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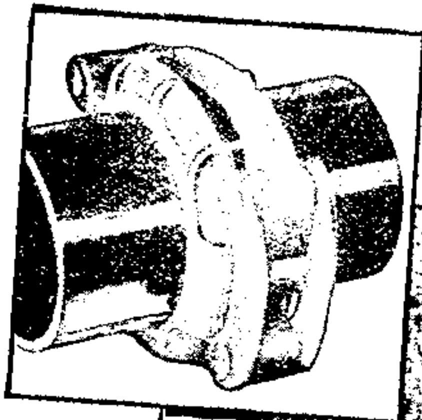

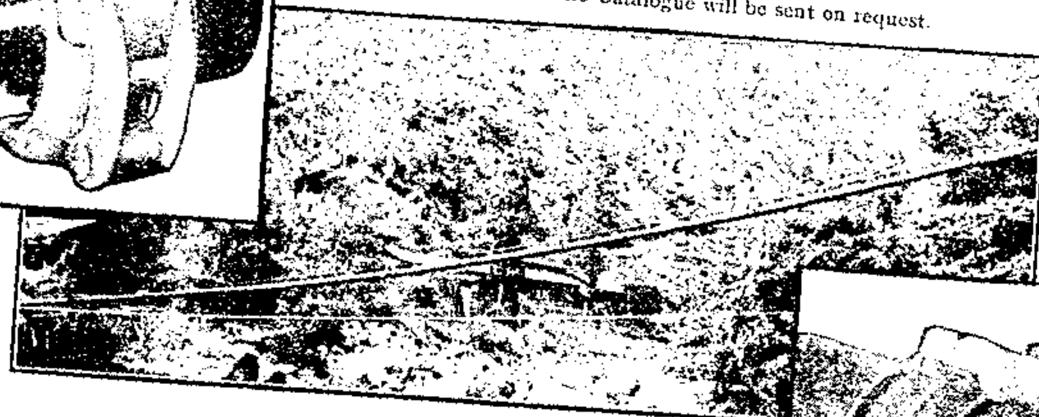

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Mural decoration in 3rd Div RE dining room

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All Reviews on Books on military subjects are included in the provisions of K.R. 535 (c) (*1935*).

MURAL DECORATION IN THE 3rd DIVISION, R.E. DINING ROOM AT BULFORD.

NEW barracks for the 3rd Divisional, R.E., have been built at Bulford, giving an opportunity to the unit to make itself really good lines, of which it could be proud.

The first step has been taken in the men's dining room, a long gable-ended room with high windows along one side.

A young artist in Salisbury was commissioned to paint a picture representing the various activities of the Royal Engineers, and the result obtained is reproduced opposite. The picture is painted on panels of S.X. boarding, lightly fastened to battens fixed to the wall, so that it can be taken down if necessary.

The picture has been very well done and the artist has succeeded remarkably in grouping his figures and producing an effect of activity. The colour scheme is made up of delicate browns and greens and suits the white and pale buff decorations of the rest of the room.

The perspective has been done with exceptional skill, so that although the observer is looking up at the picture he gets the impression of looking down on a scene which recedes into the distance.

The work was carried out while the dining room was in use and the Sappers—in fact, the whole unit—took a great interest in it. There is no doubt that it was worth while doing, and will help stimulate pride in the unit.

The name of the artist is Mr. Alfred Overton, 9, The Canal, Salisbury, Wilts. If any of the units should wish similar work carried out, he will be very glad to be consulted, and undertake the work. Any further particulars can be got from the C.R.E., 3rd Division, Bulford.

THE NEW ORGANIZATION OF ENGINEERS.

By MAJOR-GENERAL L. V. BOND, C.B.

IN *The R.E. Journal* for March, 1939,* there appeared an interesting account of a bridging operation designed to test the suitability of the new War Organization of a Field Company, R.E. The author reached the satisfactory conclusion that the new enlarged section, sub-divided into four sub-sections each in its own personnel lorry, represented a powerful and flexible working unit. The writer added that the reduction of sapper personnel involved in the new organization of divisional engineers was counter-balanced by the extra mobility and better equipment.

It is, of course, true that there has been an apparent reduction in the sapper personnel of divisional engineers but it is not by their increased mobility or by their increased mechanization that " compensation " has been given. Such a view echoes what is a very natural and, indeed, widespread misapprehension of the nature of the recent changes. It is, therefore, important that all officers of the Corps should understand the basis on which these changes were made.

The end of the war in 1918 found us on all fronts with an organization in the Division of three Field Companies and a Pioneer Battalion. In support of these there was a mass of Army Troops Companies, Road Construction Companies and other units under Corps and Army. The mobile operations which preceded the Armistice showed, moreover, that these establishments originating in the static period were far from being excessive for mobile warfare. Indeed, it was found that it was mobile warfare which imposed the maximum strain on the Engineers.

Post-war committees accordingly proposed various organizations based on these war establishments, including the provision of Field Park Companies and the expansion of Field Companies by the absorption of the Pioneer Battalions. The former proposal was adopted, but effect was never given to the latter and the three Field Companies of a Divisional Engineers remained until recently at about their war-time strength, while the Pioneer Battalions ceased to exist. In rear of the Divisions there were indeed a few Army Troops Companies and E. and M. units under Corps, but these units were primarily intended and organized for rear area duties.

* " The New Field Company, R.E., at Work," by Major D. Harrison.

Until the recent changes the only advance on this organization lay in the substitution of mechanized for horse transport, the provision of a C.R.E's pool of lorries capable of lifting the personnel of one Field Company in each Division and the introduction of some power tools generally on a Company basis.

On the other hand the calls on the Engineers had, since the war, increased in more than one direction. To tabulate these developments:

(*a*) Increasing mechanization and ever heavier loads had required a progressive increase in the weight of military bridges, requiring more labour (labour which could not be replaced by machines) and larger parties for individual tasks, such as lifting pontoons.

(*b*) The general mechanization of the army envisaged greater speed of movement while, on the other hand, improved methods of demolition and blocking and increased efficiency of air attack tended to create ever greater obstacles to movement. As a consequence, the need was felt of quickening up the passage of obstacles by the introduction of standardized bridging equipment in the form of light and heavy girder bridges, requiring trained construction parties of a definite strength.

(*c*) The possession by all armies of the mobile armoured formations introduced problems of the rapid seizure of water-lines, of the creation of tank obstacles and of the blocking of open flanks or of gaps between formations. The importance of demolitions was increased, both of those rapidly executed by the Engineers of rear guards and of deliberate schemes prepared well in rear by Corps Engineers. All these demands called for the power rapidly to move engineer units over considerable distances and brought the Corps engineer units into the front line picture.

A re-examination of the situation on these lines showed that:

(*a*) The requirements of a division in engineer units varied greatly in varying circumstances. While three Field Companies might be sufficient for ordinary routine, periods of operations would require certainly four and possibly six or more Field Companies on a divisional front.

In Mobile Divisions the variation between requirements when at rest, when carrying out a protective role covering the front of Corps or when acting in an independent role, seemed to lie between three and twelve or more strong Field Troops.

(*b*) All engineer units must be capable of rapid movement if they were to be capable of reaching the vital point in time, of getting away at the last moment, or of completing a task without falling hopelessly behind.

(*c*) The duties of Corps and Divisional Engineers were now similar in character. Corps and Divisional Engineers must, indeed, be interchangeable.

(*d*) Divisions were getting unwieldy on the road and as a consequence the principle must be to keep as much transport and material behind Division, that is, under Corps, as would be compatible with its getting up in time. For the R.E. this, in effect, meant M.T. carriage of personnel as well as of material.

(*e*) The varying requirements of Mobile and other Divisions as regards engineer units pointed also to the desirability of giving formations only those units required for routine duties while retaining, in a fluid and mobile reserve, the additional units required for their reinforcement during operations.

(*f*) While (with the introduction of new types of standard bridging equipment and mechanized tools) the personnel of Divisional Field Park Companies and of the Corps E. and M. Companies seemed unnecessarily great for the requirements of anything but static warfare, Corps possessed no engineer store-holding unit.

(*g*) The existing strength of Field Troops and of Field Company sections no longer corresponded with any standard task, as, for example, of bridging and the units were not conveniently divisible into the detachments required for the widely distributed tasks called for by the new conditions. On the other hand, a strength of some 44 to 48 working numbers, permanently sub-divided into four sub-sections, seemed to correspond satisfactorily with a large number of normal tasks, and finally that

(*h*) The other arms must take an increased share in constructing their own defences and in getting themselves over country and across obstacles.

Accordingly it was decided :

(*a*) To pull the weight of the Engineers rather farther back while making the whole organization much more fluid and mobile.

(*b*) To introduce, as the basis of the organization, a troop or section of some 48 working numbers, divided into four sub-sections each in its own transport, and to give each

troop or section its proportion of power tools. This entailed the reduction of sections in the Field Company from four to three (the normal organization of Engineers of continental armies).

(*c*) To reduce the Field Park Company to a purely store-holding and workshop unit.

(*d*) Completely to motorize the Field and Field Park Companies of Divisional Engineers.

(*e*) To increase the Corps Troops, R.E., and to convert the Army Troops Companies in Corps and G.H.Q. Reserve to Army Field Companies, identical in organization, equipment and transport with Divisional Field Companies.

(*f*) To create a Corps Field Park Company which should hold and operate the workshop equipment formerly with Army Troops Companies, man the Corps dump and take over the E. and M. duties formerly performed by the E. and M. Company. This unit, which, when functioning, must move by long bounds, was only to be partially mobile.

(*g*) To permit of the normal reinforcement of Mobile Divisional Engineers with Army Field Companies by introducing Headquarters Mobile Divisional Engineers and separate Field Park Troops.

(*h*) And to increase the field engineering responsibilities of the other arms and, as a consequence, to introduce the Infantry Pioneer Platoon and specially to train a proportion of battalions outside the divisional organization in field engineer duties.

It will be seen that, from the R.E. point of view, the outstanding features of the new organization are :

(*a*) That it is no longer correct to think of three Field Companies as the correct allotment to a Division for operations. Still less is one Field Squadron the correct answer for a Mobile Division, which, when acting in an independent role, depends entirely on its Engineers for the maintenance of its mobility.

The Divisional Engineers, in each case, must rather be regarded as the basic or minimum allotment, the reinforcement of which by one or more Army Field Companies will be normal in all active operations.

(*b*) That Army Field Companies must be trained similarly to, and as far as possible up to the same standard as, Divisional Field Units.

The writer of the article to which we have referred makes a criticism on the new organization which is certainly legitimate. It is that the reduction of sections in the Field Company to three, and their considerable increase in size and mobility, make the section almost more than even an experienced subaltern can manage; while the calls on, and casualties among subalterns will frequently require the section to be commanded by the section serjeant. The addition of two officers at Headquarters Divisional Engineers only compensates in a small measure for the reduction in officers. This is certainly true, but at a time when R.E. officers are in such demand and when, in other arms the duties of subalterns are being assumed by W.O.'s III, the case for two officers in the section cannot be successfully contested. The answer must lie in an increased emphasis on the training of junior officers to handle these important commands and in the raising all round of the standard of training of our N.C.O's, everyone of whom, even the most junior, may now be required to assume a definite command on a more or less independent task.

ECONOMICS IN MODERN DEFENCE:

A Lecture Delivered at the S.M.E., Chatham, on 9th Feb., 1939, by

D. J. F. MORTON, ESQ., C.M.G., M.C.

M. BRIAND used to insist that "war is far too important a matter to be left to soldiers." Whatever he may have meant by that remark and however untrue it may have been in 1914, there is no doubt that modern war has ceased to be the preserve of soldiers or, for that matter, sailors or airmen.

Even under a military dictatorship with all servants of the State in uniform, you may give your war economic expert military rank but his functions remain those of an economist. In fact, General Thomas, Chief of the German Economic Bureau in the Ministry of War, goes so far as to say that "the country which will win the next war, will be the one that has best succeeded in confining the activity of its Armed Forces to their proper sphere!"

Professor Sternberg and many other writers, not only in Germany but in France, America, Russia, Italy and even Japan, point out that during the course of the war of 1914 it became clear that, where modern industrial countries are concerned, the final decision in wars of the future will be determined by economic factors. I personally would add psychological factors as well, but there is no doubt that the psychological factor is greatly influenced by the economic. Hungry people are depressed people, and depressed people lose the will to win.

In coming to this important decision, foreign writers on modern war have not only been thinking of the blockade activities of the Allies in the last war. They have had in mind all the ways in which economics enter into modern warfare.

Economics enter into every sphere of modern war, but their action may usefully be studied in two halves, which I will call the defensive half and the offensive half; that is to say "Economic Mobilization" and "Economic Warfare." This lecture deals with "Economic Mobilization."

In point of fact, the two aspects of economics in war are closely related, since what we now call "Economic Warfare" in this country, namely an extension of blockade operations, is really an attack upon the enemy's economic mobilization arrangements. One must know what these are in order to attack them.

In this lecture I hope to give you, firstly, some idea of what

Economic Mobilization consists of itself and, secondly, to suggest to you the extent to which military officers concerned with military planning must nowadays take economics into account and co-operate with economic authorities even in framing their military plans.

I say without hesitation that failure to do this adequately will result in strategic plans being drawn up which are unreal, unsound and unpractical.

No naval, military or air officer, however high his rank, need become an economic expert. The Chief of the Naval Staff is not required to have sufficient knowledge of the technique of the Army or Air Force to carry out the duties of the Chief of the General or Air Staff. He must, nevertheless, have some general knowledge of how the Army and Air Force operate, of their capacity and their limitations.

Similarly, in modern war, Senior Staff Officers of the Navy, Army and Air Force must acquire general knowledge of the part played by economics in modern war, so as to know when to invite the co-operation of the economic expert in framing military plans, both for the mobilization of their own forces and, frequently, for the strategic use of those forces in war.

Professor Sternberg points out that the rulers of all countries to-day recognize the importance of the economic factor in modern war, though not all countries have yet drawn the logical conclusions from this recognition. He adds, and rightly, that a country embarking on a modern war of national effort must begin that war not merely with a Naval, Military and Air Staff, but also with an Economic War Staff. Economics constitute nowadays a fourth and separate national defence force. There are four horsemen of the Apocalypse, not three, and the gentleman with the scales is by no means the least or last of the four.

My object is to describe the views generally held throughout the world on certain outstanding principles. It is, therefore, enough at this stage to say that most foreign countries have already reached a decision on these points and have given effect to them.

The intrusion of economics into the military arena is no new thing. Throughout the ages, before any war plan was ever made, the responsible authorities have had to count the economic cost and see how best to meet it, though they may not always have been fully conscious of what they were doing.

By economic cost I mean the cost in labour and materials. That is the economic factor, which has gained so much in importance to-day as a result of modern developments in warfare.

The economic factor had achieved this importance before the war of 1914 came to an end. General Thomas of Germany, writing of the war of 1914, says :—

> " The idea that economics have nothing to do with war and that all the work in connection with mobilization preparations is entirely the province of a War Ministry was widely held (in Germany) right into the war itself, despite all attempts of those who really understood the problem to persuade the soldiers otherwise. That is why we lost the war."

When I speak of modern war, I refer to what is now called a " war of national effort " or " totalitarian warfare," namely, war between nations of high economic development, who will endeavour to mobilize and use the greatest armed forces which the economic balance of their country can sustain.

Wars of the Middle Ages and, later, even up to and including the South African War, were fought—at least in so far as England was concerned—by a relatively small fraction of the population. Not only was the number of men serving in the armed forces well below that number who could have been spared for the purpose, but the effort required to arm, equip, feed, transport and pay for these forces was very much less than the maximum effort of which England was capable.

Some people hold the view that it will never again be necessary for England to raise so great an army as she did in the war of 1914. Even so, she may still need to defend herself against totalitarian aggression. To do that will require a national effort, even if the number of men in uniform represent only a relatively small fraction of the population. It is becoming recognized, however, that we shall require numbers of people to undertake whole time as well as part time work in such new activities as Passive Anti-Aircraft Defence. But it may not be so generally realized that we shall need a proportionately greater number of persons in industry, agriculture, transportation and other essential services than we did in the war of 1914.

The armed forces themselves will require a greater proportion of men immediately behind the line than they did even in 1918. General Debeney estimates that a tank which is served by two men in action needs 46 men in uniform behind the line to look after it, while one aeroplane needs 60 men for its ground staff.

These approximate figures do not take into account the number of men or women required to manufacture the tank and the aeroplane, the munitions the latter will expend, the food, equipment and clothing necessary for the hundred odd military men concerned; nor do they allow for the men who will have to transport all these stores to the point at which they are to be used.

This great increase in the demand for men in uniform and out of it behind the lines to keep one fighting man in action is due chiefly to the increase in quantity and complication of the armament and

other stores required in modern defensive and offensive operations of war. It applies equally, not only to the Army but to the Navy and the Air Force, to Active Anti-Aircraft Defence and also to such purely passive defence measures as are at present comprised in the general term "A.R.P.," all of which need not only men, but also war stores.

Apart from actual armament, figures of a high order of magnitude apply to war stores of all kinds, food, water bottles, haversacks, blankets, boots, clothing, ships, naval stores, air stores, gasmasks, decontamination equipment, fire-fighting equipment and so on, many of which will be required for the civil population nowadays as well as for the armed forces.

Of course, the creation of large modern air forces accounts to no small extent for this expansion in requirements, but it does not account for it all. Requirements of *matériel* of all kinds in 1939 are, *pro rata*, much greater than they were even at the climax of the Great War.

Until recent years, officers of the armed forces never considered the question of how their war requirements in *matériel* were to be provided, nor, for that matter, did anyone else. Now that the problem has been recognized in all its magnitude, it is still not primarily the duty of armed forces staffs to work out detailed plans for industry. It is the duty of industry or of that part of the State organization which exists to deal with economic questions—and all States have that; or of the Economic War Staff, if the State concerned boasts such an organization.

In this connection I wish to emphasize that there is no exception to this rule. It may, for example, for good and sufficient reason, be decided to design and construct warships in Government dockyards under naval supervision. With this arrangement, which is common in foreign countries, it would nevertheless be absurd for the Naval Staff to assume that they are therefore independent of the economic factor or of the Economic War Staff. The Navy does not own or operate coal mines, coking plant, steel works, wire-drawing mills and so on. In point of fact, no navy builds a warship from raw materials; it assembles it from manufactured or semi-manufactured components.

About ten times the number of men employed in a naval dockyard on assembling a capital ship are employed in industry on manufacturing the components and semi-manufactures from which she is assembled. Moreover, that great part of the national economy, employed on the work in question, cannot at the same time be used for other work, and your Economic War Staff must make adjustments accordingly.

Although the armed forces staffs are not concerned with planning

economic mobilization, they have a duty to perform of paramount importance before it is possible to plan effective economic mobilization at all.

It is the duty of the armed forces staffs to estimate and declare what they will require in war in the shape of men and finished war stores of all kinds. They must make this estimate, not only to cover the initial stages of war but to meet the wastage and expenditure of several months of war. They, and they alone, must decide, not only upon the quantities of war stores that they will require but also the types and, what is more, they must make these decisions many months before war breaks out.

Finally, having informed the Economic War Staff of their requirements, they must try to make no major changes in their estimates, especially in design. If, however, this is absolutely necessary, they must take the responsibility of doing so and must realize that, unless sufficient time elapses between the decision of their change of mind and the outbreak of war to enable the Economic War Staff to make the necessary adjustments, the armed forces may get no delivery at all of the war store in question.

Were I compelled to confine my lecture to establishing one single point, I would choose this one; namely, that effective plans for economic mobilization cannot be drawn up until the armed forces have made up their minds what men and *matériel* they will need in war.

Now, although it is the responsibility of the armed forces staffs to decide the nature and quantity of their requirements in war stores, they must consult industry in the process.

An expert civilian designer on the staff of the Admiralty, War Office or Air Ministry can design, say, a fuze, a tank or an aeroplane which will perform all the antics the military staff require. A Government Arsenal, or other skilled armament works, employing hundreds of men of the highest skill and training in armament manufacture, equipped with every sort of special purpose machine tool and taking its own time, may manage to turn out a perfect prototype of your specialist's design. Industry as a whole, however, may be unable to manufacture the article at all.

If you want quantity in war, you must be prepared to sacrifice to some extent, not necessarily quality, but complications and unessential trimmings. Endless arguments are possible regarding the point at which the sacrifice of complications in favour of quantity production are justified. But, if these arguments are allowed to be endless, you will get neither quality nor quantity. You will get nothing at all. The reason for this is that it is not your State armament works, or even your privately-owned armament factories, upon whom you must rely to deliver the immense quantities of armaments which you will require in war, but the greater part of the whole corporate industry of the country.

It was computed not long ago, by the Master General of the Ordnance of the U.S.A., that the total capacity of those factories regularly manufacturing armament stores in peace, could only satisfy about a half of one per cent of the total quantity of armament stores required by the American Forces in the event of war.

No State, still less privately-owned industry, can afford to maintain in peace the immense range of special plant and machinery required in war to produce these astronomical quantities of armament stores. Nor can they afford to keep idle on their pay-roll the huge numbers of skilled workers needed to operate this plant.

At the same time, the manufacture of armaments demands a very high degree of skill, out of reach of the ordinary engineering works without due instruction and practice. The only solution of this problem is found in the relatively new science of "Economic or Industrial Mobilization."

I have no time to-day, even had I sufficient knowledge, to describe to you in detail the many ingenious devices employed in planning Economic Mobilization in peace. I hope, however, to have already convinced you of the necessity of planning this mobilization in peace, if a country is to make its strength felt in modern war.

It is not only as necessary to plan industrial mobilization in peace as it is to plan for the mobilization of your armed forces, it is far more necessary. The armed forces cannot exist in war unless kept supplied with war stores. Moreover, industrial mobilization affects the life and activities of the whole nation. It is thus a far more complicated matter than military mobilization.

Industrial mobilization plans must be co-ordinated with plans for military mobilization and vice versa, not only because the object of the former is to be able to supply and to go on supplying the armed forces with the war stores they require in order to wage war, but because it deals, first of all, with the distribution of man-power and labour as between the armed forces and other essential, national, war-time activities.

I have already quoted General Debeney's estimate that about 100 men in uniform are required to keep one tank and one first-line aeroplane in action. Various estimates have also been made in different countries of the number of hands required in agriculture, industry, transportation, trade and other non-military activities to keep one man in the armed forces in war. I will not quote these as I do not find any of them satisfactory, but there is no doubt that they are all right on broad lines in estimating the demand for workers in plain clothes in modern war at several times the number of men in the armed forces.

When you subtract from the total population of a country that proportion which is too young or too old to undertake any war work, the invalids, those who must continue their peace-time activities,

including the labour which must still be employed in war on the manufacture and supply of goods for export, and to provide the necessities of life for the non-military population, which includes those engaged in the manufacture of war stores, you will readily admit, firstly, that the number of men in uniform must represent but a small part of the population engaged directly in war work and, secondly, that the man-power problem requires the most intricate, detailed planning in peace.

The man-power question involves age, sex and skill.

Industrial labour can be diluted in emergency to some extent by women, children and others, who would normally be considered unfit for such work. The limits imposed on dilution through the necessity of continuing to employ young, able-bodied men in those tasks, for which women and children are totally unfitted, are rather surprising.

Then there is the problem of training.

An officer of the armed forces who was suddenly given a thousand men, labelled as officers, N.C.O.'s and men, none of whom had had the slightest military training, and was told that he would have to take this rabble to the Continent in a few days' time and there start fighting, would feel some apprehension regarding the result.

Exactly the same applies to labour for industry. The so-called unskilled labourer has his uses, but he can neither manufacture anything, nor can he drive a railway engine. He is even a menace in many spheres of agriculture, as any unskilled man who has tried to milk a cow will readily admit. When you come to such highly skilled work as the manufacture of armaments, where the margin of error allowed is sometimes as low as half a ten-thousandth of an inch, the position is still more difficult.

It amounts to this. There are hundreds of thousands of skilled workers in industry, whom you must on no account take into the armed forces, unless it be to absorb them into work similar to that for which they have trained in civil life. In principle the " enlisted man," as the Americans call him, must be drawn as far as possible from unskilled labour.

Even so, you may need more skilled labour in industry in war than in peace. You will certainly need it in some branches of industry. How is it to be provided ?

First of all, there must be some sort of labour census in peace, which will enable you to transfer labour in emergency from the luxury trades to the armament industry.

Then you must make up your mind to risk a certain lowering of the quality standard and, in order to permit this, must, as I have already stated, simplify as far as possible the designs of your war stores. Lastly, there is the question of some sort of instruction in

peace-time in order to provide a reserve of skilled labour for emergency.

You will, I am sure, admit the necessity for deep thought and careful continuous planning in peace, if war-time demands for labour are to be met.

Nevertheless, the man-power problem is not more important than several others which can, I suggest, be summarized under four heads, namely Raw Materials, in which are included foodstuffs and fodder of all kinds, fuels, both solid and liquid, as well as every sort of industrial raw material.

Secondly, Plant and Machinery, comprising not only the many special machine tools required to manufacture armament stores, but also the plant necessary to manufacture these tools, as well as the means of transportation, such as railway rolling stock and permanent way, merchant shipping, etc.

Thirdly, come the problems of Transportation itself (apart from the provision of the necessary transportation material) such as the distribution of port facilities, the organization of internal transportation of passengers and goods, the chartering of neutral vessels to supplement the carrying capacity of your own flag.

Lastly, there is the problem of Finance. How is it all to be paid for?

First, to consider raw materials.

It is now the avowed aim of several countries to develop to the maximum their domestic resources of raw materials and to invent substitutes for those that are not found in sufficient quantities in their territory.

However much this policy may be bound up with peace-time economics, it is, without question, equally a war measure, aimed at rendering the country impervious for as long as possible to the application of economic pressure against her by her enemies in war.

But the area of the world is, at present, so shared out among different nations that but few can achieve a really high degree of self-sufficiency without amassing very large reserves of certain essential foodstuffs or raw materials which can be provided by no other means than by importation.

In theory, so long as development can continue satisfactorily and internal communications within the political division can be assured, the U.S.S.R. and the British Empire, but by no means the United Kingdom, might be made self-sufficient without the accumulation of large reserves. In theory, the United States cannot do this, though in practice they may probably be regarded as potentially self-sufficient, owing to the relative ease whereby the forty or more deficiency commodities, which have been discovered to exist by the Department of Commerce, could be made available.

The fact that war-time requirements of raw materials differ in

quantity from peace-time requirements is well illustrated by petroleum. It has been computed that with the most stringent economy and rationing, a first-class power with a large navy, army or air force, will require in war a much greater quantity of petroleum products than it consumes in peace.

This is by no means due solely to a greater demand from the armed forces in war. The minimum essential requirements of mobilized industry, transportation and civil life may well equal that of all the armed forces added together and, in this matter as in all others, the armed forces will do well to bear in mind that the collapse of the economy of the non-military section of the nation, who represent well over 90 per cent of the population and something like three-quarters of the total national war effort, whether it be due to under-nourishment, shortage of raw materials or a lowering of the standard of life below what is bearable, must entail the collapse of the armed forces as well.

The armed forces, though a highly important section of the nation in war, are not a nation unto themselves, but form part, and not the largest part, of a delicately balanced war machine.

The next planning division is that of plant and machinery, though I would emphasize that there is no absolute rule of precedence or even of frontier between the different problems of industrial mobilization planning. All are equally important and inter-dependent.

Labour is required to operate plant and machinery, which in turn treat raw materials, but the plant and machinery itself is made out of raw materials by other labour. All has to be paid for and transportation questions enter largely at every stage. Vehicles of transportation are made by machinery from raw materials by human labour, absorbing wealth in their manufacture and more wealth, labour and raw materials to operate.

Two special difficulties arise in connection with plant and machinery. Most of it will be worked in war twice or three times as hard as in peace. It will therefore wear out quicker and require replacement more often. Secondly, much of the machinery used to manufacture armament stores cannot be used for other purposes. It is what is called "special purpose machinery" and therefore will not normally exist in peace-time industry to a sufficient extent to manufacture the immense quantities of armaments needed in war.

Both these difficulties can only be overcome by careful research and planning conducted over a long period in peace, and by putting into effect certain devices which have been thought out for the purpose by industrial mobilization experts.

In helping to find a solution to these problems, the armed forces can and must play a part. They must permit as many as possible of

their war stores to be designed as far as possible on the lines of similar goods used generally in peace. Further, where this is not possible, as in the case of many armament stores as opposed to articles of equipment, the armed forces must permit reasonable modifications of design, if quantity production is required.

Anything more wasteful of time, money and energy it would be hard to imagine than, say, an unjustifiable demand for a special shape of spade, shovel or blanket for armed forces' use, when types normally manufactured in peace by the thousand are ready to hand. Or, again, the design by two different armed forces of, say, two different types of fuzes, when one would really suffice in practice for both purposes.

I will not dwell long here on the subject of transportation planning in connection with industrial mobilization, since I think that by now its necessity and its nature will already have been made sufficiently clear. You may have to import increased weights of certain raw materials in war, but the shipping to do so may not readily be available and additional tonnage cannot be created in a day. You will have to carry increased quantities of materials and semi-manufactures between your factories and from them to the points of consumption. You will have to alter the intensity and flow of your normal traffic, perhaps as a result of enemy action against normal shipping lanes, ports, roads, railways or canals. All these possibilities have, in so far as possible, to be foreseen and guarded against, or alternative routes and methods considered.

Finally, there is Finance.

Those countries aiming at self-sufficiency hope thereby to exploit the economic theory that those goods which a country can manufacture entirely from its own raw materials by its own labour, which it can at the same time feed, clothe, house and adequately sustain from domestic resources, cost the country nothing. That is true in a sense, if cost is here taken to mean that portion of a country's wealth used to pay another country for imports.

No country, however, is actually in a position to put this theory fully into practice. All must sooner or later in war import considerable quantities of something or other from abroad. Most must continue, as in peace, to trade with other countries. There will, however, be some countries with whom they cannot trade in war, either because they are enemy countries or because the enemy is interfering with their neutral trade.

The only means by which, in the long run, a country can pay for its imports, is by exporting goods of equivalent value. Therefore, not only has the export trade of the country in war to be considered, and as far as possible planned in peace, taking into account the new political conditions imposed by the assumed war situation, but allowance has to be made for labour, machinery, raw materials and transport facilities wherewith to manufacture and carry your

export goods. The national energy expended on this essential purpose cannot, at the same time, be utilized to manufacture war stores or for other immediate warlike purposes.

I have, I hope, given you some idea of the questions involved in planning in peace for National Economic Mobilization in emergency; and shown that this planning must cover every national activity comprised under a very broad definition of man-power, raw materials, agriculture and food, industry, transportation, trade and finance.

Economic mobilization planning takes time; far longer than does planning for military mobilization though, like the latter, economic mobilization plans must be kept up to date to fit in with ever-changing world economic conditions.

So far I have given you a brief outline of work which must be done in peace mainly by persons other than officers of the military staffs, though I hope I have also convinced you that this work must be done in co-operation with military staffs and that it radically affects military plans. Before ending I must touch on some of the ways in which this question of economic mobilization interests even more directly those naval, military and air officers who are engaged in drawing up plans for strategic operations.

I have already stressed the first and most important point, namely, that no plans for economic mobilization can be completed until the armed forces have made up their minds what they will need in war in men and *matériel*, and that if thereafter they change their minds, they must risk a failure in supply. This, however, is by no means all.

However efficient may be the plans for the mobilization of national economy and the quantity production of war stores in emergency, no significant output of war stores, on the scale that the armed forces will require in war, can be expected for several months after the outbreak of war.

Here again, although the armed forces and the Economic War Staff must co-operate, the onus of responsibility rests first with the armed forces to decide what the wastage and expenditure of war stores will be during the period required to mobilize industry and to get output, though it is the duty of the Economic War Staff to state how long that time-lag will be and to ensure that it is no longer.

In considering this question, the armed forces staffs will do well to recall that their proposed mobilization reserve of war stores, that is to say, the war stores necessary to bring the armed forces up to a war footing, and the war reserve of war stores, necessary to maintain the forces mobilized in the first instance in the field until they can be supplied direct from the output of mobilized industry, consist of exactly the same types of goods.

You can, for example, use 18 new aeroplanes to form a new squadron, or you can use them to replace others put out of action

in an existing squadron. The armed forces staffs must decide in the light of the existing or assumed situation whether they will use the stocks of arms available as a mobilization or as a war reserve. But they cannot use them for both purposes at once.

This may seem absurdly obvious, but it applies to the enemy as much as to your own forces and is a fact often forgotten when estimating the possible strength of the enemy at various stages of the campaign.

The Economic War Staff can advise on the probable or actual situation in a foreign country at the opening of a campaign, and in its subsequent stages, but the armed forces staffs must realize the implications of any such economic assertions and translate them into terms of naval, military and air strategy.

My next point also applies both to our own armed forces and to those of our potential enemies. It is no good whatever drawing up strategic plans demanding the use of armed forces which cannot be armed or maintained in active operations for the period of time necessary to bring those operations to a successful conclusion. Equally, it is useless to plan to use forces in places or under conditions where it is impossible to supply them with the war stores necessary, even though those stores may be available elsewhere.

For example, you may plan to lock up a force at a certain place with a view to holding out until large reinforcements can arrive on the scene. If so, it is essential to calculate the estimated wastage and expenditure of war stores for the period of resistance envisaged, and to be sure that they are either immediately available *in situ*, or can be supplied from other sources.

The same idea may be taken into consideration when considering the enemy force attacking your fortress. This force must be adequately supplied with war stores or else must sit idle, admiring the scenery. To supply it will demand ships to convey the stores. The destruction of any of these supply ships might have far reaching consequences. The Economic War Staff will be able to assist in many ways in arriving at conclusions of this kind which may, in certain circumstances, radically affect strategic plans.

In this general connection, armed forces staffs must bear in mind the question of the repair of arms and equipment, both from the point of view of their own forces and those of the enemy.

If fighting is in progress close to an industrial district at the disposal of one side or the other, many items of armament or equipment, rendered unserviceable owing to minor defects, can rapidly be repaired. If, however, the action is being fought out of reach of industrial facilities, the wastage and expenditure of war stores will be correspondingly larger. In other words, the stocks at the disposal of the naval, military or air force in question, to

enable them to continue their resistance, must be proportionately greater.

I will only give one more example of conditions in which the Economic War Staff can assist the armed forces staffs, but that is of great importance. It concerns the question of types of armament stores, and like the others seems self-evident when you hear it. It also applies to calculations of the probable enemy strength as well as to our own and that of our allies at various stages of the war.

A six-inch shell will not fit into a 155-millimetre howitzer, although six inches and 155 millimetres measure very nearly the same. More important still, a 15-cm. shell made by Bofors of Sweden for their own pattern of howitzer will probably not fit into a 15-cm. howitzer made by the Putilov works in Leningrad for the Soviet Army.

The point is that most nations, with certain exceptions, which are as important as the rule, are armed with weapons of their own special design. Consequently they cannot readily get further supplies of armaments from outside sources, unless arrangements have been made in peace for this very purpose.

I have now come to the end of this very superficial survey of economics in defence and hope I have been able to convince you of the paramount importance of the problem. It only remains to add that all will be well if armed forces staffs, on the one hand, give due consideration to these problems and the Economic War Staff, on the other hand, carry out their part of war preparations with the care and circumspection demanded where our very national existence may be at stake.

Finally, I suggest that neither the armed forces nor the Economic War Staff should try to invade what is properly the sphere of the other, but that by much mutual understanding, more forbearance and co-operation most of all, the four defence forces of a country should work together for the common good.

FORMATION OF AN EGYPTIAN CORPS OF ENGINEERS.

By MAJOR (LOCAL LT.-COL.) H. B. HARRISON, R.E.

UNDER the terms of the recent Anglo-Egyptian Treaty a British Military Mission was sent to Egypt early in 1937 to advise on the re-organization of the Egyptian Army. This army is to be trained and equipped on modern lines based on British establishments, and to effect this, officers of all arms were sent out from England to advise on their own particular branch of the service.

No corps of Egyptian Engineers existed prior to the Treaty. A small department of military officers and civilian employees catered for the military works services, and a mixed company of pioneers and signallers was in being for such semi-technical work in the field as lay within its limited competence.

The original expansion programme for the Engineers visualized the urgent formation of the units for one division, viz. 3 field companies and 1 field park company, together with 2 anti-aircraft searchlight battalions.

The immediate problems to be faced therefore were :—

1. The provision of the necessary officer personnel.
2. The provision of the necessary other ranks.
3. The provision of instructional and unit equipment.
4. The formation of a competent instructional staff.
5. The establishment of a School of Military Engineering.

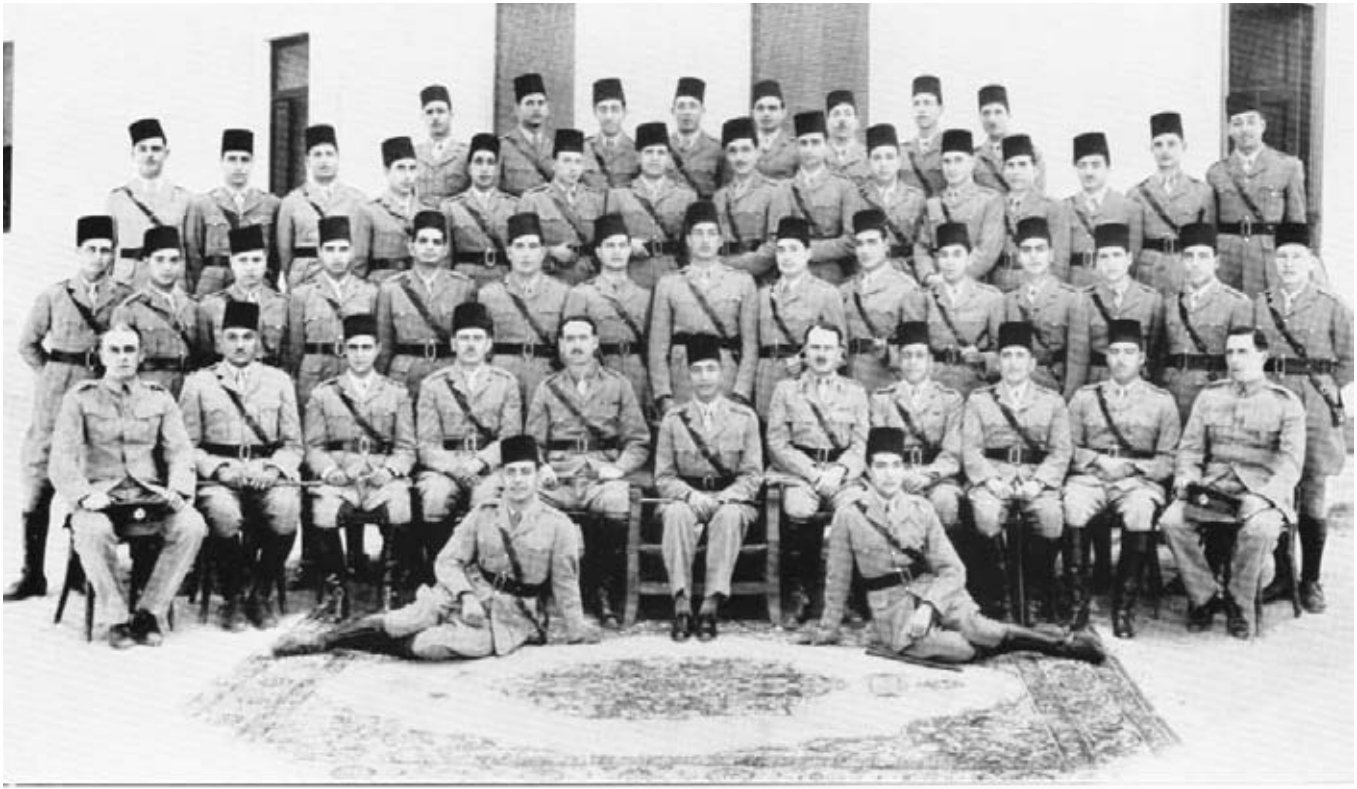
The problems are being solved as follows :—

1. *Officers.*

The normal channel of entry for officers in the Egyptian Army is through the Royal Military College, Cairo. A course of approximately two years' general military training is given before officers are passed out and posted to their particular branch of the service.

It was agreed that the training of the officers for the Egyptian Engineers should follow in principle that given to Royal Engineer officers in England. This involved a syllabus of instruction including as far as possible the training given at Woolwich, Cambridge and Chatham.

The formation of Engineer units was to start with the minimum of delay and it was accordingly decided to take in No. 1 Y.O. batch as direct entries from Cairo University. Candidates were selected from amongst students who had recently passed out of the Engineering



No. 1 Y.O. Batch and Instructional Staff, Egyptian School of Military Engineering, Cairo. July, 1938.

Formation of an Egyptian Corps of Engineers - No 1 YO Batch

Faculty with degrees, and civil, architectural, mechanical and electrical engineers in suitable proportions were chosen.

These students were given direct commissions on entering the School of Military Engineering, where they underwent a four months' military duties course followed by a six months' training in field engineering. Instruction in elementary strategy and tactics, engineer tactics and riding was included in the syllabus.

On passing out from the S.M.E. the young officers were given a two years' ante-date of seniority, which put them on an equivalent footing to those of their contemporaries who passed through the Military College.

2. *School of Military Engineering.*

The urgency of the expansion programme did not permit of the delay which would have been necessitated by the building of a new school.

Accordingly, an old Khedivial Palace on the Ismailia sweet-water canal, near Matariya, some six miles north of Cairo, was taken over, repaired and adapted to enable classes of officers and recruits to begin work as early as possible. The school is intended to remain there until suitable permanent buildings elsewhere can be erected.

N.C.O's from the existing pioneer company, together with others imported from Infantry units, were given concentrated courses to enable them to instruct on the party system the recruits taken in according to the agreed engineer expansion programme. Compulsory service exists in Egypt and recruits for the Engineers were chosen as far as possible with existing trades experience, in order to simplify the problem of subsequent adequate trades training.

A central army trades training school is under formation by the Egyptian Maintenance Corps and will be based on the system of boy training. This school will eventually supply the Engineer Corps with tradesmen of certain trades common to all units, *e.g.*, electricians, fitters, engine artificers. The workshops to be erected at the School of Military Engineering will train recruits in other trades necessary for the Engineer units.

A number of Egyptian Engineer officers from the Military Works Department were transferred to the school. Amongst these were several who had passed through Woolwich and Chatham and these formed an invaluable nucleus round which to build an adequate instructional staff.

When it was decided in England to hand over to the Artillery all anti-aircraft searchlight responsibility, the same policy was adopted in Egypt. Consequently this wing of the school was transferred to the Egyptian Artillery in May, 1938.

An anti-gas training branch of the school trains instructors for all arms of the Egyptian Army.

The school is now engaged upon its second year's training programme and is undertaking an engineer expansion considerably larger than that originally visualized.

