, on account of its position and excellent harbour, known as Simpson Harbour. This volume forms Vol. X of the *Official History of Australia in the War of* 1914–18, and is written for Australian readers and as a text book for Australian youth. But it contains a great deal of information which is of interest to all who aspire to understand the problems of Empire, for it throws light on British Colonial Policy in the 'eighties, explains how Germany came to get a footing in the Southern Pacific, and helps us to understand the Australian point of view in regard to what was looked on by Australians as a betrayal of their birthright.

On August 6th, 1914, the following telegram was addressed by the Secretary-of-State for the Colonies, in cypher, to the Governor-General

of Australia:—"If your Ministers desire and feel themselves able to "seize German wireless stations at Yap, in Marshall Islands, Nauru on "Pleasant Island and New Guinea, we should feel that this was a great "and urgent Imperial service. You will, however, realize that any "territory now occupied must be at the disposal of the Imperial Govern-"ment for purposes of an ultimate settlement at conclusion of the "War . . ." In view of the heart-burning caused in Australia in 1884, by the complacence with which the occupation by the Germans of the Old Protectorate, was apparently regarded in England, it is not surprising to read that an expedition was organized, within a few days of the receipt of the telegram, to seize these German colonies. It was under the Command of Colonel W. Holmes, afterwards Major-General Holmes, C.M.G., D.S.O., V.D., who was killed in Flanders on 2nd July, 1917, while commanding the 4th Division of the Australian Expeditionary Force. There was not much fighting, but both in the fighting and the subsequent administration of the captured colonies, the Australians showed the same qualities of initiative and resource which their brothers-in-arms showed in Gallipoli, France and Palestine. The proviso in the telegram of the Secretary of State for the Colonies, quoted above, laid the obligation for the administration of the captured territories on Australia, and it was no easy task to deal with the German colonists and the large native population with the uncertainty whether the colonies were to revert to Germany or become British after the War. A large part of the book is devoted to the details of administration and the methods by which the difficulties of government were overcome. It was Australia's first attempt to carry out an expedition depending entirely on its own resources, and although mistakes were made, the results were successful, thanks firstly to Colonel Holmes and later to Brigadier-General Pethebridge who succeeded him. One of the chief lessons learnt was the futility of short enlistments. The whole of Holmes' Force soon became time-expired and had to be relieved by newly-enlisted men, who were organized in what was known as the "Tropical Force." There was also a serious breakdown in the continuity of supplies wherewith to feed not only the troops but also the native inhabitants, the usual sources of supply and means of water transport having been interfered with by the War. The lessons have fortunately been recorded, and this volume will be of value when Australia is again called on to take her share in any struggle in which the British Empire may be involved. It is interesting to note that Japan and not Australia eventually occupied not only Yap, but the whole of the Marshall Islands, and also the Marianne, Pelew and Caroline groups, and, at the signing of the Peace Treaty, Japan was given the mandate over all these islands. The "mastery of the Pacific" is very much in the air at the present time, and to anyone who is interested in the subject this volume will be invaluable, if only for the history and geography of the Southern Pacific Islands which it contains. The book is well illustrated and copiously supplied with maps and sketches, and has a good index.

H.B-W.

LA VALLATA DELLA GIUBA.

By Comandante G. B. Carniglia.

This book is an official publication of the Government of Italian Somaliland, and is one of a series of monographs on various districts in the country. It deals with the River Juba and its valley, from Dolo, near the Abyssinian border, to the coast at Jumbo, near the port of Kisimajo, and is the report of a mission carried out by the author in the winter of 1925–26, with the object of obtaining information on the following points: navigability and volume of flow of the river, feasibility of damming and irrigation, possibility of development of harbourage and port facilities at the mouth, verifications of the map produced by a previous mission in 1923–24.

The time at the disposal of the author was the period from autumn to late spring, and he was the only white man of the party. The distance from the coast to Dolo and back, as he travelled it, is over 1,600 km., so not a very detailed examination was possible. The author seems to have got through a very large amount of work in the time, however.

A description of the river and its valley is given from the Abyssinian border to Bardera, the chief town inland, and thence on to the sea. In the former part, the river runs in what is really a cleft in a sparsely populated plateau. South of Bardera, it runs in a broad flat valley with marshy land on each side of it. Water from the river flows into these marshes (known as *deschek*) through natural channels, and the native population is concentrated round them. The channels are used by the natives to control the flow of water for irrigation, cultivation being confined to the edges of the *deschek*. Through ignorance and mismanagement, however, misuse of these channels frequently leads to flooding of the cultivated lands. The author points out the need for careful study of the behaviour of the river in flood and for official control of the irrigation channels.

The possibilities of barrage and irrigation schemes are examined, but, without more exact topographical knowledge, nothing really definite can be proposed. General lines of progress, however, are suggested, including a dam above Marriento to irrigate the higher land.

Measurements of the volume of flow at Bardera were made and are tabulated. The flow varies very greatly—from about 1,043 cub.m./sec. down to less than 60, according to the season.

Proposals are worked out for the conservancy of the river mouth to enable coasting steamers to use it; also for the improvement of the port of Kisimajo, some little distance down the coast, by building there a small breakwater to shelter lighters, tugs, etc., and by the construction of a Decauville line connecting it with Gobuin at the mouth of the Juba.

The river is navigable as far as Bardera, 600 km. up-stream, for about one-half of the year by tugs and lighters drawing 70 cm. Native water transport by dhow is declining, however; this leads to decline also of the river trade among the natives themselves. North of Bardera, no river traffic at all is possible.

As regards the exploitation of the valley as a whole, the author

suggests cattle-grazing in the northern uplands, though the difficulty of transporting the produce to market is admitted, there being neither road, rail nor river transport available. On the plains in the south, maize and sesame are grown, but the native is improvident and lacks perseverance. Control of the natural irrigation channels, however, by minimizing the danger of floods in the cultivated areas, would do much to stabilize the villages and their inhabitants. The development of artificial irrigation would go still further to improve matters. Labour, however, is a difficulty in the way of extensive developments, and it might be necessary to import it from other places in Africa. The country is not, of course, suited to colonization by European emigrants.

There are no natural resources in the valley of minerals or timber.

The book is illustrated by a certain number of photographs, not very well reproduced, and by twenty-four maps, plans and diagrams.

V.D.

THE SEVENTEENTH EARL OF OXFORD, 1550–1604.
By B. M. WARD.

(John Murray. Price, 21s.)

In 1920, Mr. J. T. Looney published his book *Shakespeare Identified*, in which he claimed the authorship of the greater number of the plays and poems attributed to Shakespeare for Edward de Vere, 17th Earl of Oxford. Since that date, The Shakespeare Fellowship, of which Colonel B. R. Ward, C.M.G., is the enthusiastic secretary, has been investigating the history of this little-known and much-maligned nobleman. The results of these enquiries are now published in this scholarly biography by B. M. Ward, which will be read by many, beyond those who are interested in Mr. Looney's theory, as presenting an interesting picture of an eccentric nobleman who was undoubtedly prominent at the Court of Queen Elizabeth, and throwing light upon the characters of many prominent men, especially on that of Lord Burghley, whose daughter was married to the subject of the book.

The Earl of Oxford was famous among his contemporaries as a poet and dramatist, but all his works, with the exception of a few early poems, have been lost. He has been handed down to history chiefly on account of his ill-temper, his ill-treatment of his little countess—which was reputed to have been done in retaliation upon Lord Burghley for the execution of the Duke of Norfolk, a relative of Oxford, a few months after the wedding—and his quarrel with Philip Sydney in a tennis-court, during which he called that future paladin a puppy. These and other delinquencies have been fully enquired into by Mr. Ward and Lord Oxford's life-long friendly relations with Lord Burghley are established, but the most interesting discovery about Lord Oxford, which is now first made known to the world, is that for the last eighteen years of his life, from 1586 to 1604, he received an annuity, extraordinary both in nature ("Our pleasure") and value (£1,000), first from Queen Elizabeth and, after her death, renewed in the same terms by her successor, for some "office," the nature of which is not divulged in any of the original documents. Mr. Ward discusses at length the possible

nature of this office. "Elizabeth was the last person in the world to scatter largess around without expecting any return." There is ample evidence of Lord Oxford's interest in the drama and his intimate connection with the players and their "masters." In his later years, he appears to have had few other interests, but during those years he is known to have been closely associated with his son-in-law, William Stanley, sixth Earl of Derby, for whom, from a different standpoint, Professor Lefranc, of the French Academy, has claimed the authorship of the Shakespeare plays. Mr. Ward comes to the conclusion that Oxford "was instrumental by means of his brain, his servants and his purse in providing the Court with dramatic entertainment," and leaves it at that. We hope that The Shakespeare Fellowship has not said its last word about this mysterious personality.

F.E.G.S.

ERRATUM.

In the March, 1928, *R.E. Journal*, page 160, instead of the initials "A.P.A.L." appearing after the review of "Elements of Machine Design" the contributor's name should read "A. G. Gadd."

MAGAZINES.

REVUE MILITAIRE FRANÇAISE.

(*January*, 1928).—Commandant Roques begins "*L'organisation du terrain d'opérations de Champagne pendant la guerre mondiale*" in this number. His intention is to draw a number of important lessons from the organization of a sector, and that of Champagne is taken as an example. This instalment is devoted to a very brief outline of active operations in Champagne throughout the Great War.

L'artillerie antiaérienne, son emploi, son organisation, by Commandant Vauthier, is written to show that anti-aircraft gunnery is not so complicated as is generally thought. To the layman, Commandant Vauthier makes out a good case for his theory, but he barely touches on the intercommunication problem, which is probably far more difficult to overcome than the problem of firing with reasonable success at hostile aircraft. The writer gives his estimate of the anti-aircraft artillery required in a division, army corps and in reserve, and he considers that three types of weapon are essential, viz., a powerful gun for reserve formations, a light gun for working in divisions, and a kind of pom-pom for working either with the infantry or in defence of certain special localities.

Commandant Maury completes *La 2e division d'infanterie de la Garde prussienne les 21 et 22 août* 1914 in this number. The outstanding feature of the 22nd was the retirement of the division, suddenly ordered by the Corps Commander on inadequate information, across the Sambre. As the French were also retiring, this lapse was put right without difficulty, apart from a certain amount of disorder. What stands out from these operations was that the artillery of 1914 could not afford sufficient

support to infantry, who had to attack concealed positions defended by machine-guns.

La question de Tanger is an interesting article on the situation in Tangier, by Commandant Galy. The history of Tangier is first traced throughout the ages; the writer then describes the negotiations leading up to the statute of 1923; and finally the existing situation is indicated. The whole question is very complicated and cannot be described here; but it seems a great pity that Spain rejected the 1923 agreement and that Italy became involved at the same time. Fortunately, Great Britain and France have stood together recently over this question, and it is to be hoped that it will be finally settled fairly soon.