This expansion aims, at present, at the formation of Engineer units as follows :—

No. 2 Field Company, No. 3 Field Company by July, 1939.
Field Park Company, Field Squadron by July, 1940.
Mobile Divisional Field Park Troop, Army Troops Company by July, 1941.

No. 1 Field Company, though still short of its full equipment, has been employed since its formation in July, 1938, at Mersa-Matruh in the Western Desert.

3. *Equipment.*

A certain amount of instructional fieldworks stores and equipment was procurable locally. The more technical items had to be ordered from England and these did not arrive in time for the fieldworks courses of either No. 1 Y.O. batch or the recruits for No. 1 Field Company. By co-operation with H.Q. British Troops in Egypt, the School of Military Engineering was, however, able to borrow for suitable periods pontoon and folding boat equipment, a small box girder set and certain demolition stores, and this arrangement enabled efficient fieldworks courses to be organized.

The following sets of model equipment were ordered from Chatham and arrived in time for preliminary fieldworks instruction :— small box girder, folding boat equipment, pontoon, and large box girder. They proved of great value.

Field units, as formed, are being equipped on the basis of the home G.1098's, adapted where necessary to meet local conditions. This equipment is ordered *en bloc* from England.

The attached photograph shows No. 1 Young Officer batch at the School of Military Engineering prior to their passing out in July, 1938. In the centre is the Commandant of the School, Kaimakam Abdel Razzak Bey Barakat who has recently visited England to study the system of training accorded to the Royal Engineers. The British instructional personnel sitting in the front row are, from left to right : C.S.M. W. J. Cherry, R.E., Lieut.-Col. H. B. Harrison, R.E., Major A. J. de Pury, M.B.E., R.E., C.S.M. T. Manley, R.E.

THE ORDNANCE SURVEY AND ITS WORK.

By MAJOR-GENERAL M. N. MACLEOD, D.S.O., M.C.

The Final Report of a Departmental Committee, appointed by the Minister of Agriculture and Fisheries in 1935 *to examine the work of the Ordnance Survey, was published in November,* 1938.

THE Ordnance Survey was started in 1791 in order to prepare a one-inch map for the defence of Great Britain. At that time surveying was an art rather than an exact science; and trained surveyors who could be enlisted for the work not being available, the Board of Ordnance (whose duty it was to make provision for defence in those days) entrusted it to a military detachment specially formed for the purpose. The first two chiefs of this detachment were Gunners, but since 1820, the Ordnance Survey—as it has been called since 1857—has been directed by Sappers. The Ordnance Survey is not, however, now controlled by the War Office. In 1855, when the old Board of Ordnance was abolished, the Survey was transferred to War Office control, but in 1870 it passed to the Office of Works; and twenty years later was passed on from the Office of Works to the Board of Agriculture (which later became the Ministry of Agriculture and Fisheries), to which it still belongs.

The reason for these transfers was that the civil had outstripped the military work of the Survey. The process had started in 1825, when a Survey of Ireland, on the scale of six inches to one mile, had been ordered in connection with the Government's policy of land purchase. Most of the Department was transferred to Ireland for this new work, but the numbers being insufficient to get it done in any reasonable time, civilians had to be recruited to assist the soldiers, thereby starting the peculiar semi-military, semi-civil organization which has continued until the present day.

The six-inch Survey of Ireland was completed in less than twenty years, and proved so useful that a similar map was at once asked for in England. Before long, however, a demand arose for a map on a still larger scale, and eventually, after about fifteen years of debate, the 1/2500 survey was started.

Once started, the Survey was so well conducted that when it was

completed, some forty years later, a distinguished and competent civil critic referred to it in the following terms :—

> " Our sketch of the history of the Ordnance Survey shows that, while the scope of the undertaking exceeds any programme heretofore attempted by any Government, the mode and style of its execution are second to none, either from a scientific, artistic, or utilitarian, point of view, and the cost of the work stroke for stroke is probably lower than that paid by any other nation for a similar purpose."

(Sir Charles F. Brickdale in the *Quarterly Review* of January, 1895.)

Long before the 1/2500 survey was finished the necessity for periodical revision had been established, and in 1882 the Treasury gave its approval to revision at intervals of twenty years, a decision which fixed the size of the Department on completion of the Survey, and which held the field for fifty years.

Before tracing the history of the Department further it may be of interest to digress, to have a look at the character of the work, and to notice some technical points. The first item to be noted is that the triangulation was not originally intended for the Survey at all. It was started as part of an international project for determining the figure of the earth, at that time one of the outstanding scientific problems of the day. This fortunate circumstance led to the triangulation being done with a care and an accuracy that might not have been given to it had it been intended only as a control for the one-inch map. Ramsden's celebrated thirty-six-inch theodolites, much better instruments than any yet constructed, were specially designed and built for the work, which aroused the greatest interest throughout the scientific world. It is interesting to recall also, in passing, that the " limelight " was invented by an R.E. subaltern employed on the Survey, to provide a luminous beacon for the longest rays.

The triangulation was only just finishing, and had not been adjusted, when the 1/2500 survey was started, nor had really satisfactory values of the figure of the earth yet been worked out. In due course Colonel Alexander Ross Clarke, R.E., the officer in charge of the computation of the triangulation, was to do this, and thereby earn for himself a world-wide reputation as a geodesist, but his first figure of the earth was not published until 1858, by which time the 1/2500 survey had started.

The 1/2500 survey was begun in 1853, and, in accordance with contemporary practice, was laid out as a number of separate " county " surveys, quite distinct from one another and from the one-inch survey, which was projected on national—strictly national —lines ; one projection for England and another for Scotland !

The primary triangulation not being ready in time, the county triangulations for the 1/2500 survey could not be properly adjusted into the primary work, and, inevitably, discrepancies—in some cases quite considerable discrepancies—remained along the lines of junctions of the various county systems. Within the limits of each system, however, errors were rare, and the Survey deserved the high reputation it soon earned, and has since retained.

The 1/2500 survey, which was not extended over sparsely populated mountainous areas, was, and still is, published in sheets covering one and a half by one miles of country (*i.e.*, measuring about thirty-eight by twenty-five inches of paper, excluding headings, margins and footnotes), in black only without contours. Sixteen of these sheets make up a six-inch sheet, though the latter are now generally published in quarter sheets, each containing only four 1/2500 plans and covering three by two miles of country.

Contouring as a method of showing heights was suggested about 1840 and the addition of contours to the six-inch map of Ireland was authorized in 1844. Ten years later, a Committee was appointed to consider the contouring of the six-inch map of Great Britain and recommended, somewhat tentatively, the insertion of contours at hundred feet intervals up to the thousand foot level, and above that at intervals of 250 feet. The Committee were reluctant to recommend a closer interval as the contours they envisaged were instrumental contours, pegged out on the ground with the aid of a level, and then surveyed. They thought, with reason, that a closer interval would make the cost prohibitive. This recommendation was put into effect, though it is doubtful whether it was, or ever will be, worth while using a level to determine the exact heights of points which are not definitely marked and capable of being identified afterwards on the ground.

The first one-inch and six-inch maps were engraved on copper, and also printed in black only. Colour printing was introduced about 1890. This improvement was probably a consequence of the application of lithography to map work and the invention of "photo-zincography," made in 1859 by Sir Henry James, R.E. (the Director-General), and Captain (afterwards Major-General) A. de C. Scott, R.E., assisted by Lance-Corporal Rider, R.E., all of the Ordnance Survey. The invention of photo-zincography led eventually to a revolution in the technique of map production, and it is gratifying to record that its further development was also due to the Royal Engineers of the Department, for the present "helio" process (helio-zincography) was invented in 1893 by Major Duncan Johnston, R.E. (afterwards Director-General) with the assistance of pensioner Serjeant-Major A. Algar, R.E.

The engraved copper plates of the one-inch map of England remained in use for many years and are still used for geological maps.

To revise maps engraved on copper it is necessary to make a duplicate of the plate by depositing copper electrically on its surface. Methods of doing this were devised as early as 1840, but for a long time it was difficult to obtain an even deposit unless expensive battery current was used. Eventually, about 1885, Captain H. Riall Sankey, R.E., then serving on the Ordnance Survey, succeeded in surmounting the difficulty and applying dynamo current successfully to the work.

It is time, however, to return from these technical details to the administrative history of the Department. Systematic revision, though authorized in 1882 was not actually started until 1890. Thereafter the twenty-year cycle was maintained, more or less, until the outbreak of war in 1914. It may be interpolated here that the revision of the 1/2500 survey and the publication of revised twenty-five-inch and six-inch plans is by far the largest branch of the work of the Department, accounting for about three-quarters of its personnel. There are nearly 52,000 twenty-five-inch sheets, and about 16,000 six-inch quarter sheets. The twenty-year cycle therefore implied an average annual output of 2,600 revised twenty-five-inch, and 800 six-inch, sheets.

On the outbreak of war in 1914 all the Royal Engineer personnel of the Survey Companies was withdrawn from Ordnance Survey work and distributed among other Royal Engineer Units, Field and Fortress Companies, from which only a proportion could be retrieved, and that with difficulty, when it became necessary later to form Survey Companies. A large proportion of the civilian personnel also joined the armies and work gradually slowed down until in 1917 only 200 revised plans were published. The effect of the war on the Survey was, however, not confined merely to accumulation of arrears of work due to reduced output. Its effect was threefold. The accumulation of arrears was only the first effect. The second was a permanent reduction in the staff after the war was over, made in the interests of economy; while the third was a great acceleration in the rate of change in the country consequent on social and economic developments after the war. Eventually the work of the Ordnance Survey got so far behindhand that, in 1935, the Minister of Agriculture and Fisheries appointed a Committee to go into the matter and make recommendations. The Committee's terms of reference were:—

(*a*) To consider what measures are necessary to accelerate the revision of the Ordnance Survey maps in order to bring them up to date and thereafter to maintain them at a high level of accuracy, while providing for such other public services as are undertaken by the Ordnance Survey Department;

(*b*) To consider what immediate steps are possible in the meantime to revise Ordnance Survey maps to the extent necessary for the purpose of town and country planning schemes;

(*c*) To review the scales and styles of Ordnance Survey maps placed on sale to the public and to recommend whether any changes are desirable; and

(*d*) To review the conditions upon which the reproduction of Ordnance Survey maps is permitted.

Items (*b*) and (*d*), which required immediate action, were disposed of in an Interim Report published in 1935; and here is the Committee's description, taken from its Final Report published in November, 1938, of the situation regarding items (*a*) and (*c*) with which it had to deal:—

"On the conclusion of the war, revision was resumed but owing to progressive reductions in the establishment in the interests of economy, it became impossible to overtake these arrears or to maintain the twenty-year cycle. It was accordingly decided to maintain the general rotation of counties, but to apply the twenty-year revision to urban areas only. . . . It was not long before it became apparent that even this modified form of cyclic revision could not be maintained, and in 1928 the cyclic revision was abandoned altogether. . . .

"The failure of the cyclic system of revision has been due not only to fluctuations in staff . . . but also to extensive social and economic post-war changes. From the point of view of the cartographer, the most important development of recent times has been the gradual flow of population southwards. . . . Apart from the general southern drift, there have also been local movements which have accelerated the rate of change. Improved standards of living and increased transport facilities have led to an outward movement from nearly all towns into newly developed or developing areas. . . .

"New factories and building estates have not been the only changes, for the advance in mechanized transport has led to a widespread demand for more and better roads. New roads once laid down have opened up new areas of country for development, until in some instances the new roads themselves no longer adequately serve the purpose for which they were originally intended, and have had to undergo alteration or replacement. Moreover, from the point of view of the surveyor, the modern development, consisting of detached, or semi-detached houses, often laid out in curves or *culs-de-sac*, presents a more difficult problem than the streets of terraced houses prevalent in the past . . . .

"The rapid changes in the countryside have led Parliament

to pass a series of enactments, many of which could hardly be put into operation at all without the assistance of really up-to-date plans. The following Acts have been seriously affected by the lack of large-scale revision :—The Local Government Act, 1929, the Housing and Slum Clearance Act, 1930, the Town and Country Planning Act, 1933, the Land Registration Act, 1925, the Land Drainage Acts, the Finance Act, 1931, which instituted the Land Value Tax, the Restriction of Ribbon Development Act, 1935, and the Tithe Act, 1936."

The Report proceeds :—

"The development of the country and the restricted staff of the Ordnance Survey have together operated to render impossible the periodic revision envisaged in 1882. It is this delay in revision which has caused the central and local government authorities and the public generally the greatest inconvenience.

"A cyclical revision of the plans of the whole country at prescribed intervals of time, whilst it offers certain advantages in the economical and orderly employment of staff, tends to break down if the changes in ground features are accelerated over a wide area. Not only is the regularity of the cycle disturbed . . . but it cannot be re-adjusted unless in other areas elsewhere changes have been below expectation.

"Such re-adjustment is, moreover, rendered more and more difficult by each delay which occurs, for if the changes have been great, normal methods of revision may no longer suffice, and the Ordnance Survey must resort to the longer and more costly operation of a partial resurvey. The obvious drawback to cyclical revision is that it at once permits the process of deterioration to begin, and that as deterioration progresses, revision becomes more difficult and more expensive, precisely as the inconvenience to the public increases."

The Committee make it clear, in fact, that the existing "cyclic" system is unequal to the demands made upon it by the accelerated tempo of modern life, and advocate far-reaching changes. Their Final Report dealing with headings (*a*) and (*c*) of their terms of reference makes five main recommendations, to wit :—

(1) That no change be made in the scales of existing maps.*

(2) That the large-scale maps be re-arranged so as to form a single national series on one projection, instead of a number of separate county series on 39 different projections.

* These scales are 1/2500 (or 25·344 inches to one mile), six inches to one mile, one inch to one mile, half-inch to one mile, quarter-inch to one mile, 1/500,000, 10 miles to one inch, and 1/M.

(3) That this re-arrangement be made the occasion for a complete overhaul of the 1/2500 survey and that, thereafter, revision should be a continuous and not a periodic process.

(4) That a new series of maps, intermediate between the one-inch and six-inch scales, on the scale of 1/25,000, be introduced.

(5) That a grid should be superimposed on all Ordnance Survey maps.

If these recommendations are accepted a number of consequences follow. The re-arrangement of the large-scale maps on a single projection necessarily implies an alteration in the sheet lines of every existing large-scale sheet, while the addition of the grid, for reasons explained in the Report, makes desirable a change, both in size and shape, of all existing maps. The Committee therefore proceeded to make a further series of consequential recommendations which are :—

(1) That the unit for the grid should be the international metre.

(2) That the large-scale plans should be square in shape, and that the 1/2500 plan should cover one kilometre square of country.

(3) That each six-inch sheet should cover five kilometres square of country, and consist of 25 plans, and the 1/25,000 sheet of 10 kilometres square of country, and consist of exactly 100 plans.

Finally, the Committee make a number of subsidiary recommendations, important in themselves, but not directly connected with the above, namely :—

(1) That when the revision of the 1/2500 survey has been completed the question of a survey on the 1/1250 scale in urban areas should be considered.

(2) That additional contours should be added to the six-inch map.

(3) That the Ordnance Survey should continue its present practice of publishing archæological maps.

(4) That the numbering of parcels (*i.e.*, parcels of land—a technical term for fields and other enclosures), should be discontinued as soon as the National Grid is introduced.

(5) That the position of the Ordnance Survey should be reviewed annually, with a view to the maximum practicable recruitment until such time as the recommendations in the Report have become effective.

The Committee considered the use of air photography for Ordnance Survey revision, and recommend that the policy of getting air photographs done by short term contracts given to civil firms, which has been in force up to the present, should be discontinued; and that the Government should consider the formation as soon as practicable of "a special Air Survey Unit capable of satisfying the requirements of the Ordnance Survey."

Air photography has a potential value to the Ordnance Survey, both for normal revision and for the overhaul of the 1/2500 survey recommended by the Committee. Air photography has already been used experimentally for 1/2500 revision, and it has been found, as might have been expected, that in recently built-up areas, a very considerable saving of time can be effected with its assistance; more than sufficient to pay for the cost of photography—very substantial though this is.

For the overhaul of the Survey, including the assimilation of two Surveys on different projections, and the elimination of the discrepancies at the common boundary, the first step is to connect up the two triangulations. Unfortunately, the stations of the original Ordnance Survey triangulation, marked mostly by stones or tiles buried deep in the ground, were very badly described. Many of them have disappeared altogether, and it is always difficult to find those that remain. Moreover, it generally proves that when the stations have been found the rays from them are no longer open, owing to new buildings and trees which have appeared in the hundred years or so since the triangulation was done. It has therefore been necessary to do the triangulation over again, and to mark the stations in a more permanent and easily discoverable manner—a formidable task upon which a start was made three years ago. The whole of the primary work, with the exception of Scotland north-west of the Caledonian Canal, has now been completed, and the secondary work is in hand. Even when the secondary work is finished, however, there will be no more than one fixed point in every 20 square miles, that is to say, about one on every fourth plan: hardly a sufficient basis upon which to re-adjust the Surveys and to get rid of discrepancies. Before the detail can be adjusted means must be found to bridge these four-mile gaps and to fix a great number of additional points. It is hoped to make use of air photography for this purpose, in fact to carry out triangulation on air photographs which will be accurate enough for the purpose in view, but which can be done a good deal more quickly than triangulation on the ground, and thus avoid holding up the detail work.

This is not by any means the only technical problem which is raised by the Committee's recommendations. The substitution of continuous for periodic revision involves many alterations in present methods of field as well as office work. Until recently it was

the practice to redraw every 1/2500 plan *in toto* at each revision. In future it will be necessary to correct the drawings, and this means drawing on some non-distorting material, on which repeated corrections can be carried out without injury to the surface. For some time past experiments have been proceeding in the use of various materials having the required properties, and it is probable that the manuscript drawings will be made in future on specially prepared aluminium sheets instead of paper, while the field revision will probably be carried out on transparent plates of synthetic resin, or some such material, instead of on tracing paper as at present.

As the result of the Committee's recommendations, the personnel of the Department has already been increased from its lowest post-war total of little over 1,000 to nearly 3,000, and a still further increase is not unlikely. The Committee envisaged an eventual maximum of about 4,000 until the overhaul of the 1/2500 survey is completed.

The gross annual cost of the Department is at present a little over £663,000, though of this sum nearly £220,000 is recovered from other Government Departments and from the public for services, maps, and royalties. The balance is, of course, a charge against the taxpayer.

The Committee refer to the question of cost in their report (paragraph 54) in the following terms :—

> "That the convenience of the public would be served by continuous revision is undeniable, but the question the Committee have had to face is whether the cost would be out of proportion to the benefit received, or so high that Parliament might find it difficult to find the money for the purpose. The broad general reply is that modern Government in a country such as ours demands up-to-date and accurate maps, and that out-of-date maps involve so much inconvenience and expense to the users that, whether indirectly or directly, the full cost involved in continuous revision must inevitably be incurred. It is therefore in every respect desirable, as well as being in the long run cheaper, to act on the frank recognition of the facts and entrust the maintenance of the national plans to the appropriate central department, which should be staffed and equipped so as to enable it to perform its task adequately."

It may be hoped that the Department will not again be called upon to make the heavy sacrifices that it had to make in the past, for there is little doubt that the country is becoming more and more dependent on its work as time passes. That the direction of this unique "key" department should be in the hands of the Corps is at once a great privilege and a great responsibility, so much so that

it is worth noting that the Committee did not recommend any change in this respect. And this notwithstanding that the arrangement has not infrequently come in for criticism.

At the present time it can be claimed that, in spite of the out of dateness of many of its plans, the Department continues to enjoy the confidence of all the chief organized bodies of map users, such as the Chartered Surveyors' Institution, the Land Agents' Society, etc. Its relations with one and all are close and cordial, a fact to which the Committee bear testimony in their report (page 27).

The activities of the Survey are carried on under the authority of the Survey Act of 1841. This gives its personnel the right of entry into private premises and power to erect boundary and other pillars on private property. Naturally these rights have to be used with discretion and their enforcement in the face of widespread public opposition would not be easy. Fortunately opposition is rare, and it speaks well for the good sense of both the public, and the personnel of the Department, that disputes—and even serious arguments—are uncommon. This does not mean, however, that a reviser's life is devoid of incident or adventure, or that he does not require patience and tact in the performance of his duties. Not a few have been suspected recently of belonging to the I.R.A. and of desiring entry into property in order to plant bombs therein!

All who are interested in Survey—and especially those who have served with the Ordnance Survey—may be recommended to study the Committee's Report (obtainable from H.M. Stationery Office, price 5s., but also in the Corps Library), in which there are many points of interest besides those mentioned above. There is, for example, a short statement of the reasons for recommending the *metre* as the grid unit (paragraph 10), and—in an appendix—a note on the projection to be used for Ordnance maps in future.

The Committee's Report has not yet been formally accepted by the Government—no doubt because other and greater issues have supervened to occupy attention—but it can safely be assumed that its main recommendations will be put into effect.

The Director-General's has recently been made into a Major-General's appointment, while two other posts in the Department will in future be held by full Colonels. With these changes it can be claimed that the Ordnance Survey now offers to the R.E. officer opportunities of exceptionally interesting work, and prospects certainly not inferior to those in any other branch of the Corps.

CO-OPERATION BETWEEN THE CIVILIAN ENGINEER AND THE MILITARY ENGINEER.

The report of an INFORMAL DISCUSSION held at the Institution of Civil Engineers on Wednesday, 18th January, 1939, reprinted by the kind permission of the Institution of Civil Engineers.

MR. W. J. E. BINNIE, M.A., President Inst.C.E., in the Chair.

SIR CLEMENT D. M. HINDLEY, K.C.I.E., M.A., Vice-President Inst.C.E., introduced for discussion the subject of " Co-operation between the Civilian Engineer and the Military Engineer " at a largely attended meeting at the Institution, at which over one hundred R.E. officers, including many senior officers, were present. He stated that the immediate approach to the problem how best could co-operation between Civilian Engineers and Military Engineers be encouraged, fostered and maintained, had come from the Military Engineers, and that subject had been definitely raised on a recent occasion of kindly hospitality by Major-General A. E. Davidson. The recent revival of the idea had, however, been simmering in many minds, and might be traced a little farther back to the Presidential Address recently delivered by Colonel H. S. Rogers, the President of the Institution of Structural Engineers.

There were no doubt many diverse motives for the desire for closer contact. Among the most compelling was the idea that, as in time of war military and civilian engineers would have to work together, it would be valuable for the two classes to get to know something of one another's mentality, outlook, and methods in time of peace. That kind of knowledge could only come from regular and continuous contact between individuals of the two classes and by frequent interchange of ideas between them. It was to explore the practical possibilities of establishing means of such contact and collaboration that the Institution of Civil Engineers had organized the meeting, and it was fortunate for those present that some of the most senior members of the Corps of Royal Engineers were here to speak on the subject. He hoped that they and their colleagues would realize that the very first opportunity had been taken of discussing the question with them. In order to make the discussion as wide as possible and to promulgate the idea throughout the different branches of the civilian engineering profession, the Council had invited to the

meeting the Councils of the Institutions of Mechanical Engineers, Electrical Engineers, Municipal and County Engineers and Structural Engineers, and he was glad to welcome the representatives of those bodies present.

Looking back to the experience of the last war and, remembering how the hypothetical barriers between military engineering and civilian engineering had been broken down, Sir Clement wondered why the contact and co-operation then established had not been kept up. In spite of that fusion of technical method and pooling of experience, there were those who persisted, even down to recent times, in putting into practice the ideas of 100 years ago of essential separation between military and civil engineers, and it was only recently that the Council of the Institution of Civil Engineers had been converted to the idea that holding the King's Commission should not be a bar to membership of the Institution. The doors were now open for those properly qualified and, in addition to the class of Associates which was open to Military Engineers, he would mention that the Institution was exploring the possibility of an even wider interpretation of their present Bye-laws, as he knew that there were many Military Engineers who would like to take up membership (*see note at the end of this article*). Other and more direct methods of co-operation were also necessary.

The clouds of war which became so black and menacing in September were still hanging over the country, and had very forcibly turned the minds of all to the great question of the organization of the civilian population, including the Civilian Engineer, for national defence. Such organization, if radically undertaken, would afford the best possible means of prevention of war itself, but to prepare and organize it was necessary to know what war was. It was no use falling into the old error of preparing for the last war. Events in Spain and China and the preparations being so blatantly made in other countries all showed that the next war, if it came, would be an Engineering war. All the accumulated knowledge and experience of Civilian as well as Military Engineers would therefore have to be drawn upon, and so it was essential that organization in peace time should at any rate be carried so far that all that reservoir of knowledge, experience and capacity would be available when required.

The immediate problem in the present discussion was, however, co-operation with the Royal Engineers, and Colonel Budden, who would follow, would put forward various possibilities of co-operation as a basis for discussion. Here he would add that in order that suggestions and ideas made in the course of the discussion might be followed up and, where possible, put into practical shape, a small advisory Committee had been constituted consisting on the military side of Major-General Collins, Major-General Bond, and Brigadier Cave-Browne, and on the civilian side of Professor Inglis, Vice-

President of the Institution of Civil Engineers, Mr. Stanier, Vice-President of the Institution of Mechanical Engineers, Dr. Faber, a Past-President of the Institution of Structural Engineers, and himself.

Lt.-Col. F. H. BUDDEN, M.C. (late R.E.), stated that the suggestions made were intended to promote discussion and to encourage others to put forward suggestions. They were not the official view of any civilian Institution or of the military authorities.

The problem could be discussed from two points of view:

(1) Co-operation from the point of view of the Civilian Engineer.
(2) Co-operation from the point of view of the Military Engineer.

The Civilian Engineer wished to know in peace time how best he could assist his country in war. On making inquiries he would learn that he could join :—

(*a*) The Territorial Army. Age limits for candidates for appointment to a Commission 18 years to 31 years. It was understood that most R.E. units had a full complement of officers with a waiting list of applicants.

(*b*) The Supplementary Reserve of Officers. Age limits 18 years to 30–35 years for a 2nd-Lieutenant and 45–50 years as Lieut.-Colonel. There was already a number of men on the R.E. unattached list.

(*c*) Officers' Emergency Reserve.* Age limits 31 years to 55 years. There was no training in peace time but members wishing to keep in touch with any particular unit in peace time might be affiliated to a unit of the Supplementary Reserve or Territorial Army, if vacancies existed.

As many Civilian Engineers were unaware how best their services could be utilized, he suggested that closer co-operation between the Military authorities and the leading professional Engineering Institutions would be of mutual benefit. The Institution of Civil Engineers was completing a comprehensive register which would give details of the training and works experience of their members, and that would enable information to be supplied without delay concerning any branch of engineering. Other Institutions would also have available similar information. Further, Institutions through their Journals could easily promulgate information to their members.

The pre-war method, under which applications were received annually by the Institution of Civil Engineers from the Army

* On the 1st February it was announced that it had been decided temporarily to close the Officers' Emergency Reserve, owing to the overwhelming response to the call made in the National Service booklet for volunteers to join this Reserve.—SEC., INST. C.E.

Council for the submission of the names of gentlemen recommended by the President to be granted commissions in the R.E. Special Reserve, had much to recommend it, and that might be revived for the Supplementary Reserve. Civilian engineers would consider it an honour to be selected by the President, while the Institution would take care that the best type of member was chosen.

The linking of the R.E. portions of the Officers' Emergency Reserve with the leading professional Engineering Institutions would also be advantageous to both sides. Where it was not practicable for those in the Officers' Emergency Reserve to be affiliated to units in peace time, the issue of a leaflet indicating generally what would be required of engineers in war would help to keep them interested. Joint Meetings might also be arranged by Institutions at important centres, where an R.E. officer would be able to explain the class of work which a civilian engineer might have to carry out in war.

The working out in peace time of a plan to enable the staffs of consulting engineers to be used as a unit on the designing of important works in war was one that offered definite possibilities, as it would ensure that the problem would be dealt with by a team of men who were accustomed to work together. Registration of the men concerned would be required so that they should be available, when called upon. That would not prevent them from being used for suitable duties in the early part of the war. The construction of such works could be arranged in the manner most convenient to the military authorities.

Speaking from the Military Engineer's point of view, Colonel Budden suggested that the Military Engineer would no doubt wish to keep in touch with the advances made in engineering practice and with the work of the Civilian Engineer, who generally had better opportunities for carrying out works, large and small, than his military brother. That might be done :—

(*a*) By the holding of Joint Meetings with different Institutions where Papers on subjects of common interest could be read and discussed. In that connection he would mention that a proposal was under consideration for holding such a Joint Meeting on demolition problems and the use of explosives with the Institution of Civil Engineers during Session 1939-40.

(*b*) By encouraging R.E. officers to join one or more of the leading professional Engineering Institutions. Although in many cases the educational qualifications were up to the required standard, it was found that their subsequent training and work made it difficult in certain cases for them to comply with the necessary qualifications for election. Further, R.E. officers in the course of their

duties had to serve in many parts of the British Empire and did not generally remain in one place sufficiently long to take an active part in the work of an Institution. Engineering Institutions might recognize those difficulties and also the fact that the military officer had a number of compulsory subscriptions to pay, and possibly agree to accept military members at special subscription rates, or even to accept a joint subscription for the three major Institutions—the Institutions of Civil, Mechanical and Electrical Engineers. It might be desirable to introduce a special class of "Military Member" to show that the Civilian Engineer was willing to assist his military brother in keeping himself up to date with the latest civilian practice.

(*c*) By Local Associations and Branches inviting Military Engineers stationed in their areas to their meetings. That had already been done by the Newcastle-upon-Tyne Association of the Institution of Civil Engineers, and other Local Associations were being urged to do the same.

(*d*) By the military authorities submitting problems for consideration by the appropriate civilian research committees, of which there were a number now in existence. Many of the problems would be similar but might have to be approached from a different angle. That should not present any great difficulty when all aspects of a particular problem were being examined. The military authorities, on their side, might be able to assist in obtaining information to help in the solution of certain civilian problems, especially in connection with impact and blast, and air raid precautions.

He suggested that the civilian liaison committee referred to by Sir Clement Hindley might either represent the three major Institutions, or be linked up with the Engineering Public Relations Committee, which represented seventeen leading professional Institutions. The Public Relations Officer could then act as Secretary to the civilian liaison committee. Such a liaison committee might also be useful in connection with suggesting suitable lectures for delivery at the S.M.E. Chatham, visits to works in progress, etc., if the military authorities were in doubt at any time.

Social contacts were also valuable and, in addition to possibly inviting more of the senior members on either side to the annual dinners, conversaziones and "at homes," the R.E., Chatham, might play a joint team of the Students of the Institutions of Civil, Mechanical and Electrical Engineers, who already competed against each other for the Young Trophy, at cricket and other games.

No reference had been made to the arrangements for the training of young R.E. officers on works with civilian firms, but, speaking as one who had worked for a year in the mechanical workshops of a British railway, he could bear witness to the fact that the experience gained was invaluable.

Major-General D. S. COLLINS, C.B., D.S.O., Director of Fortifications and Works, said that the Secretary of State for War had that afternoon personally instructed him to convey his thanks to the Council of the Institution of Civil Engineers for arranging the meeting and to say that he attached the greatest importance to the question of the help which could be given by the great Engineering Institutions in the event of war.

He proposed, first of all, to give a brief review of the duties of the Royal Engineers in war. By war he meant not only a major war but the type of war they were now having on the North-West Frontier and in Palestine.

Their work in war could be divided into two categories: (*a*) field engineering and (*b*) lines of communication and base work. Field engineering covered every type of engineering such as field defences, roads, demolition, water-supply, mining and dug-outs. The relative importance of those works naturally varied with the locality of war and might even vary from day to day in any particular locality. It was obvious that it was not possible to have a specialist for every type of engineering work and, therefore, the Royal Engineers had to have a good working knowledge of all types. As far as possible they were standardizing their equipment, but the amount they could hold was very limited. The power of improvisation was therefore a very important factor. The Royal Engineer could do very little without stores of some kind. The question of their provision and transport was very difficult, and could only be solved by intelligent anticipation on the part of the R.E. officer, who had to be in the closest touch with the various commanders, and try and foresee their requirements.

The position on the lines of communication and base work approximated much more nearly to peace-time procedure, and there the Royal Engineers had to deal with roads, water-supply, lighting, accommodation of all sorts, including ammunition dumps and so on. He had left out railways, because they were a thing on their own, although light railways, both in the front and in the lines of communication, sometimes loomed very large. Costs and accounting had also to be considered, as well as the question of store-holding. The handling and transport of the stores assumed huge proportions. There was, however, no cut-and-dried line between a Royal Engineer in the forward areas and a Royal Engineer in the back areas, as they had to be interchangeable.

A really efficient R.E. officer should primarily be a soldier; he

had not only to be able to understand his commander's orders but to try and anticipate them. Secondly, he should have a working knowledge of all types of engineering. If, in addition, he could be an expert in one type, that would be the ideal position, provided always that R.E. officers were not all experts in the same subject. The problem as far as the Royal Engineers were concerned was how to reach that ideal. They would not have got so far as they had if it had not been for the real co-operation of many civilian engineers and firms, who had taken and were taking such officers as could be spared. Owing, however, to the very great increase in expenditure on major services throughout the world, it was difficult at present, to say the least of it, to make R.E. officers available for those attachments. He would like to correct any misapprehension concerning the payment of attached officers; that was, of course, the responsibility of Government.

Even if officers had been put on such attachments they had not solved the real problem, which was how to retain the liaison so made and to make further contacts with their civilian confrères so that each officer could be kept up to date in the advances in engineering knowledge. That was the first question he would like to hear elaborated.

He was glad that Colonel Budden had mentioned the many compulsory subscriptions which an officer had to pay, and had referred to the value to R.E. officers of a joint subscription to the three major Institutions. He had benefited from such an arrangement in connection with golf while he was at the Senior Officer's School at Woking, but he supposed it was quite impossible for the great Engineering Institutions to improve the R.E. officer's engineering knowledge on the same lines.

A problem which was exercising the minds of so many civilian engineers was what was going to be their place if war broke out. Here he would like to stress the point made by Sir Clement Hindley that they had to prepare for the next war and not the last. The name "War Department" gave many people the idea that all preparations being made for war were being made by that department. That was very far from being the case, and they had an officer there who would tell them more about that. The War Department dealt only with the Army preparations and their demands for the services of engineers formed only a small percentage of the demands which would and had to be made by the country as a whole.

He would end by expressing the appreciation of the Royal Engineers for the kindness of the Institution in arranging the discussion, an appreciation which was demonstrated by the fact that one hundred and thirty R.E. officers were there, some having come long distances at their own expense.

Major-General L. V. BOND, C.B., said that there were two aspects of the problem: there was the short-term problem of how at that moment members of the civil engineering profession could be brought into contact with those who would have to call upon that profession in time of war, and the long-term policy dealing with the question of liaison in happier times and the training of the R.E. officer. As Commandant of the School of Military Engineering and Inspector of the Royal Engineers, he was particularly interested in the problem of training the R.E. officer. Sir Clement Hindley and Colonel Budden had made a number of valuable suggestions. The first suggestion was that R.E. officers should be encouraged to become Associate Members of the various Engineering Institutions. A considerable proportion of the R.E. officers at the present time were qualified technically to become members of the Institution of Electrical Engineers and the Institution of Mechanical Engineers, and quite a number of them took advantage of it. No R.E. officer, however, except in one or two special cases, had up to date become an Associate Member of the Institution of Civil Engineers, although he need hardly say how proud they would be to announce themselves as being members of that very distinguished body.

Sir Clement Hindley had said there had been an insuperable obstacle in the past. That had been removed, but, as he read the rules, the rewere still equally insuperable obstacles, inherent in the wording of the rules as regards apprenticeship, and he very much welcomed the news that the Council would consider some possible modification of the interpretation of those rules. Professor C. E. Inglis would agree that the majority of those young officers were well qualified to challenge them on the ground of academic engineering education, and not a few officers in their subsequent careers had opportunities, in the very charming words of the Charter of the Institution of "directing the great sources of power in nature for the use and convenience of man." He would not suggest that the standard should in any way be lowered to meet their requirements; they would dislike it very much if they had to come in as weaker brethren. In coming in, they would wish to be real engineers as well as Royal Engineers. If that could be done, he thought that, on their side, they could find some means of making that distinction a real assistance to an officer in his career, so that the position of Associate Member of one of the great Institutions should be the real objective of R.E. officers. It had to be made worth their while to put their hands in their pockets, even for such a worthy object.

General Collins had touched upon the difficulties of the existing method of keeping in touch by sending officers away on engineering attachments. When things were easier they would try to extend that seconding of officers, and he knew that the civilian engineers,

on their side, would be only too willing to meet their requirements. He thought that was really the best form of liaison.

He warmly welcomed the suggestion of having joint meetings between the Royal Engineers and civilian engineering bodies. But he felt that, except in a very limited sense, there was no such thing as military engineering; it was civil engineering applied to military needs. The Civilian Engineers were mostly specialists; and although the Military Engineers would sit at their feet and be very ready to imbibe instruction, they could not possibly offer instruction in any way. He thought the Royal Engineers would gain enormously by such combined discussion or even lectures. The suggestion that the local branches should help Chief Engineers to arrange visits was very important and very welcome.

On the social side he felt that the civilian engineers were not strangers to the R.E. officers at all. They met in Professor Inglis's great school, they worked there for years together, and he hoped they knew each other very well. They were making a start this year with what he hoped would be an annual event; they were asking a number of distinguished civilian engineers to dine with them at Chatham. He knew that the suggestion of playing games against Chatham would be sympathetically considered.

Major-General H. C. B. WEMYSS, D.S.O., M.C., Director of Mobilization, remarked that the number of vacancies in peace time was, in the Territorial Army and the Supplementary Reserve, limited, and in many cases the location of a Unit was the deciding factor. He would like, however, to say a few words on the question of the Emergency Reserve of Officers. That was a scheme started about 18 months ago in order to see what talent would be available in an emergency and to afford an opportunity of examining the qualifications of gentlemen, so that they could be put in the right places when the opportunity arose. Thus they would know what sort of work they would be asked to do on mobilization. The scheme, of course, dealt with all activities and not only with engineering. It had gone along slowly until the crisis in September, when applications began to pour in.

He wanted to draw attention to the existence of that Reserve and to say that endeavours were being made to make it more realistic by offering appointments on mobilization to individuals who had the right qualifications. The War Office was only one of a large number of Government departments, and nowadays practically every Government department was engaged in some form of warlike preparation. Therefore the numbers who in peace time could be earmarked for war appointments on mobilization were limited. He thought that that warning was necessary in order to avoid disappointment. He hoped that, as the register grew, it would be used to the benefit of the State in its defence. By that he meant

that they would pass on to other Government departments, with the consent of the individual, any individual who was considered to be particularly qualified for work under another department.

Professor C. E. INGLIS, O.B.E., M.A., LL.D., F.R.S., Vice-President Inst. C.E., said that the problem of closer co-operation between Military Engineers and Civilian Engineers was one of such vital importance to the country that it was a little disquieting to realize that any problem existed there at all. It was unfortunately, however, a fact that Civilian Engineers and Military Engineers in a great many cases were not moving in the same plane. The real reason was that in far too many cases the Military Engineer's, by which he meant the Royal Engineer's, knowledge of engineering was confined to what he had been taught when going through his theoretical courses at Chatham and at Cambridge, but, unlike their civilian contemporaries, far too few of them had any real opportunity of applying those principles. They learnt with a great success a knowledge of theoretical engineering, but a paucity of practical engineering experience would sooner or later tend to produce what, for want of a better word, he would describe as an engineering inferiority complex.

In the same way, the urge to join an Engineering Institution and to take part in the various discussions was not as great as it should be. More and more the young Royal Engineer tended to look towards the military and administrative side of his career rather than to the technical side. That was the cause of such estrangement as there might be between Civilian Engineers and Military Engineers, and he was glad to know that that state of affairs was being rectified.

Great help in that direction could be constantly forthcoming from the civilian side. The remedy was there at hand, because he had yet to hear of any Civilian Engineer of repute who would not be glad to take into his office, or into his works, officers of the Royal Engineers. Those offers had been utilized to some extent in the past but they had not been utilized to anything like the extent to which they ought to have been. The reason it had not been done was because the officers could not be spared, but he wondered if they were doing work of such paramount importance that it had to take precedence over the important consideration of gaining practical experience, or was there possibly some truth in the rumour that in far too many cases the Royal Engineers were being put on to jobs which were quite unworthy of their ability and early training ?

He realized that a Royal Engineer had primarily to be a soldier, and perhaps only secondly an engineer ; but was it too much to ask that, of the first 10 years after leaving Cambridge, at least 3 or 4 years should be devoted to gaining real practical engineering experience? In his opinion, at a comparatively early stage in a young Royal Engineer's career he should have acquired a sufficient amount

of practical experience to be eligible for admission as a Corporate Member of the Institution or any of the other great Institutions.

He hoped it would not be thought he was belittling the Corps of Royal Engineers by the observations he had made, because he had the greatest possible admiration for the splendid young men, splendid both physically and intellectually, who were continuing to pour into the Corps and of whose excellence he was privileged to have first-hand knowledge.

Lieut.-Colonel H. S. ROGERS, C.M.G., D.S.O. (late R.E.), President Inst. Struct. Engineers, remarked that he had had the good fortune of long and intimate association with both Military and Civil Engineers, and that experience during the war convinced him that there was a need for more co-operation between them. He was glad to be able to assure the Liaison Committee that the Institution of Structural Engineers were out to help in every way in which they could, and mentioned that under their Bye-laws they might be able to arrange for senior officers in the Directorate of Fortifications and Works to become honorary members, while holding certain appointments. He suggested that the Liaison Committee should investigate the possibility of R.E. officers being affiliated to Institutions, either at headquarters or to their Local Branches, and serve on committees, as it was in that way he had got to know and become intimate with Civilian Engineers.

He would like to call attention to a further point and that was that he hoped that the register of professional men, which he understood the Ministry of Labour were compiling, would not clash with the War Office register of the Officers' Emergency Reserve. In conclusion, he thanked the Institution for providing the opportunity for the discussion.

Mr. S. B. DONKIN, Past-President Inst. C.E., said he wanted only to refer to the experience of his firm who, for the last 30 years, had co-operated with the Royal Engineers in what was called the Electrical and Mechanical Course. That course provided that Royal Engineer officers firstly spent 16 weeks in manufacturing works, then 16 weeks in an electric supply undertaking, in a power station or on a distribution system, and then 16 weeks in the office of a consulting engineer, being put through the executive and practical engineering business of a consulting engineer's office. Many of those Royal Engineers had informed him that they gained a better type of experience in a consulting engineer's office than elsewhere, as they had to report on schemes, they had to specify, they had to report on tenders, they had to watch construction and inspect material, and finally they had to deal with certificates for payment and so on. He had found that those R.E. officers had proved themselves to be very able assistants on the many consulting engineers' staffs to which they had been allocated, and he hoped that the R.E. officers

present would bear in mind the useful co-operation that existed between the War Office and firms of electrical and mechanical consulting engineers in that scheme so that they might remember, when any large scheme was under consideration, that the advice and services given by consulting engineers were always available.

Major-General H. L. PRITCHARD, C.B., C.M.G., D.S.O., Representative Colonel Commandant R.E., said he was sure the Royal Engineers would like him to second the remarks made by General Collins expressing their gratitude to the Institution for having promoted the Meeting. It was the culmination of a great deal of help which had been given in the past, not only by the Institution of Civil Engineers but by the other Institutions. It was perfectly obvious that they were at a time when both the Military Engineers and the Civilian Engineers were particularly anxious to reconstruct the very strong amalgam which had existed between them in the latter years of the war.

He was interested in Professor Inglis's remarks and although there was no doubt that Professor Inglis (who had such an intimate knowledge of the Corps and had done so much for it) had spoken a great many home truths, at the same time he felt he could not accept absolutely everything he had said. He could assure the Professor that he could give him a very long list of Royal Engineers who had had good practical engineering experience.

General Collins had given a brief review of the work of engineers in war, taking them from the front to the base. He would like to go a little farther and to say that in the last war Civilian Engineers had been called in to take over definite jobs. He instanced the port of Basra, the taking over of the railways in France, and the pipe-line for the water-supply along the Suez Canal.

The Civilian Engineers had indicated that the military were not the only people who had units. The civilian units were the firms who were accustomed to working as a team. During the last war the Government had constantly called outside firms into consultation, and indeed were still doing so in the preparations for war which were now being made. It was also perfectly obvious that in the event of a big war there would have to be a largely increased number of R.E. units and of a very different kind from those in existence at the moment. Individuals would therefore be wanted to fill the vacancies in those units, and in addition the Government would be appealing to the civilian teams or units to come into consultation or to take over definite jobs.

He ventured to submit that if the Presidents of the great Institutions got together and considered the matter, they might be able to form a panel and a permanent staff, for which he optimistically suggested the Government might pay. They would then be able to tell the various Government departments to come to their

organization and find out who were the best people for particular jobs and who were the best people to whom to go for advice.

The organization of the Emergency Reserve of Officers was only for individuals and could not fulfil the purpose of the panel he proposed. He hoped that the Liaison Committees would press home the desire existing on both sides to get together and to have some organization to which the Government could turn to ensure that engineers could be put into the right positions in the event of war.

Mr. E. J. BUCKTON, B.SC., outlined a scheme for the formation of a new army grade of "Associate Royal Engineers," of which the training would be half military and half civil. Engineers at the age of 30, after some years of military engineering experience, would automatically leave the Army with no military rank other than Associate Royal Engineers and would be perfectly free to get experience and employment as civilian engineers. In the event, however, of the Army wishing to retain Associates in the Corps of Royal Engineers, it would merely be a matter of offering selected Associates sufficiently attractive conditions. Such Associate Royal Engineers, on leaving the Army, would be eligible for election after further experience in civil engineering works as Associate Members of the civil engineering Institutions, and later, as and when qualified, as full Members.

The total training of the Associate Royal Engineers would be longer than usual, but it would have to be if in their earlier days they were to be Military Engineers with a knowledge of civil engineering and, later, to finish up as fully qualified Civil Engineers with a considerable knowledge of military engineering. In each Unit there would then be officers who had had direct contact with civil engineering, and in each group of Civilian Engineers there would be Military Engineers obtaining civil experience and Civilian Engineers who had had military training.

Mr. BEN HOWORTH, from his experience as a Special Reserve Engineer before the war, wished to suggest the revival of that Reserve. Although there was a shortage of young engineers in civilian life, the training of Civilian Engineers with the Royal Engineers had proved in the past to be very useful, and the Special Reserve in the late war were considered as part of the R.E. organization. He therefore suggested that the Committee should consider the re-starting of the scheme.

Colonel J. E. CHIPPINDALL explained that he wished only to speak on the proposal to use engineering firms as teams. In peace time that was what they endeavoured to do as far as it was practicable, but a very frequent difficulty arose with regard to policy, as it was not always possible to foresee to what any particular job might lead when it was first started.

Looking at the matter from the war-time aspect, there were

certain difficulties. One was that the civilians were under no legal obligation to remain in an area of active operations. In the next war London might be an area of active operations. Even if they desired to employ civilian firms as firms, they could only do so by taking them over as military personnel. They were still bound by the law of the Realm, the Compensation Act of 1887, and the conditions of service of a civilian were very different from those of a soldier. It would therefore be seen that the use of civilian firms for overseas service presented considerable difficulties, but nevertheless they were trying to look into it to see whether that and other difficulties could be overcome.

NOTE.—Attention is drawn to the notices issued in the *Supplement to the R.E. Journal.* April 1939 (p. 117) and May 1939 (p. 155).

IMPRESSIONS OF PRESENT-DAY RUSSIA.

By MAJOR J. V. DAVIDSON-HOUSTON, M.B.E., R.E.

I HAVE recently returned from a tour across the Soviet Union, from Vladivostok on the Pacific coast to Moscow in European Russia. The subject of this territory is too vast to be dealt with comprehensively in a short article like this, so that I shall limit myself to a description of my own experiences and impressions.

Vladivostok, where I began my trip, is Russia's most southerly seaport in the East, and lies only about 100 miles from the Manchurian border. Ice forms in the harbour during winter, but the port is kept open by ice-breakers, and ocean-going steamers can dock there. The narrow entrance is named the Bosphorus Strait, and the inlet on which the town is situated is called the Golden Horn, after similar waterways at Constantinople. Improvements to this port have been carried out in recent years, but most of the streets are still cobbled and the suburbs consist of wooden huts. The weather is warm during the summer, and people bathe on the many beaches there. Vladivostok is surrounded by hills which help to shelter it from the northern winds. The population is mainly Russian, but there are large numbers of Chinese and Korean labourers. There are few motor-cars, which are used by the higher officials, and most of the people travel on foot or in trams. As in other Russian cities, building has not kept pace with the increase of population, and there is a shortage of accommodation. As a result of this, my hotel, which was being redecorated throughout, had to be kept open at the same time. All hotels are controlled by the town government. The restaurants are also crowded to capacity during meal periods, and queues form outside the doors. The best-dressed people are the members of the fighting services, whose uniforms are of good quality; most of the population goes about all the time in working clothes, although I saw two men in my hotel dressed in dinner jackets.

The first part of my journey was along the Ussuri railway from Vladivostok to Khabarovsk, skirting the eastern boundary of Manchuria. The country consists mostly of level grassland, where hay is mown and herds graze, while there are occasional low hills covered by fir trees. After crossing the wide Amur river, the train enters upon the Amur railway, which runs alongside the northern frontier of Manchuria. Here the country resembles that on the

Ussuri section, except that it is more hilly, and the railway pursues a tortuous course in order to avoid the marshy valleys. At Karimskaya the line joins the Trans-Siberian railway, which runs westward towards Europe, passing along the southern shore of Lake Baikal on the way. This great inland sea, overlooked by high mountains and surrounded by great forests, is almost the same length as Great Britain, and so deep that it never freezes over. Several great rivers, such as the Angara and Yenisei, connect cities on the railway with the Arctic Ocean; and during the summer small ships ply between these places and ports in Europe. The coldest part of the Soviet Union is Central Siberia, where snow begins falling in October and does not disappear till May; temperatures below minus 60 degrees Fahrenheit have been recorded. Attempts are being made to industrialize Asiatic Russia, and a great amount of hasty building is going on.

Except for a few gaps, where bridges have not been completed, the railway has recently been doubled between Vladivostok and Omsk, whence several lines run into western Russia. One of the most interesting points is Novosibirsk, at which the Trans-Siberian system is joined by the Turkestan or Turk-Sib railway, and through which passes the new "Golden Road to Samarkand." As the track is not ballasted, trains rarely travel more than thirty miles an hour. The Russians can teach us many lessons in patience, and little anxiety is wasted on the punctual arrival of trains; mine, for instance, was nineteen hours late at Moscow, but this was at the end of a nine days' journey. All passenger trains seem to be full, the passengers consisting almost entirely of officials and members of the fighting services; they are divided into First and Second categories, Soft and Hard class. The first two categories consist of comfortable two-berth compartments, the soft class has upholstered four-berth compartments, while the hard class is made up of compartments with four plain wooden bunks. There is one restaurant car for all classes, but this is apt to be so crowded that many people prepare meals in their compartments. Owing to the severity of the winter, the windows are double, and each carriage has its own heating system, which depends for its efficacy upon the diligence of the *provodnik*, or conductor. Washing is difficult, as hot water is only available for a short period after the engine boiler has been refilled; for this reason, passengers do not usually shave until the train reaches a large station with a barber's shop.

On arrival at Moscow, it is very difficult to find a conveyance to take one from the station, unless one is met by a representative of the State Tourist Agency. The Russians use the word *taksi* to include hired vehicles of the motor-car, charabanc and lorry types, which is apt to cause the traveller confusion. What we call a taxicab is generally termed *mashina*. Although Moscow, compared with other

great capitals, appears rather squalid and depressing, there are a number of fine public buildings, by far the most striking of which is the Kremlin. The Kremlin, which was built over three hundred years ago, now consists of the Palace, Uspenski Cathedral and other minor buildings, surrounded by a red brick wall which has mellowed with age. At intervals in the wall stand towers with spires rising from the tops of them, and gateways which are guarded by sentries. Most of the original structures were destroyed by fire during Napoleon's occupation in 1812, but a large palace of yellow stucco, in Italian style, was subsequently built upon the site. The rectangular lines of this edifice contrast strangely with the gilded domes and ancient Byzantine architecture of the cathedral. In this palace-fortress lives Stalin, who is said to change his bedroom every night. Next to the Kremlin is the Red Square, where the big parades are held; under the Kremlin wall stands Lenin's tomb, a mausoleum of red marble, within which Lenin's preserved remains are on view by the public once daily. Thousands of working people queue up for this, one of their few recreations. Formerly the only vehicles which could use the Moscow streets in winter were sleighs; recently, however, it has been decided to keep the streets swept for motor traffic. This has produced a problem in the disposal of the large quantities of snow which are constantly accumulating, and results in the roads (which are largely cobbled) becoming very slippery. The Russian genius for music, dancing and the theatre has survived the revolution, and appears to advantage in Moscow, where the opera and ballet draw full houses from all sections of the population. Theatrical performers are among the best paid people in the country.

And now I come to the most interesting part of this subject, the people themselves. The population of the Soviet Union comprises a great variety of races, European and Asiatic, white, brown and yellow, but the Slavs predominate. There appears to be no discrimination, however, between these heterogeneous components. A great many Jews occupy important official positions, and there is an autonomous Jewish territory, named Birobidjan, in the Far East. There is also a self-governing community of Germans, which has been settled on the banks of the Volga since the reign of Catherine the Great. These people speak both German and Russian, but retain their German names and identity; most of the servants employed by foreigners in Moscow belong to this minority. The control of a vast population in a partially developed empire has long presented difficulties to the governments of Russia, and at the present time every citizen must be in possession of a passport, without which he has no right either to travel or to reside freely. The necessity of developing Siberia has also resulted in the compulsory removal from time to time of whole communities from west to east, in addition to the transportation of persons obnoxious to

the authorities. During my tour I observed three trains full of such passengers.

The population appears to be divided into two main classes, officials (in which I include all ranks of the army and navy) and labourers. While the majority of the latter can barely afford the necessities of life, the official class has a higher scale of wages and privileges; for instance, at railway stations there are special shops and waiting-rooms for members of the Red Army. The majority of Russians know very little of what is going on outside their own country, as is evidenced by the following remarks which were made to me by relatively well-educated junior officials. "Have you heard in England of underground railways?" "Have you coal or iron mines in England?" "Have you any railway stations as big as that at Irkutsk?" "Has London got an aerodrome?" "It is reported that Canada has refused to acknowledge the British Crown." The Russians are naturally a friendly, easy-going and credulous people, treating foreigners with kindness and courtesy; this attitude is independent of official policy. Their terms of address savour of *bonhomie*: "*Tovarishch* (Comrade)" to an equal, "*Nachalnik* (Chief)" to a superior, "Father" or "Uncle" to an elder, "Little daughter" to a girl. Chess is a national pastime, and many of my fellow-travellers carried the game with them. Except in the big cities, where brick or concrete dwellings are being hurriedly built for factory workers, the greater part of the population lives in wooden houses, which they claim are as warm as any other kind; some of these houses are covered with plaster, whether for appearance or additional warmth I cannot say. A peculiarity of the villages is that almost every house has a wooden box fixed on a pole over its roof; these are for the benefit of starlings, which are encouraged by the Russian cultivator owing to their taste for insect pests.

The proverbial Russian appetite must be due to the severity of the long winter, for I found myself eating as much as my companions. The chief articles of diet which I encountered were black bread, butter (which is excellent), cheese, potatoes, porridge made of rice and butter, dried fish, beef and a great variety of soups. Eggs are sometimes not available in the cold weather, but caviare, which is a luxury with us, is eaten in large quantities by persons of moderate means. The peasants often drink a mixture of sugar and water, which of course has heating value. A very sustaining dish is a pancake wrapped round sour cream, caviare, and anything else which may come handy. The hours of meals vary in different parts of the Union, but the chief meal of the day is eaten at some hour between two and seven in the afternoon; breakfast is often as substantial as our own, and the day ends with a supper at any time between nine and midnight. Russians are capable of drinking a lot without undue intoxication, vodka being the principal stimulant. Glasses of

tea, without milk but with lemon or sugar, are taken whenever opportunity offers. The Russian is rarely without a cigarette in his mouth, but his cigarette, which he calls *papiros*, is only half the length of the ordinary article, the balance being made up of a cardboard tube which corresponds to a holder. Until recently, the Russian calendar differed from ours by about a fortnight, but the Western calendar has since been officially adopted. This sometimes leads to confusion in calculating historical dates; the October Revolution, for instance, is celebrated on the 7th November. A curious custom is the widespread use of the abacus for accounting in restaurants and shops; calculation with frames of wooden beads is also general in China and Japan.

Economic conditions present interesting features. A foreigner taking sterling into Russia can exchange it at 25 roubles to the pound, but the internal purchasing value of the rouble is about 100 to the pound. Prices and wages are thus apt to be somewhat deceptive; for instance, a breakfast of coffee, black bread, butter and cheese cost me six shillings, and a dinner of tea, beef and stewed fruit cost ten shillings. A pair of shoes may be sold for as much as eight pounds, and I witnessed a second-hand sofa being offered for twelve pounds. As in other countries, efforts are being made to render the Soviet Union self-sufficient, and it is rare to find any commodity which is foreign-made. In restaurants, "Soviet champagne" and "Soviet tokay" are freely offered for sale in bottles which closely resemble the native product. Frequently, however, there is a shortage of one commodity or another, and one sometimes sees goods in a shop-window which are not for sale inside. The arrival of a consignment of some popular article becomes rapidly known, and in a few minutes a long queue has formed outside the shop. This has led to the rise of a profession of queue-waiters, which attracts chiefly old women unable to find more profitable employment. As a result of these conditions it is possible to dispose of an old suit for about 20 pounds, and I received two offers for my watch during the journey. The purchasing power of different sections of the population may be gauged by comparing the wages of a Moscow labourer (150 to 200 roubles a month) with those of a military air pilot (1,000 roubles) and a civil engineer (4,500 roubles).

I hope that these few observations, from the limited point of view of a traveller with a mediocre knowledge of the language, will at least stimulate dispassionate study of a country that is both Eastern and Western, primitive and cultured, backward and progressive, but above all interesting and different.

THE CZECH SYSTEM OF FORTIFICATION.

Translation of an article by OBERST BIERMANN in the *Vierteljahreshefte für Pioniere* for February, 1939.

ONE of the first requisites of every fortification, and especially of every permanent fortification, is that it should help to economize the defender's man-power in order to enable him to utilize it at the decisive point. This principle must have been taken into account as a basis for the Czecho-Slovak system of land fortification. But anyone seeing the vast girdle of defensive works, and taking into account the size of the Czecho-Slovak Army necessary to hold them, might well ask where the troops were to come from who would form the field army capable of forcing a decision. Had the Czechs not contravened the spirit of the whole art of fortification when they planned and built these enormous works? Would they not have done better to have built, as a defence against their main enemy, a huge fortified zone in Bohemia, which did not absorb their whole force, but left them with an effective field army capable of manœuvre?

Enmity towards Germany had existed ever since the birth of the Czecho-Slovak State. The Czechs had dug the grave of the Austro-Hungarian dual monarchy, for which neither the Austrians nor the Hungarians owed them any gratitude. When the Poles were fighting for their very existence against Russia, the Czechs robbed them of the valuable Olsa region, including Teschen. The Czechs' only friendly neighbour was Rumania. They had, however, two powerful allies, France and Russia; not their neighbours, it is true. Paris and Moscow are far distant from Prague. Since 1924 there had been a military alliance with the French, who were to force a decision against Germany on the west. Any weakening of the German Army on that front meant a preponderance for the French. The Czechs were to draw strong German forces on themselves and hold them until a decision had been effected in other theatres of war. They were to fight to gain time, and land fortification helped them to attain their object. They had no need for a field army: that would be supplied by the French. All they required was an army that would hold the fortifications to the last ditch. The events that occurred in the autumn of 1938 proved that the overthrow of the huge Bohemian-Moravian fortress would have entailed the employment of several German armies, and this would have greatly reduced the number of Germans available for a decision on other fronts.

The other ally, Russia, with whom a pact had existed since 1935, had pledged herself to come, first of all, to the help of the Czechs by air. The "aircraft mother-ship" for the thousands of promised Russian aeroplanes required an extensive and safe space. Owing to the narrowness of the Czecho-Slovak State, the best solution to the problem would have been the conversion of a large area into landing grounds and its protection by fortifications. The central fortress mentioned above had insufficient space for landing grounds.

It must be admitted that the Czecho-Slovak land fortification could have fulfilled the two requirements. The doubtful point was that the solution was based on the policy of alliances. It stood and fell on this policy. The area of the State, as it existed from 1918 until the autumn of 1938, is of unsuitable shape for defence and fortification. In a speech delivered in September, 1938, Signor Mussolini likened it to a crocodile. The longer axis, from west to east, measures 600 miles, the cross axis, in the middle, 100 miles, *i.e.*, only one-sixth of the length. The length of the boundary is about 2,500 miles: about one half facing Germany, one quarter facing Poland, one-fifth facing Hungary, and only one-twentieth facing Rumania. In other words: nineteen-twentieths of the frontier faces potentially unfriendly neighbours.

It paid the Czechs best to turn the attack of their strongest neighbour, Germany, along the line of the longer axis of the country. A successful attack along the shorter axis, especially if made simultaneously from both sides, would have split the whole country in two. By far the most exposed portion was the district of Moravia, especially since Austria had become part of the Reich. It was on this basis that the Czecho-Slovak fortifications were carried out and their completion planned.

The northern and southern boundaries of Moravia were to be so strongly fortified that the Germans would think twice of running up against them. On the other hand, the Bohemian defences were to be so organized as to invite the Germans to break in at that point. The enemy would then be advancing along the longer axis, a favourable position for the Czechs, that would give them the desired breathing space. One position behind the other was thrown up throughout the wide area of Bohemia. Sectors strong by nature, in particular the lines of the Elbe and the Moldau, with the fortified area of Prague, offered good rear-guard positions and were heavily strengthened. In this way the Czechs, fighting a series of rear-guard actions, could fall back on the Bohemian-Moravian plateau. Years ago, newspaper accounts reported that the Czechs were developing the western slopes of the plateau for agricultural purposes. Doubts were cast on their accuracy. It may be assumed to-day that it was the intention to convert the Bohemian-Moravian plateau into an enormous redoubt, whose two flanks were the fortified boundaries

of Moravia. The redoubt was open to the east, the obvious line of retreat.

If the inroad into the "Moravian redoubt" proved successful, a series of river lines, notably that of the March (Morava), would have held up an advancing enemy. A further position to meet the attack extended along the White and Lesser Carpathians. Many notices had been published about the peaceful development of these regions. The position rested on the Beskids to the north, and on the Danube to the south, where the flank was protected by the bridge-head at Pressburg. A further attack would have led into the difficult country south of the Carpathians, the former Upper Hungary. In this way the Czechs would have kept the attacker advancing along the longer axis, while their own retreat was open towards the east, *i.e.*, Soviet Russia.

After this preliminary introduction, a description will be given of Czech fortifications, as they fell into the hands of German troops in October, 1938: first, the weaker ones, then the stronger, and finally, the largest works that were met with.

At the boundary crossings German troops came upon barricades of roads and paths. These barricades consisted of lengths of walling extending half-way across the road, alternately on the right and on the left, and loopholed for rifle fire. These walls slowed down oncoming traffic, and a barrier right across finally stopped it altogether. (*See photo No.* 1.)

For permanently closing an approach road to a farm, a double row of lengths of steel rails were embedded vertically in concrete. (*See photo No.* 2.)

Barriers erected in peace-time were supplemented during the crisis by extemporized arrangements. Many bridges were demolished.

Blockhouses, or similar erections from which fire could be brought to bear on the barricades, were only to be found here and there. (*Photo No.* 3 *shows an example.*) Such flanking arrangements had doubtless been planned from French or Belgian models, but there had not been time to carry them out.

The barricades were not manned, as the garrisons were retiring according to plan; so the German advance was not held up.

It is stated that strong blocking defences were erected in the Carpathian passes against Poland, but no details are available of their location or form of construction. It may be assumed that they were built, since the Czechs know military history far too well not to realize what an important part these passes have played from time immemorial up to the present day. At the time of the beginning of national migrations, the Huns swarmed over the Uzoka and Dukla passes into the Hungarian plains. The Avars followed, accompanied by the Czechs and Slovaks. Later on, Hungarian horsemen came over these passes and descended into the Danube basin. Mongol hordes

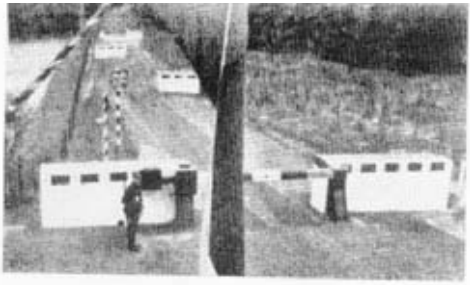


Photo No. 1.

Photo No. 2.

Photo No. 3.—Three loopholes are to be seen under the verandah. They were blocked up at first, but were afterwards opened.

The Czech system of fortification 1, 2 & 3

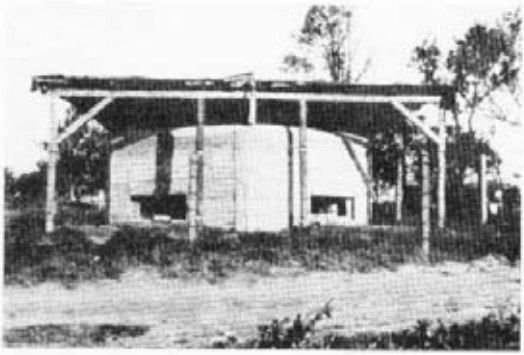
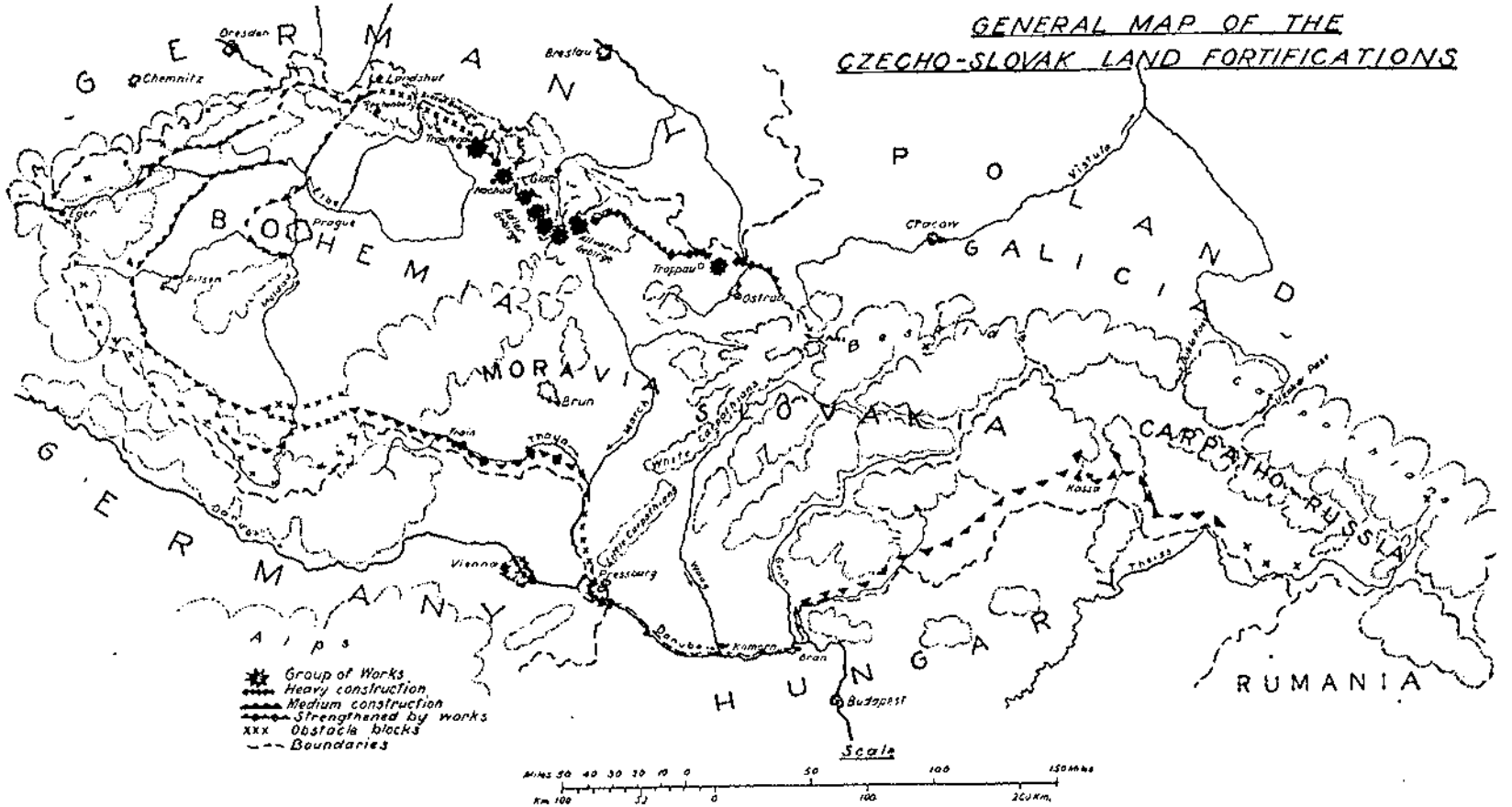


Photo No. 4.

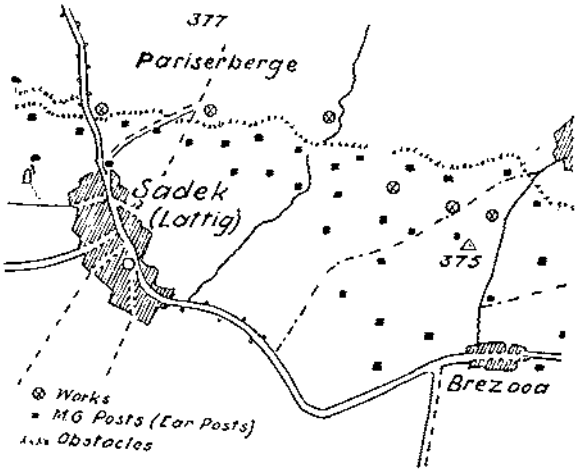
Photo No. 5.—Incomplete medium loopholed post. The enemy side is on the right. A machine-gun loophole is visible, protected on the front by a projecting "ear." The layer of protective stone is in course of construction. This so-called "detonating layer" is designed to catch dropping shells or mines, which it deflects and causes to explode prematurely before they reach the reinforced concrete wall.

The Czech system of fortification 4 & 5


GENERAL MAP OF THE
CZECHO-SLOVAK LAND FORTIFICATIONS
GERMANY
BOHEMIA
MORAVIA
SLOVAKIA
POLAND
GALICIA
HUNGARY
RUMANIA
CARPATHO-RUSSIA
Dresden
Chemnitz
Breslau
Prague
Brun
Vienna
Cracow
Vistula
Ostrau
Budapest
Komarn
Danube
Alps
Group of Works
Heavy construction
Medium construction
Strengthened by works
xxx Obstacle blocks
Boundaries
Scale

carried death and destruction over the same passes. Finally, during the World War, Russian Cossacks came over these mountain ranges up to the gates of Kassa (Kashau).

Light fortifications extend from the Riesen Gebirge all round the Bohemian basin. This light line of posts formed the first line for holding up an attacker on the frontier, and was the first that the Czechs threw up in their haste. (*Photo No. 4 shows a light defensive post with two loopholes, furnishing frontal fire.*) An attacker can render these posts ineffective by direct frontal fire (infantry or artillery) on the loopholes. The walls and roof shelter the inmates from shell splinters and rifle fire. It is estimated that 2,000 such posts were built.



SKETCH 8.

Stronger defences were, as a rule, erected later, by the construction, in front of the light fortifications, of medium works, known as "ear posts." These reinforcements were to be found, especially west of Troppau as far as the eastern slopes of the Altvater Gebirge, also in the Reichenberg basin, in the Biela sector, for the protection of the valuable brown coal district; around Pilsen, to secure the pit-coal basin and the Skoda works; in southern Bohemia and southern Moravia; along the Slovak-Hungarian boundary; and, finally, in the Olsa sector of the Polish boundary.

(*Photos No. 5 to 7 give an idea of the type of construction of these posts.*)

The posts fire almost only to the flanks. Very few have a loophole for frontal fire. Where this is the case, they are situated on a reverse slope, so that the loophole is not exposed to long-range direct observed fire. Most of these "ear posts" are incapable of defending themselves from the front, but depend upon outside help, *e.g.*,

Photo No. 6.—Completed medium loopholed post, not yet camouflaged.

The enemy side is on the left; the rear, with entrance, on the right. A view is obtained of a M.G. loophole, protected from the front by a projecting buttress "ear." The protective stone layer has been completed, also an earth ramp. There are hooks on the edge of the roof, to which the camouflage net is attached. To the right, and a little above the loophole, on the rear wall, is a ventilation hole. To the left of the door is a tube (indicated by arrow), for pushing out hand grenades.

Photo No. 7.—Completed and camouflaged medium post. The enemy side is on the right. The M.G. loophole is visible, also the upper portion of the protecting buttress "ear."

The Czech system of fortification 6 & 7

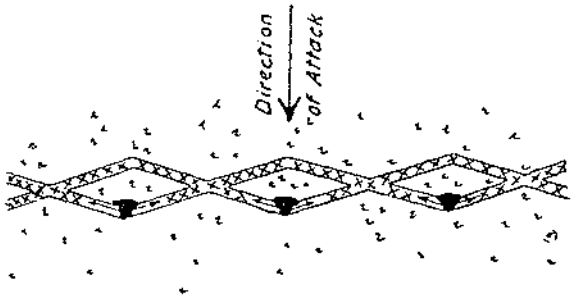
Photo No. 10.—A back view of the work (from the gorge). The front is a line connecting the two armoured turrets. The turrets have several loopholes, bringing fire to bear to the front, flank and gorge. Under the two turrets are ear-shaped buttresses for protecting the two flanking blocks. The photo gives a view of the right flanking block: in front (on the right in the picture) 1 anti-tank gun loophole; in rear (on the left in the picture) 1 M.G. loophole. The niche in the wall of the left flanking block (under the left armoured turret) is discernible. The entrance, with loopholed protection, lies in the middle of the gorge.

Photo No. 11.—The three-turreted work is here seen from the enemy side. It is not yet camouflaged, the towers and masses of concrete show up strongly against the dark background. The turrets are so deeply embedded in the concrete that it is only just possible to fire out of the loopholes.

The Czech system of fortification 10 & 11

neighbouring posts, or posts in rear, or by fire or counter-attacks from open positions. Even the larger Czech works show that the highest value is set on flanking fire, following the French model. Apparently the Czechs go still farther than the French with this principle, and abandon frontal fire altogether.

These " ear posts " secure protection against medium calibre fire. Their main safeguard depends upon their smallness, their large number, and the difficulty of hitting them. Often three or more lines of such posts lie one behind the other, as sketch No. 8 shows. The distance between the lines varies according to the nature of the country, from 160 to 270 yards, the interval between posts from 160 to 440 yards. The rearward posts cover the gaps between the forward ones.



SKETCH 9.—The fire clearances and infantry obstacles are planned on the principle of a " lazy tongs," in such a way as to compel the attacker to cross two obstacles and two lines of fire.

In specially important positions this medium type of construction is stiffened by heavy works sited among the posts. (*See sketch No.* 8.)

In wooded areas, posts and fire clearances (combined with lines of obstacles) are arranged as in sketch No. 9.

The heavy form of construction carried out in the Moravian depression, around the Glatz basin, and in the Landeshut depression, and pushed on in southern Moravia at high pressure since the spring of 1938, consisted of a single line of large works. These had, as a rule, two flanking blocks with twin machine-guns and anti-tank guns, also one to five armoured turrets. As in the case of the " ear posts," the main fire effect was produced by flanking and cross fire. Frontal fire was not strongly developed, so that the redoubts depended upon support from neighbouring works. In this case, too, there were several standard designs that could be adapted to the site with slight modifications.

(*Photos* 10 *and* 11 *illustrate types of redoubts.*)

These works are proof against fire of guns up to a calibre of about

12 inches. Roofs and walls are of reinforced concrete up to 8 feet thick, armoured turrets are 8 inches thick. The works have, as a rule, an upper and a lower story.

On the strongly fortified fronts these redoubts are spaced at intervals averaging 550 yards, varying according to their tactical importance and the nature of the country. They usually form the front line of resistance. Behind them comes a second line of machine-gun posts. Apart from a few exceptional cases, the Czechs made a point of purposely placing the strongest works in front and weaker ones in rear. The attacker is made to meet the stiffest resistance from the very start. If he should succeed, with heavy losses, in breaking this resistance, he will, while badly shaken, hit upon the weaker defences, which will be strong enough to hold him up in his weakened condition. The usual principle adopted by the French is to meet the attacker in the out-field with weaker defences, so as to loosen his formations and break up the attack. The attacker will then reach the main line of resistance greatly weakened, and will finally break up there.

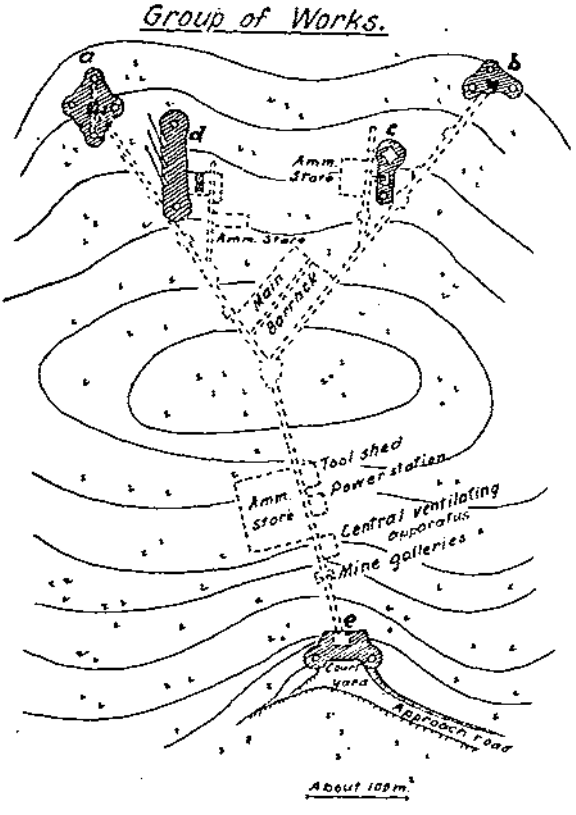
At key points in the position several works were combined to form a group of works. The construction of these was of the strongest, and proof against the heaviest calibres. Roofs and walls were 11 feet thick, and outside the walls was a layer of stone to detonate shells. The turret armour was 12 inches thick.

Such groups of works were to be found (see map) on the Hrabin mountain (east of Troppau) to stiffen the defences in the Moravian depression, also round the Glatz basin, *i.e.*, "Berghöhe," "Baudenkoppe," "Adamsberg." These three groups covered the lines of invasion from the southern part of the Glatz basin towards Moravia in the March valley, and towards Bohemia in the upper Elbe valley. The "Panske Pole" supported the position in the Adlergebirge. The exit from the Glatz county towards Nachod was closed by the "Skutinaberg" and the "Nachod" groups. The latter was still in Czech hands when the article was written. It was here that in 1757 the army of Marshal Schwerin marched to the battle of Prague. At the end of June, 1866, the Fifth Army Corps advanced into Bohemia by this route. The Landeshut depression was closed by the "Trautenau" group. It was along here that the First Army Corps pushed into Bohemia at the same time as the Fifth. Both corps belonged to Crown Prince Frederick William's Army and were hastening to the decisive battle of Koniggrätz. If they had been allowed time, the Czechs would doubtless have erected similar groups of works at decisive points in Southern Moravia to stiffen the defensive front.

The number and grouping of the elements of a group of works depend upon their purpose and upon the lie of the country. (*Sketch No. 12 shows an example of a group.*) The work consists of the

fighting blocks *a*, *b*, *c*, *d*, the entrance work *e*, the underground passages and the obstacle.

The two fighting blocks *a* and *b* appear to have been chiefly intended for main command and artillery observation posts. They have several armoured turrets of cast steel up to 12 inches thick, in which there is room for machine and anti-tank guns, as well as for observers. Blocks *c* and *d* are clearly intended for artillery purposes. In work *c* only the concrete outer wall was completed; it enclosed



SKETCH 12.

a circular opening of 25 feet diameter. From this we may conclude that it was intended as a protective turret for one or two guns. It is an open question whether these guns were intended for close-range action, or for long-range fire and protective work. Work *d* was clearly intended for short-range action, *i.e.*, the sweeping of the neighbouring foreground. It is a casemate battery with three 76 mm. guns (*see photo No.* 13). The guns are in echelon. Owing to their location and special form of construction, the loopholes of

these guns cannot be hit by grazing fire from the front. The design corresponds to certain forms used in pre-war fortification—known in France as " Casemate de Bourges," and in Austria as " Traditoren-Batterie."

The entrance work *e* is so fitted into a steep wooded slope that it cannot possibly be hit from the front by grazing fire, and only with great difficulty by curved fire. Every shot that goes over drops into the hollow behind the fort, while every shot that falls short is caught in the upper part of the slope. The fort is absolutely proof against tanks. The entrance is protected against attack at close quarters by two armoured turrets and several loopholes in the walls. Inside the entrance there are additional defensive arrangements : a grated door, enabling men to fire from the inside, and a solid drop-gate with loopholes. There is a break in the entrance passage, which prevents its being swept by fire. Close to the entrance are mine-galleries, by means of which the tunnel can be blown up. The tunnel connects the entrance with the four fighting works. On either side of the tunnel are ammunition stores, and barracks with kitchens and offices, etc. Nearer the four fighting blocks are the living-rooms. The two artillery blocks are connected with the tunnel by means of lifts and stairs, the other two by stairs only. The tunnel is as deep as 160 feet below the crest of the hill.

The whole group of works is surrounded by a broad wire entanglement, which can be swept by fire.

There are two kinds of obstacles : those against tanks and those against storm-troops. The Czechs usually combined the two in a single obstacle. This has an advantage over the dual system in requiring only one obstacle to be watched and swept by fire—a simplification—and of needing less material and less ground—a reduction in cost. The disadvantage is that artillery-man, mine-thrower and engineer can destroy both obstacles simultaneously.

The Czechs strengthened the tank obstacle by threading it thickly with barbed wire, and by widening it in front and behind with extra rows of stakes. (*See photos Nos.* 15, 16 *and* 18.)

The obstacles are built in sections, broken short in front. This arrangement prevents the flanking weapons of neighbouring works from firing into each other's loopholes.

As an obstacle against tanks the Czechs employ 4-armed reinforced concrete " hedgehogs " and, more recently, 6-armed iron ones.

Presumably the 6-armed iron " hedgehogs " are more effective, more quickly put up, cheaper, and easier to transport than the cumbersome reinforced concrete ones ; the iron ones can be taken to pieces and bolted together at site. The action of " hedgehogs " is as follows. A tank striking against one causes it to roll along in front of it, but the " hedgehog " slows up its advance and, under heavy

Photo No. 13.

Photo No. 14.

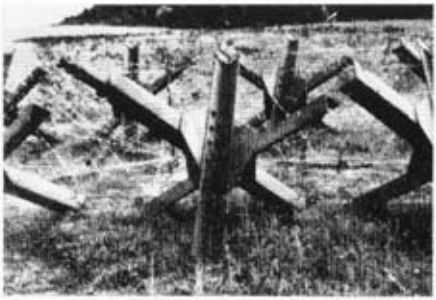


Photo No. 15.

The Czech system of fortification 13, 14 & 15

Photo No. 16.—Each column is made up out of two upright iron channels, standing in a concrete socket. The uprights are welded together and then filled with concrete.

Photo No. 17.

Photo No. 18.

The Czech system of fortification 16, 17, 18

anti-tank gunfire, the tank is brought to a standstill. " Hedgehogs " should be chained together, so that an advancing tank will have to push a row of them along in front of it. As a rule, two or three rows of " hedgehogs " are arranged one behind the other.

Another form of obstacle, that has only been introduced in recent years, is a row of reinforced-concrete posts. (*See photo No.* 16).

In some works there are to be found, in lateral prolongation of each wing wall, a row of long railway rails, standing upright, embedded close together in the ground. These are too weak to hold up a tank, but their object is to compel the tank, that is trying to engage the machine-gun loopholes, to advance so far that it will come under the fire of an anti-tank gun. It will thus not be possible for the tank first to engage the machine-gun loophole and then the anti-tank gun loophole. (*See photo No.* 17.) The high upright rails mask the machine-gun loopholes (*the right-hand loophole in the picture*) from view and fire of the approaching tank, until the latter comes into view and under fire of the anti-tank gun loophole (*on the left in the picture*).

Tank ditches with walls (*see photo No.* 18) have only been erected on the flanks of works, in lengths of 55 to 90 yards, apparently because upright obstacles would obstruct the view and fire from flanking blocks.