In the third instalment of *Au Maroc français en* 1925, by Capitaines Lacau and Montjean, it is difficult to follow the preliminary operations undertaken to restore the situation, on account of the indifferent sketches. A very interesting account is given, however, of the administrative measures taken to regroup the Army, so that the C.-in-C. could undertake the major offensive, which had to be developed before the autumn rains. It was this reorganization which laid the basis for eventual success.

(*February*, 1928).—In the second instalment of *L'organisation du terrain d'opérations de Champagne*, Commandant Roques describes the enormous improvement in communications by road and rail and the provision of railheads and depots of all kinds, carried out after the stabilization of the front in 1914. This does not make very interesting reading, but the article provides a useful study for those interested in transportation requirements during position warfare.

Colonel Armengaud begins an important article, entitled *Les enseignements de la guerre marocaine en matière d'aviation*, in this number. Apparently, the French air forces were of the utmost value in Morocco, both for offensive operations and in assisting the covering troops, and the writer has deduced some very useful lessons from the way in which they were employed. His first point is that air squadrons, except for S.S. fighters, should be equipped for instantaneous work on the outbreak of war, even though they have to be separated for a short time from most of their ground equipment. It is contended that this can be done by the addition of a couple of load-carrying machines to each squadron. Granted this organization, aircraft can be quickly concentrated for what is the main operation of war, *concentration of superior force at the decisive point*, with a minimum of delay. The writer then discusses the value of aircraft to replace a proportion of the covering troops and the organization required for the command of air forces.

In the fourth instalment of *Les victoires serbes en* 1914, Lieutenant-Colonel Desmazes and Commandant Naoutmovitch describe the Serbian offensives in the Banat and in Bosnia, followed by the Austrian decision to return to the attack. Owing to lack of war material of all kinds, the Serbs were unable to prolong any offensive operations. The Austrian C.-in-C. on the Balkans front managed to free himself of the control of Conrad, the Austrian C.G.S., and the second Austrian offensive is described in the next instalment.

The third instalment of *Au Maroc français en* 1925, by Capitaines Lacau and Montjean, describes the offensives in the Beni Zeroual dis-

trict and in the eastern sector, the latter being designed to join up with the Spanish. The operations are described in great detail, and extra illustrations are provided by oblique aeroplane photographs. These operations definitely restored the situation on the French front.

Les événements de Chine, by Commandant Girves, is a short description of events in China from April to December, 1927. The article opens with the part played by the Russians under Borodin, and closes with the recapture of Canton by Chiang-kai-Sek and the final expulsion of the Russians. In conclusion the writer points out that the Russians, like everyone else, have failed really to make friends with the Chinese and so have failed to consolidate their original successes. He also considers that there is little hope in the dominion of Chang-Tso-lin in the north for the final pacification of China. In fact, there appears to be no immediate solution.

(*March*, 1928).—In the third instalment of *L'organisation du terrain d'opérations de Champagne*, Commandant Roques describes the special administrative measures taken before the great attack of September, 1918. A wealth of detail is given, and the article shows very clearly what an enormous amount of work has to be done behind the front line before a big attack can be developed under trench warfare conditions.

Capitaines Lacau and Montjean, in the third instalment of *Au Maroc français en* 1925, describe the operations undertaken after the autumn rains set in and the administrative difficulties of the campaign, together with the measures taken to overcome them. Marshal Pétain, the C.-in-C., saw clearly that matters must not be allowed to rest after the French successes at the end of the summer, but the problem was how to continue the pressure on Abd-el-Krim and his tribes during the winter, when the native was at a great advantage as compared with the European. The solution, brilliantly conducted by General Naulin, was the continuation of pressure by loyal native troops, combined with the use of every effort to pacify any wavering tribes. As a result, Abd-el-Krim found his position getting weaker and weaker during the winter, while the French were able to prepare for joint action with the Spaniards in the following spring.

L'action de guerre et le chef is a study by Commandant de Gaulle on the qualities of the higher command. It is written in order to draw attention to the difficulty in peace-time of training higher commanders for war, and many familiar examples are given of the failure of commanders to impress their personality sufficiently on their subordinates to keep the action of the latter within reasonable limits of control.

The fifth instalment of *Les victoires serbes en* 1914, by Lieutenant-Colonel Desmazes and Commandant Naoumovitch, describes the Austrian advance and capture of Belgrad in November. The Serbian command, however, managed to withdraw the army without serious loss, and were only waiting for an opportunity to counter-attack on a large scale. The description of this counter-attack, which cleared the invaders out of the country, is left to the next number. The main difficulty the Serbs had to contend with was lack of material, and it was essential for them to gain time before launching their counter-offensive.

The second instalment of Colonel Armengaud's important article

Les enseignements de la guerre marocaine en matière d'aviation deals with the proportion of air forces to other arms required in the field, and the action of air forces. He finds that a far greater number of squadrons than is at present available is required for wars in uncivilized countries, but realizes that the proportion would have to be cut down in a Great War. The lesson from the Rif campaign is that air operations should be intimately connected with land operations, under which circumstances they have the maximum effect.

The writer concludes the instalment with the theory that "Air forces of the line" are required, which are not specialized, but can undertake a variety of tasks as required.

Les travaux de campagne dans l'armée allemande, by X., is a short study of the methods adopted in Germany to maintain the science of field works in peace-time. Being convinced that field works are a necessary corollary to both offensive and defensive action, the General Staff has allotted about £300,000 to this type of work in 1928.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

DECEMBER, 1927, TO FEBRUARY, 1928.

(*December*).—Captain Jacquemin contributes an article on the construction of a pile bridge at Agde, over the Hérault, in April, 1927. It was built to provide a temporary means of communication whilst a permanent bridge was being constructed to replace an old suspension bridge. It was 66 metres long, and 6 metres wide, allowing for a double carriageway and two footpaths. There were eight piers and each pier consisted of six piles. Steel girders were used as roadbearers over four bays, wooden beams being used for the remainder. The pile-driver was carried on a lighter.

An article by Captain Bruder gives an account of the construction of a pile bridge for heavy loads over the Wadi Mellah in Tunis by the 34th Battalion of Engineers in 1926. The bridge was 28 metres long, containing six piers, each of five piles.

(*January*).—This number contains the first part of an article called "Repair of Communications," by Lieut.-Colonel Bailly. In Chapter I(*a*) he discusses the repair of roads at the opening of a campaign, in (*b*), during a battle against a fortified front outside the zone of destruction but subject to severe artillery preparation. He gives examples drawn from the Battle of Champagne on September 25th, 1915, the Battle of Malmaison on October 23rd, 1917, and the Battle of Champagne on September 26th, 1918. In (*c*) he discusses the question in the case of an attack on a fortified front, behind which lies devastated country. He gives interesting examples of works carried out within the zone of the 10th Corps during the German retreat in March, 1917.

Colonel Beyer contributes the first part of an article on the "Sieges of Przemysl, 1914–1915." It consists of translations of articles published in the *Militärwissenschaftliche und Technische Mitteilungen* by Major Stuckheil, preceded by remarks on the defence of Galicia and Bukovina in general and of Przemysl in particular. The Russians invested that place for the first time on September 24th, 1914, and retreated on October

8th. It was again invested on November 8th, 1914, and fell on March 22nd, 1915, after an attack lasting four days. Major Stuckheil only deals with the period of armament between August 2nd and September 23rd, and with the second investment. To complete the picture, Colonel Beyer has drawn on the narrative of General Schwalb, who was Director of Engineers at Przemysl, which was published in 1918 under the title of "Defence of Przemysl, 1914–1915."

The article is written in considerable detail, and contains Tables showing the state of the garrison at various stages.

(*February*).—This number contains the last part of Lieut.-Colonel Baills' article on "Repair of Communications." There are ten photos of temporary bridges. In Chapter II he briefly describes the repair of the railways, Roye–Chaulnes and Chaulnes–Ham–La Fère, in 1917.

The article on the Sieges of Przemysl is continued by a translation of Major Stuckheil's articles, referred to above.

A.H.B.

REVUE MILITAIRE SUISSE.

(1927. NOS. 7 TO 12 INCLUSIVE.)

L'État-major russe au début de la guerre européenne. This article appears in No. 8, and is contributed by Colonel Feyler, who has brought together from many sources, some of which are enumerated, information concerning the difficult position in which the Russian General Staff found itself, towards the end of July, 1914, owing to the Austro-Serbian situation. The problem it was faced with was whether, at this time, a partial or a complete mobilization of the Russian Army should be ordered. The military situation in Russia was complicated by the fact that, both in its political and military circles, a strong desire existed not to provoke the hostility of Germany, although there was no intention in these circles to allow Austria to crush Serbia. Yet, it was felt that if Germany put her Army on a war footing, the complete mobilization of the Russian Army could not be avoided. The difficulties of the Russian General Staff were further increased owing to the uncertainty created in the situation by the British efforts to prevent the outbreak of hostilities, and also by the indecision of the Czar. The various steps taken in Russia to deal with the situation are briefly set out in the original article.

Notre défense nationale d'après l'expérience de la guerre mondiale. This article in No. 9 was contributed by Colonel Sprecher von Bernegg (since deceased), who calls attention to the fact that the neutrality of Switzerland is a voluntary one and self-imposed by its people, and consequently differs from the "guaranteed" neutrality of Belgium, which the Great Powers had by Treaty undertaken to respect. The Swiss are naturally anxious that their country and its people shall never pass through experiences similar to those undergone in Belgium in 1914 and the four subsequent years. During the Great War, the belligerent neighbours of Switzerland attached an equal value to the maintenance of its neutrality; no doubt largely because they were practically equally matched, and certainly also because they were aware that the Swiss people were ready to range themselves against the Power that should

first violate their territory and possessed an Army capable of playing an effective *rôle* on whichever side it might come into the field. Hence, Switzerland did not in those years experience the inconveniences of war. That Switzerland can still maintain its neutrality and effectively guard against the violation of its territory, if the Swiss people will see to it that their military activities are something real and not merely a mirage, is the last message delivered to his countrymen by Colonel Sprecher.

Les deux genres de guerre. Colonel Feyler deals in No. 10 with the situation created in Switzerland owing to the doctrines of the League of Nations.

La cartographie suisse. This is an anonymous contribution, and appears in No. 10. The question of producing new maps of Switzerland has been raised recently ; views as to the scales which should be adopted, V.I. of contours, etc., of a number of persons who are interested in the subject, have been collected and are given.

L'arme de l'air. Lieutenant E. Næf furnishes in this article in No. 11 some particulars relating to the Potez 25, a French machine.

Notre cinquième arme. L'aviation de chasse. Lieutenant E. Næf is also the author of this article in No. 12 ; he describes therein the Swiss A.C.1 machine, and the Dutch machines Fokker D. XIII and the Fokker C.V.D. He further states that recently the question of the Swiss Air Force was raised in the National Council, and an urgent demand made for reforms in this branch of the service. The Swiss War Minister stated in reply that the whole organization of the aviation service in Switzerland was still of a tentative nature, and that it was proposed to carry out further experiments in relation thereto during the current year.