As a naturally strong obstacle in the front line may be mentioned the Danube, between the mouth of the March at Theben and that of the Gran at Gran. This obstacle was supported by the fortifications round Theben, the Engerau bridge-head south of Pressburg, the old Austrian fortress of Komorn at the mouth of the Waag, recently strengthened, and the Gran fortifications. But its main strength was based on the Danube flotilla. The latter consisted of :

2 gun-boats, each of 540 tons, with crews of 120 men, two 155 mm. guns, two 105 mm. howitzers, two 76 mm. guns, four 47 mm. guns, 4 machine-guns ;

1 monitor of 200 tons ;

15 to 20 minelayers, each of 240 tons ;

9 to 10 dispatch boats, each with one 76 mm. gun and 2 machine-guns ;

20 armed motor-boats and numerous guard-boats.

The lower March formed a water obstacle not to be underestimated.

If the Czechs had had enough time for preparation at their disposal they could have fortified the Thaya section between Frain and the mouth of the March. They could thus have made use of the flooded area around Frain.

On the whole, time was the decisive factor in Czecho-Slovak fortification. The questions, where and how the fortifications were to be built, had been clearly laid down. The problem of cost was of comparatively minor importance, since the Allies provided the necessary credit in cash and goods. The main basis of all fortification work, the time for construction, is what sealed the fate of Czecho-Slovak land fortification.

As long as Germany's power lay in the shackles of the Versailles Treaty, there was no incentive for the Czechs to think of strong land fortifications. It was more to the point to have a powerful, well-equipped army, capable of advancing from Egerland to the west, to join the French, who would have crossed the Rhine and invaded southern Germany. From there they could have marched shoulder to shoulder with their allies in a northerly direction along the valleys, a much simpler method than crossing the rivers from west to east. Small forces would have sufficed to hold up an incursion of the weak German enemy upon the naturally strong boundary of Bohemia or Moravia.

But when the Third Reich came into existence the situation changed. About the beginning of the year 1933, carefully planned preparations were made for construction ; the position of works was laid down, ground reconnaissances were carried out, the network of roads was strengthened and completed, land was acquired, etc. The most important sectors, especially round the Moravian depression and the Glatz basin, were tackled first. The greatest importance appears to have been attached to suitable methods of construction, rather than to speed in execution. But the danger increased when, in 1935, Germany proclaimed its freedom to re-arm. The occupation of the Rhineland in 1936 was a signal for extra speed in construction. The spring of 1938 brought Austria into the Reich. Germany now enclosed both Bohemia and Moravia. The Czechs continued the work with maximum energy, but their efforts might be compared with an attempt to complete a retaining dam before an oncoming flood. The dreaded flood came all too soon. The dyke was still unfinished and could not withstand the rush of water.

A general verdict on the condition of the Czecho-Slovak defences in 1938 would be : " Everything still incomplete." There was no such thing as a continuous defensive front. Only a few sectors had, approximately, their full fighting value. A break-through in a few weak spots must have brought about a collapse of the whole defensive system. The Czech soldiers were standing in a position already lost. There is little doubt that the spring, and certainly the autumn of 1939, would have shown a very different picture of the defences. With the concentration of all the available labour of the country on the building of fortifications, about 75 per cent of its

fighting power would have been attained in the spring, and 100 per cent in the autumn. It is certain that in that case the Czech soldiers would never have abandoned their line of fortifications without fighting. They would have defended it, even if their allies had not at once come to their assistance. They would thus have gained time, with the hope that the political and military situation might take a turn in their favour. It was not their fault that they abandoned the ramparts, but the fault of the politicians, who had set the soldiers the enormously hard task of arming and fighting against an immeasurably superior enemy, who hemmed them in from every side, without giving them time fully to prepare for such a struggle.

"WORKS PROCEDURE" IN THE MILITARY ENGINEER SERVICES IN INDIA.

By CAPTAIN G. C. RICHARDS, R.E.

INTRODUCTORY.

THE purpose of this article is to explain, primarily to the young R.E. officer destined to become an Assistant Garrison Engineer in the Military Engineer Services, the procedure laid down for the administrative, financial and technical control of Works Services in India. Nothing more than a broad outline of the procedure is attempted, but it is hoped that this may form the basis of a clearer understanding of the procedure in all its exhaustive detail, as set forth in the book *Regulations for the M.E.S.*

GENERAL.

The M.E.S. carry out engineer services not only for the Army, but also for the R.A.F., the Royal Indian Navy, Ordnance Factories and for the civil administrations of Baluchistan and the tribal territories of the North-West Frontier Province. This article has particular reference to procedure in relation to works for the Army, but the same principles apply in general to works for other authorities though the procedure may vary in detail.

"Works procedure" has been designed and evolved to give full *control* over the carrying out of engineer services, from the day when the need is born for some new service (whether it be the building of a new cantonment or merely the re-whitewashing of a row of stables) until the time when the new (or repaired) structures are completed and the last rupee of the cost has been paid. This essential control is divided into three categories :—

(i) Administrative Control.
(ii) Financial Control.
(iii) Technical Control.

ADMINISTRATIVE CONTROL.

This form of control comes into effect immediately a new service or work is mooted. It is primarily exercised by the Staff, but the engineer officer is actively concerned with it, both in his capacity as an adviser to the Staff and on account of the effect such control

has on the design, extent and progress of the actual work which he will, as an engineer, have to carry out. Administrative control ensures that the service proposed is really necessary, agrees with approved policy, is in accordance with authorized scales (*e.g.*, certain scales of accommodation, lighting or amenities are fixed for barracks in the plains, others for hill stations) and is given an order of priority with other proposed services. To assist the authority, who is responsible for exercising control, to decide on these points, the engineer officer will be called on to estimate the cost of the service.

It is obvious that no authority can decide on the relative necessity for a new service, or on what should be its order of priority with other proposals when competing for the limited available funds, unless he knows what the new service is likely to cost. And before he finally approves that a new service should be carried out, he will want to lay down, to fairly close limits, how much may be spent on it. The controlling authority therefore calls on his engineer staff to estimate the cost of the new scheme, and the estimate is normally provided in two stages :—

(i) An approximate estimate.
(ii) A project estimate.

The former is drawn up in the earliest stages of a newly-proposed service and enables the controlling authority to decide on relative necessity and order of priority. It is important that this approximate estimate should be reasonably accurate and, in particular, that it must not be an under-statement ; for on the approximate estimate an important decision of policy is made, *i.e.*, whether or not to proceed with work on the proposed scheme. The importance of avoiding under-statement in approximate estimates is emphasized by the fact that, if a new service is likely to cost over Rs. 20,000, the proposal and its approximate estimate have to be submitted to the highest Army authority, the Commander-in-Chief in India, for *Acceptance of its Necessity.*

Should it then be decided that the new scheme merits active pursuit, a project estimate will be made ; this will be drawn up in considerable detail, should be accurate to within 10 per cent of the eventual cost, and will be the basis on which the final *Administrative Approval* is given, and on which funds are allotted.

The two stages of administrative control should be clearly understood. First comes acceptance by high authority of the necessity of the proposed new service. Secondly, and *only* after such acceptance, the engineer is called on to prepare a project estimate and to this is accorded administrative approval to carry out the actual constructional work as soon as funds have been allotted for it.

The amount of administrative control, and the authority who can give administrative approval, naturally vary according to the size

and importance of the service. For this reason, engineer services are divided into three categories :—

(i) *Major Works, i.e.*, new works costing more than Rs. 20,000 (about £1,500).

(ii) *Minor Works, i.e.*, new works costing up to Rs. 20,000.

(iii) *Maintenance Services*, which include the repair of existing buildings and roads, the running of electricity and water-supply installations and the maintenance of furniture.

In *Regulations for the M.E.S.* are detailed the authorities who can administratively approve the execution of services once acceptance of necessity has been accorded. As a guide, it may be taken that G.O's C.-in-C. of Commands give administrative approval to major works and the more important minor works, though in certain circumstances the approval of the Q.M.G. at Army Headquarters is necessary, or even the approval of the Secretary of State for India in the case of big projects costing over Rs. 10 lakhs ; minor works up to Rs. 10,000 are administratively approved by G.O's C., districts, and small minor works (up to Rs. 1,000) come within the powers of brigade commanders. Maintenance services are treated rather differently, in that a general administrative approval to the maintenance for a year, at a stated cost, of all the property within a given Garrison Engineer's charge is automatically granted at the same time as funds are allotted for the year's maintenance work ; the G.E. can then, at his own discretion, carry on with the maintenance without further approval from above.

FINANCIAL CONTROL.

The procedure for ensuring a strict control over the financing of military works is very closely defined in considerable detail in the *Regulations*. The amount of this detail, and the strictness in observance which is demanded, is apt to prove confusing and irksome to some engineers ; but an understanding of the principles which underlie it, will show that the procedure is logical, reasonable and necessary.

Financial control is required to ensure that :—

(i) No expenditure or liability is incurred on a service until funds to meet it have been specifically allotted.

(ii) That funds, once allotted, are spent on that service for which allotted and are not used elsewhere without permission.

(iii) That the total cost of a service does not exceed what it was estimated to cost (a small excess is permitted, with certain restrictions).

This control is effected through the combined efforts of the Administrative Staff and of the engineer officers who are entrusted with the execution of the works service ; they are assisted and advised in this control by financial advisers and accountants ; and the effectiveness of the control is watched by military auditors. The duties of financial advice, accounting and auditing are combined, to an extent, under the staff of the Command " Controller of Military Accounts." To give him financial advice and to carry out a financial audit of his works accounts, each Garrison Engineer has attached to his office a " Unit Accountant," who is an official subordinate to the Command C.M.A.

The financing of Military Engineer Services is on the following lines. Each year the Government of India sets aside a sum of money to maintain the Army as a whole ; and a portion of this sum is put at the disposal of the Quartermaster-General to spend on the Military Engineer Services. Certain percentages of capital values are laid down as a guide in determining the funds required for the maintenance of buildings, electric and water services, furniture, etc. ; in addition there are certain obligatory charges, such as rents, to be met. G.O's C.-in-C. of Commands submit their requirements for these Standing Charges, as they are called, as well as their list of approved major and minor works. The demands always exceed the funds available and the necessary adjustment and distribution is made by the Q.M.G. on the advice of the E.-in-C., who is in a better position in many cases to estimate the relative urgency. The final link in this distribution of funds down the chain of command is that a Garrison Engineer will be informed that such-and-such funds have been allotted for the execution of such-and-such service. This is usually the " all clear signal " to the G.E. to get on with the work, which by then will have been administratively approved and will have been " technically sanctioned " (this phrase is discussed later in this article). Once funds have been so allotted, it is the G.E. who, primarily, becomes responsible for financial control of those funds. It is the G.E. who has to watch carefully that the funds are spent economically, that they are spent only on the work for which allotted, and that the cost of the work does not run beyond the funds allotted for it. He also carries out the detailed accounting which shows how every rupee of the allotted funds has been spent, though this more properly comes under the heading of Technical Control.

These paragraphs on Financial Control cannot be ended without a brief reference to the fact that estimates *are* inevitably exceeded or saved on, in spite of all the detailed procedure of control that has been evolved. In either case, it is the engineer's duty to foresee the likelihood of excesses or savings as early as possible, and to report the facts at once, so that savings can be transferred usefully to

other services, or so that funds to meet excesses can be provided from savings on other projects.

TECHNICAL CONTROL.

It is the military engineer who bears the main responsibility for exercising this form of control over engineer services.

The scope of technical control covers the actual design and execution of the work. It is intended to ensure that :—

(i) The *design* and *specifications* of the work as proposed are in accordance with sound engineering principles and give adequate regard to economy.

(ii) Any *estimate* made truly represents the probable cost of the work.

(iii) The actual *execution* of the work follows the approved design and specifications.

(iv) All *payments* made for the work represent fair payment for work done and are in accordance with the terms and conditions of contract agreements.

(v) All expenditure on the work is properly *accounted* for.

The necessity for all these factors of technical control is very obvious and will be readily appreciated by the engineer.

We have already referred to the fact that, when the necessity for a proposed service has been accepted, and it seems likely that funds for carrying it out will be made available, the Garrison Engineer will probably be ordered to prepare a design, draw up specifications and prepare a project estimate for administrative approval. Depending on the size and importance of the service these designs, specifications and estimates will be " vetted," from a technical or engineering point of view, by the C.R.E., possibly by the Chief Engineer and perhaps by the Engineer-in-Chief. Having passed this technical " vetting," the scheme will be given *Technical Sanction*, a term which is somewhat analogous to administrative approval ; the latter was given only after a full consideration of the scheme by the Administrative Staff, and technical sanction is given only after the engineer staff have decided that the scheme in all its detail is a " good thing." Administrative approval and technical sanction having been given, the next step will probably be the preparation of a suitable contract document ; then, funds having been allotted, the work will be put out to tender, a contractor will be chosen, the contract documents will be signed, and the actual construction will start. On the size and importance of the work will depend the seniority of the engineer who can give technical sanction to a service, and accept a contract to carry it out ; as a guide, a G.E. has powers in these matters up to Rs. 40,000 and a

C.R.E. up to Rs. 100,000; if the work is estimated to cost more than that, the authority of the Chief Engineer, or of the E.-in-C., has to be obtained.

The next step in technical control, that of the actual execution of the work, is the G.E.'s responsibility solely. But it is in this aspect, perhaps above all others, that he is especially trained.

Finally, the G.E. has to arrange for payment for the work done, and he has to prepare and keep detailed accounts of all such expenditure. The actual payments will usually be made by the Controller of Military Accounts (who acts as a sort of Treasurer or Paymaster to the G.E. in respect of funds which have been allotted for works services) on the basis of bills submitted by the contractor for the work he has done. The C.M.A. usually makes this payment by cheque in favour of the contractor. And, though the C.M.A. will before making a payment have thoroughly audited the contractor's bill, it is the responsibility of the G.E. to ensure that the bill represents fairly the work that has been done.

Some further explanation is necessary of the procedure whereby the C.M.A. makes the actual payments for work done and services rendered. What happens is that when funds are allotted for a service, the credit is *not* given to the banking account of the G.E. (he has no such account) but to the account, at the Imperial Bank of India, of the Command C.M.A. It is thus the C.M.A. who pays the bills of the contractors whom the G.E. has employed to carry out works services, and it is the C.M.A. who sends the G.E. a cashable cheque to provide ready money (an "imprest") with which to pay labourers directly employed on M.E.S. works. It should be noted that, by this procedure, the C.M.A. himself acquires a considerable degree of control; for, being an official auditor and accountant as well as a treasurer, he is obviously not going to pay any contractor's bills until he is quite satisfied that the G.E. has exercised his own control fully, both financially and technically.

Conclusion.

The foregoing paragraphs have done little more than touch upon the *detail* inherent in "Works Procedure," but it is hoped that they will have proved sufficient to explain the principles upon which that procedure is based. The whole object of the procedure is to ensure a strict control over every engineer service from the time it is initiated until the day it is finally completed; firstly, administrative control to establish the necessity for a service before any liability on it is incurred and to ensure that it is provided only on a reasonable scale; secondly, financial control to provide just sufficient funds to pay for the service; and thirdly, technical control to ensure that the service is executed according to sound and economical engineering practice and that a proper account is kept of all expenditure on it.

MECHANIZATION OF ENGINEERS IN THE GERMAN ARMY.

(Précis of an anonymous article in the *Revue du Génie Militaire* of July-August and September-October, 1938.)

Translator's Note.

In view of the recent mechanization of field companies in the British Army, the publication of the following article seems opportune. There are several points of interest.

Firstly, the question of rapid intercommunication within the divisional engineers, without which the advantages of mobility and increased output will be largely lost owing to the lack of control and co-ordination.

Secondly, the reference to the importance of a "cavalry" rather than an "infantry" outlook in the handling of divisional engineers.

Thirdly, there is the odd mixture of lorry, horse and foot.

* * * * *

German military writers have been paying great attention to the mechanization of transport and of equipment. In the engineer arm the development of mechanization is well advanced and the object of this article is to consider some of its outstanding characteristics. The author discourages a tendency in France to overestimate the soundness of German doctrine but feels that a study of the German organization and outlook would be profitable.

1. Engineer Organization.

In the German Army, the engineers are all of the field company (sapper and miner) type. Unlike the French, there are no specialist units; Signals being a separate arm, and Works a separate military construction service.

The engineers are organized into Corps or Divisional Battalions. They are partially mechanized, and their composition is as follows:—

Battalion H.Q. (partly in M.T.).
One Intercommunication Section (all in M.T.).
Two companies on foot (with M.T.).
One company (all in M.T.).
One Echelon of Engineer Material (in M.T.).
One Bridging Train (in M.T.).
One Light Column of Engineer Stores (in M.T.).

Some engineer battalions are fully mechanized.

The *two companies on foot* are composed of :—

Company Headquarters (partly in M.T.).
Three Section Headquarters (partly in M.T.).
Three Sections each of 3 platoons (each 1 light automatic).
Each section has 2 horse-drawn wagons for stores and tools.
One Power Tool Section (3 lorries).
One Baggage and Supply Column.

The *Mechanized Company* is of the same strength as the company on foot. The company and section commanders are, however, carried in touring cars and all other personnel in lorries (3 per section).

The *Echelon of Engineer Material* is a reserve at the disposal of the battalion commander.

The *Bridging Train* contains equipment for bridges and rafts, motor boats and boats with outboard motors, carried on trailers.

The *Light Column* carries explosives and light technical stores and tools. This column and the Echelon of Engineer Material are constituted only on mobilization.

The strength of a company (foot or mechanized) is about 160 all ranks.

2. M.T. Instruction.

Such a high proportion of M.T. in a unit necessitates a proper number of N.C.O's and men trained in driving and maintenance.

This training is a battalion responsibility, under a specialist, the *Militar-Kraftfahr-Sachsverständige*. Instruction is given in driving a particular vehicle, followed by driving different vehicles, then cross-country driving and, finally, driving competitions.

A proportion of N.C.O's and men are given advanced instruction at the School for Motorized Troops at Wunsdorf (near Berlin).

Cinematograph films are extensively used in training.

The writer then refers to a German military article, by a Major von Ahlfen, which points out that the mechanized engineers are a new arm, as yet lacking a definite role and doctrine. Just as the cavalryman was not a mounted infantryman, so must the motorized engineer develop an " M.T. Spirit," one of dash and self-confidence, analogous to the cavalry spirit. Extensive training in M.T. work is required to build up the right spirit. The problem of fitting-in this training with all the other technical instruction will always be difficult.

Officers and N.C.O's must all be expert drivers across country and under all conditions.

3. SPORTS AND COMPETITIONS IN M.T. TRAINING.

Major von Ahlfen states that in some units of other arms in the German Army, M.T. competitions are discouraged because of frequent accidents and damage to vehicles. He, personally, considers M.T. competitions of the greatest value in training and that troubles can largely be avoided if drivers are allowed to compete only in competitions for which they are adequately trained. Serious motor trials are for veterans, not beginners.

In war, engineers are often called upon to carry out reconnaissance, movement and work at night, after the day's march. These and other war conditions should be introduced in M.T. competitions for engineers. Movement and map reading at night with a minimum of lights are of great importance.

It is also important to provide different types of events to encourage all standards of drivers.

4. POWER TOOLS IN ENGINEER UNITS.

The French writer claims to have studied current German literature on the subject and considers that the general tendencies in the German engineers are as follows :—

(*a*) To discard plant that is not thoroughly mobile.

(*b*) To prefer plant carried on trailers drawn by personnel lorries to special vehicles.

(*c*) To aim at standardization of mechanical tools based on civilian types, in order to ensure a ready supply of reserves and spare parts.

Omitting electrically-driven machines, the power tools in the German engineers are of two categories :—

1. Demolition tools.
2. Bridging tools.

Demolition Tools.

The writer mentions having described these in the *Supplement* to the *Revue du Génie Militaire* of September-October, 1936. They include motor saws and compressors carried by divisional and corps engineers. There is also a special machine for re-sharpening and re-tempering compressor drills.

In the same category should also be included the pneumatic pile drivers used not only for heavy bridge construction but also for building dams for inundations and in connection with anti-tank obstacles.

Bridging Accessories.

Engineers are provided with outboard motors and motor boats. The outboard motors are portable by hand, powerful, readily placed in position and adaptable for use in shallow water.

The author describes the motor boat. It appears to be similar to that used by the Royal Engineers.

In addition to the above, the Germans are arranging for the provision in Corps and Armies of special sections carrying power tools, either for the construction of improvised bridges (drills, metal and wood lathes, augers, circular and band saws) or of earthworks (diggers) where a large output is required.

5. Intercommunication in Engineer Units.

The French author refers to an article which appeared in the *Vierteljahreshafte für Pioniere*, of May, 1935. It considered that carrier pigeons and messenger dogs were unsuitable for employment in a partially mechanized unit such as the engineer battalion; and that, while the telephone and helio were adequate for foot companies, wireless was required whenever mechanized companies happened to be detached from headquarters.

On the line of march, mounted orderlies, cyclists and motor-cyclists would normally suffice. If, however, Battalion H.Q. wished to be in touch with mechanized companies on the move, wireless equipment, preferably on M.T. and which could function on the move, would be needed.

The *Intercommunication Section* of the engineer battalion contains:

(*a*) Two light cable cars carrying 12½ miles of heavy and 2 miles of light cable and eight telephone sets.
(*b*) Two small cable cars for line maintenance.
(*c*) Two touring cars for line reconnaissance and supervision, one for the section commander, and one for the section warrant officer.
(*d*) Visual signal equipment.
(*e*) Submarine cable.
(*f*) Four portable radio sets.

In addition, each company has a telephone set for communicating with a detached section; and the Bridging Section, the Light Engineer Stores Column and the mechanized company each have a wireless set for communicating with battalion headquarters.

The Intercommunication Section is commanded by an officer, with a warrant officer as second in command and another warrant officer as wireless specialist.

The section commander must keep in close touch with the tactical situation and be ready to establish intercommunication in

the shortest possible time. Intercommunication will be required principally in river crossings and in demolitions. During river crossings, the battalion commander will require to be in touch with his companies placed at the disposal of the infantry, with his mechanized company (usually employed with the reconnaissance group) and with engineer reconnaissance parties accompanying the forward troops.

In demolition work he will want early information from his companies of their requirements of stores and explosives, and will want to be able to pass these demands to the Light Stores Column, by which the stores are supplied.

Note :—The author introduces a tactical exercise to illustrate the employment of the Intercommunication Section. As no lessons of particular interest appear to be illustrated, the exercise has been omitted.

6. Employment and Training of the Mechanized Company of Engineers.

Here the author refers to another German military paper which considers that, as the liaison between mechanized columns on the move will inevitably be intermittent, the enemy will endeavour to profit therefrom by bold operations against the flanks and rear. Flank protection and the filling of gaps in the general front will be of a great importance. In these, mechanized engineers will play a considerable part.

The wide distribution of mechanized units will often render engineers liable to attack from the air and by A.F.V's. Engineer units must therefore be trained to move rapidly and to defend themselves. They must be able rapidly to break up into sub-units and equally to re-concentrate when required. Driving skill must therefore be high class, and sub-units must be trained to act on their own initiative.

The mechanized company, especially if operating on a wide front, will often be without the A.A. protection usually afforded by other arms. Its light automatics (9 per company) are few. When halted, its vehicles should be widely spaced, all available cover utilized and all A.A.L.A's got into position as a matter of routine. Enemy A.F.V's will always constitute a serious threat, to meet which rapid blocking of roads, the protection offered by woods and other anti-tank localities, and movement by bounds behind a screen of motor-cycles offer some counter. Engineer units should, however, possess anti-tank weapons. The motor-cyclists should be trained not only as dispatch riders but also in protective and reconnaissance duties. They must be experts in finding their way in strange country with and without the aid of maps.

The mechanized company must be thoroughly versed in the full use of its vehicles. The loading and unloading of tools and stores must be as rapid as a battery coming into action.

In regard to technical instruction, the primary role of the mechanized company is to create belts of demolitions, taking advantage of its high degree of mobility to extend the belts over the widest possible front. It must be thoroughly trained in using bridging equipment because, in working with mechanized formations, every minute saved in completing a bridge may be of vital importance. It must also be prepared to ferry forward elements, motor-cyclists with light machine-guns for example, over rivers by means of special light equipment or improvised rafts.

The role of the mechanized company is therefore relatively specialized and some portions of the normal engineer training programme, such as heavy bridging, might therefore be omitted; in regard to defences also, it should concern itself with obstacles rather than earthworks.

Over-specialization in the training of the mechanized company is deprecated but it must be trained to have a "cavalry" rather than an "infantry" outlook.

7. Conclusion.

Although the German engineer battalions have been only partially mechanized, it is important to note that none of the important elements, *i.e.*, organs of command and intercommunication, echelons of stores supply, bridging trains, remain on foot.

The German engineers are designed to assist other arms not only by engineer work but if necessary with fire power (9 light automatics per company, machine-guns and anti-tank weapons). They are being trained to take every advantage of modern methods and of the opportunities in war which greater mobility offers.

A HOLDING DEMONSTRATION IN SEPTEMBER, 1917.

By LIEUT. COLONEL J. H. DYER, M.C., R.E.

"So Gideon, and the hundred men that were with him, came unto the outside of the camp . . . and they blew the trumpets and brake the pitchers that were in their hands . . . and all the host ran and cried and fled . . . and the Lord set every man's sword against his fellow, even throughout all the host."

JUDGES, CH. VII, VERSES 19-22.

INTRODUCTION.

WE have all read of the Wooden Horse of Troy, and many of us have read the story in *Beau Geste* of dead men being exposed to bluff the enemy in the defence of a desert outpost by the Foreign Legion. That dummy figures, as well as dummy bridges, pontoons in movement, and tanks, were used on occasion in the Great War is perhaps less well known.

As Kipling said (or should it be sang?) of the Sappers long ago, "We are the men who do something all round," and it may be of interest to record one more example of the varied jobs that fall to the lot of a field company on active service.

In September, 1917, the 8th Division, B.E.F., having been twice heavily engaged in the Third Battle of Ypres, was holding the Lys Valley sector. Although no attack was intended in the new area, it was desirable to keep the enemy on the alert, to avoid him concentrating his resources on the actual sectors of attack farther north.

The month opened quietly, but the enemy gradually became more apprehensive and showed increasing air and artillery activity. This was just the effect desired, and it was assisted by our firing several artillery and machine-gun barrages, accompanied on one occasion by a raid. Dummy camps of condemned tents were constructed, guarded by sentries with light automatics for firing at enemy low-flying machines, while lorries trailed netting over the roads behind our lines to give the impression of movement by raising clouds of dust. The camps were duly shelled by the enemy. In addition, "L" Special Company R.E. carried out three Livens projector gas discharges opposite Warneton between 12th and 18th September. These probably caused the enemy heavy loss, while certainly doing nothing to allay his anxiety over impending attack. Incidentally, gas attacks were not an entirely unmixed curse from the point of view of the target. A

German retaliatory minenwerfer gas shell bombardment killed many of the rats and mice with which our trenches were infested!

Preparation.

On the 6th of September, the 2nd Field Company R.E. received orders to commence work on some 400 dummy figures. It was originally suggested that these might be released by pulling strings. Reconnaissance, however, showed No Man's Land to be in the usual condition of a Flanders battlefield, thickly strewn with our own and remains of enemy wire and all manner of debris, while the shell craters resembled a lunar landscape. It was therefore decided to use electrical release for the figures. These were made up from two light " A " frames, hinged together at the feet. One frame was to be stapled to the ground, while the other could be brought by springs to an upright position (carrying on it the silhouette of an armed man) when the spunyarn securing it was cut by an electric detonator. The detonators were to be fired from an exploder in the front trench. See Plate I (page 238).

An all-metal circuit of insulated cable was found to give the most certain results in firing the detonators. But an earth return, using an 18 pdr. cartridge case as earth plate, was found to give passable results, provided the earth was well damped. This was therefore embodied in the drill, as it gave a slight additional safeguard if the return lead should be prematurely cut by enemy shelling.

To avoid too many eggs in one basket, the 60 dummies to be placed out by each squad were further sub-divided into 3 groups of 20 dummies each. Each of the three groups was to be fired in turn by an improvised three-way switch connected to the exploder at the firing point, where was also a galvanometer and test cell, to check whether the leads remained intact after laying.

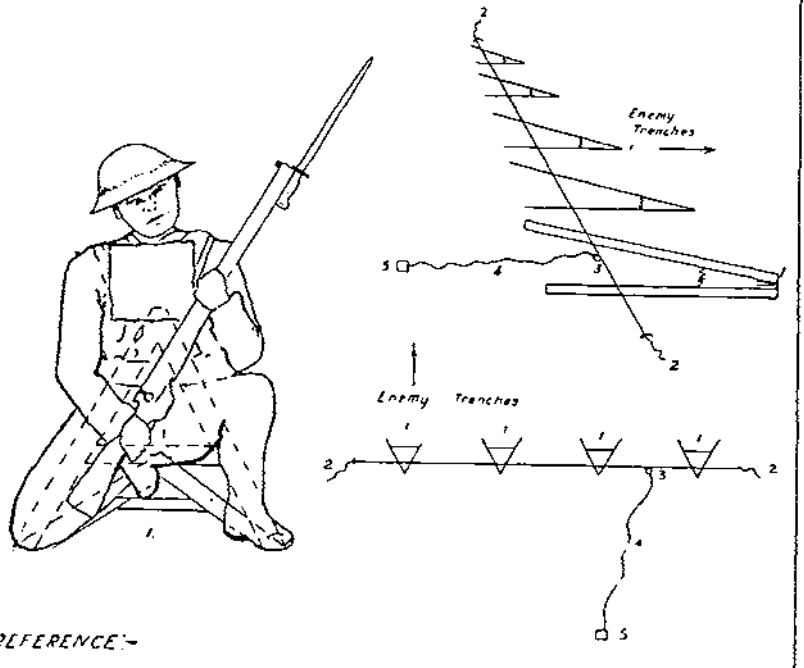
Rehearsal was carried out behind the lines, by day and by night, until the carrying out, securing, and wiring up ready for firing of the dummies could be done rapidly and in complete silence.

Cardboard for the dummy figures, wire bedsprings and butt hinges were obtained by local purchase from civilian resources. Timber was obtained from the local R.E. dump, being cut to size by a small petrol-engine-driven circular saw, of which the company was in irregular possession. This circular-saw outfit was carried by a " spare " wagon and pair of horses, and proved invaluable on many occasions.

The various outlines cut out in the cardboard were obtained from men's silhouettes traced against a wall, the individuals being quite recognizable. It was found that, at about 200 yards, the grey of the steel helmet and bayonet, the flesh coloured face and hands, and the dark shadow under the helmet are what is principally seen. The figures were painted accordingly. It was perhaps unnecessary to

have added, in certain instances, rows of medal ribbons, wound stripes, and R.E. badges, but the troops had to have their joke. When all was ready, none doubted that " Fred's Cardboard Army " (so named in honour of Fred Karno) would present a stout front to the foe. The German machine gunner was pictured, gallantly serving his weapon under our barrage, while exclaiming in outraged tones, " *Gott strafe* England ! I've shot that fellow ten times and he's still there ! " It was a case of " He's dead, but he won't lie down."

As the number of detonators and amount of electric lead required necessitated six firing points, the front for the demonstration was divided into six sectors. The field company was specially organized into six squads, each commanded by an officer or N.C.O.; squad commanders carried out thorough reconnaissances for the routes for the carrying parties and the gaps to be cut through our own wire for taking out the dummies. Overland routes were used, as the dummies, if carried



REFERENCE :-

1-1. Figures secured to double "A" frames.
2-2 Spunyarn stapled to the ground and securing figures.
3. Detonator tied to spunyarn.
4. Leads to exploder.
5. Exploder in front trench.

PLATE I.

through winding communication trenches, were very liable to damage. A favourite definition at that time was " A guide is a man who loses his way," and it was certainly very easy to do so at night. One had to become adept at using all manner of minor landmarks—a dead man, a sandbag tied to a low stake, an abandoned coil of wire, etc.

The German machine gunners were rather active about this time, and any movement seen in the moonlight was promptly fired at. There was some anxiety as to what might happen " on the night," when carrying parties numbering several hundreds would be moving slowly up, bearing conspicuous dummies and probably falling into shell holes and swearing at the tops of their voices. (The remark that " The Army in Flanders swears terribly " was just as true 200 years after it was written!)

On the 18th September, orders were issued by 8th Division stating that a demonstration was to be made at a time and date to be notified later (actually 5.40 a.m. on 20th September) to simulate an attack on the VIII Corps front from the River Lys at La Basseville northwards, the 14th Division carrying out a raid on the left of the 8th Division. On the 8th Division front, dummies were to be exposed in the sector previously reconnoitred, opposite Warneton (*see* Map, p. 240), under the orders of G.O.C. 25th Infantry Brigade (Brigadier-General Coffin, V.C., D.S.O., late R.E.). The signal for the dummies to be exposed was to be the opening of an artillery and machine barrage.

The object of the demonstration (not disclosed to junior officers at the time, naturally) was to help an attack on an 8-mile front by the Fifth and Second Armies East of Ypres.

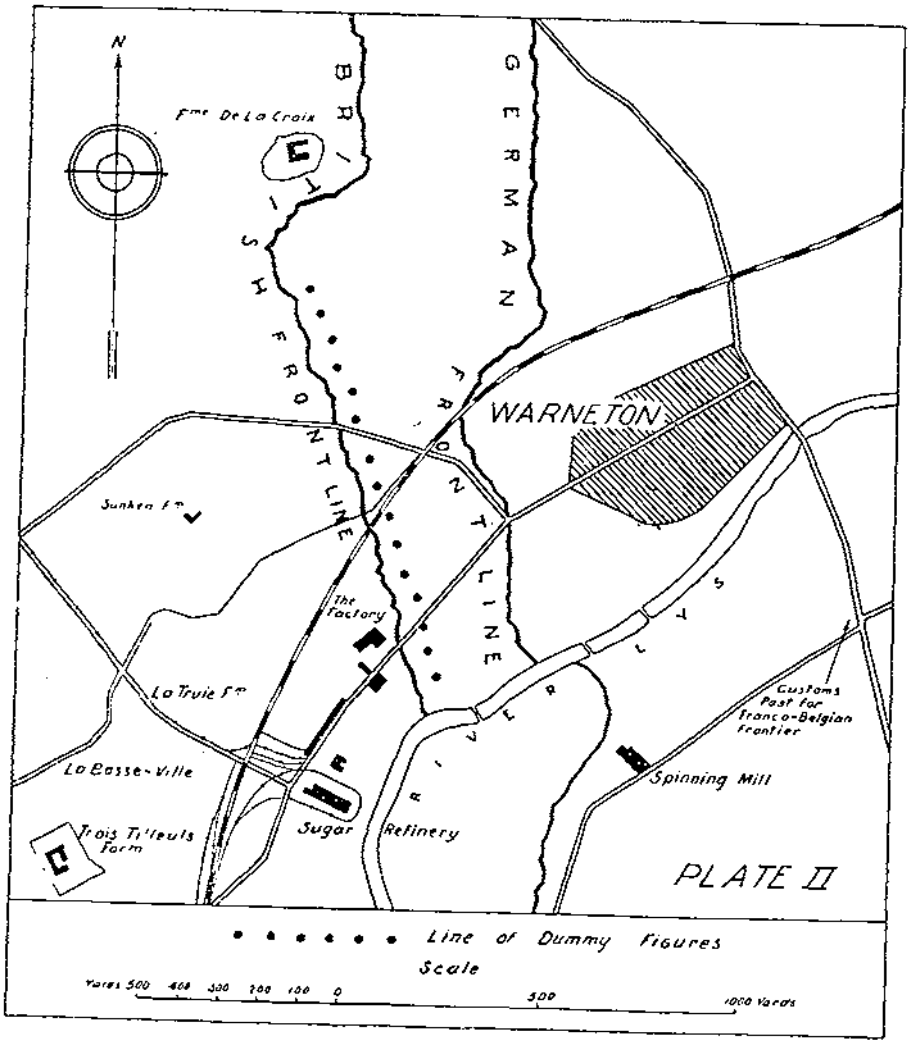
EXECUTION.

At 5.30 p.m. on 19th September, the 2nd Field Company paraded in camp by six squads, each approximately one officer, two N.C.O's and twelve Sappers. Each squad moved off by lorry at 15 minutes' interval to north of Plug Street Wood, where it met an infantry carrying party of 50 and collected 60 dummy figures from a dump previously formed and concealed.

It was still dusk as we reached de-bussing point, and a German observation balloon hung low in the sky, seeming to glare balefully at us. As a broad Scots voice was heard to observe nonchalantly, " Yon Gairman sausage balloon looks compar-r-r-atively close!" and one had the rather uncomfortable feeling of advancing on a wasps' nest, after it had been stirred up. A field battery near by was being heavily shelled by the enemy: the camouflage netting over one gun was blazing, and the gunners, ignoring enemy fire and the risk of exploding ammunition, were stoutly endeavouring to extinguish the flames with buckets of water.

As one carrying party moved off in the dark, an indignant warrior was heard to exclaim, "Like a lot of . . . sandwich men!" and there certainly was some resemblance. A few moments later, there was a sound of stumbling, and the same voice said, "Mine's broken, serjeant, need I carry it any farther?" Needless to say, permission to drop it was withheld, in no uncertain terms.

After an interminable journey at about one mile an hour, the front line was reached and the figures dumped, to be taken out in relays by the Sappers and fixed 50 to 100 yards in front, after lanes had been cut through the wire and infantry covering parties posted. Tapes were laid to show the route: these speedily became invisible from mud, and the best method was to pick the



tape up and let it run through one's hand. Fortunately the enemy remained very quiet, scarcely firing a shot. Several times during the night, coloured lights and rockets went up from the enemy lines, but they were apparently only testing their communications, as the expected artillery barrage did not follow. One wit in the company described it as a Brock's Benefit, remembering the old Crystal Palace days. By 1.30 a.m., each squad had completed fixing its figures in position on the 200 yards of front allotted to it. To avoid casualties from enemy defensive fire, the front line was then evacuated, except for a skeleton infantry garrison and the six firing parties, consisting of squad commanders and their orderlies.

The night passed slowly, but at last the gaunt ruins of Warneton (just behind the German front line) began to show faintly against the dawn sky. Only a few minutes to wait now. At this moment came an unrehearsed effect: there was a succession of distant coughs behind the German lines, and "Carpet Slippers" (so-called from their soft approach) passed overhead, to burst with a series of reverberating crashes on the communication trench and also on the railway line running back from our lines. This caused some annoyance, as the railway line had been selected for a line of withdrawal, being less likely to be shelled than the communication trench. A few moments later came one or two isolated shots from our guns—was it the signal? Yes, no doubt of it, as the full throated roar of our artillery and machine gun barrage followed, together with the firing of rockets and ignition of some smoke candles. The enemy replied promptly, his machine guns could be heard firing above the din, with their peculiar irregular beat, whilst salvoes of shell continued to arrive on our front and support lines for threequarters of an hour. Most of the dummies were soon shot away, while those that remained were sniped by German field guns. It may or may not be true that a man's past life parades before him at lightning speed during his last moments, but at any rate the writer had vague childhood memories of "Musical Chairs" as, with his orderly, he passed down a communication trench, hearing the shells falling a few feet away on either side.

To what extent the dummies contributed to giving the enemy an impression of actual attack one cannot tell: he would, in any case, have opened fire in reply to such a barrage as our artillery and machine guns put down on the morning of the 20th September. Let us hope "Fred's Cardboard Army" did their bit, certainly the Sappers and infantry carrying party did theirs.

Lesson.

The value of careful reconnaissance, drill and rehearsals, where an operation lends itself to such methods. There were no casualties among the Sappers or the infantry carrying parties.

APPLIED SCIENCE.

By CAPTAIN E. S. DE BRETT, R.E.

THE inability of the 1st Fortress Company in Gibraltar to do anything in the rowing world except break oars and come in last in races, compelled us to take the matter up seriously and scientifically! We discovered that both the Naval style and the old "rule of thumb" style, which always had been used, were not the most efficient for racing in the fixed-seat gigs which are the standard boat in Gib.

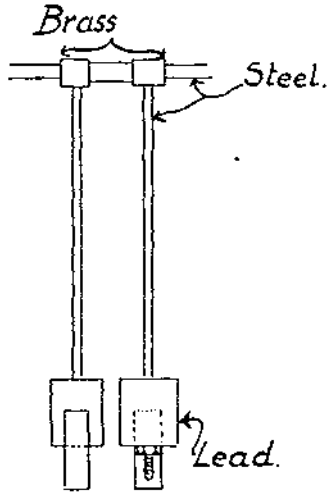


Fig. I.

The style which we developed and the methods of training which we adopted led to complete domination of the rowing for several seasons. The following is an attempt to put on paper what we carried out in practice.

My O.C., who had benefited by a close association with the scientific world while commanding the Y.O's at Cambridge, said: "You will make an accelerometer and find out what is wrong." Being a well-disciplined officer I said "Very good, sir," and then took Rikki-Tikki-Tavi's advice to "go and find out."

After frenzied research and the stirring up of long dormant dynamic theory, I evolved a machine which consisted of two pendulums about 6 in. long, each with a stop at bottom dead centre, which allowed them to swing in opposite directions (Fig. 1).

Thus, when the axle was placed athwart the boat, one pendulum swung out when the stroke was made and the other when the recovery was made.

The object was, therefore, to produce a style which (i) would swing the former as far as possible and the latter as little as possible and (ii) since work done (I fancy) is a function of acceleration multiplied by time, the former must occupy as large and the latter as small a proportion as possible of the cycle from entry of the oar into the water, through the stroke and recovery, to the entry on the next stroke.

The first thing to be done was to find out if the stroke used was efficient. To do this we made an accelerometer in the instrument shop. The materials used were :—

Derelict clocks, alarum	.. ..	one
Rollers typewriter (surplus)	.. ..	one
Brass, scrap Lead, scrap Steel rod, scrap Timber, plank $\frac{3}{8}$ in. (?)	.. ..	as required

Figure II is (I hope) a self-explanatory diagram of the machine, which had a wood cover to prevent it getting wet when in action. The connecting rods of steel between the pendulums and the recording device were hinged at the pendulum end and supported on steel rollers running on brass paths *over* the recording paper. The black blobs are springloaded pencils which must be offset from the con. rods so as to move along the same line ; this is only for convenience in analysing the diagram. *Under* the recording paper and below the pencils was a brass plate to ensure that the pencils made a clear mark.

The lead pendulum weights were adjustable on the rods to alter the swing, if necessary, and no damping device was required, as the lead did not rebound perceptibly from the brass stops at the end of the swing.

Oddly enough, this curious machine produced a diagram (Fig. III) which represented, broadly speaking, the stroke pull above and the recovery below the line A.B.