W.A.J.O'M.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1927. TOME II. NOS. 4 TO 6 INCLUSIVE.)

Les opérations de l'Armée belge. The account of the Battle of the Yser is continued, the events of October 23rd/25th, 1914, being dealt with. Short accounts are given of the operations in the neighbourhood of Nieuport, in the Tervaete " loop " of the river, at Dixmude and in the region immediately to the southward of this town. The events of the 23rd are dealt with in No. 4 ; at this time the French 42nd Division was on the extreme left of the Entente line, and had taken over from the Belgian Army the section of the front between the sea and Nieuport. The Germans delivered strong attacks against the Belgian Army on the 23rd ; its 1st Division was obliged to yield ground, but the enemy did not follow up his success at this point. A more serious situation was, however, created on the section of the front held by the Belgian 4th Division ; the enemy succeeded during the morning in seizing the canal bridge at Tervaete and established himself on the left bank of the waterway. Further south, the Germans made a series of attacks on the bridgehead at Dixmude during the night of October 23rd/24th, but were not able to make any progress. It was intended that the Entente troops should launch a combined attack against the enemy forces in the Flanders

section of the front on the 23rd; however, the necessary orders were issued at too late an hour for effective action to be taken on them. The situation, as it presented itself to the Belgian High Command on this date, is briefly reviewed in No. 4.

The events of the 24th are sketched in No. 5. Instructions had been issued for a brigade of the French 42nd Division to co-operate with the Belgians on this date, with a view to dislodging the German troops which had obtained a footing on the west bank of the canal in the Tervaete "loop." The Belgian troops were, however, worn out by the fatigues they had undergone, and were further very weak in numbers; they were not in a condition to undertake offensive operations. Indeed, they could not hold their own against the German attacks, and yielded more ground; by the evening of the 24th, they had fallen back from the canal along a stretch of front extending to some 14 km. A part of the French 42nd Division had been moved to the southward of Nieuport for the purpose of assisting the Belgians during the day, but it was not able to intervene effectively. Further south, the French troops (IX Corps) continued their offensive in the region of Dixmude; directing their effort towards Passchendæle–Roulers, they made a slight advance on the 24th. The Germans now delivered strong counter-attacks against the parts of the front held by the French IX Corps and the British 7th Division; the Entente troops were able to retain their positions.

The situation on the section of the front held by the Belgian Army was, at this time, causing the Belgian High Command considerable anxiety, and a memorandum, the text of which is set out in No. 5, was, in consequence, drawn up reviewing the condition of affairs, and forwarded to the Chief of the French Military Mission. In view of the serious state of affairs on the Belgian front, General d'Urbal, who was in command of the French forces in Belgium, issued orders to his troops at 6.30 p.m. on the 24th, directing them to act in support of the Belgian Army on the following day. The orders issued by the Belgian High Command at 8 p.m. on the same day provided that the Belgian Army should act on the defensive and hold on to its position as long as possible.

Instructions were issued on the 24th to the Engineers of the Belgian 2nd Division, directing them to operate the canal sluices at Nieuport, at the changes of the tides, in such a way as to cause water rushes in the waterway with a view to interfering with the German bridging operations.

The events of the 26th are dealt with in No. 6. The Belgian 5th Division, which was on the right of the Belgian line, near Oud Stuyvenskerke, delivered a counter-attack, on the initiative of its commander, on this date, and succeeded in making a small advance. Further south, the bridgehead at Dixmude was heavily bombarded by the Germans, who again advanced to the attack against the works held by the Belgian and French troops, but were repulsed.

During the 25th, the decision was taken to carry out the inundation of the region eastward of the Nieuport-Dixmude railway. The French had already carried out inundations in the neighbourhood of Dunkirk in September, 1914, and were, at this time, proposing to extend the flooded area eastward of the line Dunkirk-Bergues-Rexpoede. The Belgian High Command, however, opposed the French project for extend-

ing their inundated area, as the floods would then have reached to the banks of the Yser, and it would, in consequence, have been necessary for the Belgian Army to abandon the line held by it. In view of the representations of the Belgian High Command, the French did not proceed with their scheme. Details concerning the Belgian and French inundation projects are given in No. 6 of the *Bulletin*.

Problème de la sûreté. The 7th article of the series under this title appears in No. 4; Major Barthélémi, of the Belgian General Staff, analyses therein the measures adopted by von Moltke in 1870 for the purpose of ensuring the safety of the German Armies during their pursuit of the French forces retiring on Metz. The article is informative and interesting.

L'effort belge au lac Tanganika pendant la Guerre 1914–1918. The first two parts of an article under this title, by Captain Weber, of the Belgian General Staff, appear in Nos. 5 and 6. The Belgian effort in this theatre was directed towards obtaining and maintaining command over the waters of the Lake; this involved the completion of the railway line, already under construction, to the shores of the Lake; the creation of a naval base to cover the Lake terminus of the railway; and the construction of a flotilla for use on the Lake, and its maintenance in an effective fighting condition. In these circumstances, engineering necessarily played a large and important part in the activities of the Belgians in this region.

La réorganisation militaire et la durée du temps de service en France. This article, which is an anonymous contribution, is contained in No. 5; it deals with the manner in which the French legislature approached the problems relating to the peace and war organizations of the French Army, and in which it also determined the basis of the periods of military service for its component parts. The subject is treated on scientific lines, and the article is not only instructive but also interesting.

Les chars de combat. The first of a series of articles under this title appears in No. 6; Major Liévin, its author, furnishes technical details concerning various types of tanks which have either been introduced into the service or are being experimented with in France, Italy, Great Britain, America and many other countries.

W.A.J.O'M.

COAST ARTILLERY JOURNAL.

A writer in the October number discusses the possibilities of local military schools and the quickest way for the junior officers to acquire knowledge on military matters, both in the general subjects required of all officers, and in special subjects essential only to his branch of the Army. He notes how difficult it is to obtain first-class instructors in every subject in sufficient numbers to be available at all stations, and finally makes out a case for text-books.

Live, up-to-date text-books on every subject, from the pens of the best instructors in the army, instead of lectures and lessons given by lower-grade instructors. Such text-books to be used by all teachers, who will finally supervise the examinations. These will also be prepared by the

writers of the text-books. The author thinks that if such examinations are carried out on the "hit or miss" principle, questions covering a whole subject can be answered in a quarter-of-an-hour and corrected in less than a minute. His suggestion for an hour's study leaves one rather dazed; it is as follows:—"During the first 30 minutes each student "reads and reviews the lecture. During the next 15 minutes oral dis- "cussion follows under the direction of the instructor. During the "last fifteen minutes the examination test of about 50 questions is "given. . . They can be marked and returned to the student at the "following class."

"They are magic time-savers: thorough to the nth degree: fair "beyond question, and as exact in marking as mathematics." But composition seems to be neglected, which may lead to difficulties in connection with the student's subsequent ability to write orders later on in his career.

An interesting article is given on the question of the possibilities of finding means of subsistence for the armies and civil populations of two (or more) European belligerents in case of another war. For meats, fats, grains, cereals and forage each state is dependent on one or more of its neighbours and also on other continents, Canada, Australia, United States, South America, etc. This being the case in peace-time, might not the supply of such necessities become even more difficult than that of ammunition and warlike stores? Before the War, Italy subsisted on Russian wheat; Germany depended on Russian and Polish poultry and eggs, and partly on Russian barley. Rumania's large wheat yield has been seriously diminished by agrarian legislation; she has actually had to import it herself. Turkey's productive capacity has been brought to a standstill. The economic distress in Hungaria and Bulgaria has caused them to close their exports. Europe, exclusive of Russia, has therefore doubled her wheat importations since 1914.

The shortage includes sugar.

To-day the Argentine, Australia, Canada, India and the United States control the food of the world. If England should not succeed in directing the foodstuffs from Australia, Canada, South Africa and India to her own or her allies' ports, Europe could, in a short time, be starved out as thoroughly as was Germany during the War.

This statement casts an interesting side-light upon the United States' proposal for an overwhelming fleet and the breakdown of the last conference for the limitation of armaments.

In the January, 1928, number a writer describes the military situation of Argentina. He mentions South America's immensity. Of ten republics, three exercise a marked influence on the commercial world of to-day, while one is larger than the United States, and might become the greatest producing state in the world; Argentina, the second, which is two-thirds as large as the United States, is the largest exporter of meats, cereals and hides in the world, while a third produces three-fifths of the world's supply of nitrates. The ten republics produce bountifully almost every essential to civilization.

In Argentina, the people have developed from a mixture of European stocks rather than from a blend of European and native races: in this

she is different from the others, and consequently, assisted by her wonderful climate, she has to-day an alert, vigorous and progressive population, who respect the relation of law, order and peace to prosperity.

Her territories consist for the most part of vast, well-watered plains. With natural obstacles on nearly all her continental marches, and an ideal internal railway net, Argentina is fairly safe in case of war with any of her neighbours, while over 1,000 miles of Atlantic coast-line would ensure communications overseas. But a maritime invader could reach the vital nerve centre, Buenos Aires, without much trouble at present, though the probability of war with a European country seems remote. Her natural rival is Chili: they both desire the leadership in South American affairs, and have an extensive common land frontier. What looks like a definite boundary settlement, however, appears to have been reached at last.

Every able-bodied male has to register during the first three months of his 19th year: at the age of 20 he is enrolled in the Regular Army (active or inactive): at 30 he passes to the National Guard, and from 40 to 45 he belongs to the Territorial Guard. The service term in peace is one year. The active Regular Army consists at present of about 30,000 volunteers and conscripts, the former being mostly candidates for commissions.

Officers are appointed exclusively from graduates of the government military college, near Buenos Aires, after a four years' course. The training and discipline is excellent, and the pay adequate, with efficiency as the basis of promotion. All schoolboys receive military drill from the age of 12, and at 15 they are trained to shoot. The volunteers must be public school boys, who enlist at the age of 17 and soon become N.C.O.s: those who do not desire a commission become professional N.C.O.s and are allowed to re-enlist up to the age of 50, receiving an annually increasing bonus to encourage them to remain in the service.

The country is divided into five divisional regions, the division at war strength consisting of three infantry regiments, a cavalry regiment, an engineer battalion and a signal battalion. The actual war strength of a division is 16,000.

The government owns and works its own factories for the supply of clothing, boots, tents, aeroplanes, small arms, leather equipment and S.A.A. The arsenal is capable of turning out a million rounds of S.A.A. per diem in war-time. The present equipment and reserve of munitions, however, is not up-to-date.

Though a wealthy nation with great purchasing power, she lacks coal, iron and sulphur, and her inherent weakness lies in the fact that she is not a manufacturing community, but must necessarily be dependent on Europe and the United States.

In the February number another Coast Artillery Corps writer gives an article on the military situation of Brazil.

The largest state in South America, she has a boundary which marches with every other state except Chili and Ecuador, and has had more than the same number of boundary disputes. These are the results of loose wording in the boundary definitions originally laid down by Spain and Portugal for their old colonies.

Her great strength lies in the vast spaces lying between her land frontiers and her centres of population; the only frontiers open to invasion are those between Brazil and Uruguay, Paraguay and Argentina, and they have been stabilized by treaty. Her sea-coast of some 4,000 miles has a number of important and commodious harbours, which are well connected by rail to the centres of industry.

Brazil has had two successful wars, firstly with Argentina over Uruguay and secondly with Uruguay, but, even so, the feeling of patriotism is rendered to the province, of which there are twenty-two and all independent, rather than to the nation.

Her population consists of whites, Indians, negroes and half-castes: there is no colour line. It is therefore only in some very great crisis that a strong spirit of national unity and sacrifice could be aroused: her only rivalry is with Argentina.

She is essentially an agricultural country and is self-supporting in foodstuffs except wheat and flour, but has corn and rice instead. Her products are principally coffee, sugar, cereals, meat, hides, cotton, rubber and manganese ore, but almost all war requirements must necessarily be imported. Brazil's natural wealth and resources make her financially sound in the long run, but at present her huge national debt makes her present condition uncertain: she could not begin a war without very large foreign loans.

Roads and railway service are poor, except near the large centres.

The country is divided into seven military districts, under a divisional general, but the organization is weak. Every male at the age of 21 is conscripted, the usual service being two years with the colours, seven in first-line reserve; seven in second-line reserve and eight in the militia. The strengths in 1925 were 40,000, with a trained reserve of about 70,000 more: mobilization is estimated to collect half a million, but the law is so unevenly enforced that the actual war army is a very uncertain entity. A division would consist of two infantry brigades, an artillery brigade, a regiment of cavalry, a battalion of engineers and an observation battalion consisting of air, communication and transport troops.

A war against another South American state might be a long affair, as the enemy might have great difficulty in finding and pinning any definite defensive force, owing to the great distances to be traversed and the lack of communications.

An interesting experiment was carried out in Texas when a troop of cavalry, "completely horsed and equipped at all times, ready for such "mounted tactical missions as might be assigned them, during or upon "completion of the journey, was moved by motor trucks a distance of "300 miles over rough country in 36 hours." At the end of the journey, horses and men were reported as being in "good physical shape for any "kind of military duty." Fourteen trucks and a tank were employed: the route passing over country roads and a seventy-five mile stretch of hilly country. 160 miles were covered the first day and 140 the second.

On another occasion a Field Battery was moved 700 miles in a similar manner.

The United States Ordnance Board is said to be completing tests with a self-directing anti-aircraft gun: a microphone in connection with a

sound locator first swings the gun towards the source of the sound and then fires it. The secret of allowing for "lead" or "lag," however, is well kept, and the actual results of fire are still in the future.

The following guns are also being developed :—

a. 75 mm. pack howitzer—six load parts—9,200 yards range—15 lb. shell—traverse 6°.

b. 105 mm. divisional howitzer—split trail—12,000 yards range—33 lb. shell—traverse 45°.

c. 75 mm. divisional gun—split trail—14,800 yards range—15 lb. shell—traverse 45°.

d. 4·7 in. corps gun—split trail—20,000 yards range—50 lb. shell—traverse 60°.

e. 155 mm. corps howitzer—16,400 yards range—95 lb. shell—traverse 50°.

f. 155 mm. army gun—two loads—26,000 yards range—95 lb. shell—traverse 60°.

g. 8 in. army howitzer—two loads—18,700 yards range—200 lb. shell—traverse 60°.

D.M.F.H.

HEERESTECHNIK.

(*April*, 1927.)—*Barrel-strain caused by Firing.* An article written by Dr. Schwinning, of the Technical School, Dresden, for the Artillery Proof Committee, in 1918, in which he investigates strains in barrels, simple and compound. The Author, as far back as 1909, worked out the main features of a process for making simple tubes having the properties of layered barrels; but nothing came of it in Germany. It has now attained practical importance abroad under the name of "autofrettage."

Construction and Effect of Aerial Bombs (*continued*). Major Justrow considers the effects of aerial bombs under (1) Impact effect, (2) Splinter effect, (3) Poison effect of gases of detonation, (4) Pressure effect of the same, (*a*) local, (*b*) at a distance.

As regards (1) he finds aerial bombs from 12 kg. to 1,000 kg. far inferior to the common types of shell from 10·5 cm. to 42 cm. He then points out the ineffectiveness of bombs against armour, and gives figures for percentage of hits in American trials against the various types of surrendered ships, deducing therefrom that from a height of 13,000 feet, under battle conditions, aircraft has practically no chance of hitting a ship under way.

Another deduction is that great energy of impact is not in itself an object to be striven for, but only an accompaniment of the high velocity necessary to improve marksmanship. Apart from this only sufficient energy of impact is required to pierce the target and thus allow a delay-action fuze to bring about the bomb's maximum performance. Houses are the chief target requiring penetration. Bombs must not explode on striking the roof, but must be provided with both instantaneous action on hitting pavements and road-surfaces and delay-action for penetrating roofs. Requirements are: against living targets, splinter-effect; against buildings, a large quantity of explosive, in order to obtain

pressure of detonation gases. Against a railway bridge, the iron members of which to a great extent escape the gas-pressure, destruction is best effected by a bomb combining powerful splinter-effect and gas-pressure. The size of bombs depends on the nature of target, but the size should not be increased unduly at the expense of the number of bombs carried. The container must be strong in the head and in construction generally, so as to stand the impact, but, apart from this, there is no necessity for great strength as is the case with gun shells. The larger a bomb, the greater in proportion is the charge, varying thus from 40 to 70 per cent. of the total weight. Bombs for use against troops and dug-outs should correspond in effect to the 7·7 cm. shell.

(*To be continued.*)

Russian Views of Constructional Measures for the Protection of the Inhabitants of Towns against Air Attacks (continued). The same view is adopted by another writer, Koshewnikow, who, in a treatise on this subject, holds it as quite incredible that civilian building should, in naïve and innocent lack of understanding, persist in its standpoint that it is not concerned with war. He thinks that the only explanation for this failure lies in the absence of a sufficiently strong impulse towards a correct understanding, such as would have been given by the air-bombardment of Berlin, projected and prepared by the Entente Powers for 1919. For the planning of towns in future and for the improvement as much as possible of existing towns, Koshewnikow lays down many principles, based upon an axiom that the degree of destruction by air-bombardment will be directly proportional to the degree of crowding together of the buildings and to their height. They are:—

(1) The crowding together of buildings cannot be permitted; towns must be decentralized.
(2) Houses may be extended down, but never up.
(3) There must be as many as possible trees, gardens and parks.
(4) Underground railways (as projected in Moscow) and underground cinemas, as gas-shelters, are recommended.
(5) The proportion of the area of streets and open places to the area covered by buildings should be increased to 1 : 1.
(6) All streets to be made as broad as possible.
(7) Main streets to be laid out S.W.–N.E. so as to be swept by the prevailing wind.
(8) Houses to be built at least the distance of their own height from the street and from each other.
(9) In crowded towns no old or burnt-out houses to be replaced.
(10) Artificial pieces of water and fountains are recommended at the ends of main streets.
(11) Blind alleys and places where gas can collect to be opened up.
(12) Government offices not to be in large buildings in the centre of the town, but in groups of smaller buildings in spacious and inconspicuous surroundings.
(13) Regularity of line to be avoided in planning, so as to make identification from the air more difficult.

As regards the houses themselves:—

(1) No building to have more than three storeys above ground.
(2) The rules for foundations, walls and floors, to be as in earthquake areas.
(3) Cellars, or where they do not exist, stairways are to be fitted up as gas-shelters.
(4) The subterranean portion of new buildings to be covered with reinforced concrete.
(5) Glass windows in gas-shelters and stairways to be replaced by triplex in iron frames.

If many of Koshewnikow's proposals sound at first too utopian, it must still be conceded that, owing to the rapid advance of science and technics, what seems fantastic to-day may become reality to-morrow. It is equally certain that, in the present rising Russia of the Soviet Union with its wide and thinly populated spaces, where the State is sole owner, many a measure is capable of being carried out which simply cannot be taken into consideration by West European nations. An interesting case in point is the new capital of Siberia at what used to be called Novo-Nikolaievsk, which has been almost stamped out of the ground.

The Author of yet another treatise on this subject, Truchatschow, takes a more definite standpoint. He says that, as it takes 12 feet of reinforced concrete or 60 feet of earth to afford protection against a 2-ton bomb, no state can face such provision. The only rational method for large towns, say, Moscow with 1½ million inhabitants, is to build a deep underground railway network, capable of evacuating all the inhabitants of a sector of the town in from 35 to 40 minutes, and large enough to afford accommodation for the whole of the inhabitants.

As this system is obviously inapplicable to small towns the following measures are recommended:—

(1) The cellars of the most massive buildings to be registered with their capacities, and preparations made for strengthening them.
(2) All subterranean passages to be opened up and put in order.
(3) Suitable places to be chosen for galleries to be mined and the necessary material prepared.
(4) All telephone, electric light and power cables to be put in underground.
(5) Businesses which it is necessary to carry on above ground to have their premises strengthened and camouflaged.

As regards defence against gas-bombardment from the air Truchatschow distinguishes:—

(*a*) The prevention of gas from penetrating into occupied places.
(*b*) The localization of the effect of gas by making its spreading more difficult.
(*c*) The removal of gas.

For all these cases, provision should be made of fresh air to the whole town from gas-free districts outside the town, and also for sucking out infected air.

As the tubes necessary to provide the fresh air may need to be as

large as two metres in diameter, the underground railway system must be used for this purpose. Systems of smaller tubes for distributing fresh air are to be laid down in peace and might be made available for the post office pneumatic parcel service.

(*To be concluded.*)

Construction and Effect of Aerial Bombs (continued). For the effective destruction of factories, railway stations, large bridges, etc., the bomb with great splinter-effect is not suitable. Here it is better to use the bomb with a large quantity of explosive. Ideas as to the necessary size of these mine-bombs vary considerably, inasmuch as no simple method of comparing effects has as yet been laid down. The largest bomb in the War was the German one-ton bomb containing two-thirds of a ton of explosive, but since the War the United States have produced a bomb intended principally for use against battleships and containing nearly one ton of explosive.

In mine-bombs, both splinter-effect and poison-effect are entirely subordinate to pressure-effect. The most difficult task remains, viz., the determination of the destructive radius of the air-pressure wave of a detonating bomb. TNT, Picric Acid, and other explosives, which were used in the War, had detonation-velocities of over 6,000 metres a second.