The machine was sufficiently sensitive and accurate to enable the difference between the various parts of the stroke and the different types of stroke and recovery to be clearly distinguished. We even went so far as to try and get an efficiency figure, by measuring the areas above and below the line for two crews who were in training for one of the races. We discovered that " B " crew, who had learned

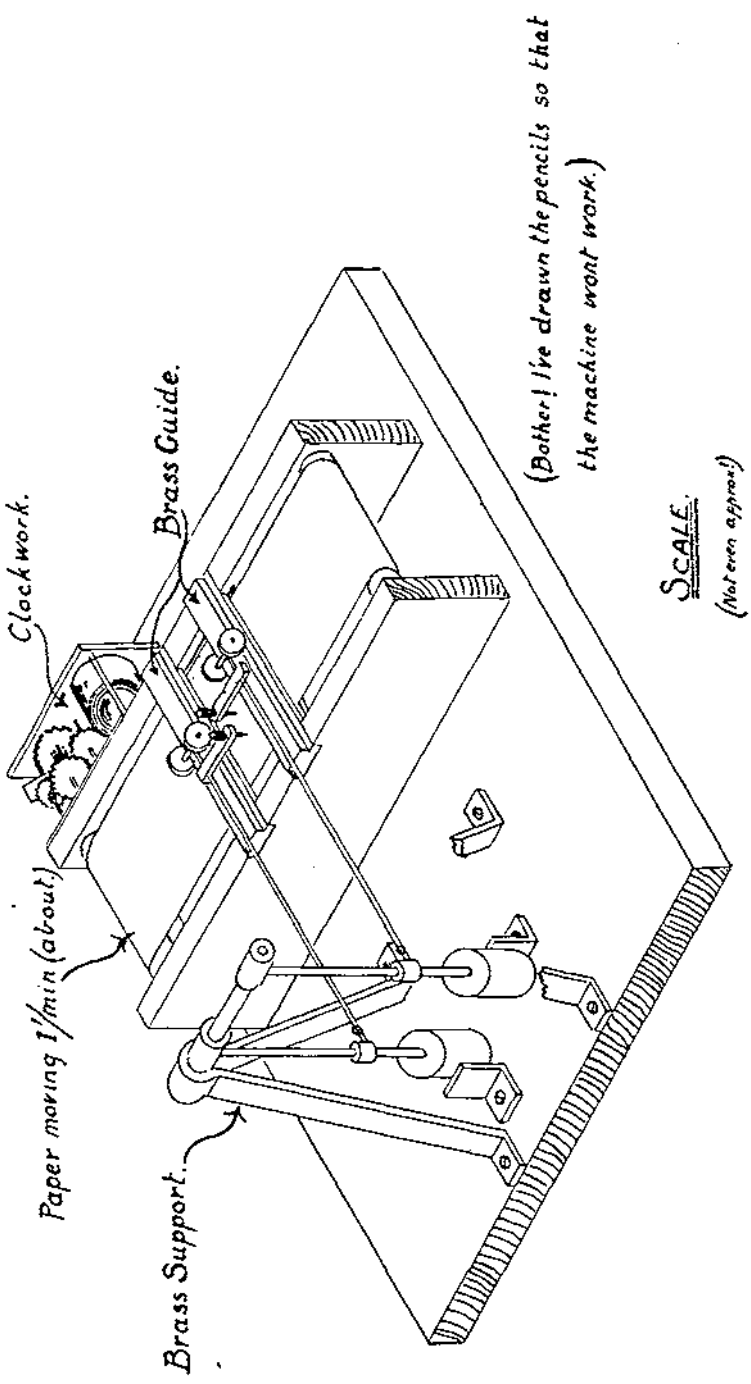

Clockwork.
Brass Guide.
(Bother! I've drawn the pencils so that the machine won't work.)
Paper moving 1"/min (about)
SCALE.
(Not even approx!)
Brass Support.

Fig. II.

the new style only, had a better figure that " A " crew, who were veterans of many seasons rowing and who had won every race the previous season. This gave " B " crew much encouragement and made " A " crew look to their laurels. The crews were drawn in opposite halves and both reached the semi-finals, " B " crew having a slightly easier passage. " A " crew were beaten on the post, after a gruelling race, by the Royal Welsh Fusiliers, who were in turn handsomely beaten in the final by " B " crew, who did the fastest time of the series in very similar conditions to previous days.

The efficacy of the machine and the style were thus established and the importance of starting on the right lines was demonstrated.

The stroke as finally perfected had a pleasantly idle and effortless appearance, though a high degree of physical fitness and muscular strength was required to carry it out. The effect on the onlooker can best be described by the comment of a gunner, who was standing by me as I watched the final of the series referred to above. " Just look at those——s doing no —— work and oiling through the water like ——— ! " The blanks were picturesque but un-Parliamentary.

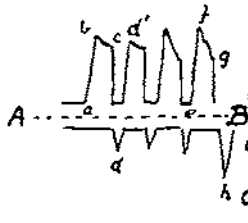


Fig. III.

Shortly after this triumph of modern scientific methods, I was detailed to conduct a retired R.E. officer of eighty-three summers on a tour of the galleries, a strenuous walk which did not daunt him. As we looked down on the harbour we saw some crews practising and I told him of our efforts. He was politely interested and said, " Yes—yes, that reminds me of the year —— when I was in charge of the tug-of-war in my unit. We were very poor and I thought that the good lookers might not be the best pullers. So I made the whole company do a five-minute pull individually on a dynamometer. We turned out an odd-looking team—but they won ! "

(I have a complete " Course of Instruction " for our methods which I shall be very pleased to forward " free of charge in plain wrapper " to anyone who may be interested.)

DESIGN OF CONCRETE MIXES.

By CAPTAIN H. H. C. WITHERS, R.E.

NOTE.—The Standard Tests for Concrete are all fully detailed in Appendix I of the *L.C.C. Building By-laws* 1938 and in the " Recommendations for a Code of Practice for the use of Reinforced Concrete in Building " issued by the Building Research Station in 1934. Descriptions are not therefore given in this paper.

The design of the concrete mix, as apart from structural design, is probably a subject about which most R.E. officers know very little, yet its importance both from the point of view of economy and structural safety cannot be over emphasized. The following paper deals with the preliminary design of the mix and not with its production on the job, except in so far as the former is affected by works conditions. The latter is fully dealt with in E.-in-C.'s *Technical Paper No.* 15.

The design of a concrete structure does not end when the last stress has been worked out and the last member drawn. In designing them, certain strengths have been assumed. Can it be taken for granted that these will be attained uniformly throughout the building? If so, are these the highest values that may with safety be used, or could economies be effected by taking higher strengths?

The answer to these and similar questions lies in a study of the materials which go to make up the concrete to be used. These materials are steel, cement, stone, sand and water.

The properties of mild steel are well known and, provided the steel is obtained from reliable sources with a test certificate, it can be assumed to be up to standard. The same applies to the cement, provided it is not tampered with, is properly stored to avoid absorption of water, and is used within a limited time after receipt (say up to four months in dry climates and one month in very wet climates). The remainder of the materials, termed aggregates, and the water, vary from place to place and require careful study in order to obtain the best results.

The success of the original design, judged both financially and structurally, depends on a knowledge of how best to combine the materials available.

A great deal of research on this subject has been done and is still

going on. If the knowledge so obtained is utilized, concrete giving a specified uniform strength can be obtained in the work and important economies can be effected either by using higher working stresses and more rational factors of safety, or by reducing, within limits, the quantity of cement. This necessitates :

(1) Careful design of the mix.
(2) Close field supervision.

In this connection it is interesting to note that the main difference in the grades of concrete laid down by the L.C.C. and by the Code of Practice is in the supervision and testing, NOT in the richness of the mix.

Once a good mix has been found, the rest is a matter of supervision to ensure that the mix as designed goes into the work.

In order to design a good mix, it is necessary to know what a good mix is.

Definition.

A good mix may be defined as the *cheapest* mix which can be *placed* in the *positions shown in the drawings* to give a *uniform* concrete of the required *strength and density*.

In order to understand the problems presented in designing a good mix, an explanation of the meaning and application of the terms used in the above definition is necessary.

Taking the various requirements in turn.

Economy.—The most economical mix is usually that which has the smallest quantity of cement per unit volume of *finished* concrete. In some cases where different aggregates are available, the price of the various aggregates may prove to be the ruling factor. Different mixes with the same amount of cement give different quantities of finished concrete. Care must be taken not to obtain economy at the expense of the density of the concrete.

Workability.—This is the term used to denote the ability of the concrete to be worked into place ; *i.e.*, its " consistence." It depends on the quantity of cement and water in the mix and on the grading of the aggregates. The structural design may call for various degrees of workability. Until lately the workability of a mix used to be described as " stiff," or " dry " and " sloppy " or " wet." In modern practice, these terms " stiff " and " sloppy " are only used to denote the general state of the mix. The workability is measured by the Standard Slump Test, but this test alone cannot be relied upon to control the concrete, as some people apparently expect it to do. It controls only the workability ; it can *not* control the amount of water in the mix. Failure to appreciate this will lead to disastrous results. The human factor enters very largely into the test, so that practice and care are required if consistent results are to be obtained.

As a rough guide to the degree of workability of a mix, mixes of :—

(i) 0–1 inch slump are of low workability and are suitable for mass concrete or precast vibrated work.

(ii) 1 in.–3 in. slump are of medium workability and are suitable for reinforced concrete with small to medium amounts of reinforcement, and for most R.C. slabs.

(iii) 3 in.–6 in. slump are of high workability and are suitable for heavily reinforced work and for work in thin or intricate sections.

A workability equivalent to a slump of over 6 in. is very seldom required, while a high workability cannot be obtained with a lean mix without sacrifice in strength.

Strength.—Modern research has confirmed the theory that the strength of concrete, *when fully compacted*, depends only on the ratio of the quantity of water used to that of cement. This is the basis of design for concrete mixes, though in actual practice the "fully compacted mix," *i.e.*, one which occupies the same volume as that calculated from the specific gravities of the separate constituents, is only a laboratory phenomenon.

The L.C.C. have laid down a standard method of testing the strength of concrete ; this is measured by the stress required to crush a six-inch cube made in a specified manner. It may sometimes be necessary or desirable to use a test specimen of shape other than a six-inch cube. Notes on various shapes of test specimens are given at the end of the paper.

Density.—A dense concrete is usually required, as this provides the best protection both against weathering and chemical attack and for the reinforcement. To obtain a dense concrete, the aggregate must be so graded that the particles are of such sizes that the voids of each size are filled with the largest particles which will enter them.

Uniformity.—This can only be ensured by adequate supervision and by constant testing.

The Practical Problems of Design.—In practice the density, strength, and workability are all inter-dependent and to design a good mix resolves itself into the consideration of three main problems :—

1. The quantity of cement required in the mix.
2. The quantity and quality of water.
3. The grading and quality of the aggregate.

Taking them in turn :—

1. Quantity of Cement.

One basis for deciding on the cement content of the mix is that the quantity of cement is that required to fill the voids in the mixed

aggregates. In a really well graded aggregate, which has been filled into a container and consolidated by vibrating, the voids will rarely be less than 18 per cent ; more often they will be between 20 and 23 per cent. The above theory would then require a volume of cement equal to about 1/5 of the volume of the mixed aggregate. In practice, this is a very common mix for good concrete with a high workability and giving high strengths. For less workable mixes, less cement may be used in proportions down to as little as 1/16 of the volume of the mixed aggregates. Where very high workability is required together with high strengths or where waterproof work is required, mixes containing up to as much as 3/10 of the volume of the mixed aggregates may be used. Obviously, lean mixes cannot be expected to produce as dense concrete as rich mixes.

For reinforced concrete it is essential that the concrete shall not be porous, or rusting of the steel and consequent spalling-off of the concrete cover will occur. Mixes leaner than 1 to 6½ should not be used in this class of work.

The final cement content can only be decided by the results of trial mixes based on the preliminary design.

Special Cements.—Notes on the various types of special cements are given later. They should only be used after careful consideration has shown that their use will be definitely advantageous to the work.

2. Quantity of Water.

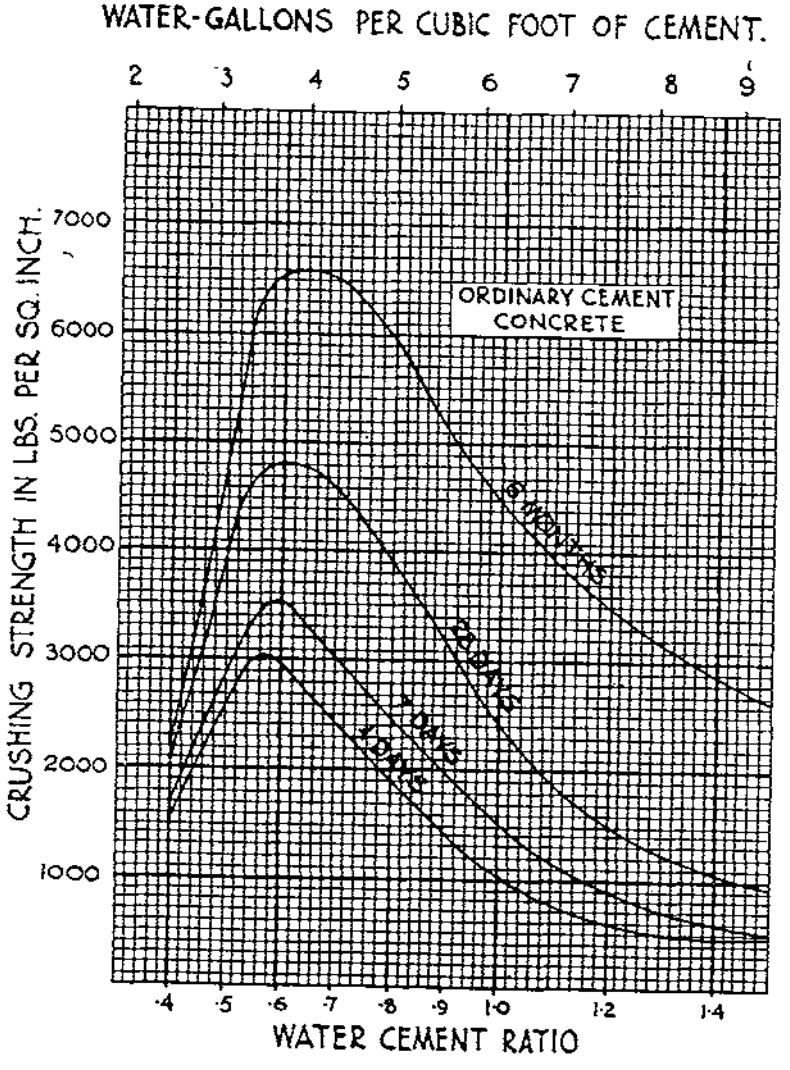
The main factor in controlling the strength of the mix is the quantity of water in it, taken in conjunction with the quantity of cement. The amount of water also affects the workability to a very marked degree.

The quantity of water required to hydrate the cement is very small (about 20 per cent of the weight of the cement). To get a mix which is workable, a much greater quantity of water is required than that for the chemical reaction only, with the result that the theoretical maximum strength can never be attained in practice. The strengths which may be expected in the field for various water/cement ratios are shown in Fig. 1.

The quantity of water in the aggregates must be allowed for. This is so important that, though it is mainly a matter for field control, it will be discussed at some length later.

Quality of the Water.

The water must be free from organic impurities, oil, acids or alkalies. It should be tested by the L.C.C. standard test for organic impurities. Generally speaking, a water that is fit to drink can usually be used for making concrete, but, if there are any doubts, it is advisable to send the water for analysis and report to a laboratory.



RELATION BETWEEN WATER-CEMENT-RATIO & STRENGTH

FIG. 1.

(TAKEN FROM MODERN METHODS OF CONCRETE MAKING)

3. Grading and Quality of the Aggregate.

A graded aggregate is one containing all sizes of particles between the particular limits set for that aggregate.

The grading of the aggregates is the main factor controlling the density of a mix, but it also influences the workability which can be obtained with a given amount of water and cement.

To determine the grading of an aggregate, it is necessary to divide it up from the smallest to the largest particles. Deficiencies or excesses of any particular size can then be corrected. The analysis is done by passing it through sieves of various sizes, but it is obvious that a limited number of divisions only can be made. The following are the standard sieves :—

Description.	Aperture size.
$1\frac{1}{2}$"	$1\frac{1}{2}$"
$\frac{3}{4}$"	$\frac{3}{4}$"
$\frac{3}{8}$"	$\frac{3}{8}$"
No. 4	·187"
,, 7 (8)	·0949" (·0937")
,, 14 (16)	·0474" (·0469")
,, 25 (30)	·0236" (·0232")
,, 52 (50)	·0116" (·0117")
,, 100	·0060"

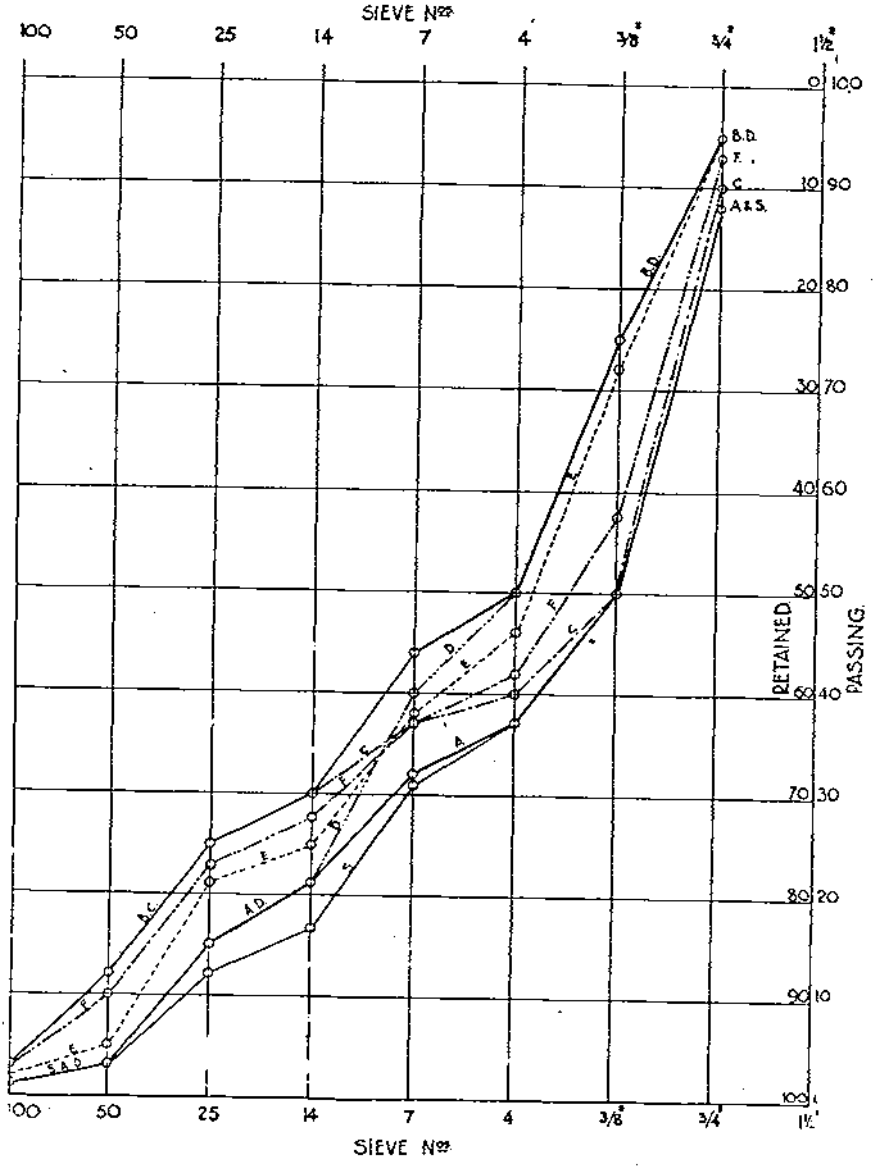
(The figures in brackets are the standard American sieves where they differ from ours).

Again, it is obvious that the whole of the aggregate cannot be analysed through these sieves, so that a sample must be taken. This should be done by the standard method of "quartering." About 3 lb. of fine, 10 lb. of coarse, or 15 lb. of mixed aggregates are required for samples for sieve analysis.

Taking the analysis, for which the Code of Practice lays down a standard method, consists simply in passing the sample through the sieves and weighing the amount retained on each sieve. A grading curve can then be plotted. In plotting such a curve it is usual to express the quantity retained on each sieve as a cumulative percentage (*i.e.*, the figure arrived at for the No. 4 sieve is the sum of the percentages retained on the No. 4 ; $\frac{3}{8}$", $\frac{3}{4}$" and $1\frac{1}{2}$" sieves, and so on). The sum of these percentages divided by 100 gives what is known as the Fineness Modulus. Mixes made with different aggregates, with the same F.M., and the same cement content require approximately the same amount of water for a given workability and hence give the same strengths. This, therefore, forms a basis for obtaining a grading. Some authorities use this fact combined with a given proportion of coarse to fine aggregate to design the mix, but in this paper it is

GRADING ZONES
CURVES FOR 1½" & ¾" AGGREGATES.

FIG 2.



only proposed to use it as a basis for obtaining the preliminary grading.

A series of grading curves is shown in Fig. 2, with details in Table IV.

Grading Zones.—The grading curves A, B and S in Fig. 2 give the boundary curves for mixes in which the maximum size of aggregate is ¾ in.

B is the upper limit curve. Gradings should not be finer than this.

A is the lower limit curve, and gradings, unless the aggregates consist of shingle and natural sand only, should not be coarser than this.

S is the lower limit curve for gradings containing only shingle and natural sand.

The other curves show various other gradings and notes on them are given later, together with a table showing their various properties.

These curves were prepared at Quetta from experiments and from several thousand different gradings used on the work there. They may be taken to be of general application, since they have been found to lie very close to the zone curves for similar mixes produced at the Building Research Station, London (see *Road Research Technical Paper No.* 5). For any big job, however, or in a laboratory, zone curves should be produced for local aggregates. The curves given here will form a useful basis from which to start.

Maximum Size of Aggregate.—The maximum size of aggregate depends on the type of work. For reinforced work, the maximum size of aggregate should not exceed ¼ in. less than the minimum distance between reinforcing bars, nor in general be greater than the minimum cover over bars. A ¾ in. aggregate usually meets these requirements. Some designers are inclined to reduce the cover to as little as ½ in. while using a ¾-in. aggregate. This is not recommended, as the bars will act as screens, tending to obstruct the concrete and to prevent it from flowing between them and the shuttering, causing segregation and honeycombing, while some bars may get forced out of place against the shuttering and thus be exposed when the latter is removed. On the other hand excessive cover, especially in members subject to bending, is objectionable as it leads to cracking of the cover (which has little tensile strength) and exposure of the reinforcement to weather and moisture.

In very intricate work a smaller maximum size of aggregate may have to be used, but it should be avoided where possible as it is very expensive. For large work or for mass concrete, maximum sizes up to 2½ in. are used since these aggregates are usually cheaper. It should be noted that an aggregate is usually called X in. provided not more than 15 per cent is retained on a X-in. mesh sieve. If more than 15 per cent is retained, then it is designated as the next

TABLE IV.

Mix No.	Boundary Curves A	B	S	C	D	E	F	A_1	B_1	A_2	B_2	A_3	B_3
Nominal Mix	1:1·6:3	1:2·5:3·7	1:1·6:4	1:2·0:4·0	1:2·1:3·7	1:2·0:3·8	1:1·75:4	1:1·35:3·35	1:2·18:2·85	1:2·1:5·2	1:2·9:4·7	1:2·74:6·3	1:3·1:6·0
Meal Mix	1 : 5	1 : 5	1 : 5	1 : 5	1 : 5	1 : 5	1 : 5	1 : 4	1 : 4	1 : 6½	1 : 6½	1 : 7½	1 : 7½
Cement cwt. per 100 c. ft. of finished cement	18·5	16·9	18·5	18·0	18·75	17·5	17·3	24·5	20·7	15	14·85	12·8	12·0
Weight lb. per c. ft. of finished cement	152·5	152·0	154·0	156·0	152·0	154·5	154	156·0	152	151	150·7	153	151
Voids in fixed aggregate. Loosely filled	25·3	22·4	23·9	21·5	28·1	20·6	22·0	27·1	22·4	25·3	22·4	25·3	21·7
Compacted	19·1	18·4	19·7	17·6	21·2	17·6	19·4	19·1	18·4	19·1	18·4	19·1	18·4
Water-cement ratio (by weight) (By volume)	0·65 0·945	0·75 1·08	0·57 0·82	0·67 0·965	0·84 1·21	0·77 1·11	0·77 1·11	0·60 0·864	0·66 0·95	0·71 1·02	0·82 1·18	0·82 1·18	0·90 1·30
Slump. Inches. (Av. of 3 tests)	6"*	5¾"	6"*	5¾"	2¾"*	4¾"	5"	5¾"*	6"	4"	4"	4"	2"
Laboratory strength, 6"-tube at 28 days (Av. of 3 cubes) lb./in.².	3911	3435	4292	3732	3358	3150	3638	4230	4010	2736	2518	2362	2016
Fineness Modulus of grading ...	5·53	4·66	5·61	5·13	5·00	4·96	5·07	5·53	4·66	5·53	4·66	5·53	4·66

NOTES.—(1) * Slump unreliable showing tendency to fall away altogether.

(2) For the MINIMUM strength to be expected on the Works, deduct 25% from the Laboratory strengths.

(3) These figures were obtained in a Works Laboratory as opposed to a Research Laboratory. It is not possible to keep exactly to the conditions laid down in the Code, nor are super accurate instruments available. Conditions are kept as nearly as practicable to those laid down in the Code.

larger size. This is not a hard and fast rule ; various authorities take values for the amount retained ranging from 0–15 per cent.

Proportions of Aggregates.—Aggregates are divided into coarse and fine aggregate, the dividing line being arbitrarily taken on a sliding scale as follows :—

Maximum size of aggregate.	Dividing sieve.
$\frac{1}{2}''$	No. 14
$\frac{3}{4}''$	,, 7
$1''$	,, 7
$1\frac{1}{2}''$	,, 4
$2''$	,, 4
$2\frac{1}{2}''$	,, $\frac{3}{8}''$

There are three terms in general use to define the proportions of a mix. These are the " field mix," the " real mix " and the " nominal mix." The first indicates the proportions in terms of the damp loose volumes as measured on the work. The " real mix " indicates the proportion of cement to the volume of the dry rodded mixed aggregates. This is the term which is coming into general use to define a mix in place of the " nominal mix," which gives the proportions in terms of the dry rodded volumes of the aggregates taken separately.

It will usually be found that a scientifically designed mix will not give proportions 1 : n : 2n. This is seldom the best mix.

In general, the leaner the mix the greater the care required with the grading, especially for high workabilities.

The Quality of Aggregates.—Aggregates may be natural (*i.e.* shingle and sand) or artificial (*i.e.* crushed rock or stone).

Shingle aggregates give a more workable and denser mix, probably on account of the smooth round shape allowing the mix to " flow " more easily. Less water is required and therefore they give stronger or more economical mixes. They are also usually harder than crushed rock aggregates and so are specially suited for places subject to heavy wear. Some authorities contend that shingle mixes with no crushed aggregate are liable to be weak in shear and tension.

The requirements of a good aggregate may be summarized as follows :—

Coarse Aggregate.—Must be hard and durable, clean and free from clay film or organic matter. It should not break into thin or laminated particles.

Fine Aggregate.—Generally as for coarse aggregate and it must be free from dust, shale and soft flaky particles.

Cleanliness.—Aggregates *must* be clean. A dirty or dusty aggregate may reduce the strength of the concrete by 30 per cent or more.

PROCEDURE FOR DESIGNING A MIX.

From the information given in the preceding pages, the following procedure may be deduced for designing a concrete mix :—

1. The crushing strength required should be taken from the working stress and factor of safety used in the structural design. (It must be remembered in this connection that the crushing strength for a laboratory mix should be taken as 25 per cent higher than that required in the work). This fixes the W/C ratio, which can be read off the curves in Fig. 1.

2. The type of cement to be used depends mainly on :—

(*a*) The purpose of the structure (*i.e.*, tank, or normal building, etc.).
(*b*) The place of construction (*i.e.*, liability to chemical attack, subsoil water conditions, etc.).
(*c*) The time available.
(*d*) Weather conditions.

3. The workability and maximum size of aggregate required can be decided by a study of the design drawings. It is possible that, for different parts of the structure, different degrees of workability may be called for.

Where a lower degree of workability can be used in some parts of the job, either different mixes and gradings altogether may be taken, or the cement and water content of the same mix may be reduced. In either case it is essential that there should be enough work to warrant a departure from the standard mix, with adequate supervision on the job to ensure that no confusion can take place.

4. The strength together with the workability and type of concrete (*i.e.*, whether reinforced or not) indicates the approximate cement content of the mix (*i.e.*, 1 : 4, 1 : 5 or 1 : 7, etc.).

5. The cement content and the workability together indicate the type of grading required. In this connection the relative costs of the available aggregates must also be considered.

6. From the sieve analysis of the aggregates a suitable grading must be worked out (see worked example).

7. A trial mix should then be made. If the desired workability is attained with less than the maximum amount of water permitted by the W/C ratio fixed, the quantity of cement should be reduced slightly. If a greater amount of water is needed, the cement must be increased to maintain the fixed W/C ratio. In the former case the grading is probably good, in the latter a different grading should be tried.

Two or three trial gradings and mixes may be required to arrive at the most economical and suitable mix.

Crushing strengths and weights of cubes (to the nearest ½ oz.) at 28 (or 7) days should be taken to check up on the strength and density.

The following example will make the procedure clear.

Worked Example of Trial Grading.

Data.

1. A reinforced-concrete building in a temperate climate with fairly heavy reinforcement (maximum 3½ per cent). Minimum cover 1 in.

2. Working stress taken at 750 lb./in². Factor of safety required 3.

3. Subsoil water not likely to be encountered but in any case it contains no harmful salts.

4. The time for completion is ample to allow the use of normal Portland Cement.

5. A sieve analysis, with prices, of the aggregates available is given below. This is in the usual form of cumulative percentages.

Name of Aggregate	Designating letter	Price per % C. ft.	Field Decantation Test	Sieve Nos.								F.M.	Remarks
				⅜	⅝	4	7	14	25	50	100		
Kach Quarry Sand	T	10/-	12%	0	7	12	14	18	21	81	90	2·43	As quarried and delivered on site.
	T_1	15/-	3%	0	7	12	14	18	22	84	96	2·53	Washed.
Hanna Sand	U	10/-	7%	0	0	15	31	65	76	93	96	3·76	As quarried and delivered on site.
	U_1	13/-	3%	0	0	15	31	66	78	95	98	3·83	Screened.
Bostan Quarry Sand	V	12/-	12%	0	0	3	3	6	9	60	89	1·70	As quarried and delivered on site.
	V_1	17/-	5%	0	0	3	3	7	11	65	94	1·83	Washed.
Crushed Rock Sand	W	18/-	Nil.	0	0	0	0	44	66	92	98	3·0	Screened at crusher and delivered on site.
Baxter Crushed Rock	X	10/-	Nil.	11	57	85	90	100	100	100	100	6·43	As for D.
Granulator Crushed Rock	Y	11/-	Nil.	6	40	80	84	94	98	100	100	6·02	As for D.
Shingle	Z	9/-	Nil.	4	50	86	90	98	100	100	100	6·28	Screened, washed and delivered on site.

Design.

From 1 and 2 it is obvious that a dense concrete of high workability is required (say 4–5-in. slump) with a minimum strength in the work of 2250 lb./in² at 28 days. The preliminary laboratory test cubes must therefore have a strength of 2800 lb./in². Since the minimum cover is 1 in., a ¾-in. mix will be suitable.

From 3 and 4 it will be seen that there are no conditions necessitating the use of special cements. Normal Portland Cement will be used.

From the curves in Fig. 1 it will be seen that the W/C ratio should not exceed 0·96 (by vol.) to give 2250 lb./in². at 28 days. To satisfy the above conditions a real mix of about 1 : 5 will probably be needed, with a grading rather nearer the upper limit curve than the lower. It may be found possible later to reduce the quantity of cement, but as a preliminary a 1 to 5 mix should be tried.

In order to work out a grading; a value for the Fineness Modulus must be assumed. A grading on the general lines of curve F (Fig. 2) would be suitable. This has an F.M. of 5·0.

By a process of trial and error it will be found the following combination of the available aggregates gives approximately the required F.M.

Aggregate	F.M.	Price per 100 c. ft.
1 Vol. of Y	1 × 6·02 = 6·02	1 × 11/– = 11/–
4 ,, ,, Z	4 × 6·28 = 25·12	4 × 9/– = 36/–
½ ,, ,, W	½ × 3·0 = 1·50	½ × 18/– = 9/–
2 ,, ,, T_1	2 × 2·53 = 5·06	2 × 15/– = 30/–
Total 7·5 Vols.	37·70	86/–

The F.M. of the mixed aggregate made up as above will be 37·7 ÷ 7·5 = 5·02, and the price 86 ÷ 75 = 11·5/– per 100 c. ft.

The resultant grading of the aggregate in the above combination is now worked out from the sieve analysis given. (Note.—The quantity retained on the sieves is in proportion to the number of volumes of aggregate used.)

GRADING OF MIXED AGGREGATE.

This appears to be a reasonable grading. It should be made up and tried out in a 1 : 5 mix and cubes taken to check the strength. During mixing the water should be added gradually and carefully measured, and slump tests taken at intervals as, if the desired slump is obtained with less water than the maximum allowed by the W/C ratio of 0·96, then the mix should be repeated with the cement content slightly reduced.

Other combinations of the aggregates should be worked out, since more than one combination will give approximately the same F.M.

and a better grading may be found. If necessary further trial mixes should be made.

The cubes should all be carefully weighed (to the nearest $\frac{1}{2}$ oz.) after curing in identical conditions for the comparison of the densities of the mixes.

The best mix can then be decided on, and those in charge of the actual construction informed accordingly.

			Quantities retained on Sieves							
Aggregate		Volumes	1"	¾"	No. 4	No. 7	No. 14	No. 25	No. 50	No. 100
(1)	Y	1	6	40	80	84	94	98	100	100
(2)	Z	4	16	200	344	360	392	400	400	400
(3)	W	½	0	0	0	0	22	33	48	49
(4)	T_2	2	0	14	24	28	36	44	168	192
(5)	Sum	7·5	22	254	448	472	544	575	714	714
Final Grading of Mixed Aggregates		Line (5) ÷ 7·5	3	34	60	63	73	77	94	99

Practical Notes.

The following notes, though not strictly within the scope of the paper will probably be useful to anyone who has to design a mix.

1. *Water Content of Aggregates and Bulking.*

When designing a mix, all the aggregates must be taken perfectly dry. On the job this is seldom the case. Allowances *must* be made for the amount of water in the fine aggregate or disastrous results will follow.

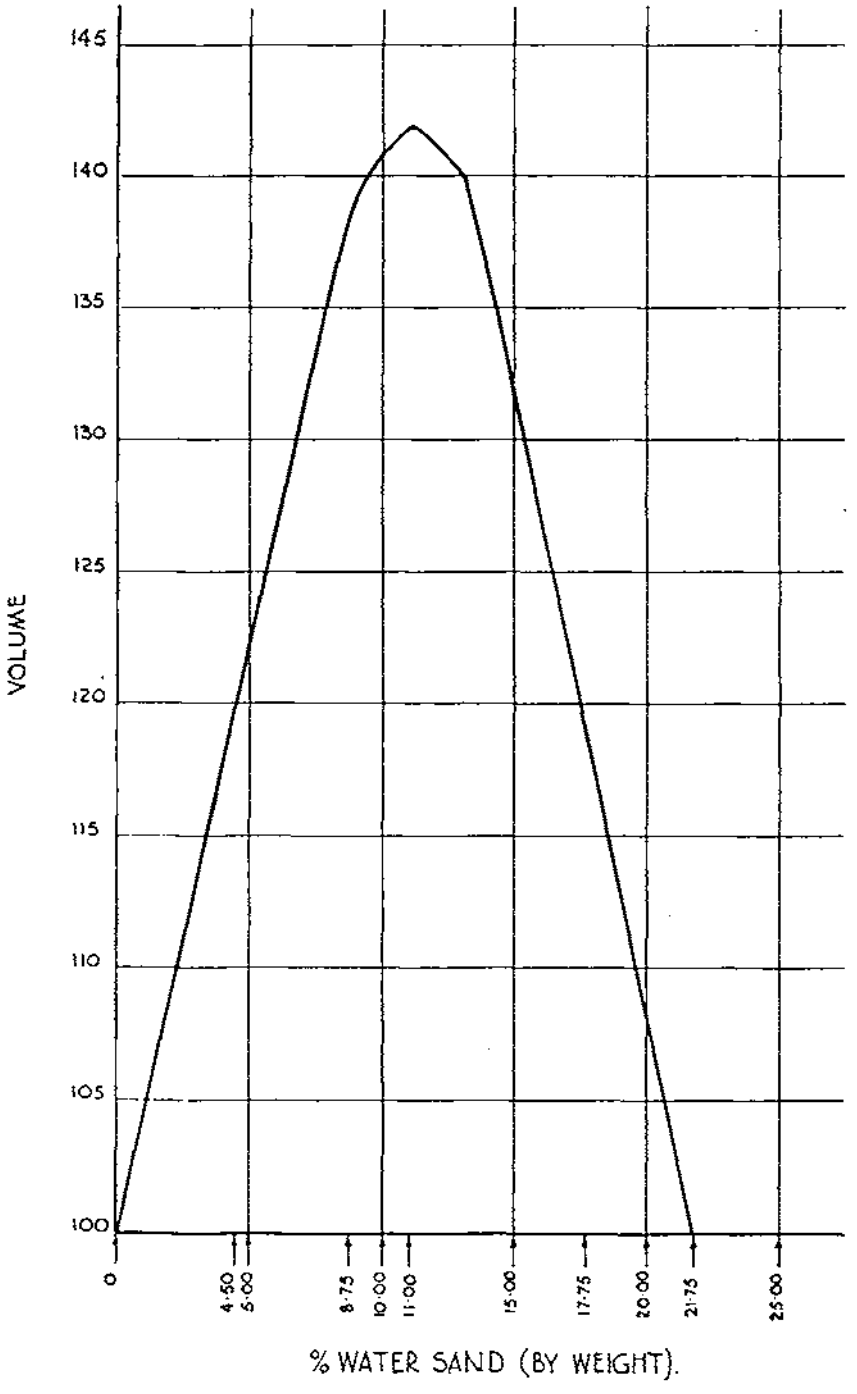
Normal coarse aggregates rarely contain more than 2 per cent by weight of water even when thoroughly soaked and, except in large mixes, the water in them makes very little difference. This does not include brick, coke breeze or other porous aggregates; for these experiments for water content would have to be made locally.

Fine aggregates may contain up to 25 per cent of water by weight. They also increase (or "bulk") in volume when wet. Unless due allowance is made on the job for both these factors, the work done in designing the mix is pure waste of time.

BOSTAN SAND

BULKING CURVE

FIG. 3



A " bulking curve " for sand is given in Fig. 3. It will be noticed that inundated sand occupies approximately the same volume as dry sand ; this is a very useful property and is made use of in measuring the quantity of water in sand.

The bulking of different sands differs, curves should therefore be made locally. This can easily be done as follows :—

A container of known volume (say 1 c. ft.) is filled with perfectly dry sand ; small quantities (say 1 qrt. = 4 per cent of 1 c. ft.) of water are added and thoroughly mixed. After each addition, the volume of the sand is measured until at saturation point the volume should have returned to the original figure. This procedure should be repeated several times and a curve plotted.

To obtain the quantity of water in the sand, the wet sample may be weighed, dried and weighed again. This takes a long time, so the following method is recommended for use on the job :—

Fill a small cylindrical can, about 2 in. diameter and 8 in. deep, with the sand for test by throwing handfuls vigorously into the can. No other consolidation is required. Then inundate the sand, rodding it with a pencil or ¼-in. bar the while. The sand will shrink ; measure this decrease and work it out as a percentage of the decreased volume. (If the original 8 in. depth shrank to 7 in. when inundated, it means that the volume of the sand when dry would have been 7 in. Hence the bulking is 1 in. on 7 in. or 14·3 per cent.) The quantity of water contained in the sand can be read off the bulking curve and the amount deducted from the quantity to be added to the mix. Extra sand must be added equivalent to the percentage bulking. Whether to use the wet or dry side of the bulking curve can only be told by experience, but it is usually fairly obvious.

2. *Chemical Attack and Waterproofing.*

In all cases where concrete has to withstand chemical attack the first object should be to make it as impermeable (*i.e.*, as dense) as possible.

To obtain this quality the most important factors are the W/C ratio, curing and grading, in that order. Aluminous Cement is more immune to chemical attack than Portland Cement ; sea water, sulphates, sulphur gases, sugar and beer all attack Portland Cement in varying degrees, but have little or no effect on Aluminous Cement.

For water tanks it has been proved in practice that a 1 : 5 concrete mix can be made reasonably impermeable up to a 35 ft. head of water. For this type of work a harsh mix should be avoided, as it is important to have a sufficient quantity of fine material in the mix. Admixtures may be used ; there are either void fillers, water repellents, or water absorbents. The general opinion, however, of most concrete engineers is that admixtures are not worth the money

spent on them, and that better results can be obtained by increasing the cement content.

Another method of securing waterproof concrete is by surface treatment. There are the following main types :—

(*a*) Penetrative surface treatments. These penetrate the surface and fill the pores for a certain depth.
(*b*) Plaster coatings. These involve the application of a mortar containing some patent admixture.
(*c*) Membrane coatings. These consist of bituminous or asphaltic coatings.
(*d*) Non-bituminous coatings. These comprise cellulose compounds and drying or semi-drying oils.

Aluminous Cement gives, as already stated, a more impervious concrete. This may, therefore, also be used for waterproof concrete work.

3. *Test Specimens.*

The L.C.C. Standard Test specimen is a 6-in. cube. It has been found that in square prisms, once a height to side-of-base ratio of 2 has been exceeded, the crushing strength does not vary appreciably with an increase of this ratio. In America, for this reason, a 12-in.

RELATION OF SHAPE TO STRENGTH OF TEST SPECIMENS.

Shape of Specimen		Ratio					
1. Cylinders ...	Diam./Height	1·0	0·66	0·5	0·33		
	Apparent crushing strength	1·0	0·90	0·88	0·81		
2. Square Prisms ...	Side of base/height	2·0	1·0	1/2	1/3·7	1/8	1/12
	Apparent crushing strength	1·38	1·0	0·93	0·85	0·84	0·82
3. Cubes	Larger/smaller	12/8	8/4	6/4			
	Apparent crushing strength	0·9	0·85	0·9			
4. Cylinder to Cube	Reduction of 15–25% of the cube strength for a cylinder of corresponding diam.						
5. Tensile strength to Compressive strength	S_t/S_c varies between 1/8 and 1/12.						

high by 6-in. diameter cylinder is used as standard, as this shape of test specimen gives results more nearly approaching those to be expected in the work. The strengths are lower than those obtained from cubes due to column effect.