It stands to reason that the more rapidly the explosive detonates, the more gas is formed in unit time and the greater is the blow. We must, therefore, be prepared for the development of explosives for mine-bombs along the line of increase of detonation-velocity, as well as increase of volume of gas and increase of heat. This does not apply to splinter-bombs nor to shells, where such an increase would mean breaking up into smaller fragments than required, and an increase of sensitiveness which would make the explosive unsafe for shells. The detonation-velocity of, say, 6,000 metres a second is not transferred as such to steel case or to surrounding air, but the gases formed by the explosion and the amount of heat set free produce an enormous pressure which is transferred to air and earth. It is not possible to measure this enormous pressure at the place of its origin, as no instrument could stand it, but it has to be deduced. Hopkinson, Landon and Quinney, worked out a pressure of 120 tons to the square inch, but the Author, basing his opinion on the tension required to tear in two a steel rod, considers this figure far too low. Using Waals-Abel's formula, he works out for TNT 540 tons to the square inch even when its density is as low as 1.

A chart of seismographic records of explosions shows how the ground-waves with their small amplitude arrive first at the recording station, followed by the air-waves with their large amplitude heavily damped. An attempt is then made to check, by means of pressure measurements of various explosives, the different formulæ propounded, viz.:—

$$\text{pressure} \propto \frac{1}{\text{distance}}; \quad \text{pressure} \propto \frac{1}{\text{distance}^2}; \quad \text{pressure} \propto \frac{1}{\text{distance}^3}$$

(Berthelot's formula) (Rüdelberg's formula)

and the results are summed up as follows:—The initial shock of an

explosion is approximately proportional to the size of the charge; the pressure at the seat of explosion is extraordinarily high; at first it falls off very quickly, being inversely proportional to the square of the distance; from 4 metres' distance to 500 metres' distance, the pressure is inversely proportional to the distance.

Practically, this means that at 500 metres from an explosion of one ton the pressure is ·04 kg. per square cm., or sufficient only to break windows, while at 50 metres from the same explosion the pressure is 3 kg. per square cm., or sufficient to knock down a thin brick wall of large surface.

The Author deduces that a small concrete shelter sunk in the ground with walls half-metre thick is proof against the air and earth pressure-effects of the largest known bomb, provided that the bomb bursts at a distance from it greater than the radius of the crater.

(*To be concluded.*)

Russian Views of Constructional Measures for the Protection of the Inhabitants of Towns against Air Attacks (concluded). If it is not possible, for financial reasons, to make a central ventilation system for the whole town, there must be provided smaller systems for single buildings, with the twofold object of producing the requisite excess of pressure in the living-rooms and of drawing the infected air away from the house. It is in this second object that Truchatschow goes farther in his demands than Pavlov. The air to be forced into the living-rooms, except when it is taken from a great height, must be passed through a gas-filter. Together with these measures, Truchatschow considers necessary the issue by Government of regulations for the planning of towns in such a way as to provide ventilation and to remove from town-design everything likely to cause gas to accumulate.

As the first real impulse to creative activity of Russian town-builders and architects, and for the awakening of constructive thought in this direction, he proposes a competition. It is interesting to note how quickly this idea was taken up. In the programme of the Defence Section of the Aviachim appear the following tasks:—

No. 13. "The working out of a plan for the building of towns and large Government establishments in accordance with the demands of air-chemical defence."

No. 14. "The working out of practical measures for the collective gas-protection of dwelling-houses and public buildings in association with the organs of the People's Commissariat for Internal Affairs."

From the foregoing it becomes clear what importance is attached in Russia to the problem of the protection of important towns and centres against air-attacks by gas and explosive bombs, and what possibilities are being considered in solving it.

And what of Germany? The Author laments that no German "Aviachim" for stirring up the authorities and the people has yet been formed and that it is only in *Russia* that people think of what steps might be taken in Germany to protect the inhabitants of towns against the new air and gas weapon which continues to develop increasingly.

(*June*, 1927).—*The Gauge-proving Shops at Spandau Arsenal and their Importance to the Army* (concluded). In proving gauges the principal points to be attended to are temperature, pressure of application and contact-errors. As regards temperature, the standard metre is the distance, at the temperature of melting ice, between two lines on an iridio-platinum rod kept in Paris. The standard metres of other nations, which have agreed to the metrical convention, are of the same material and form. Their errors have all been determined. The standard-metre in Germany, for example, is ·0017 mm. short.

As regards measuring-pressure, in the case of bullets and other objects of small cross-section, owing to flattening the pressure of application should be zero. Older types of measuring machines allow of pressure from 3 up to as much as 7 kg., but Zeiss, the optical instrument-makers, who lead in these matters, work with their latest machines to a pressure of 150 grammes (5·3 oz.).

As regards contact-errors, the making of a perfect surface, either plane or cylinder, is impossible. By most accurate measurement with the appropriate instruments there will always be found slight deviations which cause surfaces, which should fit together, to fail to touch at every point. This distance apart is called the contact-error, and varies according to the degree of finish and to the size of the surfaces in contact. With equal degrees of finish, the contact-error is largest when tested by surface-contact, less with line-contact and smallest with point-contact. If a cylindrical bore is measured by these three different methods, three different results will be arrived at, and up to the present no correlation has been possible.

The article concludes with some general remarks on the proving of gauges, but says that, as far as gauges for the Army are concerned, they differ so widely that no general instructions for proving them can be given. Each case must be separately considered, before deciding how the proving is to be carried out in the most appropriate manner and most correctly.

Automobile Development in the United States and in Germany. The occasion of the annual publication by "Automobile Industries" (February number) of the latest statistics about automobile manufacture in all countries is utilized by Dr. Stadie for making deductions as regards types of cars and prices, engine-details, number and size of cylinders, revolutions, braking and tyring, and generally as to the trend of manufacture. An increase of 3·7% in the number of automobiles produced in the U.S.A. and Canada during the year under review, as compared with a 20% increase the year before, points to the saturation of the American market, and indicates that the maximum production of the U.S. automobile industry has been reached, if not passed. We must be doubly armed to resist early American efforts to capture European markets.

The Construction and Effect of Aerial Bombs (concluded). Major Justrow sums up:—Increase in size of bombs is tempting when one observes their powerful local effect. Further, since with increased efficiency of A.A. defence the height at which the bomb is released must increase, and therefore its chance of hitting diminish, a large distance-

effect of the bomb which does not get a direct hit, is desirable. This latter argument, it is true, applies to us (Germany) and not to our enemies, who will have no successful A.A. defence to reckon with. Against the larger bomb can be urged that less hits per trip can be obtained, and although the local effect is directly proportional to the size of the charge, the distance-effect falls off very much. The author thinks that the 1-ton bomb brought out before the end of the War was already too large, and that the smaller destruction effect of a 300-kg. bomb is more than compensated for by there being three chances of hitting instead of one. This question has got to be decided by the various nations, but it seems to him probable that the bomb of 1-ton and over will be reserved for special tasks, *e.g.*, the destroying of a pier of the Rhine-bridge by a direct hit. He considers that also in the choice of medium and small bombs limitation is the key-word—a 300-kg. bomb for specially important and extensive targets, *e.g.*, factories, a 50-kg. bomb for fortified towns, dug-outs, etc., a 12-kg. splinter-bomb, and perhaps a quite small hand-grenade for use against aircraft, might fulfil all requirements.

What of the targets? The most paying are ammunition-dumps, either at home or in the field, explosive-factories and shell-filling establishments. A well-aimed small bomb (50 kg.) may wreck a whole ammunition-depot, a whole explosive-factory. Such places on account of expense cannot be protected against bombs. They can only be camouflaged and built so as to localize damage and explosions. Other important targets are large factories, especially their power-stations, iron railway-bridges, large railway-stations, fortified towns, shelters, etc. For all of these sufficient protection from above is hardly possible on account of the enormous expense. The destruction of a single building will not as a rule put a whole factory out of action, unless that one building is the power-station. The latter must, therefore, be camouflaged, and it is even worth consideration whether it should be given reinforced concrete protection.

Generally, it may be said that the ever-growing fear of air attack should drive only the human being underground. It will only be in the rarest instances that arrangements can be made for works to be carried on under earth protection. How far powerful elastic nets over important buildings afford protection against bombs has not yet been proved by trial. As regards river-crossings, the author says that an armoured roof over a bridge would come more expensive than an alternative bridge (which may be doubted), and that in any case it cannot be made absolutely safe.

As regards the protection of people, it is not possible to guard them against direct hits of large bombs. Of these they must take their chance. Half-a-metre of reinforced concrete will probably suffice against direct hits of bombs up to 50 kg. Shelters of this nature, as numerous as possible, small, well-distributed and easily accessible, must be provided where, owing to the importance of the establishment, repeated attacks are to be expected, and where crowding together cannot be avoided, *e.g.*, in important factories, gas and electricity-works, railway-stations, etc. The existing subways of the latter can be comparatively easily made into shelters.

For the remainder of the population cellars will have to suffice, but in order to meet the case of the upper storeys falling and blocking the cellar-entrances, fresh cellar-exits will have to be provided leading direct into the open air. One should never lose sight of the fact that the best and cheapest protection for men and buildings against the air lies in the active and passive defence of our aircraft and guns.

Lendvay's Protractor. The firm of G. Thiemann, Berlin W.50, Marburgerstrasse 16, has put on the market a combination of dividers and protractor, designed by Major von Lendvay, of the Hungarian Army, and intended for the use of officers reading maps. The dividers can be used up to a 6-in. span, and the whole can be carried easily in the waistcoat pocket. One compass leg ends at the top in a circular plate, half of which is graduated in degrees and the other half, for artillery purposes, in 320ths of four right angles. A separate plate with four pairs of points at fixed distances apart (·5, ·8, 1 and 1·3 cm.) can be fixed by means of a screw at the centre of the protractor, over the edges of which any required pair of points can be pushed forward. Distances and scales are marked thus—between one pair of points " ·8 " means that the points of this pair are ·8 cm. apart. On the right " 100 " and on the left " 12·5 " mean that this distance represents 100 metres at a scale of 1 : 12,500. And so on for other scales and for other pairs.

One compass leg is graduated in millimetres, the other is flattened and serves as a stencil for marking on maps column of route, march-lengths of brigade, battalion, etc., and is provided with scales of metres and of paces at 1 : 75,000.

The French Regulations for the Training and Employment of Engineers, 1926. It is instructive to see how these Regulations strike the German reviewer.

The difficulty about the training of the French Engineers, which include the Signal Service and Railway Troops, is their manysidedness. Generally, it is sought to surmount this difficulty by posting to the Engineers recruits who have had appropriate previous training in civil life, and also by specializing, *i.e.*, by forming Engineers of various main types and not training all Engineers in every branch.

The wider this specialization is, the greater becomes the total number of Engineers necessary. As a counter-measure, it is attempted, in addition to a man's special training in his own branch, to give him enough training for him to be able to take his place as an assistant in other branches. Comparing this with Germany, the author complains that owing to the limitation of the Engineer arm (14 Engineer Coys. to 10 divisions), forced by the Treaty of Versailles and the subsequent decisions of the Inter-allied Military Control Commission, specialization could only be undertaken to a very limited extent. It is true that 14 Signal Coys. were also permitted, which could be diverted as Engineers, but railway troops had to be entirely renounced.