For various reasons, such as cost of transport when cubes have to be sent away for test, cubes, square prisms, or cylinders of dimensions other than the two standard types described above are sometimes used. The following table gives information connecting approximately the shape of test specimen to the strength.

Notes on Gradings and Mixes.

(*a*) Gradings given in Fig. 2.

Type A.—Boundary curve (coarse) for $\frac{3}{4}$-in. mixes with crushed aggregate and natural sand.

Mix inclined to be harsh (slump test unreliable for W/C ratio over 0·64).

This type of mix is most suitable for mixes of low workability. For medium or high workability it is only suitable for the richer mixes.

Type B.—Boundary curve (fine) for $\frac{3}{4}$-in. mixes with any type of aggregate.

Mix inclined to be over-sanded. It is most suitable for high workability with lean mixes, but can be used for any mixes.

Type S.—Boundary curve (coarse) for $\frac{3}{4}$-in. mixes with shingle and natural sand aggregates.

Other properties as for type A.

Type C and F.—Good general purpose mixes; economical and giving high strength dense concrete with good workability.

Type D.—Not a good type of mix. The grading curve is too steep between the No. 7 and 14 sieves indicating a grading with too much of one size of aggregate.

Type E.—Not a good type of mix. The grading curve is too steep between the No. 25 and 50 sieves indicating too much of one size of aggregate.

General.

(1) Small deviations outside the boundary curves will not appreciably affect a grading.

(2) "Jump" gradings, *i.e.*, gradings with an entire absence of material between any two sieves, may be used and will give good results. They should not normally be used if a smooth grading can be obtained.

(3) Gradings with too much material of any one size nearly always give harsh mixes and bad results.

(4) Summarizing :—

Coarse aggregate. This should be about 56–68 per cent of the total aggregate by weight. The grading of the coarse aggregate does not greatly affect the general characteristics of the mix, provided that the quantity retained between the dividing sieve and the next larger sieve lies between 3 and 8 per cent of the total aggregate by weight.

Fine aggregate. This should be about 41–31 per cent of the total aggregate by weight.

The sum of the amounts retained by the following sieves should lie between the quantities shown :—

Sieve Nos. 14 and 25	..	12–19% of total aggregate by weight.
25 „ 50	..	17–20% „ „ „
50 „ 100	..	14–22% „ „ „
7, 14 and 25	..	16–25% „ „ „

These figures were obtained by analysing a large number of good and bad mixes from the various contracts in Quetta. The low strength mixes invariably came outside one or more of the limits given above. This does not mean that a low strength can be ascribed solely to a variation in one of the above limits, but it does mean that a grading that departs from one of these limits should be looked upon with suspicion.

(*b*) Gradings for Vibration.

When the concrete is to be consolidated by vibration, the grading should be of type A.

In general, a much lower workability may be employed than for similar work with hand punning, with a resulting economy in cement, but in Quetta, where walls up to 14 ft. high 4 in. thick with central reinforcement are being poured in one lift and consolidated by vibration, it has been found that a comparatively high workability is required. About a 3-in. slump appears to be most satisfactory, but such a high workability leads to danger of segregation and consequent honeycombing if the period of vibration is too long (over two minutes). Wet mixes may also lead to lack of adhesion with the reinforcement.

It is doubtful whether consolidation by vibration does in itself give increased strength, but it does materially reduce the percentage variation in strength. Any increase in strength is probably due mainly, if not entirely, to being able to use a drier mix and still get good concrete in work where, with hand punning, a mix of much higher workability would be required which would necessitate more water, and consequently more cement, to obtain a given strength.

This is where the economy of vibration lies, though it is somewhat offset by the fact that denser concrete is obtained, so that more concrete is required to fill a given space than with hand punning.

(*c*) Bad gradings.

Over-sanded, under-sanded or harsh mixes always require more water for a given workability than a correctly graded mix. This apparent contradiction can be accounted for by considering the sand, or that part of the fine aggregate passing a No. 25 sieve, to act as a "lubricant." If there is insufficient sand, the mix will not "flow" without a large quantity of water, the water acting as the "lubricant." A point is finally reached, rather suddenly in the case of under-sanded mixes, when the cohesion which held the mix together gets swamped and the whole mix falls away and segregation occurs. This explains the behaviour of the slump cones, which give irregular slump readings varying from 1 in. to 8 in. from the same mix, showing that it is a very harsh mix. On the other hand, sand can hold a large amount of water. Alone it is "stodgy" and does not flow till it has been inundated and has an excess of water. Hence a mix containing too much "fines" also requires a large quantity of water to make it workable.

An over-sanded mix may produce a concrete which is not very dense and hence is apparently very economical in the cement per unit volume of finished concrete. This must be guarded against.

(*d*) Variations in grading.

Should the water required on the job unaccountably rise for a given consistency, the cause should be looked for in variations of the aggregates and their gradings (usually too much "fines" or dust). This indicates the fallacy, previously referred to, of relying only on the slump test to control the mix in the field, as it will give no indication that more water is being used to obtain the given slump. This actually occurred in Quetta. Unless the quantity of water as well as the slump is rigidly controlled and never allowed to exceed certain maxima specified by the designer of the mix, disastrous results will follow. Unfortunately, these results only become apparent when the test strengths come out 7 or 28 days later, leading to the unpleasant necessity of rejecting and cutting out the weak concrete.

Literature.

The following books are recommended for study:—

(*a*) *Handbook on the Code of Practice for Reinforced Concrete* by Scott and Glanville. Price 8s. Gives details of all the standard tests.

(*b*) *Modern Methods of Concrete Making* by Wynn and Andrews. Price 1s.

Both the above are published by Concrete Publications Ltd., of 20, Dartmouth St., London, S.W.1.

(*c*) *Plain and Reinforced Concrete Construction* by Probst. Price 30s. Published by Ed. Arnold and Co., London.

(*d*) *Concrete Engineering* by Singleton-Green. 2 vols. Price 8s. each.

(*e*) *Plain Concrete* by E. Bauer. Price 24s. Published by the McGraw-Hill Publishing Co. Ltd.

(*f*) The *Technical Papers* and publications of the Building Research Station, Garston, near Watford, London.

(*g*) The new *M.E.S. Handbook* and the E.-in-C.'s *Technical Paper No.* 15.

NOTE.—*Road Research Technical Paper No.* 4 gives a detailed description of a simple and effective method for the control of water in aggregate by a new vibration system. Tests with this system on work in contractor's hands in England showed a reduction in the variation in the strength of concrete, in which the usual allowances were made for bulking and water in the aggregate, from 23 per cent to 10 per cent, while it eliminated entirely the occasional weak mix.

CEMENT STABILIZATION OF SOIL.

By A. H. D. MARKWICK, ESQ., M.SC., A.M.INST.C.E., A.M.I.E.E.
(of the Road Research Laboratory).

NOTE.

INASMUCH as lectures, given periodically at the S.M.E. on soil stabilization, are given by gentlemen who are interested in the sale of bitumen and bitumen products, the question of stabilization by the use of cement is not mentioned, but for active service conditions it is probable that cases may arise where this latter form of treatment may be of the greatest help in providing quickly a temporary hard surface until time, men and materials allow a better road to be provided.

The Road Research Laboratory have been experimenting for some time on soil stabilization, but on a basis that would not meet active service conditions. They are now, however, carrying out tests on a new basis to see, with different types of earth, what success can be obtained with the minimum addition of sand and gravel, the ideal being the need for cement only.

The article following is a short note prepared by Mr. A. H. D. Markwick, M.SC., A.M.INST.C.E., A.M.I.E.E., with the kind permission of the Director, Road Research Laboratory, to give officers an idea as to what is being done and to bring to their notice that cement stabilization may possibly be the answer to one of the early problems in a European war, a problem which is definitely not solved by the use of bitumen, however optimistic the advocates for the sale of bitumen may be.

An important problem in military engineering is the construction of short lengths of access roads, from main roads to ammunition and store dumps located at short distances from main roads. Roads of this type may have to be constructed in virgin country at very short notice and the minimum of materials and equipment will be available. If by some process the soil could be formed into a sufficiently hard and strong material to bear lorry traffic for a number of months, a very desirable solution of the problem would have been found. The better known processes of soil stabilization, using bituminous materials in the form of cut backs or emulsions, do not

meet the needs of the case, for the soil only becomes hard and stable when the moisture has dried out. This takes time, even given the hot weather necessary for this process to be successful. In the last few years, the process of cement stabilization of soil has attracted some attention in the United States of America, where it has been used for low cost roads. This material may be regarded as an earth concrete. It sets in 24 hours and gains strength with age in a similar manner. Whilst, of course, the high strengths obtainable with good concrete aggregate are not to be expected, the material is one which shows promise and may fulfil the particular requirements of the military engineer. Reference will first be made to published American Work and a brief account will then be given of experiments carried out in this country.

TABLE I.

CLASSIFICATION OF SOILS IN TESTS ON CEMENT-SOIL ROADS.*

Class.	Type of Soil.	Remarks.
I	Sandy soils.	Outstandingly beneficial results from small quantities of added cement. 4 to 6 per cent cement hardened soil appreciably and resulted in negligible loss on 12 freezing and thawing cycles.
II	Silty soils. (Group A-4 and A-7-4 on U.S. Bureau of Public Roads Classification.)	Decided hardening by the addition of 6 to 8 per cent cement.
III	Clayey soils.	Appreciably hardened by the addition of 10 per cent cement.
IV	Unusual Bad Soils of limited occurrence (*e.g.* highly plastic clay, peaty muck).	No recommendations, as tests not completed. It is stated that it is possible that successful treatment may be evolved from the tests which are being carried out.

* Results abstracted from paper by M. D. Catton, (*loc. cit.*).

Many papers have been published in the United States of America in the last year on cement stabilization. In this article reference will only be made to an important symposium of eight papers presented to the Highway Research Board.* Most of these are concerned with the actual construction, by mix-in-place methods, of experimental cement-stabilized roads in various parts of the United States. The work described is the construction of long lengths of low cost roads by mechanical methods and is quite different from the problem considered. A paper by Catton on the basic principles of Soil-Cement Mixtures (*loc. cit.* page 7), describing

Fig. 1.—A 3-cu. ft. single-shaft mixer for stabilized soil.

the effect of cement on various types of soil, bears directly on the present problem. Catton classifies soils into four groups, based on the well-known U.S. Bureau of Public Roads Classification. For the details, reference should be made to Catton's paper, but a simplified summary of his results is given in Table I. It will be seen that, generally, the more nearly a soil approaches a normal concrete aggregate, the greater the benefit derived from adding a given proportion of cement. In order to meet the conditions of the American climate, Catton adopted a weathering test, consisting of a

* Highway Research Board. Proceedings of the Seventeenth Annual Meeting. Part II. "Soil Cement Mixtures for Roads." Washington, 1937.

Cement stabilisation of soil, Fig 1 (Page 269)

number of cycles of freezing and thawing, as a measure of the mechanical properties of the material. Materials which would withstand 12 freezing and thawing cycles without appreciable disintegration were considered good.

Shortly before particulars of this work reached the Laboratory, preliminary experiments were carried out at the Road Research Laboratory with cement-soil mixtures. The soil used was a brick earth, which belongs to Class II of Catton's classification. The method of measuring the mechanical properties was to crush 4-in. cubes of the material at 7 and 28 days, exactly in the same way as concrete. Tests were carried out with soil-cement mixtures ranging from 6 : 1 to 12 : 1. The following results give an approximate idea of the properties of the materials :—

Ratio dry soil : cement by weight.	Percentage cement content.	Average strength at 7 days.	Average strength at 28 days.
6 : 1	18	507	890
9 : 1	11	290	530
12 : 1	8	—	240

It was also found that the incorporation of aggregate resulted in considerably increased strengths. While no great accuracy is claimed for these results, for individual results varied appreciably, the process seemed very promising, and it was decided to construct a small experimental road. The particular application visualized at the time of these tests was for cycle tracks and footpaths and, after consultation with the Cement and Concrete Association, it was decided to reduce the cement content to 40 : 1 (soil and cement) and to incorporate 50 per cent of ballast aggregate with the soil. No time was available to test this material and it was afterwards found that its strength at 28 days was only 40 lb. per sq. in. The sections were laid on a road 10 ft. wide and had to carry lorry traffic up to 5 tons in connection with constructional work. The following sections were laid: 6 in. thick, surfaced with a 1-in. bituminous carpet, and 6 in. and 4 in. thick, surface dressed. Whilst the 6-in. and 4-in. surface dressed sections have failed, the section which was covered with a bituminous carpet has withstood the traffic reasonably well.

The mixing and laying methods used are, however, of more direct interest in the present problem. Two different makes of portable single-shaft mixers of 3-cub. ft. capacity were used, one of which is illustrated in Fig. 1. Sufficient water was added to the

soil to make it plastic and the cement was then added. The material was spread exactly in the same way as concrete and was consolidated by tamping. It is necessary to cure the material by spreading sacking or by covering with sand which is kept damp, if cracking is to be avoided. Further work is now in hand to investigate in detail the possibilities of cement stabilization from the military standpoint.

NOTES FROM THE R.E. HUNT BOOK, 1882–1894.

By CAPTAIN M. C. A. HENNIKER, M.C., R.E.

THE years 1882 to 1894 may be described as the last of the Golden Age of Soldiering, and an interesting light is shed on the period in the pages of the *R.E. Hunt Book* in the Mess at Aldershot. In the Golden Age, the profession of Arms and the sport of foxhunting were almost synonymous. There had been a long period of peace and the spread of science and invention appeared to give promise of more. How, therefore, could a young officer better spend his time than by foxhunting three or four days a week? Or, as some wag has inscribed in the *R.E. Hunt Book*, the motto of the R.E. Mess might well have been *Quo Fox et Gloria Ducunt*.

It is not intended to argue the merits of that sort of training to-day, but there is no doubt that it bred men to whom we owe much that is good in our Corps. From their writing one may judge much. They were men of simple and direct character. Their style had not the cultured obliquity that sullies all Service memoranda to-day: and they could all spell. They were outspoken, too; indeed, they were often rude. The huntsman of the Garth, locally known as The Pieman, comes in for many rough rebukes. "There will never be any sport till The Pieman is knocked on the head and put in the boiler. . . ." "The best huntsman in England—for a Bad Day." But they justly gave him credit on the rare occasions when he displayed sufficient cunning to hunt his fox successfully, even though he never ventured to leap the smallest fence.

They jumped some hairy obstacles then. In 1891 the point-to-point included a 15-foot ditch and there is a picture of one R.E. officer clearing a five-bar gate with iron spikes on top, while a Staff Officer (D.A.A.G. for Musketry) elected to stand aside and open it. The rider's topper is at the full scope of his hat-guard and his face wears a benign smile, in contrast with the pained expression of the D.A.A.G. Anyone who takes the trouble may see that very gate to-day. One pales to contemplate it.

But they were not always super-men, and when our elders tell us "that we didn't do that sort of thing in my young days," we may point to some of their peccadilloes written in black and white fifty years ago. We may see one young blood "whose horse was a clinker at timber" jumping a style and hitting Mr. Hargreaves broadside on as he landed, to the detriment of the latter's knee.

Then there is the unruffled Sapper whose horse had kicked the Master's, so that blood poured from the near hind. "Good gad, sir," cried the angry Master, "your mangy beast has lamed my horse. . . ." "Oh really," came the prompt reply, "he often does that." Then there is the occasion when a young officer found himself twenty miles from barracks when hounds were taken home. He hacked gamely home and discovered as he reached the stables "that his horse could only put three legs to the ground"; and one can only admire his strength of mind in not noticing it twenty miles sooner. Lastly, there is the officer who could not ride or who did not like it. One often wonders what these unlucky fellows did before the days of motor-cars. "Grin and bear it" one hears one's elders say. Not so this young man whose fertile brain was no stranger to strategy: he burnt his riding boots to avoid the officers' ride.

Hunting in the eighties was prosecuted with a leisurely magnificence. The riders would stop for breakfast on the way out. One writer explains that some of the Vine country "cannot be recommended to an ardent lover of the sport, though, for those who prefer their legs under the table to astride the pig-skin, the cold pheasant was excellent." In the same season, we are told, the Garth Hunt was honoured by the presence of Their Royal Highnesses The Duke of Connaught and Prince Christian "in a sporting sort of trap with four horses and out-riders." How much more picturesque than in a Phantom Rolls.

Ladies in the hunting field were rare. So rare, in fact, that each appearance receives a special mention. It is not till 1892 that a R.E. officer's wife receives this honour.

Trains hampered hunting then, too, but not being electrified, the danger was less. Also they could be stopped to assist in the chase. This happened twice on 18th December, 1892, near Winchfield. (To-day, 1st February, 1939, it was only by the merest chance that half the Garth Hounds were not slaughtered by an express.) The menace of wire (peace and war) had hardly begun. In 1884, a writer complains of the wire in Buckfield Park, and one can only assume that what is now the poor man's cheapest way of enclosing stock was once the fad of rich men only. In 1892, the field with the H.H. found themselves entrapped in a wire entanglement "of the most improved military pattern." This also occurred on a rich estate.

Nowadays, officers sometimes arrive late at the meet. This is usually because they are delayed by military duty, and perhaps they were so delayed fifty years ago. But their lateness was often due to losing the way. They also used to lose the way home, "which is exasperating." Presumably they did not have the liberal supply of maps we now enjoy. Another difficulty was the absence of the telephone. It was not possible to ring up the kennels on a frosty morning to ask if hounds were going out, and it was consequently

not uncommon to get to the meet and find no one else there. By contrast in 1892, when some sportsmen went to meet Mr. Garth's hounds at the North Horns, they found the Highland Light Infantry in full marching order with transport there as well. Luckily, many of the meets were near at hand. On 1st February, 1894, the Ripley and Knaphill Harriers met at the R.E. Mess to hunt an outlying stag believed to be in Pyestock Wood. Filled with cherry brandy and good cheer, they moved off across Laffan's Plain, found their stag and after an amphibious operation captured him in Fleet Pond.

The horses were private ones and not chargers. The latter were used for hacking to the meet, and there is a fine sketch of one young man "Mounted by Her Majesty, or Hacking a Hairy." He is hammering down a hard high road exclaiming "Just 20 minutes to do the last 4 miles, by gad." Trailers have now largely replaced the railway horse box, but in those days the train was commonly used for the more distant meets. The horses, by the way, all had docked tails, and a noseband was the exception rather than the rule.

The sport was neither much better nor much worse than it is to-day. They had their great hunts and their blank days: so do we. Perhaps one of the most original was in 1889, when Her Majesty's staghounds hunted their stag into a hat shop, where he browsed for some time on green ribbons. He was at length removed in a covered wagon "and there was a small bill for bonnets. . . ." One always expects good sport and a picture of 1886 depicts "Anticipation and Realization." The first shows an undulating country with broad fences and good viewpoints (not unlike the Heythrop Country) with hounds in full cry and horses extended: the dream of all foxhunters. But "Realization" is a different kettle of fish. Three bedraggled sportsmen are returning wearily in the pouring rain. In turn they exclaim: "D——n country, d——n hounds and d——n game preservers."

The first recorded point-to-point was on 21st March, 1891, round a Q-shaped course of about 4 miles. There were two races—lightweight and heavyweight. The weighing was not very meticulously carried out, for one officer by wearing no waistcoat rode four pounds under weight, while another "carried a flask full of shot, a sandwich case full of lead, the billiards room fender and the coal scuttle to bring himself up to 16 stone"—three stone over weight. But perhaps this is hyperbole. They started in a blinding snowstorm, crossed the main road four times and "rattled through the noisy streets of Crookham." An officer "who was much admired" came under the starter's orders in full uniform but unfortunately stuck at the first fence. One horse joined the spectators early on: another was damaged breasting a park paling in Crookham: a

third, whose rider's head "was seen bobbing about amongst the horses' hoofs," was only caught at Hartley Row (five miles away) by a mounted orderly. Nevertheless, twelve horses finished in the lightweight and seven in the heavy.

The next year the course was more nearly straight and there was not so much grief. The principal damage was done to a telegraph pole laid horizontally to make an obstacle. This was most appropriately broken by the officer commanding the telegraph battalion, "who failed to comply with the regulations for preserving telegraph poles from damage." The meeting was still a light-hearted affair. One officer was only able to make the weight by wearing the pipe-clay belt of a soldier spectator. But the local populace, remembering the lavish hospitality of the previous year, turned out in great numbers to witness the spectacle, and the local newspaper records this fact.

There was apparently no race in 1893 and the next year was the first in which the trophies for which we now race were presented by Colonel Sir Arthur Mackworth, *Bart.* and Lieut.-Colonel Lindsell, R.E. The race began in an unusual way. The riders were lined up in "a greasy lane" and the first fence was the one out of it. The course was not far from the one we now ride. The riders and spectators (categorically, "married officers, bachelors, riders and N.C.O's") set out in four brakes from the Mess. On the way, by furious driving, the riders managed to overtake the N.C.O's to borrow a corkscrew. (Our elders will be relieved to hear that the Serjeants' Mess can still be relied upon in times of crisis such as this.) Sixteen horses started but another fifteen remained in barracks. The writer of the time thought this was not due to lameness but to the "gruesome arrangements" laid on for the meeting. These included two farrier serjeants, with Martini-Henry carbines and ten rounds apiece, a horse float and an ambulance. After the races it transpired that the ambulance was full of beer.

There was actually not much grief, but one horse tried to jump a tree. "The clever horse accomplished this without difficulty but the jockey was left perched in the branches. From this commanding position he observed with disgust his horse recaptured by an officious spectator and he was obliged to continue on his course." Another officer made a reconnaissance of the far side of one of the fences in advance of his mount and "on reporting all correct the animal was induced to follow him."

* * * * *

It is easy for the Nimrod of 1939 to look back with wistful longing at the pages of the *R.E. Hunt Book;* or by contrast, for the survivors of the Golden Age, standing on the bleak eminence of advancing

years, to look with something akin to scorn on us. But there is no good in these reflections; rather is it better for old and young alike to join in the swinging metre of the writer of 1888, who wrote :—

A FORWARD CAST.

A little more inaction, and again the joyous sound
Of heart-reviving holloa, of trusty note of hound,
Of cheery horn, of cracking whip, they drive the cares away,
As we rattle through the underwood the cubs at break of day.
Though older, I feel younger, as day by day glides by,
And summer's blue departeth for winter's leaden sky.
Wrinkles quit my forehead, care to bliss yields up a place,
When again the woods re-echo with the music of the chase.*

* There is nothing in the *Hunt Book* to say whether this is original verse or not.

Maj-Gen Alexander Gavin StevensonCB CMG DSO

MEMOIRS.

MAJOR-GENERAL A. G. STEVENSON, C.B., C.M.G., D.S.O., COLONEL COMMANDANT ROYAL ENGINEERS.

"FORTY YEARS OF DISTINGUISHED SERVICE": Thus, justly, *The Times*, on 14th March last, epitomised the career of an engineer officer who combined with his eminently soldierly qualities and strength of character, extensive knowledge of mechanical and general engineering science.

Alexander Gavin Stevenson, son of Archibald Stevenson of South Shields, was born on 15th October, 1871. Of notable Scots ancestry on both sides, he was educated at Chanonry School, Old Aberdeen, and at The Royal Military Academy; and was commissioned in the Corps on 13th February, 1891, being second in "Faber's" Batch. At the "Shop" he had gained prizes for Drawing and Fortification; and at the S.M.E. he was awarded the Fowke Medal of his year. After his S.M.E. Courses he remained at Chatham for some months in the Training Battalion; and then spent a year at the Elswick Works, Newcastle-on-Tyne, followed by a year with the 10th Railway Company at Woolwich Arsenal—experiences which were to serve him well very soon, and throughout his years of varied service.

In the autumn of 1895, Lieutenants Stevenson and Polwhele, at the special request of Colonel Sir H. H. Kitchener, Sirdar of the Egyptian Army, were posted to that force. They were sent to Korosko—above the 1st Cataract of the Nile—to begin a railway to Murat Wells, whence the line was to be extended later to Abu Hamed, thus following the chord of a great loop of that river. Actually, little of this line was built; but the initial work done by Stevenson and Polwhele at Korosko, in collecting and training the nucleus of what, later, became a very large Egyptian railway battalion, proved of the utmost value when, next year, the Egyptian Army was ordered to conquer Dongola Province.

For this campaign, the starting-point of the railway was shifted from Korosko to Wady Halfa. Stevenson's railway nucleus was rapidly expanded, and trained into the organization which Lieut. Girouard* now created and used to lay the railway 203 miles to

* Later Colonel Sir E. P. C. Girouard, K.C.M.G., D.S.O.

Kerma, in Dongola Province. The story of the construction of the 568 miles of railway, across the desert and along the Nile, is to be found in Lieut.-Colonel Sandes' book *The Royal Engineers in Egypt and the Sudan*. Stevenson's part in this work was extremely important. From 1895 to 1899 he was the Locomotive Superintendent of the Sudan railways, including charge of the workshops, which were continuously being expanded. Moreover, he had accompanied Major the Hon. M. G. Talbot, R.E., on the original reconnaissance from Korosko *via* Murat Wells to Wady Halfa; which decided Kitchener to alter the route of the railway, and to construct it from Wady Halfa to Abu Hamed, instead of from Korosko. He followed up this reconnaissance with another, which fixed the general line of the railway; and he marked thereon two localities where water might be found. This suggestion proved to be correct; a fortunate event which greatly simplified the construction of the railway.

Besides his railway duties, Stevenson was several times in action in operations. At the battle of Firket, in June, 1896, and in the advance on Dongola in September, he was orderly officer to a brigade commander. He commanded the gunboat *Metemmeh* during the advance to Khartoum in August and September, 1898, and also at the Battle of Omdurman.

While the development of the conquered country was proceeding in 1899, Stevenson reconnoitred the route for an extension of the railway from Atbara to Halfiya, opposite Khartoum; and on completion resumed his post of Locomotive Superintendent.

For his services in the Sudan campaigns Lieutenant Stevenson was twice mentioned in dispatches, and was awarded the Khedive's medal with three clasps, the British Sudan medal and the D.S.O.

When the South African War opened, in October, 1899, Stevenson was still serving in the Sudan. Lieut.-Colonel Girouard had arrived in Cape Town on the Army Headquarters Staff as Director of Railways. Very soon he had a telegram sent to the War Office to ask the D.A.G., R.E.,* for a Locomotive Superintendent to be sent out urgently. ". . . Suggest Stevenson or Newcombe, from Sudan. . . ." The reply came speedily, ". . . Stevenson *and* Newcombe embark. . . ."

As soon as the British forces began to occupy the railways in the Orange Free State and Transvaal, Stevenson took up the post of Locomotive Superintendent of the "Imperial Military Railways"—the title of the captured system of lines. In this capacity he had to organize a constantly expanding locomotive department, with engine running arrangements and workshops. No easy task with only a scanty nucleus of technical personnel lent from the Cape Government Railways, and tradesmen gathered from the troops. Stevenson's

* Major-General Salmond.

sound knowledge, experience and great tact enabled him to smooth out all difficulties over a railway system extending some 1,800 miles. The Boers became expert at derailing trains; but Stevenson's workshops repaired the damaged engines with the utmost regularity.

In July, 1901, Stevenson received serious injury in a railway accident, while travelling on inspection with the Traffic Manager, his assistant and Newcombe near Komati Poort. The railway telegraph had broken down; "line clear" could not be obtained, and the Traffic Manager himself decided to start off along a line with many cuttings, steep gradients and sharp curves. A train had already entered the section from the other end, and a head-on collision resulted. The Traffic Manager was severely injured, his assistant was killed. Stevenson with presence of mind had flung himself flat on the floor, but he was pinned under a wagon which mounted the verandah of the inspection coach. Although much injured he directed that jacks be fetched from the engine, and instructed how the wagon should be lifted off his thighs. After partial recovery, he was invalided home.

His war services in South Africa included the Advance to Kimberley, and Operations in the Orange Free State, Transvaal and Cape Colony. He was mentioned in dispatches, and awarded the Queen's South African Medal and three clasps.

Captain Stevenson was next employed, from September, 1901, until 1904, on administrative railway work under the Colonial Office in London. During this period much of his work was inspectional, and he acquired much knowledge of the many constructional and mechanical engineering firms in the Midlands and North Britain. He returned to Africa again, for railway work, in October, 1904, to Somaliland where, together with Capt. G. W. Denison and four other ranks, he surveyed an alignment from Berbera towards Harrar. But in March, 1905 the party was recalled to England.

On return to England, Stevenson was posted to Aldershot as Officer in charge of Machinery and Electric Lighting, and remained there two years. In May, 1907, he was again sent out on Railway work—to East Africa (now Kenya) and Uganda, where he was given the task of reconnoitring areas for possible branches and extensions to the 600 miles of the so-called Uganda Railway. The main items of the programme were: in Kenya, survey for three branch railways and an investigation of the possibility of producing water power from the various falls between Nairobi and Fort Hall; in Uganda, a topographical survey of the country N.E. of the Nile; a railway reconnaissance of the area bounded by Lake Victoria, the Nile, Lake Albert and a line running approximately from Mount Ruwenzori to Entebbe, and for the utilization of the water power of the Ripon Falls at Jinja; and a telegraphic longitude between Entebbe and

Butirba on Lake Albert. The work was expected to take one year, but actually took nearly two. The country was not particularly salubrious, and the strenuous nature of the work took its toll of the party. In November, 1908, Stevenson himself went down with a clot which paralysed him down one side; this fortunately dissolved in a few days but it necessitated him being invalided, and the after effects long troubled him. Luckily, all the work in Uganda was within a few days of completion, and he was able to take all necessary data with him and write his report whilst on leave. Much of the work for which he had surveyed was put in hand. As an example of his thoroughness, efficiency and accuracy, the 60-mile railway line from Jinja to Lake Kioga cost three per cent less than Stevenson's estimate.

After return home in 1909, Captain Stevenson married Elizabeth Nicoll, daughter of Surgeon-Major Jobson. He was posted to Dover for a few months' temporary duty, and then appointed Inspector of Iron Structures at the War Office, which post he held from 1909 to 1913. He also provided valuable backing and technical advice on the War Office Mechanical Transport Committee, and he took keen interest in the development of tractors and lorries for military purposes, and spent much time attending their trials and on manœuvres with them. During this period he was consulted by Field-Marshal Lord Kitchener over the technical problems arising out of the restoration of the house at Broome, which the latter was preparing for his occupation.

In the autumn of 1913 Stevenson was promoted to Major, and moved to Devonport to command the 20th Fortress Company, R.E., a unit allotted on mobilization for siege duties to the First Expeditionary Force.

In August, 1914, Major Stevenson mobilized the 20th Fortress Company and proceeded to France, where soon his company was employed under fire constructing a semi-permanent heavy bridge over the River Aisne at Bourg. For the first year of the war his company was used partly in front line work, to ease the acute shortage of field companies at that time, and partly in back areas on works of the kind subsequently carried out by Army Troops Companies.

Stevenson was appointed C.R.E., 6th Division, in August, 1915, but not for long. In December, 1915, when it was decided to appoint a Controller of Mines to each army, Stevenson was selected for that post with the Second Army. There he supervised from its inception the blowing-up of the Messines-Wytschaete Ridge, possibly the outstanding achievement of his career. This deep mining offensive, the largest carried out in the Great War, culminated in the firing of one million pounds of explosives prior to the attack of 7th June in the Battle of Messines. An unusual testimony to Stevenson's gift of creating enthusiasm among men of all ranks under his

command reached the writer, who met by chance in 1918 an Australian officer, transferred from France to E.E.F. This officer, a mining engineer in civil life, was describing his experiences as a tunneller in France. He mentioned with fervent admiration the confidence engendered among the skilled miners at Messines by the R.E. officer in control who, he said, knew every detail of their work, and " himself a large man " crawled everywhere below ground to ensure the efficiency of the work being done. Eventually he disclosed the name—Colonel Stevenson !

In November, 1917, Stevenson accompanied the British Force to Italy as Deputy Engineer-in-Chief, and there remained until April, 1918. From Italy, he returned to France to be Chief Engineer, Fifth Corps with the Third Army and, as such, took part in the final victorious advance, including the Battles of the Selle and the Sambre. After the Armistice he served on the Rhine with the Army of Occupation as Chief Engineer, IVth Corps, until September, 1919. He had been promoted to Lieut.-Colonel in the Corps in September, 1918.

For his services during the Great War, Colonel Stevenson was seven times mentioned in dispatches, promoted Brevet Lieut.-Colonel and Brevet Colonel and awarded the C.M.G. (1917), the C.B. (1919), and the Italian Order of St. Maurice and St. Lazarus 4th Class.

Colonel Stevenson's first employment after the Great War was to command the Railway Training Centre at Longmoor.

In August, 1920, he was appointed to the War Office as President of the newly created Royal Engineer Board—now the Royal Engineer and Signals Board. There he had to deal with the many changes in design of our engineer equipment necessitated by the experience of the war : in particular, the design of the new pontoon equipment now adopted in the service.

He was an ideal President, competent to direct, while leaving technical detail work to those under him qualified to do it. Invariably he took charge of the meetings of committees, and they got through the maximum of work in the minimum of time. He secured the services of eminent civil engineers and scientists as honorary members of the Board. But before his tenure of the Presidency was due to expire, he was ordered abroad urgently for service at Constantinople.

Of this period on the R.E. Board a colleague wrote " . . . he was always exceedingly knowledgeable, very genial and pleasant to work under, with a *bon mot* never far away."

He was promoted substantive Colonel in February, 1921.

It was in the autumn of 1922 that Stevenson was suddenly appointed Chief Engineer to the British Force in Constantinople,

where he arrived during the period of acute tension. The Turks, under Mustapha Kemal Pasha, were threatening to attack the allied troops on the Bosphorus and Dardanelles. The British C.-in-C., General Sir Charles Harington, had to maintain a force in Chanak, across the Narrows, from an advanced base in Gallipoli which, if hostilities ensued, would only be approachable from the seaward side of the Peninsula. It fell to Stevenson urgently to produce this Kilia Base, "out of nothing or little."

Many piers had to be constructed, and miles of road built on both sides of the Straits. Aerodromes, camps, hospitals, power plant, water supply and workshops, all had to be provided speedily. The civilian labour consisting mainly of unskilled Armenians with a few Greek artisans. Of this mass of work, a senior officer present comments: "I have never heard anything but praise of the Royal Engineers all that winter—a praise which the other arms do not give them very lightly; and the model city which they built in a mud heap is a marvel." Besides the Kilia Base, Stevenson had to provide many additional works to meet possible eventualities in the Constantinople Defence Area.

In April, 1923, Stevenson returned to England, and was posted to the Aldershot Command, as Chief Engineer, remaining there until August, 1926. He was appointed A.D.C. to The King in 1925, promoted to Major-General in May, 1926, and gazetted Colonel Commandant R.E. in December, 1935.

After the Armistice, Stevenson had been responsible for the production of a successful Tattoo in the Army of Occupation. Lord Rawlinson, while C.-in-C. at Aldershot in 1923, again employed his great appreciation of colour, power of imagination and other special talents for this purpose. Many of the most popular and permanent features of the famous Aldershot Tattoo and particularly the "Lantern Display" have grown from his sketches at that time. For four years he was Vice-Chairman of the Tattoo Committee and practically acted as artistic producer, and only in later years was a professional producer introduced.

During a few months on half-pay, Major-General Stevenson bought the Red Cottage, Sandhurst, to be the family home. He was appointed Engineer-in-Chief at Army Headquarters, India, in November, 1927, and held that post until his retirement in June, 1932. Though he had never been in India before, he quickly adapted himself to Indian conditions and procedure. During the early part of his time as Engineer-in-Chief he toured extensively to get first-hand knowledge of the country, and of what was going on; and this at a time when a very large building programme was in progress, a large portion of which was the improvement of the accommodation for Indian Troops, involving in almost every case the complete

reconstruction of their barracks. There was also much work in progress on the Frontier—roads, bridges and accommodation.

The end of his time in India was a time of acute financial stringency, and many of the improvements which were initiated under his orders had to be postponed for want of money. Even his equable temperament came under considerable strain during this period of enforced economies, reductions which he felt, and represented strongly, would reduce efficiency and cause his officers to be overworked. He said little about this period, but it had tried him severely and affected his health. Nevertheless, he worked indefatigably for his service; he left his mark, and all who served under him remember him with great affection.

Stevenson took unusual delight in the archæological and beautiful features of India. With his keen eye for interest and beauty he was an ideal guide, and he made the most of his flair for rapid water-colour sketching; and from all his tours he brought back most interesting sketches of what he had seen.

On retiring from the service, Stevenson and his wife returned to Sandhurst village and made a very happy home—a focus of hospitality for their many friends. This provided a convenient centre while his three sons were at Wellington College. It was a great source of pride to him that all three elected to seek a career in the service. The eldest is a lieutenant in the Queen's Cameron Highlanders, the second a flying officer in the Royal Air Force and the third now a cadet at the Royal Military Academy. His only daughter is married to Squadron-Leader Worthington, R.A.F.; so the various services have recruited well from the Red Cottage.

Stevenson held strong views on giving service to the community; he did not believe in vegetating on retirement and he found ample scope for his energy and skill. Soon he was elected to the Rural District Council of Easthampstead, on the various committees of which body his all-round experience of engineering was of great value. He gave time also to the Sandhurst parish and designed for its church council the lay-out of their electric lighting installation. Always he maintained an active interest in the doings of the Corps, and welcomed warmly those with whom he had served. Particularly he kept touch, through the "Tunnellers Old Comrades' Association," with the mining fraternity who had served under him in the Great War, and he succeeded the late General R. N. Harvey as President of that Association in 1937. Also, he was President of the Sandhurst branch of the British Legion.

Although by nature an outdoor man, Stevenson showed little inclination for hunting, shooting or ordinary games. He was a firm horseman, a strong swimmer and tireless walker. As a Y.O. at the S.M.E. he was a keen yachtsman, who thoroughly enjoyed

the cruises afforded by *Dotterel* and *Bucaneer* in those days. At the same time his artistic interest received strong impetus from his friendship with S. T. Aveling, of Rochester, with whom he tramped Kent and Sussex to sketch and paint landscape and architectural beauty. He would gain inspiration in his workaday problems from this source, too; a friend relates that " . . . as soon as he took a pencil or brush in hand, ideas would flow. . . ."

The early days of motoring provided a great hobby for him. He took to a motor-cycle in 1901, followed by a series of cars of early vintage, and capped by a " Thornycroft " famous for 17 years in the Aldershot Command. An active member of the Royal Automobile Club, he served for several years on its Races Committee, and as Timekeeper at the " Gordon Bennett " Motor Race in Ireland in 1903. Later, he was one of the supervising officials for the " Prince Henry Motor Tour "—a gathering of senior officers of both countries which traversed England and Germany in 1911. In his retirement he worked enthusiastically in his garden in such spare time as he found.

In the eyes of his comrades and friends, Stevenson possessed great qualities. " A big man in every sense of the word, he had patience, tolerance, wisdom and great commonsense." Possessed of outstanding ability, sound judgment and resource, he had a quick perception able rapidly to appreciate a situation. He could formulate a project with a few strokes of the pen or pencil, over which the less nimble-minded would take a long time. In mature years his knowledge and experience covered a great range of subjects, and he was quite at his ease among men of the highest professional attainment.

Stevenson possessed too an exceptionally agreeable temperament, which could hardly be disturbed into irritation or anxiety by any unforeseen or disagreeable events. In emergency he worked calmly and steadily to meet the situation. Nothing would rattle him; he could be relied upon implicitly in all circumstances and conditions. Apt to be deliberate at the outset, he would act very quickly, accurately and with determination. His cheeriness and composure in unpleasant circumstances were a great tonic to his companions. He revelled in personal close investigation of any engineering problem in the field. It was his habit to take off his coat to demonstrate how a difficulty—particularly a mechanical one—should be dealt with.

Among those associated with him this large-hearted man inspired genuine affection and respect. Never afraid to speak his mind, Stevenson could do so without giving offence; he created no jealousy and could harbour no resentment. A firm generous friend, while eager to help others he gave little thought for himself. His tastes were simple. He loved children and they came to him naturally. He liked to hear and to tell a good story.

Ill health overtook him over two years ago and his energy began to flag; further weakness ensued in January this year, and on 13th March this lovable and good soldier passed peacefully in his sleep at his own home.

(The compiler gratefully acknowledges the great assistance he has received from many correspondents.)

M.G.E.B-M.

MAJOR-GENERAL J. E. DICKIE, C.B., C.M.G.

JOHN ELFORD DICKIE was the eldest son of the late Colonel John Dickie, *J.P.*, of Titchfield House, Kilmarnock, who commanded the 1st Volunteer Battalion, Royal Scots Fusiliers. He was born at Kilmarnock on 26th April, 1856, and was educated at Kilmarnock Academy and afterwards in London. He was commissioned in the Corps from the Royal Military Academy on 17th February, 1875. After his courses at Chatham, he went at the end of 1877 to India, where he was to spend the rest of his service.

He was first employed in the Military Works at Roorkee, but on the outbreak of the Second Afghan War at the end of 1878, he went on active service with the Kandahar column, in charge of field telegraphs. When the first phase of the war ended, the Kandahar column remained in Southern Afghanistan during 1879; after hostilities had broken out again, Dickie was attached to the 4th Company, Bengal Sappers and Miners, with Sir Donald Stewart's force, that marched from Kandahar to Kabul and took part in the actions of Ahmad Khel and Saifndeen. He remained in Afghanistan as Superintendent of Telegraphs, 3rd Division (as Stewart's force had become), until the conclusion of the war, when he went back to Roorkee with the 4th Company. He received a mention in Despatches. In the summer of 1881, he went to Military Works at Poona, and thence to Meerut; but in 1882 he again went on service with the Indian Contingent to Egypt, as Superintendent of Telegraphs. He was present at Tel-el-Kebir. He was again mentioned in Despatches and received the Order of the Medjidie, 5th Class. He returned to India at the conclusion of the campaign and served in the Military Works at Chakrata and Ranikhet until December, 1895, when, now a Captain, he went once more on active service with the Burma Expeditionary Force as Superintendent of Telegraphs. He remained in Burma until the end of 1886, and then went back to Military Works, where he served at Jhansi, Ambala, Chakrata, Meerut and Lucknow; becoming C.R.E., Peshawar, in 1899. In 1900 he went as Field Engineer with the China Expeditionary Force, and was again mentioned in Despatches. He was promoted Lieut.-Colonel in 1901.

On return to India, after a short time at Meerut, he was in 1905 appointed C.R.E., North-Western Frontier Province, and Secretary to Government in the Public Works Department. In addition, when the divisional organization was introduced, he became C.R.E.,

Maj-Gen John Elford Dickie CB CMG

1st (Peshawar) Division. In this latter capacity, he took part in the Mohmand Expedition of 1908, being mentioned in Despatches and receiving the C.B. In February, 1911, he became Director-General of Military Works, with the temporary rank of Major-General, and held this appointment until April, 1913, when he retired.