The Germans were obliged to hold fast to the Universal Engineer, capable of undertaking every kind of technical work, and even to develop him so as to keep abreast of the advance in civil technics. In the face of the Engineer's plethora of tasks, the German long-service (12 years), so far from being a set-off, acts disadvantageously in that it keeps away

the very person needed—the tradesman. A noticeable example of this is in the Bridging branch, in which the watermen, even in 12 years' service, do not attain the proficiency of the so-to-speak born waterman, while the French, with their short service, have at their disposal strong well-trained and intelligent recruits taken from a numerous and capable class of watermen, trained on their many canals and on the swift rivers of the Western Alps.

The short period of service in the French Army makes specialization in the Engineers the best system, and they are still able to give their specialists sufficient training for them to be of use in other branches. "If one recognizes as correct the dictum of an Englishman that 'that nation has the best chance of winning the next war which can change with the least friction its peace economy for carrying on war, and bring every man to that spot where, in accordance with his peace activity, he can employ his powers in the most effective manner,' then the French have, with their specialization in Engineer-training and their systematic distribution of tradesmen-recruits, approached very closely to this ideal."

After this piece of very high praise the reviewer takes exception to the inclusion in Part I of a special drill for the Engineers—with a special weapon, the carbine—holding it better to do as the Germans do, *viz.*, equip, train and drill the Engineers as infantry. This may safely be conceded, not only because of such help as Engineers may in exceptional cases afford by acting as infantry, but chiefly because it ensures that the Engineer will understand the principles of infantry action.

An introduction to the Regulations formulates the principles which guided the commission of four senior officers who collaborated in writing the book. While recognizing that national feelings and ideas must govern in these matters, the reviewer, instead of the French idea of convincing the subordinate of the necessity and appropriateness of his orders, so as to obtain from him the utmost obedience, prefers the German way of basing "even now" the obedience of the subordinate more upon his sense of duty and will than on any conviction.

He finds it also "characteristic" that the commissions charged with writing Engineer-manuals were presided over by infantry-officers (divisional commanders) and included each an artillery officer. This composition, however, he considers justified on the grounds that the Engineer arm exists for the purpose of serving the fighting arms, of which infantry and artillery are the chief.

In a report to the Minister of War, mention is made of the changes in Engineer establishments since the War, *viz.*, considerable increases in Telegraph troops and in Bridging troops, the re-inclusion in the Engineers of Light Railway troops and the raising of special electro-mechanical, heavy bridging and water transport units. The reviewer states that these changes coincide with what the Germans had also worked out from war-experience as necessary in their own army. He points out that the omission of Gas and Flame-projector units, in accordance with the Washington Agreement, by no means implies an unconditional renunciation of the weapons concerned, and thinks it would be better to reckon on these Engineer branches being also represented in the French Army.

The remainder of the instalment consists of an interesting résumé of

the contents of Part I, but without any comments or comparisons with the German Army.—(*To be continued.*)

Petroleum and the Air Force. " L'Aérophile " is quoted to the effect that the great difficulty of providing the French squadrons with petrol during the War is no secret. The story is still told in certain circles of a ship which arrived from India with a cargo of castor-oil, the opportune arrival of which alone saved a cessation of activity in the air. Thus the French Air Force was for some time at the mercy of a German torpedo. This lesson of the past is not forgotten, and the Cabinet will certainly bear it in mind as soon as they are occupied with the question of the Petroleum Monopoly. The questions to be asked of the War Ministry are :—Is our Air Force completely dependent upon foreign countries for petrol? Have we sufficient provision for war? Can we in war make certain of replenishment?

(*July*, 1927).—*The International Motor-lorry Exhibition at Cologne, 20th–31st May*, 1927. This was the first international exhibition of automobiles in Germany for fifteen years; in spite of which very few foreign exhibits were sent. Dr. Stadie attributes this to the facts that in this particular branch—as opposed to cars—Germany has already recovered her pre-war lead. He makes certain deductions based upon the statistics of the Exhibition :

(1) Germany evidently strongly inclines to the heavier type, over 80% of the exhibits being of over 2 tons, whereas the latest returns from the U.S.A. show that 96% of all motor-lorries are tenders under 2 tons.

(2) The best method of coupling, decided as regards cars with the dry multiple plate, is not yet decided in the case of lorries, where cone-clutches are still plentiful.

(3) The lorries tend also to go over to six cylinders.

(4) The question of valves is also not yet decided with the lorries, of which 58% still have the hanging valve.

(5) The most popular lorry is the 3–3½ tonner, as evidenced by the greatest number of types shown (11), and by the fact that only three of the leading firms, Daimler, Hansa-Lloyd and Vomag failed to put in one of this type.

The Trying-out of Substitutes for Petrol in France. A list is given of the cars which took part in the Automobile Club de France race of 1,700 miles, which occupied 13 days of March and April last year. Half of the total starters were lorries, viz. : 3 Panhards, 2 Renaults, 3 Berliets, 1 Le Dion, 1 Peugeot and 2 others. These were exclusively gas-driven, burning wood, wood-coal or Carbonite (a compressed wood-coal). The remainder were : 1 Ford and 2 Citroën cars, using Acetylene ; 2 Peugeot cars using Pétol (? Ketol, a product of cellulose) ; 1 car using Heavy Oil (" Held " engine) ; 1 car on compressed Methane ; 1 car on pure alcohol ; 1 Government car on Methyl Alcohol ; 2 Army cars using Benzol-spirit mixture.

Lectures and demonstrations were given at various places en route. Communication of the results of the trial was promised after full investigation.

Safety Arrangements in the Storing of Ammunition, by L. Stegmann. Germany, having been obliged under the Peace Treaty to destroy almost all her remaining ammunition supply, has at any rate been spared the large accidental explosions which have taken place in other countries. Lessons are, however, to be learnt from these accidents, and their teaching should be compared with what we formerly considered necessary for safety in these matters. The largest disaster of this nature occurred at Lake Denmark, U.S.A., on 10th July, 1926, and a full report of it is given in " Army Ordnance " for Sept.–Oct. of that year.

Fire was caused by lightning-stroke at 5.15 p.m. in temporary store-house No. 8. Black smoke poured out at once, and at 5.20 the store blew up, followed five minutes later by temporary store-house No. 9, which stood next to it in the same line of buildings, and 36–37 metres away. Many other explosions followed, some larger, some smaller, the most severe being that of shell-house No. 22, situated 580 m. from No. 8, which occurred at 5.45 p.m.

The report of the Court of Enquiry was divided into three parts, *viz.*: 1. Finding of Facts. 2. Opinions. 3. Recommendations.

The Court found that the buildings were provided with lightning-conductors and that they were in good order. They added, however, a rider that all metallic parts of buildings and also all metallic contents of buildings, should be earthed, so apparently these important safeguards had been omitted. The necessity for this precaution lies in the fact that these masses of metal serve to form induction currents, the effect of which has often been to cause greater damage than the lightning-stroke itself.

The explosives stored in No. 8 did not go up immediately the lightning struck, but five minutes later. This shows that the lightning first set fire to some inflammable stuff, and that two different kinds of explosive were stored in the same building. The Court of Enquiry's first recommendation was that this practice be avoided in future. The German Regulations for Practice Ammunition forbade this originally in 1906, but have since been modified to the extent of laying down what particular kinds of ammunition may be stored together.

An appendix to the report contains observations of the effect of the explosions on the buildings of Picatinny Arsenal, in the neighbourhood of Lake Denmark, from which it appears :—

(1) That, after windows and doors, roofs suffer most.

(2) The better the roof holds together, the more damage is done to the walls.

(3) Walls and partitions in order of resistance starting with the weakest : corrugated-iron sheeting, wooden panelling, brick walls, XPM, stone walls, reinforced concrete.

(4) Store-houses that were nearly full offered greater resistance than empty ones.

Based upon the foregoing and upon his own experience, the writer then lays down his own conclusions. He considers it of the greatest importance to choose materials for walls and roofs, so as to exclude as much as possible the formation of wall-splinters and of air-pressure waves. A charge of powder burning in the open air develops only quite slight air-pressure; with modern powder there is even none at all. The more, however, a charge of powder is enclosed, *i.e.*, the smaller the admittance of air to the space in which it is burning, the greater the development of energy. In Germany, peace powder-houses were built accordingly. The external walls consisted of a rammed mixture of chalk and sand, and were only just strong enough to carry the roof, windows and doors. Inside they were plastered with cement mortar, outside with a good hydraulic mortar, and also oil-painted. The roofs were made of light woodwork, and carried over their planking powdered pumice-stone and an outer layer of mill-board. If a building like that was blown up, it would dissolve into a cloud of dust—forming no splinters and allowing no appreciable air-pressure to develop. Unfortunately no such instance is known, but two of these powder-stores had to be removed to make way for other buildings, and yielded to dismantling very easily. Where the danger is less, as in shell-stores, the whole building has been made of reinforced concrete, and in some cases the two methods have been combined, *i.e.*, a reinforced concrete framework has been built with partition walls and roof, as for a powder-house.

The more dangerous the stores the smaller should be the store-house. The 1926 Regulations lay down that one or two walls are to be built lighter than the others, so that the air-pressure waves may be sent off in the least dangerous direction—presumably, when such a direction exists! Ventilation is of great importance to prevent the collection of inflammable gases through possible decomposition, but also in order to keep down the temperature inside the buildings and to avoid "sweating" on the walls. Ventilators should be provided just above ground-level, and also under the eaves.

At Lake Denmark, buildings sunk in the ground proved their value against air-pressure waves, but they introduced difficulties of drainage, ventilation and the loading and unloading of stores. Also at Lake Denmark the protection afforded by natural rises in the ground was effective. Where such do not exist, earth-parapets can be built up, but these are such a hindrance to traffic that it is better to space the stores well apart (50 metres) with a considerable distance (500 metres) between the depot and administrative offices, quarters, shops and power-station. Such intervals should be planted with trees, conifers for choice, since deciduous trees afford little protection in winter, and their leaves when dry are a danger as regards the outbreak and passing on of fire. The subject has a dual aspect, the guarding against explosion and the minimizing of its effects when it occurs. The latter province is the Engineer's own; in the former he has an all-important part, but the rest is left perforce to the "care and conscientiousness of the ammunition personnel."

F.A.I.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

JULY—AUGUST, 1927—(*continued.*)

Technical Weapons and Services (continued). Lieutenant-Colonel Paschek, having given us in the last number a list of the tasks devolving upon Engineers, now gives us his ideas of how they should be organized.