During the Great War, he was re-employed in May, 1915, first in the Censor's Department, and later as Chief Engineer, London Defences. In May, 1917, he went to France on the Lines of Communications, and in 1918 was employed with the Independent Air Force in Eastern France, principally on the preparation of aerodromes. He was demobilized in September, 1919. For his services, he was again mentioned in Despatches and received the C.M.G.

After his retirement he settled down at Charlton Kings, near Cheltenham. He was awarded an Indian Good Service Pension in 1936.

In 1882, he married Mary, daughter of the late Major-General J. W. Welchman, C.B., who died in 1925, and by whom he had one son, Captain J. W. V. Dickie, who pre-deceased him; and in 1933, he was again married to Mdlle. Marie Maisonête.

An officer, who served under him, has recorded:—

General Dickie was of a very pleasing personality, good tempered, kindly, straightforward and a thorough gentleman; he had many friends and possibly not a single enemy.

He was hospitable but not of the self-advertising kind, and the writer has good cause to remember how, when he did a kindly act, he tried to gloss over and conceal it.

CORRESPONDENCE.

A GUIDE TO THE OLD TESTAMENT.

10, Menai View,
Bangor,
April 18th, 1939.

To the Editor of *The Royal Engineers Journal.*

SIR,

While the publication of a second review in *The R.E. Journal* to a book, namely *A Guide to the Old Testament*, p. 135 of the March issue, is surely a departure from precedent, no one will dispute the qualifications of the second reviewer to write on the archæology of the Holy Land.

As the writer of the first review, p. 645 of the December, 1938, number, I must, however, question the statement of the second reviewer that my criticism was "somewhat heavily coloured by the writer's own opinions."

My points were :—

1. That the explanation of the Old Testament to pupils is admittedly a difficult task.

2. That the author regards the present views of the higher critics as proved facts.

3. That he does not mention any of the numerous occasions on which the critics have been found to be in error.

4. That there is little or no reference to the recorded views of our Lord and the New Testament writers on the Old Testament.

5. That the New Testament is surely the best guide to the Old.

As regards 1 and 5, I presume that I am in agreement both with the author and the second reviewer.

Statements 2, 3 and 4 can be verified by perusal of the book. That the higher critics have made numerous mistakes is not an opinion, but a fact.

Yours faithfully,
F. C. MOLESWORTH.

SUMMARY OF TWO LECTURES.

Delivered on 16th and 20th February, 1939, at the Senate House of the University of London.

By MAJOR-GENERAL H. L. PRITCHARD, C.B., C.M.G., D.S.O., Colonel Commandant, Royal Engineers.

Title of Lecture No. 1 :—A.R.P. Organization and its Relation to Imperial Defence.

Title of Lecture No. 2 :—A.R.P. Organization.

LECTURE NO. 1.

This lecture would clear the ground for the second lecture. It would attempt to place A.R.P. organization in its proper setting within the general strategical conception of Imperial Defence. It was necessary to obtain a proper perspective before examining A.R.P. organization.

When the British Empire embarks upon war, it stakes more than any other first-class power. The structure of the scattered British Empire is very different from that of other powers. These small islands are the head and heart, the sea communications the arteries, the dominions and colonies the limbs.

If we are severed from our oversea connections and trade, these islands could not support one-quarter of their population. Only one thing is worse than war, *i.e.*, losing it. Loss of war would be, by Great Britain, irretrievable. We should suffer the fate of Carthage. We are an Empire or we are nothing.

The British Empire, from the nature of its structure, requires time to collect its great resources and strength and bring them into action. We must have some secure strategical framework on which to assemble, some pivots of manœuvre from which to develop and exert our strength.

This framework, these pivots rest on the Home Country, the territory of our Egyptian ally through which the Suez Canal passes, India, Malaya. These are linked by our sea communications, along which we have a chain of naval bases and harbours, Gibraltar, Malta, Alexandria, Port Said, Haifa, Aden, Bombay, Trincomali, Singapore. Also, in the past we have relied on the friendly neutrality of Spain and our alliance with Portugal. A cardinal feature of our strategy has always been the neutrality and security of Belgium and Holland, and, finally, our interests are now inextricably mingled with those of France, with whom we stand or fall.

Provided that the security of this framework is maintained in war, provided that the Navy, with the co-operation of the Army and Air Force, preserve a considerable degree of security on the sea communications radiating from these pivots, *then in time* we can bring to bear the whole strength and resources of the British Empire.

The time lag will be in direct proportion to our pre-war preparation, training and efficiency. The tempo of modern war has been greatly accelerated. We cannot afford the amount of time in which we indulged in the past.

Undoubtedly our opponents will select us as their Enemy No. 1. It is vitally important that we should parry the first hurricane blow directed from the air at our head and heart, particularly London. But this is not the only task. An Enemy has the means and the power to create simultaneously awkward situation elsewhere in the Empire. We cannot divide the war into phases and deal with each separately in the manner most convenient to ourselves. Introspection of our own plans, with the wish as

father to the thought, without consideration of the enemy's actions would be fatal to success.

Previous principles of Imperial strategy.

In the past, the only access to the British Empire was by sea. Science has caused the world to shrink. Railways, motor roads, aircraft, wireless have reduced time and space.

In the past, diplomacy arranged a strong coalition of allies, the Navy swept the seas and secured our Imperial strategical framework and blockaded the enemy in his ports. Then, having concentrated our resources, we co-operated with allies in striking hard on land, where decisions were obtained and the victory won.

Formerly, we supplemented our man-power by using our wealth to subsidize allies. Now, allies could only be attracted by the practical certainty of joining *the winning side*.

The world had now reached the stage of totalitarian preparation for war in peace, a procedure almost as expensive as war itself. It rapidly reduced the standard life of every member of a nation. Totalitarian preparation started too early might lead to revolution before challenging; totalitarian preparation started too late might involve totalitarian disaster and annihilation. Air power had brought civilians into the front line. Now it did not suffice to train only soldiers and sailors. It is necessary to train civilians to play their part.

Success cannot be expected from marshalling only a portion of our man-power, and that largely untrained, against totalitarian preparation and training and careful distribution of all resources to every branch of war effort.

The Lecturer then developed arguments for the necessity to strike a balance between defence and offence and the need for a delicate adjustment of all resources to the competing demands of the strategic conception, as applied to the whole Empire in proper proportion. In fact, balance and proportion should be the " slogan " in all preparation. Balance in our judgment, proportion in our action. No offensive of any sort was possible in the air, on the sea or on land, unless the production of our resources and the Imperial strategical framework and pivots of manœuvre were protected.

As a result of air power taking war into the third dimensions, civilians were now in the battle and defence of a line or lines must be supplemented by defence of *selected* areas behind.

The Lecturer estimated that in the last war three-quarters of the Empire's war effort emanated from these islands, and half of it from greater London. Our towns, with their complicated, concentrated system of life, were the best bombing targets in the world

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A sound military principle in defending a position was, not to dissipate resources but concentrate on defence of vital localities. We must now concentrate our defence upon those areas in towns where the sources of our national strength and essential services were situated and select for protection those people who maintain the national life and war effort.

Allotment of Resources.

The Lecturer gave a list of outstanding services in the nation, military, naval, aerial and civilian, competing for an allotment of resources to maintain the national war effort, in order to show the intricacy of the problem of making allotments proportional to the relative importance of each demand.

Again he repeated that balance and proportion were the secret of success and that this must be borne in mind when considering A.R.P. demands.

The Lecturer further cleared the ground for the second lecture by picking out the governing factors which create the conditions in which we have to maintain our war effort and the nation's life during air raids, which should therefore influence the formulation of our plans. He referred to the time to be expected for preparation, the time available for action when the emergency occurs, the scale and nature of

the attack, intensity, duration and frequency and consequent effect on warning, evacuation, protection and other items.

He reviewed our active defence by aircraft, guns, searchlights and balloon barrage, the possibility of interception of the enemy and the casualties inflicted upon him, the necessity to concentrate passive defence on target areas and the priority to be given to those engaged in national service.

Finally, the Lecturer emphasized that the whole object of A.R.P. was *not* to make war safe and comfortable for everyone, but to defeat the enemy's object, which was to paralyse our war effort and national life. Our object, therefore, must obviously be to *maintain our maximum war effort* and the *life of the nation* in spite of air raids, and *to win the war*.

LECTURE No. 2.

A.R.P. Organization.

The Lecturer provided the audience beforehand with a short printed pamphlet, which is reproduced on pp. 293–8 giving a concise précis of A.R.P. organization as it is to-day and as it may develop.

The Lecturer took this pamphlet as the basis of his lecture. He began by a brief résumé of the outstanding points brought out in his first lecture. He then emphasized the necessity for everyone in the country to be air-raid minded according to the degree of his responsibility, beginning with every Ministry of the Government, down through local Government organization, and the heads of all undertakings and business concerns, and finally the householder. It was necessary that every one of these authorities should create their air raid branch, to prepare for the emergency and to keep it in control when it occurred.

The Lecturer then announced his intention to—

(1) Give a brief résumé of work involved in A.R.P. as classified in the table.
(2) Give a brief résumé of the principles of organization before September, 1938.
(3) Deal with reorganization since September, 1938.
(4) Suggest probable further reorganization and tightening up.

His résumé of A.R.P. work under the 26 heads touched upon some of the many problems involved and gave a general idea of the magnitude of the work for which an organization was required.

He then drew attention to the seven classifications of types of work which should influence the distribution of duties in any organization. He pointed out that the work must be widely decentralized, and that 16 out of the 26 headings of A.R.P. services concerned subjects which the ministries of the central Government and all the local Government councils were accustomed to manage in normal times. Consequently, it was realized that if we could graft on to our normal system of Government, central and local, additional organization to cope with 10 more headings of work of a new but cognate type, then we should obviously avail ourselves of the stored up experience, training and customs, not only of the Government officials concerned, but of the general public, and especially of large undertakings who are accustomed to certain channels for dealing with the Government's organization.

Hence the decision to delegate responsibility for various headings of A.R.P. work to the Ministries usually concerned and to decentralize responsibility on to local Government Councils.

By throwing a portion of the expenditure on to the budgets of local Government authorities, a partnership was established to promote efficiency and financial examination of schemes.

At this point the Lecturer interpolated a brief résumé of the system of local Government organization in normal times, in order to make it clear what modifications were necessary to adapt this organization to A.R.P.

He then drew attention to the very large number of Government authorities, central and local, and commercial undertakings involved, how these worked with a great deal of independence and lack of co-operation, and how the chain of responsibility and distribution of duties was frequently disconnected and at other places knotted. He also referred to the large expenditure of time required for discussion of proposals, by councils, of large numbers and by Committees in time of peace, and the amount of apparently unavoidable reference to higher authority and back again.

However necessary and desirable this procedure might be in peace, it was a menace to an organization required to prepare for war with great rapidity and to function promptly during war.

Here then, we have one of the main causes of the delay in preparation of A.R.P., so that it was not until March, 1937, that Parliament passed the A.R.P. act, and not until July, 1938, that the Fire Brigade Act was passed. These Acts only enabled work to be undertaken, but the inertia of the machine delayed accomplishment.

The crisis of September, 1938, threw a floodlight on the situation. It revealed the necessity for a much more definite system of control, much clearer chain of responsibility and distributions of duties down to the smallest units, for more rapid decisions at the top and decentralization of authority to give decisions and approval to the lower grades of the hierarchy.

It also disclosed the necessity for much larger and more experienced whole-time paid staff, both in the upper and the subordinate grades, to reinforce every part of the organization, central and local.

Columns 6 and 7 of the printed table gave a brief précis of the valuable reorganization work done in these lines by Sir John Anderson since September last.

The Lecturer referred to some points in this reorganization, the Regional Commissioners and their staffs, Regional Inspectors, the groupings of A.R.P. work for the whole of Greater London under one control, the co-ordination by Chief Constables of the work of the separate organization of Air Raid Wardens with the work of the Police. The reinforcement and co-ordination of Fire Brigades and of Rescue Parties, responsibility for all medical services under the Ministry of Health, traffic control, decisions as to policy for protection, etc.

The last two pages of the printed pamphlet endeavoured to indicate the new reinforcement and reorganization proposals already ordered and the Lecturer had ventured to incorporate therein some suggestions for reinforcement, reorganization and tightening up of the chain of responsibility and distribution of duties based upon the seven different types of work and grafted into the existing organization.

In particular, he stressed the necessity for the co-ordination of the work of the A.R.P. branches of 10 different ministries. It was this valuable co-ordination which Sir John Anderson was doing and it should be regularized and established by the creation of a Ministry of Civil Defence, organized in seven directorates corresponding to the different types of A.R.P. work, *i.e.*, Administration, Police, Engineering, Fire, Medical, Postal, Stores and Equipment, plus a Finance Department.

He stressed the necessity for a strong and influential engineering organization at the Ministry and in Regional and local councils, to get the engineering profession and the building trades on to the work of protection in target areas.

Summing up, we may say that reorganization required strong reinforcement of all grades of expert whole-time paid staff in every part of the hierarchy, rapid decisions at the top, such as Sir John Anderson was giving, decentralization of financial control and authority to approve and order, power delegated to small selected executive sub-committees of councils, organization on the lines of the seven types of work at headquarters and in local Government offices.

Co-ordination and co-operation everywhere, and notably by the establishment of a new Ministry of Civil Defence as outlined in the last page of the printed pamphlet.

1 Item	2 Headings of A.R.P. Services.	3 Classification of Types of Work.	4 Central Government Ministries concerned in Normal Times.	5 Local Authorities normally concerned.	6 Central Government Ministries concerned in Preparation for War.	7 Local Authorities concerned in Preparation for War.
1	Evacuation	A. General Administration	Not Normal	Not Normal	Health Education Transport	L.C.C. Metro. Borough Councils County Borough Councils Borough Councils Urban District Councils Rural District Councils Railway Companies Road Transport Users
2	Warning	G.P.O. P. Police	Not Normal	Not Normal	Air Ministry G.P.O. Home Office	Observer Corps G.P.O. Local Metropolitan and County and Borough Police
3	Camouflage and Lighting Control	E. Engineering Administration and Liaison P. Police	Not Normal	Not Normal	Home Office	Engineers of Metro. Boroughs and County and Borough and District Councils Metropolitan and County and Borough Police
4	Intelligence	P.	Home Office	Police of Local Governments	Air Ministry Home Office	Observer Corps Police of Local Govts. Air Raid Wardens
	Essential Services (Items 5A to 5L)					
5A	Postal, Telephone and Telegraph Services	G.P.O.	G.P.O.	G.P.O. Local Staff	As in Col. 4	G.P.O. Local Staff
5B	Water Supply	E. Engineering Administration and Liaison	Health	Municipal Undertakings, Metro. Water Board, Local Water Coys.	As in Col. 4	As in Col. 5
5C	Drainage	E.	Health	All Local Govt. Councils, Thames Conservancy and Special Drainage Boards	As in Col. 4	As in Col. 5
5D	Electric Light and Power	E.	Transport advised by Electricity Commissioners	Central Electricity Board (Grid), Municipal Undertakings, Commercial Electric Coys.	As in Col. 4	As in Col. 5

1 Item	2 Headings of A.R.P. Services.	3 Classification of Types of Work.	4 Central Government Ministries concerned in Normal Times.	5 Local Authorities normally concerned.	6 Central Government Ministries concerned in Preparation for War.	7 Local Authorities concerned in Preparation for War.
5E	Gas Supply	E.	Board of Trade assisted by the Gas Council of the Industry	Municipal Undertakings, Commercial Coys., *e.g.*, Gas, Light and Coke Coy.	As in Col. 4	As in Col. 5
5F	Petrol Supply	A. and E.	Board of Trade Transport advised by a Committee	Commercial Oil Coys. and Motor Industry	As in Col. 4	Traffic Commissioners. Regional and District Transport Officers. Groups of Users. Commercial Oil Coys. Motor Industry
5G	Railways	A.	Transport	Railway Coys.	As in Col. 4	As in Col. 5
5H	Road and Bridge Maintenance	E.	Transport	L.C.C., Common Council of City of London, Metro. Borough Councils, County, Borough and District Councils	As in Col. 4	As in Col. 5
5I	Road Transport	A. and E.	Transport	Municipal Transport, Commercial Transport Companies, *e.g.*, L.P.T.B., Private Users	As in Col. 4	See opposite Item 5F
5J	Traffic Control	P.	Home Office Transport	Police, Metro. and of City of London and of Counties and Boroughs	As in Col. 4	As in Col. 5, plus Special Constables
5K	Mercantile Marine Ports, Docks	A.	Admiralty Board of Trade	Shipping Industry, Port of London Authority and other Harbour Boards	As in Col. 4	As in Col. 5
5L	Food Supply and Distribution	A.	Board of Trade	Trade Organizations and Food Storage Coys.	Board of Trade Transport	Food Dept. of Ministry Trade Organizations See also opposite Items 5F and 5G

1 Item	2 Headings of A.R.P. Services.	3 Classification of Types of Work.	4 Central Government Ministries concerned in Normal Times.	5 Local Authorities normally concerned.	6 Central Government Ministries concerned in Preparation for War.	7 Local Authorities concerned in Preparation for War.
6.	Police Duties	P.	Home Office	Police, Metro. and of City of London and of Counties, Boroughs and Districts	As in Col. 4	As in Col. 5, plus Special Constables
	Protection (Items 7A to 7H)					
7A	Protection against High Explosive	E.	Not Normal	Not Normal	Home Office advised by Engineers, Office of Works	All Local Govt. Authorities, all large Undertakings and Industrial and Business Concerns, Householders
7B	Protection against Fire	F. Fire Bde. Organization	Home Office	Independent Fire Brigades of L.C.C., City of London, Metro. Boroughs and of Boroughs in Provinces	Home Office, Central Advisory Council and Fire Service Commission	Fire Inspectors, specially appointed Fire Boards, Group of all Fire Brigades in London Metro. Police Area, Fire Brigades of every Borough and District in Provinces in co-operation under Local Govt. Authorities, Fire Brigades of all large Undertakings and Industrial and Business Concerns, Householders
7C	Protection against Toxic Gas	M. Medical	Not Normal	Not Normal	Home Office, Health, Transport (for Decontamination of Roads and Vehicles)	See opposite Item 7A
8	Rescue Work	E.	Not Normal	Not Normal	Home Office advised by Engineers	See against Item 7A In London County under L.C.C.
9	Provision and Distribution of Stores and Equipment	A., E. and M.	Not Normal	Not Normal	Home Office	Only partially organized responsibility as against Item 7A
10	Medical Services, First Aid and Decontamination, Ambulance Transport, Casualty Clearing Stations, Hospitals, Doctors, Nurses, Medical Stores and Equipment	M. and A.	Health	Medical Officers of Health of L.C.C., of City of London, of Metro. Boroughs, Counties, Boroughs and Districts	Health Transport	As in Col. 5, also of large Undertakings and Industrial and Business Concerns, Railway Coys. and Road Transport Agencies

1 Item	2 Headings of A.R.P. Services.	3 Classification of Types of Work.	4 Central Government Ministries concerned in Normal Times.	5 Local Authorities normally concerned.	6 Central Government Ministries concerned in Preparation for War.	7 Local Authorities concerned in Preparation for War.
11	Research and Experiment	E. and M.	Not Normal for A.R.P.	Not Normal for A.R.P.	Health, Home Office in Liaison with Engineers and Scientists	Not a Local Service
12	Emergency Education of Children during War	A.	Not Normal	Not Normal	Education	L.C.C., Councils of all Local Govt. Authorities and Religious Authorities
13	Education, Training and Control of the Public in A.R.P.	P. and M.	Not Normal	Not Normal	Home Office Inspector General A.R.P. Health Ministry	38 Regional Inspectors, A.R.P., Commissioner of Metro. Police, Chief Constable sof City of London and of Counties, Boroughs and Districts, Special Constables and Air Raid Wardens, A.R.P. Organizers, Medical Officers of Health in Metro. Police Area of London and of City of London and of all Counties, Boroughs and Districts. Red Cross Society, St. John Ambulance Organization

Total number of classifications of work, seven—

i.e., A., General Administration. G.P.O., General Post Office. E., Engineering. F., Fire Service. M., Medical. P., Police; also Children's Education.

Total number of Ministries concerned, ten—

i.e., Home Office, Health, Transport, G.P.O., Board of Trade, Treasury, Education, Admiralty, Air Ministry, Office of Works.

REINFORCEMENT OF LOCAL GOVERNMENT ORGANIZATION

To provide following Organization in every County, Borough, or District Council outside the Metropolitan Police Area of London.

Civil Defence Sub-Committee of Council.

A Member of the Council (or nominated Person) to be Chief Co-ordinating Officer ..... Already sanctioned.
Chairman of the Council's Finance Committee ..... Already exists.
A selected Member of the Council ..... " "

Executive Officers (all paid) under the Orders of the Chief Co-ordinating Officer.
A.R.P. Staff Officer ..... Already exists.
Clerk of the Council for Civil Defence (additional to existing Clerk).
Engineer for Engineering Administration and Liaison (may be the existing Surveyor if another Surveyor appointed under him).

EXECUTIVE OFFICERS—*cont.*

Chief Constable ..... Already exists.
Assisted by Chief Special Constable and by Chief of Air-Raid Wardens ..... Both already exist unpaid.
Officer for Fire Services.
Medical Officer of Health ..... Already exists.
Education Officer ..... " "
Manager of Stores and Equipment.

Reinforcement by a strong *paid subordinate staff* for all the above officials, and proper office accommodation.

GREATER LONDON REORGANIZATION.

i.e., Within the Boundary of the Metropolitan Police Area.

Civil Defence Sub-Committee of Local Authorities, *consisting of* :—

2 Selected Members of the L.C.C.
1 " " " " Common Council of the City.
3 " " " " Standing Joint Committee of Metropolitan Boroughs.
A Selected Chairman and Co-ordinating Officer.
Total of Sub-Committee, seven.

Under the Orders of the Co-ordinating Officer, the following whole-time paid Officers :—

An Officer for Organization and Administration.
A Financial Officer.
The Commissioner of Metropolitan Police, assisted by the Chief of Special Constables and the Chief of Air Wardens.
Officers for Engineering, Fire, Medical, Educational and Stores Duties as with Provincial Councils.

SUGGESTED ORGANIZATION OF A NEW MINISTRY OF CIVIL DEFENCE.

DUTIES to co-ordinate the work of the A.R.P. Branches in each of the ten Ministries concerned.
Responsibility for the standard and readiness of Civil Defence throughout the Country.
To consolidate the Civil Defence Estimates submitted by each of the ten Ministries, to present them to Parliament and to allocate the Expenditure.

ORGANIZATION AT HEADQUARTERS OF MINISTRY.

The Minister.

Under Secretary of State.

Permanent Under Secretary of State.

Director of Organization and Administration Director of Finance Director of Police Director of Engineering Director of Fire Services Director of Medical Services Director for Postal Services Director of Stores and Equipment	Eight Directors in liaison with A.R.P. Branch in each Ministry concerned. Each Director responsible to the Minister for his section of the above defined duties.

FOR LONDON AND THE PROVINCES.

Regional Commissioner for London Metropolitan Police Area	(already announced)
Nine ,, ,, ,, England, excluding London	,, ,,
One ,, ,, ,, Scotland	,, ,,
One ,, ,, ,, Wales	,, ,,
One Representative from each of the ten Ministries concerned on the Staff of each Regional Commissioner	,, ,,
A Regional Inspector on each Regional Staff, with District Inspectors under them	(already exist)
District Inspectors for Fire Services	(already announced)
,, ,, ,, Engineering.	
,, ,, ,, Medical Services.	
,, ,, ,, Stores and Equipment.	

All Reviews of Books on military subjects are included in the provisions of K.R. 535c (*1935*).

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

BEHIND THE LINES.

By Colonel W. N. Nicholson, C.M.G., D.S.O.

(Jonathan Cape. Price 10s. 6d.)

This is an amusing and instructive book. Col. Nicholson was posted to the 51st Highland Division, as D.A.A. and Q.M.G., on mobilization in 1914 and he watched its teething troubles when concentrated at Bedford. The personnel of the Division was magnificent but Colonel Nicholson does not disguise the fact that for several months the Division was unfit to take the field. Not only through lack of proper equipment but owing chiefly to the inexperience of officers and N.C.O's, especially in all matters affecting administration, and discipline in its fullest sense. Regular adjutants, on whom units had leaned, had been withdrawn and the first commander of the Division was hardly the man to deal with the situation. Under "Uncle" Harper's command, and as experience was gained in France, the Division found itself and became, as we know, one of the very best. Looking at the picture Colonel Nicholson paints, one naturally asks, "now that Territorial Divisions have become part of the 1st Line Strategic Reserve, how soon could they be used"? Of course many steps have been, or are being taken to remove the obstacles to progress that existed in 1914 and there is still part of the fund of experience gained in the war available. It is to be hoped, however, that Territorial officers and the staff will read this book to remind themselves of points of weakness which annual camps do not reveal.

In 1916, the author became Chief of the Q Staff in the 17th Division and in 1918 joined the staff of a corps, which he calls a bad one. His comment on the way the various staffs, with whom he worked, lived and how they functioned are interesting and instructive. We are not given a textbook on the Administrative Staff System but we are shown how a staff officer with imagination, and a determination to get things done, can alleviate the hardships of the fighting soldier and help to maintain his morale.

Some of Colonel Nicholson's criticisms are caustic enough, but they are never offensive. I should certainly advise young staff officers to take note of them.

C.W.G.

GAS IN THE NEXT WAR.

By Major-General Sir Henry Thuillier, K.C.B., C.M.G., D.S.O.

(Geoffrey Bles. Price 5s.)

Sir Henry Thuillier's book is the fifth in "the Next War" series, which is being edited by Captain Liddell Hart. The first four of the series were uneven in quality but included two excellent volumes. Sir Henry Thuillier's book is as good or better than the best of its predecessors.

The series is published with the object of giving the public an idea of the probabilities of a future war. This volume, like its predecessors, is short and non-technical

—a book which could be read in a couple of hours. But though it is designed for the non-military public, there are few soldiers who would not find in it both profit and interest.

Too high a proportion of the many writers who, during the past few years, have published their views on gas as a weapon of war have put forward opinions unbacked by knowledge or experience. The author of the present volume has made full use of his unique experience to present a balanced view of a subject which has suffered through being material of which sensation can be made.

Eight short chapters give a straightforward account of the use of gas during the three and a half years between the first German gas attack in the Spring of 1915 and the Armistice, which just forestalled our use of "DM" smoke clouds, from which striking and important results were anticipated. Simply and clearly told, this part of the book constitutes the main evidence upon which are based the author's subsequent conclusions on the value of gas as a weapon of war, its humanity, the prospects of its abolition and the strategy of its employment.

Sir Henry Thuillier then deals firmly and sanely with aspects of his subject upon which popular misconceptions are apt to prevail. He explains how improbable is the discovery of some unknown and devastating war gas. He analyses the facts about gas casualties and shows that, for barbarism, gas cannot compete with high explosive. On the one hand, he allays the fears of those who imagine that "one gas bomb dropped "at Piccadilly Circus would kill every living creature from Chiswick to Blackfriars" and, on the other, shows how mustard gas sprayed from low-flying aircraft may, under favourable conditions, be most effective and the wearing of gas masks most lowering to efficiency. He argues most convincingly that international agreements against the use of gas are no more likely to be kept than international agreements restricting any other method of warfare.

The sense of balance which pervades the whole book finds final expression in the concluding paragraph ". . . we may hope that gas may not be employed in the "next war, but must be absolutely prepared for the probable contingency that it will. "If it is, there will be no need to panic. Discipline, courage and well-conceived measures "of defence will certainly prevent it from bringing about any decisive success, or "even any large measure of death or suffering."

R.H.D.

LONCIN.

By COLONEL NAESSENS and L. LOMBARD.

(Verviers, G. Leens. Price 3 francs.)

Loncin is a full account, with plans, of the defence of Fort Loncin, the last of the Liége forts to be captured by the Germans in August, 1914. Colonel Naessens was its commandant. Much has been written about Forts Vaux and Douaumont at Verdun, but the story of Fort Loncin deserves to be known and remembered; for it carried on an active defence, refused to surrender, and finally, after ten days, was destroyed by a 16-inch shell penetrating to the magazine.

The fort, built in 1888, to General Brialmont's design, was on the western side of Liége, covering the Brussels road; it was triangular in trace, with a central mass of un-reinforced concrete covering its casemates and magazines; mounted two 8-inch, one 6-inch and two 4·7-inch guns in cupolas, and had four 2·28 Q.F. guns for defence of the gorge and ditches. Its war garrison was 350 artillerymen and 200 infantrymen, and a small permanent staff.

The mobilization of the fort and the clearing of the foreground were begun on the 1st August, and the first incident was the capture of a German, a merchant of Liége, who was detected reconnoitring the fort—it may be added that a German officer confessed in a Belgian hospital that the maps of Belgium had been kept up to date by the use of cyclists.

When the town and citadel of Liége were captured on the 6th August—General Leman, the commander of the fortress taking refuge in Fort Loncin—the fort become exposed to attack from the gorge, for which it was not prepared. Commandant Naessens placed observation parties outside, and with other small parties harried the Germans night and day. One party in a car, carrying orders from General Leman to the other forts, passed through Liége with all its lights on and was not stopped. Colonel Naessens declined to listen to invitations to surrender made by German *parlementaires*, under threat of vengeance being wrecked on the town. Thanks to the observation parties, the guns of the fort dealt with and silenced the 4·2-inch gun and 8-inch howitzers brought against it, although nearly asphyxiated through the ventilator system in the fort breaking down. But at 4 p.m. on the 15th, 16-inch howitzers opened fire; the fourth shell hit the fort, and was followed by a shell every four minutes until 5.45 p.m., when one of them penetrated the magazines containing 12,000 kg. of explosive, and demolished the whole central concrete nucleus. The German infantry then advanced and took possession. Forty of the garrison managed to escape and rejoin the Belgian Army; seventy-nine were so badly wounded that the German medical officers proposed to shorten their agony by cutting their throats. General Leman and Colonel Naessens recovered from their injuries.

There is a short sketch of the career of the latter, who rose from the ranks, and was over fifty in August, 1914, having been born 29th February, 1864. The energy of the defence seems to have been due to him and his influence over his men. It is pleasant to read the General von Einem was very courteous to the prisoners and praised them for their determined resistance.

J.E.E.

A SHORT OUTLINE OF MODERN TACTICS.

By Brigadier-General A. B. Beauman, C.B.E., D.S.O.

(Hugh Ress, Ltd. Price, 3s. 6d.)

The author says in his foreword to this book that it is not intended to be an extensive treatise, but it merely attempts to outline to what extent the latest developments in armaments and doctrine are likely to influence future warfare.

So many of the weapons which have been introduced or developed since the last war have not been used in large scale operations, so their method of employment must be to a large extent based on conjecture. The author has quoted many cases of the use of new weapons, both in Spain and Abyssinia, and drawn valuable lessons from them, but, as he quite rightly points out, the weapons were used either in limited numbers or were of doubtful efficiency and in many cases employed against an ill-equipped enemy.

The book sets out concisely and simply the tactical problems that arise as a result of modern equipment and organization and suggests solutions to them on broad lines, and shows very clearly the modifications that have been imposed on the principles, as present laid down, in the Training Manuals. Read in conjunction with these manuals, this book should be of great value.

E.C.P.

ADMINISTRATIVE ASPECT OF OPERATIONS, STAFF DUTIES AND TRAINING.

By Lieut.-Colonel J. G. Elliott, *p.s.c.*

(Sifton Praed & Co., Ltd. Price 4s. 3d. post free.)

This is an intelligently-written little book of some seventy small pages.

It is really a guide to the administrative staff officer, particularly in his dealings with other branches and departments, and is in no sense a detailed exposition of administration. There are no new ideas, but the author has combined the purely

technical and the more psychological aspects of the tasks of the administrative staff officer in a particularly happy way. He shows the importance of the close touch between Q and G, and in particular, between Q and I, a touch too often forgotten; in which connection he aptly quotes Sir Hastings Anderson's remark that "if G want to walk a hundred yards, Q have to run a mile." He deals also with the general problems of administration ahead of rail-head and in the organization and working of the Lines of Communication.

Lastly, he has a valuable chapter on training in which he stresses the great importance of training, administratively as well as tactically.

It is a useful little book from which all staff officers could obtain value.

H.G.E.

PASSAGE DE LA MEUSE PAR LA 163E DIVISION.

By COL. A. GRASSET.

Editor: *Berger-Levrault.*

This book has been presented to the Institution of Royal Engineers by the author. The operation of forcing the crossing of the Meuse took place in the last few days of the war. Neither the French nor the German divisions concerned had a rifle strength of more than one-third of establishment, though the artillery had their full complement of guns; and the French had the further disadvantage of advancing over a zone where all communications had been obstructed; the only bridging equipment with the 163rd Division was waterproofed bags from which light rafts could be constructed. It was known also that the Armistice was in prospect.

Nevertheless, when the forward infantry and engineers reached the south bank on the evening of the 8th November, they immediately, in anticipation of orders, commenced reconnaissance for a crossing. The river was 90 yards across, in flood and icy cold. All boats had been removed and the bridges and a weir across the river demolished; there was little material in the villages; but the demolitions had left the bridge girders and the steel framework of the weir lying in tangled masses in the stream. November 9th opened with mist which assisted further reconnaissance, and when, in the afternoon, the division received orders from the Higher Command (who feared that the Germans, feeling safe behind the Meuse, would refuse the Armistice terms) to force a crossing, a plan was ready.

When night fell and the fog had thickened, the Germans, feeling secure for the night, withdrew many of their posts on the bank to the higher ground; those that remained were not very alert, though there was intermittent machine-gun fire. During the night, the Sappers, completely hidden but in very difficult working conditions, got footways of planks across the ruins of the weir and one of the bridges; and also established two raft ferries. The leading infantry rushed the remaining posts, and in the early morning, three battalions (one out of another division, which had got into the area through a curious lack of *liaison*) got across on the left, only to find advance impossible owing to natural obstacles and an awakened enemy; on the right, a complete regiment of three battalions crossed and, advancing obliquely towards their right, penetrated over a mile before the lifting of the fog at 10 a.m. on the 10th discovered them, in a series of isolated companies, bumping into the astonished Germans on the higher ground. These Germans, however, were the remnants of the Prussian Guard. Their artillery quickly made communication across the river an impossibility, while the position was too confused for the French artillery to give effective support, and skilful counter-attacks recovered much of the lost ground; but at nightfall, the French still held an effective bridgehead of about half a mile radius. On the left, the three battalions who had crossed, pinned down within very narrow limits, failed to advance but held their ground. All attempts by the Sappers to renew the communications failed.

During the night, news of the signing of the Armistice arrived and put an end to the operation; though fighting went on until 11 a.m. The Sappers had re-established footways during the night, proper bridging equipment was at hand, and the French artillery would now be able to take an effective part. Had the operations continued, there can be little doubt that the division would have been able to make the crossing secure.

From the engineer point of view, the lessons seem to be the value of early reconnaissance, that enterprising troops will find a way across the most formidable obstacles, and that to stop such troops demolitions must be very complete. The advantages and disadvantages of fog at a river crossing are also well illustrated.

The narrative of the three days, which after a lapse of twenty years must have required great research, is extraordinarily vivid, and the book is very well worth reading.

E.V.B.

AN OUTLINE OF FORESTRY.

By THOMAS THOMSON, M.SC., and M. R. K. JERRAM, M.C.

(Thomas Murby & Co. Price 7s. 6d.)

The preface to this eminently readable as well as practical book states that it is intended not only for students, but for the interested layman as well, in which category we must include R.E. officers, all of whom are concerned with the using of wood, and most of whom, at some portion of their career, have to plant, tend and fell trees.

An early chapter, perhaps the most interesting of the whole, describes the life and growth of a tree. Its reactions to its environment—soil, temperature, wind and so forth—as described, almost make one credit it with intelligence of a high order. Thus, the diameter of a spruce, whose crown is exposed to regular wind pressure, measures $\sqrt[3]{Cx}$, where C is a constant, and x the vertical distance between the C.G. of the crown and the point at which the diameter is measured. If the tree is given more room, and the wind pressure consequently becomes greater, the thickening of the stem proceeds faster in the lower part than above. In this and all similar cases, the tree's reactions are, of course, mechanical, but the author is careful to state that the processes by which it does so are by no means fully understood.

We can all pick up useful hints from the chapters dealing with planting, felling and mensuration; but it is probably from those parts of the book dealing with management and the tending of woods that we can learn most, since we have the same problems in afforested catchment areas, and among roadside trees. It is true that the forester looks mainly to the ultimate sale value of his trees, and that we can hardly be expected to feel the same enthusiasm for distant future profit to the Treasury, yet pride in our jobs, and the obvious advantages of having our wooded areas in good condition, ought to make us devote to them more attention than we usually do. The layman is little conscious of the unceasing war which the forester wages against the natural enemies of his trees, frost, weeds and rodents in early stages, insects, fungi and many kinds of birds later on. An incentive to sound wood-management ought to be the knowledge that tree ailments, if not checked on our side of the fence, may spread to, damage and even destroy, our neighbours' property.

It hardly needs emphasis that in the U.K. we are badly off as regards forests. At the outbreak of the Great War, only 4·3 per cent of our land area was under forest and most of that was privately owned. As a result of war experiences, it was decided to plant 1,770,000 acres of conifers and 100,000 acres of hardwoods, enough, when mature, to enable us to carry on through three years of emergency. The programme is steadily being carried out.

Our military textbooks often confront the reader with a depressing list of definitions at the very start. In that respect, we might well copy the method adopted in this book of placing a glossary at the end, with full explanation and references to the text. This largely makes up for the absence of an index, which might conveniently find a place in a second edition.

F.C.M.

GREAT ENGINEERS.

By PROFESSOR C. MATSCHOSS.

Translated by DR. H. STAFFORD HATFIELD.

(London. G. Bell and Sons, Ltd. 1939. Price, 12s. 6d.)

The author has attempted to show the development of engineering from the earliest times to the beginning of this century in the form of a series of brief biographies of representative eminent engineers. Besides describing their actual achievements, stress is laid upon the human side of their lives, on their personalities, and the vicissitudes through which they passed before ultimate success.

The book has 44 illustrations and is divided into three parts :—

I—THE GREAT ENGINEERS OF ANTIQUITY.

As it was not considered necessary to enter their names in the book of history alongside those of princes, kings, statesmen and generals, little is known of engineers of early days.

The author pays tribute to those who have contributed to the beginnings of civilization and deals shortly with the Chinese engineer "Yu," who afterwards became Emperor of China, and with the great Egyptian engineers.

Among the engineers of classical antiquity he gives brief accounts of Mandrocles, who built a bridge of boats across the Hellespont over which Darius invaded Europe, of Pythagoras and Archimedes, of Philo, the inventor of the magazine bow and arrow, of Vitruvius and Hero.

Vitruvius required his young engineers to have the following qualifications " possess not only natural gifts, but also keenness to learn, for neither genius without knowledge, nor knowledge without genius suffices for the complete artist. He must be ready with a pen, skilled in drawing, trained in geometry, not ignorant of optics, acquainted with arithmetic, learned in history, diligent in listening to philosophers, understand music, must have some knowledge of medicine and of law and must have studied the stars and the courses of the heavenly bodies."

He also stresses the necessity for practical experience.

All the present-day qualifications of a Royal Engineer officer !

II—FROM THE FALL OF THE ROMAN EMPIRE TO THE DEVELOPMENT OF MODERN TECHNOLOGY IN THE EIGHTEENTH CENTURY.

In this period, war and Church were the main clients, and engineers were concerned in the building of cathedrals, development of guns and printing machines, etc.

Amongst others are found in this section Leonardo da Vinci, the most versatile engineer and inventor in this period, Georgius Agricola, the great mining engineer, and von Guericke, the inventor of the air pump and electric machine.

III—GREAT MODERN ENGINEERS.

In this section the author deals with the engineers responsible for development of electrical and mechanical engineering, such as James Watt, Robert Fulton, George and Robert Stevenson, Richard Trevithick, Alfred Krupp, Henry Bessemer, Werner

von Siemens, N. A. Otto, Rudolf Diesel, C. A. Parsons, T. A. Edison and George Westinghouse.

The number of engineers that can be dealt with in one volume is limited, and, in particular, the author apologizes for the omission of the great civil engineers who built roads, canals, bridges and tunnels. He expresses the hope that these will be dealt with in a later volume.

An appendix is given of the sources of information, to enable a reader to amplify his knowledge if required.

This book should appeal to all those who in the words of the author are "lovers of technical achievements and of the men responsible for them, who show by their lives that great deeds are brought about by ideals, which are far beyond the mere material valuation of technical work."

A.W.S.

L'ÉDUCATION TECHNIQUE EN FRANCE AU DIX-HUITIÉME SIÉCLE. (1700–1789.)

By FREDERICK B. ARTZ.

This pamphlet is a reprint from the *Revue d'Histoire Moderne* (*Sept.–Dec.*, 1938.) It has an interest for military readers, as it devotes considerable space to an account of the development of military schools in France during the eighteenth century. The other three chapters deal with the progress of teaching in the primary and secondary schools of France, with the establishment of schools of civil engineering, and lastly, with naval education.

It was a period which saw a marked development of teaching and science in England too, and many references are made to John Locke. Great stress was laid on the importance of practical teaching; Locke's views were taken up by men like Rousseau, La Chalotais, Diderot and Condorcet, all of whom pressed for the practical training rather than the theoretical. The increasing use of mechanical contrivances for military purposes gave rise to a definite advance in higher technical education. The term "engineer," first applied in the army, became familiar in civil life; the builders of roads, canals, and bridges were beginning to be recognized as "engineers." The department of the Ponts et Chaussées was instituted in 1716, and quickly developed to include map-making and mines. Several engineering schools sprang from the Ponts et Chaussées, and created a body of young engineers whose enthusiasm spread itself throughout the country.

In the army, the progress was equally significant; indeed, the author remarks that "the victories of the French Armies in the wars of the Revolution and the Empire were not due to the sudden changes which followed the fall of the old regime, but to the improvement in organization and formation of the Royal military forces during the second half of the eighteenth century."

The establishment of cadet schools under Louis XIV produced marked improvements over the system of training young boys in the regiments; they were really too young to be brought up in the rough life of the barracks. Louis XV continued his predecessor's work and formed in 1751 the Royal Military School at Vincennes. Only sons of noble houses were eligible for entry, until the Revolution opened the officer's career to all who showed the necessary aptitude. Other schools rapidly followed, notably the Cavalry School at Saumur, founded in 1771. There had been others before that at Metz, Douai, Angers and Besançon. The School of Military Engineering at Mézières had been established in 1748, and its technical teaching had already reached the highest standard in Europe. Monge, the father of graphic solutions, taught at Mézières; he must have found his system of particular value to the young military aspirants.