A. In the Division.

The Engineers of a Division consist of a Pioneer battalion (H.Q. section, 3 ordinary coys., 1 specialist coy., 1 park section, 1 stores section, 2 light Pioneer columns with 2 rapid bridges). If the Division is acting independently, a Construction battalion is added (H.Q., 3 to 4 Construction coys., and 1 light Construction column). The ordinary coys. of the Pioneer battalion are organized for quite independent use, and also half-coys. and sections can work independently. Divisional Pioneers, as compared with Brigade Pioneers, carry heavier tools, more explosives and tank-mines and more technical equipment for close-quarter fighting, obstacles and temporary bridges, also 1 or 2 m.g.'s for ground and air-defence, rams, field forges and, where possible, a power plant. The travelling equipment is limited by the fact that the vehicles have to conform to the fighting transport, and must always be kept down in numbers.

The Specialist coy. would, as a rule, contain a chemical section, a search-light section, a camouflage section, and a fourth section corresponding to the special needs of the field of operations, *e.g.*, a stone-borer section. In the first section are troops with gas-projectors and medium flame-projectors, in the second section are worked light and medium incandescent and arc-lights (25 to 60 cm.). The camouflage section is equipped for works on a fairly large scale. Stone-borer sections are equipped for working electrically or pneumatically. The transport is on a larger scale than that of the ordinary coy., so that possibly some of the equipment will have to be included in the Pioneer column.

The Bridging columns are for bridges for opposed crossings. The rapid foot-bridge equipment is to take infantry, cavalry and cyclist-detachments, mountain-batteries and quite light armoured-cars. It is in certain cases handed over to the fighting troops and erected by their Pioneers. The Bridging column also carries materials for all types of wooden bridges and of divisional bridges for the forward area, especially for the neighbourhood of the enemy. Loads are to include all weights of vehicles within the independent Division or within the Corps: 4″ guns, 6″ howitzers, 8·4″ mortars, laden 3-ton lorries (many countries demand 5-ton) with trailers, and at least light tanks. M.T. is desirable, with the possibility of transference to H.T. A column to carry up to 140 metres' length of bridge would require 10 ordinary and 30 moderately heavy wagons. In case of need the whole can be packed on M.T.

The Pioneer column carries in 20 to 30 medium wagons, or a less number of lorries:—(*a*) In any case, a portion of the special equipment of the Pioneer battalion, including a fairly large power work-shop

(*b*) Supplementary stores, tools, explosives, camouflage, and consumables for all units of the Division, and reserves of the same. Two important points are that the column must carry equipment already prepared for temporary bridges and that it cannot dispense with a certain number of technical personnel, say, one section for the three columns.

The Construction coy. carries almost exclusively earthwork and woodwork tools, which simplifies also the Construction column of the battalion. This column, which carries also a reserve of entrenching tools and construction material for the fighting troops, is in any case to be estimated as 40 medium H.T. vehicles strong.

B. In the Corps.

The principal Engineer unit in the Corps is the Pioneer Regiment.

Other units are: An independent battalion of Pontoneers for opposed or rapid crossings on a larger scale; at least one regiment of Construction troops; and—as far as they are organized separately—Road construction battalions and Corps tool columns, similar to those of an independent Division. Each Division must keep one battalion of G.D. Pioneers permanently allotted to it. Even the French, who are so much given to centralizing, do not depart from this.

C. In the Mounted Division.

As the fighting methods of the Mounted or Light Division do not differ widely from those of the Infantry Division, the duties, composition and equipment of their Engineers will be the same, but more M.T. is necessary, and for the whole of the Tool columns it is essential.

D. Army Pioneers.

Army Headquarters and General Headquarters need Engineer units:—

(*a*) As reserves to allot to army units or to armies.

(*b*) For the very large constructive services in their own areas. This applies also to the case of L. of C. areas, where formed, and in any case for the administration of back areas. The rule is that, the farther from the front, the less is it necessary for such organizations to be military and the more they pass into the administration of the state and of private undertakings. This is most in evidence in the home country.

(*c*) For technical assistance to all portions of the Field Army. Accordingly, we find among army pioneers the same pioneer-formations as among the components of the Army, together with special ones available for allotment elsewhere or used by the Army itself. Reserves of personnel are kept here in great numbers and divided up into many branches. They make it possible for the number of pioneer troops, commands and establishments to be increased, or for new ones to be created, which experience shows to be often necessary. Similar to the pioneers of the armies, are retained at G.H.Q. about one Pioneer regiment and at least one Construction regiment *per* army, also Divisional bridging columns in varying numbers. Regiments and battalions for road construction and in every case for railway construction are increasing in number.

The following are specialists: Pontoneer bns., chemical bns., technical close-quarter fighting and miner coys., search-light coys., camouflage coys., and finally motor-boat coys. and river-running coys. The composition of their chemical warfare troops is kept by the nations particularly secret. Search-light coys. are medium and heavy (60 cm. and 150 cm.). The camouflage coys. are for camouflage tasks on a large scale. The close-quarter fighting and mining coys. are principally intended for position-warfare. There is a disinclination to provide fortress-engineers proper, since modern permanent fortification is chiefly a matter of scattered and camouflaged "Fortified Zones," and the fighting for such does not differ so much as formerly from the attack and defence of field-positions fortified for prolonged occupation. For the still remaining permanent barrier fortifications we need at most the provision of special material, but not of special personnel.

Motor-boat coys are provided by G.H.Q. for large and difficult undertakings of crossings and to assist in bridge-building. They can also be used for fighting purposes on rivers and canals, and for transport. The equipment is either confined to definite large waters or is loaded on wagons or lorries. Where there are no proper river-navigation troops their duties devolve upon the motor-boat, bridging and pioneer units.

River-mining coys. for attack and for blockade have equipment columns with mines and mining accessories.

Special services are also provided, with varying organizations, by electrical bns., field railway coys., telferage coys., railway-construction coys. and heavy-bridge construction coys.

Electrical battalions work either by connecting up to local power-stations or by means of their own plant. Their composition is characteristic—two to three similar coys., each with a small amount of transport, and a very large battalion column. The coy. consists of H.Q. section, one section tradesmen, and 3 to 4 sections of auxiliary labour. The column contains a great variety of equipment for work-shops, boring, lighting, pumping, electrified obstacles, etc. Lorries are used to carry the dynamos, transformers, etc. Field-line and Telferage coys. have their equipment organized according to practical units for use (*e.g.*, the Austrian light railway section is for 30 km. of line, and 3 trains carrying 400 tons daily).

The Telferage coys. are for providing light lines in forward areas, heavier lines in back areas generally being done by civil firms. Equipment is generally held ready in wagon-loads and loaded on the military railway or on army lorry columns only when required. That of broad-gauge construction coys. remains, whenever possible, in tool units until it is used, and the same with the equipment of the Heavy Bridging coys. for army iron bridges. These bridges, after rapid foot-bridges and divisional bridges, form the third kind of bridge of the field army. The iron road-bridge carries all loads up to 17" howitzers and heavy tanks; the iron railway bridge carries all broad-gauge traffic. Both the Austrian types, Herbert and Roth Wagner, have made good.

Technical supplies *en masse* are provided by the Pioneer branches of the Army Field Stores. The latter will be arranged for at or, at least,

close to the railway, and will be as far as possible subdivided according to technical branches.

Material can partly be parked in separate wagon-loads, or it can be sent forward to smaller depots of army-formations. In exceptional cases the formation of special depots for stores required for definite tasks is justified.

The tendency is to do away with purely Pioneer parks, since generally stores have to be replaced, building-materials procured in large quantities and prepared for use, so that Engineer work is inseparable from storing. Such work is done by the Army Artificer Coys., assisted by Labour Coys.

Peace-Organization.

Peculiar to the Pioneers is a peace-organization into regiments (English brigades) and independent battalions, which makes training as simple as possible. Over these are group-commanders and technical inspectors, and above all an Inspectorate of Pioneers. Besides the regimental units, there are military technical schools, research and experimental establishments, instructional troops and camps of exercise, and establishments for production and assembly.

For a transition as frictionless as possible to the much more numerous and more extensive organizations of the Field Army, a very wide-embracing mobilization plan is necessary. The War Ministry must—in accordance with the laws for the general organization of the country and the auxiliary services—not only seize upon the unfit and oldest categories, perhaps for the greater part for technical services, but must also comprehend all national and private measures. The troops are altogether overburdened with reserves of personnel and material, even when parks and stores are concentrated in large depots at head-quarters.

Large nations, the armies of which are formed into groups of armies, necessarily build upon the Pioneer Brigade, which is the army engineer unit, but can also be used independently. Such a body might, in peace, include: Brigade Staff, 3 to 4 bns., construction regiments, a reserve for the special coys. of the Pioneer field bns., a reserve and a depot for park and store services with bridging and pioneer columns. In peace, each bn. of this brigade would contain staff, 4 coys., 2 reserve-detachments and 1 stores-depot for the following portions of the field Pioneer bn., 3 G.D. coys, at least 3 coys. of Infantry Pioneers, at least 6 Construction coys. and the pioneer train.

For a field army with independent divisions the independent Pioneer bn. on the same principle takes the place of the Pioneer brigade. Cavalry pioneer detachments of the mounted division should have their own peace-cadres.

General.

We have seen that the engineers of the countries which are free to develop their armies are utilizing, up to the present, all technical innovations or, at any rate, are still trying these out. The fighting arms and labour tend to become more separate. In training and in methods of working, as also with equipment, which is in many countries in a backward state, the greatest simplicity and standardization are being sought. Machinery must help.

In the next few years there are no indications as yet of revolutionizing technical innovations likely to influence Pioneer organization fundamentally. To us "conquered" (the Austrians) the most effective technical weapons are forbidden. We must the more endeavour to become masters of these weapons in imagination, since the day must come when our war-technics will once more be free to unfold.

Permanent Fortification (continued), by Colonel Schneck. In this number the consideration of the *rôle* played by permanent fortification in the Great War is extended to :—

(2) *Belgium.* The Belgian fortresses, dating from Brialmont, could not long withstand modern heavy artillery. They were thus unable to prevent the violation of Belgian neutrality, but by delaying the German advance (Liége) or by keeping German troops away from it (Namur and Antwerp) they achieved their purpose.

(3) *France.* Verdun—Toul—Epinal—Belfort, in 1914, gave the beaten 1st and 2nd French Armies the support necessary for them to hold up the Germans. Lille was surrendered without fighting, Rheims and Laon were evacuated, the quite obsolete Longwy, Montmédy, Les Aguelles fell to the German heavy artillery, Maubeuge held out for 13 days and thus contributed to the victory of the Marne ; the successful defence of Verdun ranks with the battle of the Marne in its decisive effect on the result of the War.

(4) *Russia.* The Russian fortresses were of ancient types, and so weak that the Russian plans did not contemplate prolonged defence. Nevertheless they fulfilled their purpose in serving as rally-points, in permitting the centre of gravity to be transferred, and even by a few days' resistance in enabling a beaten army to escape destruction.

(5) and (6) *Italy* and *Rumania.* These countries alone furnish no such example of permanent fortification serving its purpose as the foregoing.

Plan for closing the English Channel by means of Floating Towers.

Two floating towers, 120 feet high, 60 feet square, and accommodating a garrison of 100 men, were made in 1918 at a reported cost of £1,200,000 each, as part of a grand scheme for blocking the English Channel against German submarines by means of a steel boom. A picture of one of these towers appeared in *L'Illustration*, of the 26th February last.

Seeing in the Dark.

The British Army appears to be trying out an invention deserving of the greatest attention, which makes it possible in complete darkness to search for objects with infra-red rays and to project an image of the object, when found, upon a screen in ordinary light rays. The immense importance of such an invention can hardly be exaggerated, since the enemy can be fired at without any suspicion on his part that he is under observation.

(SEPTEMBER–OCTOBER, 1927.)

The magazine surpasses itself in this number, which, in honour of the tenth anniversary of the great break-through battle, known to the Austrians as Flitsch-Tolmein and to the Italians as Caporetto, is devoted to Mountain Warfare. The number has been extended to 176 pages, and contains 10 photographs and 25 sketches. It was not considered necessary to include an account of the battle itself, but there is an introduction on the subject by Lieut.-Colonel Horstenau, the director of the War Archives in Vienna, which is followed by detailed accounts of subsequent operations, viz., the advance of the 9th Mountain Brigade, 5th–12th November, and the fighting for Monte Grappa, 13th–16th November. It was the preservation of Monte Grappa, after the disaster of Caporetto, which saved Italy from complete collapse: while the advance of the 9th Mountain Brigade, the turning movement from the north, is remarkable in that it reached the Monte Grappa before the Italians had had time to settle into their positions, and was then diverted, by orders from the Corps, at the moment when it might have rendered service of inestimable value to the attackers.

Other historical articles are Maj.-Gen. Lempruch's "The Capture of the Hohen Schneid," an account of fighting amongst glaciers, the experience of which "has altered all pre-war ideas on the subject," and two examples of attack and defence from the Rumanian front. The remaining articles are of a general nature. Major Mikulicz discusses the question whether it is better in mountain-warfare to attack by thrust up the valley or by capture of the heights, and answers that it all depends on circumstances, but generally both forms of attack are necessary. The whole subject of mountain-warfare is then very thoroughly covered by "Mountain-guns" (with 8 photographs); "The History of Mountain Troops"; "Mountain Troops of the German Army"; "The Military Importance of Mountain-climbing and Winter-sport"; "Machine-guns in mountain-country"; "The Use of Artillery in mountains"; while Reconnaissance and Observation Services, Engineers, Aviation, Tank attack and defence, all find a place; as does also an account of Austrian mountain-warfare literature.

Of the Engineers, Captain Regele says that, in mountain-warfare, communications are their first and most important task. Without them there can be no fighting at all, no materials can be brought up to fortify a position. He attaches great importance to artillery-formations having engineers permanently allotted to them, since nothing short of this will enable the guns to get forward and into action quickly, and even single guns, when they have been able to follow the infantry closely, have often proved decisive. Engineers must have their own mule or man-carrier columns, and, as their work is particularly exposed, they must have their own anti-aircraft defence. The need of Engineers is very great in mountain-warfare, so that there must be more of them in proportion to the other arms; but, in order to get the full value out of them, they must have had mountain-training.

(NOVEMBER–DECEMBER, 1927.)

Salonica in the Great War. Captain Wisshaupt writes, in a pleasant, easy style, and yet giving chapter and verse for every important statement, the story of the development of the idea of attacking Salonica. He then considers the presumable advantages and disadvantages of such an attack, some of which are surprising. For instance, that the capture of Salonica would enormously increase Bulgarian territorial demands, to the embarrassment of their ally, Austria: that Entente troops released by the capture would certainly be transferred to the Western Front, while Bulgarian troops thus released could not be obliged, and would not be willing, to serve on any other front: that Salonica uncaptured would remain a threat to the Bulgarians, which would keep them faithful to their allies! In spite of these considerations he thinks that the Central Powers made a mistake in treating the Balkans as a subsidiary theatre, and that their front opposite Salonica was in reality a portion of their main front, as proved by events at the end of the War. Salonica should, therefore, have been captured.

The Development of Artillery Material in and since the War (continued). This instalment commences with " that indispensable artillery minimum of position-warfare and much-desired accompaniment of mobile warfare," the 6-in. How, of which the best example in the War was the 155-mm. *Canon Court* Schneider M 15. A short description is given of the British 6-in. Mk. I Howitzer, characterized as " a good and powerfully-built gun of good performance, but on the heavy side, and not so pleasing in appearance as the Skoda and Schneider howitzers."

6-in. guns and 8-in. howitzers are also dealt with, and descriptions are given of the Italian 260-mm. howitzer (Schneider), with the photograph of a battery, and of the German 42-cm. howitzer, with photograph. Two more good photographs are those of the new Danish 155-mm. Schneider-Howitzer L22, and a front view in the firing-position of the French (and American) 155-mm. G.P.F. Gun with Filloux splayed carriage.

Armoured Cars, by Major Heigl. The author deals with these under the headings: Characteristics and *Rôle*: Historical: Peculiarities of Construction: External appearance: Tyring: and shows himself to be just as accurate and full of information on the subject of Armoured Cars as he is on the subject of Tanks—or, indeed, of Artillery.

It is interesting to see a photograph of the first real armoured car, with four-wheel drive, complete armouring and machine-gun in revolving cupola, and to learn that this was offered to and turned down by the German Army in 1905.

In recounting the post-war services of the armoured car the author has omitted to mention Ireland, 1920–22, where, in action, in raids and round-ups, escort duty, patrolling, or even in carrying dispatches through country where a motor-cyclist dispatch-rider had no chance of arriving, the armoured car was invaluable.

(*To be continued.*) F.A.I.

ARTHUR FFOLLIOTT GARRETT PRIZE ESSAY, 1928.

SUBJECT SELECTED:—WATER SUPPLY ON ACTIVE SERVICE.

AN expedition is to be sent to the Crimea to capture the fortress of Sevastopol. Its strength and equipment are those of the British Expeditionary Force first landed in August, 1914 (4 divisions, 5 cavalry brigades, etc.), but local conditions are as in 1854. The expedition may land where it actually did, or at Balaklava.

You are requested to advise the C.I.G.S. as to the provision of water on and after landing.

An account of the topography and climate of the Crimea, with some notice of the water supply, will be found in *The Medical and Surgical History of the British Army which served in Turkey and the Crimea during the Russian War in* 1854–5–6, Vol. II, p. 15.* In general, in 1854–6, water was obtained from streams, existing wells and springs. This was sufficient in winter, but inadequate for 70,000 men and 10,000 horses in summer.

It may be assumed that, by sinking additional wells to sea-level, sufficient water may be obtained, except in July-August, when the streams nearly dry up and 20 per cent. must be obtained by condensing sea-water. Possibly some of the well-water near the coast will be brackish.

Any assumptions found to be necessary from want of *Engineer Intelligence* must be clearly stated to be such.

Essays must reach the office of the Secretary, Institution of R.E., not later than the **30th November, 1928.** Essays must not be signed, but each essay must bear a pseudonym, and the name of the writer, enclosed in a sealed envelope marked with the same pseudonym, must be attached.

The following are the conditions of the Arthur ffolliott Garrett prize:—

1. The prize, which will take the form of a piece of plate, to be chosen by the recipient, was instituted by Mrs. Garrett in memory of her late husband, Major Arthur ffolliott Garrett, O.B.E., R.E.

2. Qualifications of the recipient: To be an officer on the Active List of the Royal Engineers, not above the substantive rank of Captain on 1st January, 1928.

3. The essay must not exceed **10,000** words.

* By the courtesy of the Librarian, the book can be seen at the War Office Library *Professional Papers of the R.E.* have been consulted, but do not appear to contain anything on the subject.

MONTGOMERIE PRIZE.

ATTENTION is invited to the conditions under which this prize, in value about £14, is offered for competition each year.

1. The Prize is awarded by the Council of the Institution of R.E. in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. It has been decided that the Prize shall be confined to Officers on the Active List not above the rank of Substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

The following are suggested as subjects for contributions:—

(*a*) Descriptions of works actually carried out in peace or war.
(*b*) Invention.
(*c*) Design (excluding works of defence).
(*d*) Labour organization on work.
(*e*) Scientific investigations generally.
(*f*) Accounts of exploration work and surveys.

COOMBE HOUSE, CROYDON.

THE R.E. Corps Committee would again like to draw the attention of officers to the advantages granted to the Corps in the provision of Coombe House, Croydon, as a place of rest for R.E. officers and their families.

Comparatively few have up to the present taken advantage of this opportunity of a free holiday in a beautiful country house offered by the generosity of a retired officer and his wife.

Visits can be arranged with the minimum of formality either by interview or correspondence with the Secretary, R.E. Corps Committee, Room 231, War Office (if desired, through the medium of friends in the Corps).

The only condition imposed is that applicants must be in need of a change, rest, or holiday, or even of somewhere to stay when their financial resources are somewhat strained.

It is thought that the scheme offers particular advantages to officers and their wives returning from foreign service, or when on half-pay.

OFFICERS' CONVALESCENT HOME,

OSBORNE, ISLE OF WIGHT.

For Officers of the Royal Navy, Army, Royal Air Force and Royal Marines, presented to the Nation by King Edward VII.

Telegraphic Address:—"Convalescent, Cowes."

Accommodation is provided for 60 Officers.

The grounds extend to about 300 acres, with private golf course, tennis courts, and croquet lawns; and there is every facility for outdoor and indoor recreation.

Physicians and Surgeons from the London Hospitals visit Osborne regularly.

Full information can be obtained by writing direct to the House Governor and Medical Superintendent.

Applications for admission should be addressed direct as follows: (*a*) By Officers of the Royal Navy, Army, Royal Air Force, and Royal Marines, to the Director-General or Director of their respective Medical Service or Department; (*b*) by Officers of the Indian Army and Royal Indian Marine, to the Military Secretary, India Office, London, S.W.1.

Major-General *Sir S. GUISE GUISE-MOORES, K.C.B., C.M.G.*, House Governor.

King Edward VII.'s Hospital for Officers,

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This Hospital was founded by Sister Agnes in April, 1904, and is for Regular Officers of the Royal Navy, Army, Indian Army and Royal Air Force on the Active List.

No charge whatever is made for maintenance or nursing, but Officers are responsible for the payment of their physicians, surgeons and treatment. There is no honorary Medical Staff. Patients may be treated by any Physician or Surgeon on the Staff of a London Hospital.

Officers not on the Active List can be admitted by arrangement, when the case is suitable.

Officers wishing to be admitted, or requiring further information, should write to Sister Agnes, 17, Grosvenor Crescent, S.W.1., or call between the hours of 11 and 1.

Officers are asked to subscribe 10s. or more annually. Subscriptions may be sent either by units or by individuals, to Lloyds Bank Ltd., G2. Section, 6, Pall Mall, S.W.1., or to Sister Agnes, 17, Grosvenor Crescent, S.W.1., from whom Bankers' orders can be obtained.