The Navy, too, shared in this expansion of practical teaching. A school for the young sons of impoverished nobles was established at Rochefort in 1771, and followed by others at Brest, Toulon and Le Havre. The practical courses spread. The whole science of engineering was carried forward by this movement. The impetus was greater in France than anywhere else; the history of the French Army is a long record of the advancement of military science.

W.H.K.

YOUTH OF YESTERYEAR.

By ION S. MUNRO.

(Wm. Hodge and Co., Ltd. Price 2s. 6d.)

As a record of the effort that was made by Glasgow, this book has its value; particularly the first chapter, which brings out clearly the gap that existed after the regular forces went overseas, leaving few reserves and no formations to fall back on. Training of raw recruits involved 6 months to a year and this gap was filled by the Territorial Force.

The filling of this gap would have been better brought out in the book if it had recognized more truthfully the semi-preparedness that was so forcibly put by Mr. Lloyd George in his speech in the Commons on 8th May, 1939.

The cost of sending semi-trained troops overseas was very heavy but, in spite of that cost, they filled the gap and made it possible for other troops to be trained. All the more credit to them that they had given of their time and energies in peace-time to prepare themselves to defend their country. And again we are in the same position and, if we had been faced with war or should we be faced with war within the next 8 months, the same position will again arise and it is the Territorials that will have to fill the gap.

The Introduction brings out well this spirit of National Service but this might have been better embodied with the closing paragraph, the Phantom Column, into a final chapter that would have pointed the way to the youth of to-day.

The opening chapter is good and describes well the service that the T.A. gave to the country when no one else was ready or prepared.

The value of the succeeding chapters would have been greatly enhanced if they had included more vivid sketches that would have helped the youth of to-day to visualize war as it was; it is too largely a chronicle of events, perhaps inevitable in so short a summary. Perhaps too it could have pointed the way to a more full probing into history by giving references to places where the enquiring mind could have followed up.

There is little in the book that paints a picture that would help the youth of to-day to visualize the physical hardships, the thirsty heat of the East, the stunning effect of the intense bombardment, the élan of the attack, the long monotony of the intervening periods, even the monkey-like search for lice as the only relief to that monotony and the nerve strain of waiting, never knowing what would happen and the feeling that it engendered of "Sufficient unto the day is the evil thereof . . . ."

The best chapters are perhaps those which deal with the 5th Scottish Rifles and the Glasgow Highlanders; and by separating the arms, the book, although it pays lip service to co-operation, fails to bring out to the full the team spirit that pervaded divisions such as the 51st and the 52nd.

G. de C.E.F.

MAGAZINES.

CIVIL ENGINEERING MAGAZINES.

Publication.	*Date of Issue.*	*Article.*
Roads and Road Construction.	May, 1939.	"The Crawley By-Pass Road." This article gives an excellent description of a modern concrete road now in the making, including the latest types of concrete vibratory machines.
Concrete and Constructional Engineering.	May, 1939.	"'Vacuum' Concrete." Describing an American method of extracting water from newly-laid concrete (mixed very wet for workability) so as to reduce the water-cement ratio.

THE MILITARY ENGINEER.

(*January–February*, 1939.) *After Munich, What?* An Armistice Day Reverie, 1938. G. A. Roush.

An outspoken article, written on the conclusion of the Munich Agreement, 1938. As events have moved quickly since then, interest is only roused, as it is probably an expression of what is general American feeling on the European situation.

Earth Movement at Fort Peck Dam. James J. Halloran.

On 22nd September, 1939, a large landslide occurred during the construction of the Fort Peck Dam on the Missouri River. About 5,000,000 cubic yards of material, involving 500 yards of the upstream face of the dam, slipped into the reservoir which the dam was forming. Some men and plant were lost in the slip. Sub-surface investigations have been made by taking samples from depths of 20 to 300 ft. and the Board of Consulting Engineers are carrying out investigations. Their report, which presumably will follow, will be of interest.

Roman Ruins. Roger Shaw.

A short semi-humorous article prompted, apparently, by the author passing an afternoon in Jamaica "with a cluster of buck privates from the British Garrison, the Sherwood Foresters, of Nottingham."

Nitrostarch Demolition Explosive. J. M. Young.

An article of considerable interest to all Royal Engineers. T.N.T. in block form has for many years been the standard demolition explosive of the Corps of Engineers in the U.S.A. The large demand for this explosive at the outbreak of a major war, for shell and bomb fillings for the Army and Navy, might cause a shortage in its supply for demolition work. The various alternatives likely to be available, with their advantages and disadvantages, are considered. These are Dynamite,

Ammonium Nitrate Dynamite, Tetryl, Ammonal, Guncotton, Ammonium picrate, blasting gelatin, Picric Acid and Nitrostarch.

It is concluded that the three most likely substitutes for T.N.T., in order of preference, are Nitrostarch, Picric Acid and Ammonium Nitrate Dynamite. Tests of Nitrostarch and Picric Acid showed that Nitrostarch is a good substitute for T.N.T. in power as an explosive and in convenience in packing.

So satisfactory is Nitrostarch considered, that the next consignment of explosive ordered for the Corps of Engineers will be half T.N.T. and half Nitrostarch, so that further comparative tests may be carried out and further experience gained in its use.

The Platoon Demolition Equipment. J. M. Young.

The revision and modifying of the demolition equipment of the Platoon in the Corps of Engineers has just been completed. Most of the equipment used was, until very recently, excess stock left over from the Great War. The Clover Brand of time fuze, the fuze lighter, detonating cord, dynamo exploder and electric leads are each discussed, and in some cases the equipment has been replaced by that of more recent design, while in others the old war-time material continues to be completely satisfactory.

A list of the demolition equipment carried in the Engineer Platoon is given. Not included in this list but of considerable interest is the air compressor and I.C. engine-operated jackhammer, with which the Platoon is equipped. No camouflet apparatus is carried.

The Lower Columbia River. Cecil R. Moore and R. E. Hickson.

The Columbia River, flowing into the Pacific between Washington and Oregon, is 1,210 miles long, 460 of which are in Canada and 750 in the U.S.A. It is one of the major national resources of the U.S.A., providing a great salmon fishing industry, a large amount of seagoing trade and immense water power, besides magnificent scenery. The development of the Columbia River system is still in its infancy, but this article relates the enormous amount of work already done to improve the entrance from the Pacific. The bar at the entrance is continually shifting but work on jetties and dykes has now created a channel, in general 1,000 feet wide for depths of 30 feet, and up to 35 feet depth there is a minimum width of 500 feet. The entrance to the river is fortified.

Campaign of the Ten Thousand. John McWhorter.

An historical article dealing with the Greeks and Persians and the Campaign of Cyrus in 401 B.C.

The Mutterings of Mars.

A short commentary from the American point of view on the world situation, discussing the Japanese invasion of China and also the European situation.

The National Archives of the United States. R. D. W. Conner.

"Strictly speaking, public archives are public documents, parchments, papers, journals, ledgers and entry books, that have accumulated in the course of the ordinary and extraordinary business of a government and contain a record of its legal and administrative activity." These archives are of great value, not only in a directly practical way but also culturally and sentimentally. Their preservation is considered essential by every civilized nation, but it was only in 1926, 150 years after the Declaration of Independence, that the erection of a national archives building was authorized by Congress in the U.S.A.

A series of disastrous fires, in 1877, 1880 and 1881, caused a committee to be formed to make recommendations for guarding the archives against fire; but Congress showed little interest, and it was not until 1926 that 8,750,000 dollars were allotted for the erection of a national archives building. This building was completed in 1937.

The article deals with the duties of such an institution, and also the technique of preservation of records, documents and photographs.

Corps Engineers in Manœuvres. Lieut.-Col. Herbert D. Mendenhall.

The experiences and observations of an engineer officer on the Third Army Manœuvres in Southern Mississippi. The writer gives the story from the engineer point of view and deals with the early reconnaissance carried out of roads and bridges. Shortage of engineer troops, especially in very wet weather on roads that are not tarmac, was a great difficulty. He was also faced with the classification of bridges by loads; the Engineer reconnaissance report gave a bridge as unsafe for loads over 5 tons, but the Corps Commander personally saw a log truck carrying 15 tons get over safely. The reply was: "it would be one thing for a private log truck to break through a bridge in the face of official warnings, and quite another for a 15-ton howitzer to crash through."

It is interesting to consider British Army establishments in conjunction with his conclusions, which are:

1. With the mechanizing and motorizing of the divisions, a larger proportion of engineers should be assigned to them to take care of the increased maintenance necessary on the divisional roads.

2. In a manœuvre the Corps Engineers should be supplied actually with a substantial quota of engineer troops of some character, to perform Corps Engineer duties.

3. Combat engineers should be assigned to infantry units within the division for specific tasks only, returning to the regimental command immediately upon completion of those tasks.

4. Corps engineers should conduct all engineering reconnaissance for information for which the Corps Engineer section will require information. Sufficient officer personnel and transportation should be permanently assigned to accomplish this.

5. A better means of map overlay reproduction should be developed than the old hectograph jelly pad. There are several dry methods now in use using electricity that could be assembled in one self-contained unit, having a gas-engine-driven generator for use when the headquarters was not supplied with proper current.

111th Engineers in Third Army Manœuvres. Lieut.-Col. John Lansdale.

A short article on the experience of the 111th Engineers as a unit in the defending forces of the Third Army Manœuvres.

The T.V.A. Construction Program. Theodore B. Parker.

The Tennessee Valley Authority Act authorizes the construction of dams and reservoirs on the Tennessee River to provide a nine-foot channel, to assist navigation and control flood water. There are no less than nineteen major projects either under construction, proposed, or completed. The article deals with many facts and impressive figures.

A Battle of Civilians. Major Eldridge Colby.

An article on the American Civil War, bringing out lessons to be learnt from the battle of Big Bethel.

The Mobilization of the Telephone in Hurricane Emergency. Edward Goring Bliss.

An outline of the damage caused to the telephone system in the New England States by the great hurricane of September 21st, 1938, and the methods employed to mend the 500,000 telephone lines which were put out of action.

E.S.B.

(*March–April*, 1939.) *Engineering Aspects of the New England Hurricane of September*, 1938. By Colonel James A. Grant.

The article begins with a brief description of the three previous hurricanes in New England, before going on to describe in some detail that of 1938.

This hurricane brought to light many defects in the design and construction of buildings, sea-walls, breakwaters, etc., which should be of profitable study to the structural engineer. One of the most alarming effects of the storm was the complete and sudden breakdown of all means of communication.

It is interesting to note that, though the course of the storm was traced throughout, its speed and direction were changing so that it eventually reached land some time before it was expected.

Sulphur Production. By Irven Hanson.

An account of the birth and development of the American sulphur industry, in which the hot water method of mining is briefly described in non-technical language.

The Columbia River between Vancouver and the Dalles. By Major Theron D. Weaver.

A general description of the work being done to improve the Columbia River for navigation.

Pay as you Shoot. By Gault Macgowan.

The author argues that it pays the nation always to be prepared for war, rather than to affect a policy of disarmament and arm only when a war appears imminent.

Soil Stabilization. By Lieut.-Colonel Bernard E. Gray.

A somewhat detailed account of the principles and methods of stabilizing soil to produce good wearing surfaces for roads and landing-grounds, including a description of the types of road-making machinery employed. The author concludes by advocating a more general application of these methods to military uses, not only in back areas but for roads in forward areas as well.

The Conservation of the Alaska Salmon Fisheries. By Frederick A. Davidson.

An article which shows the conservative nature of the salmon.

Notes on Camouflage Testing in Texas. By Colonel Henry A. Finch.

The camouflaging of vehicles and machine-guns by means of nets garnished with bits of sacking, blankets and the local bushes, was tested by visual and photographic observation from the air at altitudes from 500 to 10,000 feet. The camouflage was certainly successful but it could hardly have been otherwise in the terrain chosen for the tests.

Population Changes and the National Defence. By Robert Cook.

This article makes very depressing reading.

The author shows with conviction that not only is the population of the U.S.A. and other civilized countries decreasing in numbers, but also in physical and mental quality. He approves of certain Nazi methods of tackling these problems, and argues that if the democracies wish to survive, they must adopt a far wider eugenic outlook and plan the future of the race with bold practicality.

A Simplified Study of Flood Run-off. By Captain Benjamin F. Chadwick.

A short article on a subject which must be of great importance to engineers in a country where devastating floods occur so frequently.

Strategic Mineral Supplies in Germany. By Major G. A. Roush.

An interesting and detailed analysis of Germany's mineral resources, studied in the light of her recent acquisitions and possible future aspirations. Austria and the Sudetenland do not appear to have materially increased the self-sufficiency of the Greater Germany.

The author concludes that even if Germany carried out in entirety the territorial expansion outlined in *Mein Kampf*, she would still be far from self-sufficient in

minerals. And the realization that such an expansion would not be permitted "even in Europe's present supine condition," has prompted Germany's recent energetic drive for trade barter agreements.

Mineral Water at Hot Springs, Arkansas. By Lieutenant Frederick W. Cron.

A brief account of the development and chemical constitution of the water at Hot Springs.

Marine Corps Schools at Quantico. By Major Gerald C. Thomas.

An outline of the work carried out at this School, which shows a very comprehensive syllabus.

Surveying by Speedometer. By Harry Shutts.

If sufficient care is taken to keep tyres at the correct pressure, the motor-car provides a quick and reasonably accurate means of traversing in a flat country where there are long stretches of straight roads.

S.R.G.S.

REVUE MILITAIRE SUISSE.

(*January*, 1939.)—*Le combat de Marchais et le "miracle" de la Marne.* By Colonel Grasset. There are several versions of the "miracle" of the Marne, but the best version is that there was no miracle at all. It was Joffre's sound strategy which, taking immediate advantage of a gap in the German front brought about by his Sixth Army under Manoury, reinforced by the Paris garrison, gained the victory. Colonel Grasset claims that the credit was due to the skill with which General Franchet d'Esperey attacked Bulow's exposed right flank on September 8th with his XVIIIth Corps, and caused Bulow to retreat, widening the gap between him and von Kluck.

The action at Marchais on September 8th is graphically described and illustrated.

La marche à l'ennemi. By Capt. Delay. An elaboration of the official Field Service Regulations of 1927, on the subject of the approach march.

Rail-route et défense nationale. By F. Tissot. A discussion of the relative advantages of rail and road transport for war purposes arguing a case for increased motor-transport capacity for the Swiss national defence, without reducing the rail facilities.

(*February*, 1939.)—*Le service du transit.* By Colonel Dubois. The vulnerability of communications has not been lessened by the increased rapidity of locomotion. Attacks on communications, in order to strangle the fighting front and to throw into disorder the rearward services, will be a very prominent feature in warfare. The increased range of artillery, and the power of aerial bombardment have made it possible to inflict much more damage behind the lines than hitherto. Attacks on the communications used to be made by way of the flanks and wide enveloping movements; now the front need not be pierced or turned in order to inflict damage. The zone of supply must be further behind the fighting line, in order to be out of range of the guns and in order to leave room for manœuvre and retreat; for retreat has come to be regarded as a possible strategical necessity, especially for the Swiss, who cannot expect to hold a superior enemy for long on their frontiers; they must use the manœuvre of retreat when necessary.

Switzerland offers no great depth for communications. Her depots and magazines will be in the central zone of the country, and her problem of transportation is to that extent simplified. She need not use intermediate depots or magazines.

The article describes the Swiss system, which is in process of revision and simplification.

Le combat de Marchais et la "miracle" de la Marne (concluded). By Colonel Grasset. After a description of the rest of the fighting on September 8th, by the

troops of the XVIIIth Corps, Colonel Grasset points out the effects of the Hentsch visit, and in conclusion he says that "the action at Marchais, in itself an episode of secondary importance, but occurring at a critical point of the immense battlefield of the Marne, and at a particularly psychological moment, was the determining cause of the retreat of the German right wing, and, consequently, of the French victory."

Rail-route et défense nationale. By F. Tissot. A further article on the rail versus road problem as it affects Switzerland. The author strongly advocates a greater development of the motor transport in the interests of national defence. The tendency of the Swiss Federal measures of late has been to enhance the value of the railways, while neglecting the road services. But, as the author remarks, in the event of war, much of the railway system would be out of action. This problem affects most European countries to-day, but in very different degrees. Railways cannot be dispensed with, nor can they be allowed to deteriorate; if petrol supplies gave out they would be vital necessities. A proper balance between the two systems is required.

(*March*, 1939.)—*Importance des formations organiques.* By General Rouquerol. This article, written just before the death of its distinguished author, deals with the disadvantages invariably arising from the detachment of formations from their organic groups to act under other commands. There were many instances of this during the Great War, and some glaring examples are quoted. Many readers will remember the same thing in our own armies. The drawbacks are obvious, but the avoidance of the system is not so clear. Disintegration of the normal formations leads to a lowering of morale; and an increase of casualties was almost invariably the result.

It is clear that, somewhere in the scale of formations, detachment of organic bodies such as brigades or divisions must be resorted to in times of emergency. The author urges that the practice be reserved only for the direst need, and then confined to as high a formation as possible.

Le service du transit (concluded). By Colonel Dubois. The functions of the new Service du Transit of the Swiss military system, which has replaced the former "Service des Etapes," are explained. It is claimed that the system now in force will simplify the transportation service behind the armies, and will make the most of both rail and road service.

Courtes méditations. By Colonel Montfort. A series of reflections on current military topics; chiefly connected with Swiss practices and methods; a collection of twenty-four paragraphs.

Les compagnies motorisées de fusils-mitrailleurs sur trépied. By Capt. Sauer. The Swiss Army has recently been provided with 9 motor machine-gun companies; 3 to each light brigade. One of these has 18 machine-guns and is directly under the Brigadier's command; the other two have 12 guns each and are part of each cyclist battalion. The article describes their composition in detail and discusses their employment.

W.H.K.

REVUE DU GÉNIE MILITAIRE.

(*November–December*, 1938).—*L'Étalonnage des ondemètres des Postes Radio-électriques Portatifs.* By Capt. Lionnet. An article on the gauging of wave-metres for portable wireless apparatus used in the field. The universal use of wireless telegraphy and telephony throughout the whole organization of a field army has led to demands for much finer selection of wave-lengths. The author describes both the theoretical and practical methods of adjustment of the necessary scales.

Une mission d'officiers du Génie en Autriche (1763–1765). By General Dorbeau. After the close of the Seven Years' War, which deprived Austria of the province of Silesia, Maria Theresa applied to Louis XV for the services of a French mission of military engineers to advise on the new fortifications of her Bohemian frontier. Louis sent four officers, headed by Colonel Dajot. The mission was a delicate one, and the members were enjoined to preserve the greatest discretion. They were forbidden, on pain of the severest punishment, to make any copy of any document or plan, or preserve even the merest draft of their proposals or designs, in order to allay any suspicion of transferring the Austrian military secrets. There was a chivalry about these matters in those days.

But the mission was not too successful. The French proposals were in favour of fortifying Pless rather than Koeniggratz; and differences arose with the Austrians which made it advisable to withdraw the mission. The Empress decided that her finances would not permit the fortification of the Bohemian frontier, and the members of the mission were suitably thanked for their services. In the sequel, the Pless project was completely abandoned; Koeniggratz was re-fortified, but it was subsequently de-classed, and in 1866 it played no part in the campaign of that year except to give its name to the decisive battle.

Vauban à Arras. By Jules Duvivier. A short article on the history of the fortifications of Arras. The old frontier town changed hands many times in its chequered career, and not until 1659 did it finally belong to France. Vauban was charged with the revision of its defences in 1688. His principal addition to the existing defences was the Citadel, which will be remembered by those who took part in the Arras operations of the Great War. It was sited in the angle between the Crinchon river and the Dainville stream. It was pentagonal in shape, with a wide moat on three sides.

Vauban also built the barracks, riding school and arsenal, and reconstructed most of the old bastions round the town.

As the frontier receded with more settled times, Arras became of secondary importance, and little more was added to Vauban's work. The fortifications were de-classed in 1889, and finally dismantled in 1891; only the Citadel remaining as a memento of the great engineer.

(*January–February*, 1939.)—*Les origines de la fortification bastionnée.* By General Lazard. An historical research into the origin of the bastion. The almost universally accepted date of the first introduction of the bastion is that of the iron cannon-ball in place of the stone projectile. Previously to the bastion, the fortifications of antiquity had their towers, which, if they projected beyond the face of the walls, were in a sense bastions themselves.

The author gives a rapid review of the development of fortifications in the Middle Ages; but the main purpose of his article is to trace the bastion back to early Egyptian origins. The remains of very ancient Egyptian works have provided enough material to form a theory of this nature, and a number of interesting archæological facts are given, with illustrations, which lend support to the author's views. (*to be continued.*)

Étude d'un procédé de rigidification des passerelles suspendues. By Lieut. Ferrandon. A mathematical study of a method proposed for stiffening suspension bridges by the use of longitudinal cables stretched between the pylons and secured closely to the decking.

Une expérience de transmissions radioélectriques en haute montagne. By Capt. Daubigny. An account of the radio-electric system of communications employed in a recent exercise carried out by some Alpine Ski sections in July last year, on Mont Blanc. The parties ascended Mont Blanc itself, keeping up communication throughout, and the distribution of the posts is fully described, with a map of the scene of operations.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*January*, 1939.)—*La Guerre*, 1914–18, *sur le front russe. Souvenirs de campagne d'un officier de l'armée impériale russe.* By Lieut. Jusret. The war adventures of Captain Koukharevitch are concluded in this number, with an account of his experiences on the Riga front and in Rumania. The memoirs are strictly personal and convey little information of value.

Dix-huit mois de guerre en Chine (1937–1938) (*I*). By Capt. P. Materne. It will be a long time before any comprehensive account of the present Chino-Japanese war is available, but this article by Capt. Materne gives us a concise summary of the principal events since the war started; with some interesting comments on the operations. The battle of Shanghai (August to December, 1937) was the most stubbornly contested campaign, up to date; and it was fought with unexpected skill by the Chinese. The want of aeroplanes, munitions and of modern equipment generally appears in all the attempts made by the Chinese to stop the invading columns; but it by no means follows that Japan will be successful in the long run. The wearing down process can be carried on by Chiang Kai Shek for a much longer period yet.

There are no details of any engineering operations; it would be interesting to read, for instance, how the Japanese met the inundation problem. The figures for the Chinese forces can only be fairly approximate.

L'Electricité en Belgique. Organisation économique et financière. By Lieut. Michel. The author, a highly qualified electrical expert, describes the wide distribution of electrical power now organized in Belgium, which is one of the most highly electrified countries in Europe. Figures and diagrams are given showing the annual output each year from 1914 to 1935; and the power installed in each of the nine provinces of the Kingdom.

A map shows the position of the central generating stations and the lines of high tension transmission.

(*February*, 1939.)—*Pages d'histoire; Ma deuxième mission en Russie pendant la guerre.* By Lieut.-General Semet.

In December, 1915, the author, then chief of the staff of the Belgian Cavalry Corps, was appointed to the command of the Belgian motor machine-gun Corps recently sent to Russia. His experiences there included participation in the Brussilov offensive of June, 1916, in which the VI Corps, to which the Belgian units were attached, bore a very prominent part. The services rendered by the armoured cars gained them two citations. Soon afterwards, the signs of revolution and disruption appeared in the Russian armies, and the author has a pathetic picture of the rapid break-up of all resistance. As there was no more fight left in the armies, he applied to be returned to the Yser front. His units followed later by the roundabout way of Siberia and America.

Dix-huit mois de guerre en Chine (*II*). By Capt. P. Materne.

The narrative of events is carried on to the fall of Hankow in October, 1938. The earlier resistance of the Chinese, in spite of the heavy losses around Shanghai and Nanking, had stiffened the national spirit, and obligatory military service was decreed. Two hundred regular divisions were formed, and drilling and training were carried on in Western China, where communications with the outside world could still be maintained. Guerilla warfare on the widest scale has been prepared, and in every Chinese division there is special training for officers in this style of warfare. These officers penetrate through the Japanese lines and spread among the villages, organizing the guerilla bands, to the continual harassment of the Japanese. Such methods must have a cumulative effect on the enemy, and if munitions and supplies can be kept up from outside, it seems likely that China may yet succeed in getting rid of her invaders.

The battle of Kiukiang (20th July–20th September, 1938), and the capture of Hankow (20th October, 1938) are well described; and numerous sketch maps assist the narrative.

Les bases d'une politique nationale des carburants. By Capt. Crahay. The problem of ensuring an adequate supply of motor spirits, especially in time of war, is as urgent in Belgium as elsewhere, and the author urges a more active policy, backed by the Government, for the development of internal resources. Belgium has extensive coalfields and is, therefore, interested in the latest developments in the exploitation of oil from coal. The report of Lord Falmouth's Committee, published in February, 1938, is referred to.

The article covers the subject in a broad manner, and enumerates the various methods now in use or being tried out in different countries to obtain national supplies of petrol.

The petrol supply is, indeed, the key to modern warfare.

La differentiation du caractère chez le combattant. By Lieut. Cornet. A psychological study of the present-day soldier, of whom so much is demanded in handling the complicated mechanical contrivances put into his hands.

(*March*, 1939.)—*Séance académique de l'École Royale Militaire* (*17th December*, 1938). An address by the Commandant of the Royal Military School at the annual meeting, followed by a lecture on chemical synthesis.

Dix-huit mois de guerre en Chine (*III*). By Capt. P. Materne.

This instalment deals with the air operations of the war and the Russo-Japanese incident at Changkufeng.

The Japanese, says the author, started the war with 1,300 aeroplanes (400 fighters, 700 chasers and 200 reconnaissance planes). The Chinese had some 900 aeroplanes. The chief objects of the Japanese air attacks have been the Chinese aerodromes, the railways, the river transport, troops on the march or in concentration, and the larger towns and cities. The toll of the aerodromes and the towns has been heavy, but the damage to the railways has not been very great. Usually the delay to traffic has been limited to the time required for repair. Materials are kept close at hand, and the repairs have been effected in remarkably short time.

The frontier incident at Changkufeng was not intended by either Russia or Japan to develop into general hostilities. What began as an outpost affair assumed considerable proportions in a short space of time, until a division on each side became engaged. The Japanese drove off the Russians, who returned, greatly reinforced, and made a strong attack on the disputed hill. But in the end the Japanese held their trenches, and the fire died out. The chief result of the episode was the continued vigilance of Japan on the Manchurian border, where a very large force has to be kept to watch the Soviet menace.

W.H.K.

RASSEGNA DI CULTURA MILITARE.

(*January*, 1939.)—*Giuseppe Garibaldi*. By A. Solmi.

A sketch of the career of Garibaldi.

I navigatori liguri (*concluded*). By G. M. del Vascello.

One of the distinguished navigators mentioned in this article is Giovanni Caboto, better known as John Cabot, a Genoese by birth, who, placing his services at the disposal of King Henry VII of England, set out from Bristol and discovered Newfoundland and Labrador. On his return the King gave him a reward of £10, and an annual pension of £20, which Cabot lived to enjoy for two years. The writer adds the comment: England thus conquered America for the sum of £50.

Esploratori e colonizzatori sulle vie dell'impero. By Marshal Graziani.

An account is given of Raffaello Gestro, who explored the course of the Juba river.

Studi di strategia sulla guerra mondiale. (Il piano austriaco.) By General Ago.

This article is continued from the November number.

The Austrian force operating against Serbia consisted of the 2nd, 5th and 6th Armies. The 2nd Army was subsequently withdrawn for the campaign against Russia, only one corps being retained for the Serbian field force. Marshal Potiorek's plan was to attack the Serbian Army from the north with the 5th Army, and from the south with the 6th Army.

The campaign was a failure. The two armies were out of touch with one another, separated by high mountain ranges. The Austrian Armies were not equipped for mountain warfare, the intelligence service was not good, the country was extremely difficult, and the Serbian resistance had been greatly underestimated.

On the Russian front, Marshal Conrad's dispositions consisted of grouping the main portion of the Austrian forces in Galicia for operating against the Russian Armies collected near Warsaw, while a smaller body covered eastern Galicia.

As previously pointed out, the German and Austrian plans were not in agreement, and it was Austria who had to give way. General Ago repeats his assertion that the German strategy was wrong, and that the Central Powers should have concentrated their first efforts on defeating Russia.

L'autarchia e le forze armate. By Brig.-General Cabiati.

The writer discusses the desirability of making Italy, as far as possible, self-supporting and independent of imports.

La crisi europea per la questione cecoslovacca.

An account of the reaction to the Munich Conference.

Nuove tendenze sui particolari costruttivi dei materiali radio campali.

Lieut.-Col. Rossoni explains recent improvements in field radio sets.

Viabilità militare con particolare riguardo alle soprastrutture ed ai materiali leganti esclusivamente italiani.

Captain d'Amico continues and concludes his article on road surfacing.

The first type here described is the silicate of soda road. Limestone of medium hardness can be used as ballast, and silicate of soda is produced on a large scale in chemical industry. Silicate of soda is the only substance that can be used as binding material for earth roads, and, as such, it is extensively employed in the United States.

Modern war conditions often require that a road shall be constructed in the shortest possible time; the silicate of soda road fulfils this condition better than any other type. The chemical action is as follows:—Owing to the porosity of the limestone, and the colloidal property of silicate, the latter is decomposed into hydrated sodium carbonate and amorphous silica, under the action of the carbonic acid contained in the air and water. The amorphous silica becomes partially crystallized, and is combined with the soda of the carbonate to form crystals of a new silicate of soda. The excess of amorphous silica forms a cementing substance that impregnates the crystals of silicate of soda, which continues to absorb silica in the process of hardening. Hence the importance of using a silicate with a maximum content of silica.

A great advantage of the system is that it permits the use of a cheap form of road-metal. Practically any limestone may be used. The presence of magnesium carbonate is an advantage, a small proportion of quartz is not harmful, but an excess of clay diminishes the resistance to atmospheric agency, and prevents complete penetration of the silicate.

Water used for diluting the silicate must be free from animal or vegetable matter. Broken stone with sharp edges is preferable to rounded shingle. While soft materials,

such as talc and chalk, should be avoided, the best results are obtained from stone of medium hardness, in preference to very hard stone, such as fluorite.

The most recent specification requires the following proportions in the aggregate :—

(1) Broken stone from 50 to 60 mm.
(2) Broken stone from 25 to 30 mm.
(3) Grit from 0 to 12 mm. in the following proportions :
25 per cent (0 to 1 mm.).
50 per cent (1 to 6 mm.).
25 per cent (6 to 12 mm.).

In order to obtain a layer of 10 sq. metres, 13 cm. thick, the mixing is done by hand in a measure containing 1·3 cubic metres, using the following proportions :— 0·66 m^3 of large ballast, 0·34 m^3 of small ballast, and 0·30 m^3 of grit in the proportions noted above.

The mixing is done, firstly, twice dry, then, after adding the silicate (without water), twice wet. In hot weather it is good practice, before the second mixing, to spray 15 to 20 litres of water over the mixture with a watering can.

When working with large quantities of material, the tendency is for the larger stones to sink to the bottom. The mixture should therefore be worked up with shovels and not with rakes.

The cross slope of the road, from centre to sides, should be 3 per cent.

The mixture should be spread as soon as ready, as the initial set takes place very rapidly. On no account should the mixture be left lying in heaps during the mid-day stoppage of work.

The sub-grade over which the ballast is spread should be free from projections or hollows. Any form of stone is suitable as a foundation, provided few cavities are left and the stone itself is porous.

As soon as 30 linear metres of road have been covered, rolling should be begun. Adjustment of the surface, correction of the camber, and a second rolling should all be completed before the mixture has taken on a permanent set. To obtain a good result, it is necessary that the mortar should work up to the surface.

The final operation consists of spreading vitreous silicate in powdered form, mixed with (0 to 12 mm.) grit in the proportion of 1 kg. of silicate and 5 kg. of grit per sq. metre. After a final rolling the road may be opened to traffic whatever the season of the year.

Another type of road, here described, makes use of powdered asphaltic rock of Italian origin. The material may be used either hot or cold.

The cold process has recently been tested successfully in the re-surfacing of roads extending over 520 km. in length. The procedure adopted is as follows :—

The metalled surface (whether new or old) is made up to the required camber, and washed clear of dust. If old, it is scraped. It is then allowed to dry.

The surface is then sprayed with asphaltic oil or tar by means of a sprayer. A new surface will require 0·2 to 0·3 litres of oil or tar per sq. metre ; an old one about half this amount. The oil must be spread uniformly.

Asphaltic powder (obtained by crushing until the largest pieces do not exceed 5 mm. across) is then at once spread evenly over the oiled surface, allowing 12 to 15 kg. per sq. metre (the higher figure for heavy traffic).

Immediately afterwards a layer of grit, treated with the same oil or tar, is spread, while dry, over the asphaltic powder. The mount of oiled grit per sq. metre is as follows :—

0·009 $m.^3$ with pieces of 8 to 12 mm. when 12 kg. of powder are used.
0·012 $m.^3$ with pieces of 10 to 15 mm. when 15 kg. of powder are used.

The quantity of oil to be mixed with the grit will vary between 15 and 25 litres per cubic metre, according to the fluidity of the oil. The higher the temperature, the less oil will be required.

The surface will then be consolidated with an 8- or 10-ton roller, and the finishing touch will be given by throwing a few shovelfuls of powdered asphalte over the completed surface.

In the hot process a mixture of tar and asphaltic powder is used.

The maintenance of roads surfaced by any of the processes mentioned above presents no special difficulties, except that, in the case of asphaltic roads laid by the hot process, it is necessary to have perfect weather, free from frost, mist, rain or snow, and a boiler is, of course, required.

(*February*, 1939.)—*L'autarchia e le forze armate.*

Brig.-General Cabiati concludes his article with an optimistic view of the position of Italy with regard to self-sufficiency. He admits that only a small proportion of the fuel required is obtained within the country. But Italy is nearly independent of imported food supplies, thanks, largely, to the frugal habits of her people.

Clausewitz e la teoria della guerra. By Lieut.-Colonel Canevari.

Clausewitz's great work, *On War*, is little known in Italy, where Jomini's principles have been chiefly studied. In this first instalment the writer briefly describes the arrangement of Clausewitz's work.

Sullo sfondo dell'Impero. By Lieut.-Colonel Micaletti.

A sketch of the development of the Italian colonial empire, and ideas for the future of Libya and Abyssinia. The writer deals with the international situation in the Mediterranean, and the importance of the Red Sea and the Mediterranean for Italy.

La difesa del forte di Monte Festa. By Captain Salbitani.

An account of the defence of the fort of Monte Festa between the 30th October and the 7th November, 1917. The fort was situated so as to command the junctions of the Fella and the But streams with the Tagliamento. (*To be continued.*)

La crisi europea per la questione cecoslovacca.

This article terminates the description of events that occurred after the partition of Czechoslovakia in October, 1938, and quotes the opinion of some of the leading French and English newspapers.

La verifica della stabilità dei ponti metallici scomponibili.

Captain Betocchi here investigates the stability of sectional metal bridges with interchangeable parts, and restricts his calculations to the main girders, leaving cross joists and longitudinals to be dealt with on their merits.

In the type of girder discussed, in which the members are, as far as possible, interchangeable, many of them are unnecessarily strong, and all that is needed is a calculation of those subjected to the greatest stress.

In the simplest form of lattice girder, in which all the members, other than the top and bottom flanges, are inclined at about 60 degrees to the horizontal, the flanges are subjected to a maximum stress at the centre of the span, and, ordinarily, it will only be necessary to consider the upper, or compression flange at the centre. Similarly, the shear being a maximum at the ends, it will only be necessary to consider the diagonals nearest the supports.

The writer concludes with a specific example of a bridge of 24-metre span carrying a motor vehicle weighing 15 tons, and shows that the standard type of bridge is strong enough.

La marcia degli automezzi nel deserto.

Colonel Amione has made a study of the movement of mechanically-propelled vehicles across sand or uneven country. He deals with the following four cases :—

(1) a carrying wheel,
(2) a carrying and driving wheel,
(3) a carrying chain track,
(4) a carrying and driving chain track.

He starts with the following data as regards tyre pressures on the ground :—

20 kg. per sq. cm. for wheels with solid rubber tyres.
15 kg. per sq. cm. for wheel with semi-pneumatic tyres.
5 to 7 kg. per sq. cm. for wheels with high-pressure pneumatic tyres.
3 to 4 kg. per sq. cm. for wheels with low-pressure pneumatic tyres.
1·5 to 2·5 kg. per sq. cm. for wheels with very low-pressure pneumatic tyres.

Various points come into consideration, such as the surface of the tyre tread, the load, the nature of the ground, etc. The general conclusions arrived at are as follows :—

(1) for carrying wheels.

On rock or on a giving surface, wheels should be large to overcome obstacles and avoid sinking ; tyre pressures should be low.

(2) for carrying and driving wheels.

All-wheel driven vehicles are preferable, wheels should have a large radius and low-pressure tyres.

(3) for carrying chain tracks.

These are little used except in towed vehicles ; the pressure on the ground is slight.

(4) for carrying and driving chain tracks.

The track should be rigid and not too pliable, its centre of gravity should be equidistant from the two ends, the gradient should not be too severe.

(*March*, 1939.)—*Le risorse economiche dei paesi mediterranei.*

In this first instalment General Deambrosis discusses the economic resources of the countries bordering on the western Mediterranean : France, the Iberian peninsula, and Italy. In the matter of agriculture, France has a considerable advantage over the others. Where minerals are concerned, the relative proportion is 3 : 3 : 1. In spite of her much smaller area, Italy has a far longer coast line than either of the other two countries, and consequently a larger sea-faring population.

Clausewitz e la teoria della guerra.

Colonel Canevari continues his article on Clausewitz and deals with the planning and conduct of war, and military criticism.

La difesa del forte di Monte Festa. (Concluded.)

Captain Salbitani describes the Austrian attack on the fort, the gallant defence of the garrison, and its refusal to surrender when surrounded. In the end the guns were blown up, and the garrison made a sortie. The commander and a few men got away.

Forze armate della repubblica polacca.

The peace strength of the Polish Army consists of 93 regiments of infantry, 40 regiments of cavalry, 31 regiments of field artillery (besides horse, heavy, anti-aircraft, etc.), and various units of engineers. Service in the army is for 18 months with the colours, 17½ with the reserve, and 10 with the territorial militia. It is calculated that Poland can mobilize 60 to 70 divisions of infantry, 1 cavalry division and 13 independent cavalry brigades.

The navy is small and consists mainly of coast defence vessels, as well as of a river flotilla. The air force possesses 1,300 aeroplanes. The frontier is only fortified on the German and Lithuanian borders.

Le pile a secco nei mezzi di trasmissioni elettrici e radioelettrici.

Lieut.-Colonel Gatta describes at some length the dry battery in ordinary use for telegraphic and radio work in the army, its internal construction, chemical action, and useful life. The specific energy of a battery is the proportion of its energy in watt-hours to its weight in kilogrammes. This is usually 50 for both anode and cathode batteries. The cost of energy is 0·36 lire per watt-hour, which works out to 18 lire per kg. weight of battery.

The writer calculates that during the campaign for the conquest of Barcelona, which lasted a little over a month, about 20 tons of dry batteries were used. The cost of these is about 1 per cent of the expenditure on artillery munitions for the same period.

Endeavours are being made to use indigenous material as far as possible for the manufacture of batteries. Manganese dioxide has hitherto been imported from abroad, but it will in future be obtained from pyrolusite mined in Sardinia and Sicily. Graphite is obtained from Germany.

La marcia degli automezzi nel deserto.

Colonel Amione concludes his study of the movement of mechanically-propelled vehicles across sandy tracts. Various kinds of sand are analysed, a study is made of the formation of sand dunes, and the action of a camel's foot is investigated.

The final conclusions arrived at are as follows :—

(1) the pressure of wheels or tracks must be kept as low as possible,

(2) if chain tracks are used, they must be motor-driven : wheels, if used, must be all-driven and of large diameter,

(3) trailers must be used as little as possible,

(4) vehicles must have a big range of speeds,

(5) their construction must be strong,

(6) the engine must be provided with an efficient air-filter, and all inlet holes must be protected from sand.

A.S.H.

MILITÄRWISSENSCHAFTLICHE MITTEILUNGEN.

(*January*, 1939.)—*German Military Policy in the Past and the Present.* By General von Cochenhausen.

A lecture delivered to the Vienna branch of the "Deutsche Gesellschaft für Wehrpolitik und Wehrwissenschaften." General von Cochenhausen dwells on the importance of close co-operation between the army and the leaders of industry.

The Combined Defence Forces of Nations.

In this introductory article Lieut. Field-Marshal Schaefer describes the basic organization of defence in different countries, dealing, in turn, with the army, navy, and air force, and the latest developments in each. (*to be continued.*)

Military and Political Retrospect of the Year 1938.

Major-General Paschek discusses the main events that occurred in the last quarter of the year, viz., the German attitude towards Britain and France, the further development of the Czechoslovak question, and the Mediterranean problem.

The Civil War in Spain. By Major-General von Lerch.

The battle of the Ebro began on the 25th July, 1938, with the forcing of that river by the Red Catalan Army. After a three months' struggle, involving heavy losses, General Franco had only succeeded in recovering the ground lost in July. On the 30th October, he opened his seventh great attack. The battle ended on the 16th November, with the Republican Army evacuating the left bank of the Ebro, and falling back. A pause in the fighting followed, and a general air offensive was opened against 150 "Red" towns ; the main attacks being delivered against Barcelona and Valencia. (*to be continued.*)

(*February*, 1939.)—*Artillery in Olden Times.* By Colonel Loncarevic-Syposs.

A sketch of the progress of artillery from the 11th century until the Thirty Years' War (1618–1648). The art of the ancient Romans in constructing engines of war had been completely forgotten, and was only gradually revived during the Middle Ages. The machines finally produced were very powerful, and even after the discovery of

gunpowder the older weapons were only gradually superseded, and were not finally abandoned until the 17th century. By that time cannon had become mobile weapons that played an important part in battle.

Military and Political Retrospect of the Year 1938.

Major-General Paschek deals mainly with the events in the Far East, with the British Empire and the United States. He concludes with a review of the re-armament of the great powers. From his point of view the strategic position of the Berlin-Rome axis has greatly improved.

The Combined Defence Forces of Nations.

Lieut. Field-Marshal Schaefer describes the machinery of administration: finance, land, forestry, mines, manufactures, commerce and industry. It is the duty of every nation to produce as many as possible of the necessaries of life within its own borders.

Further points dealt with are trade and communications, labour and mechanical energy.

The "Pocket-Book" Map.

Dr. Rotter points out the disadvantages of the present system of mounting and folding maps. An unmounted map soon becomes illegible at the folds, and, after constant use, it falls to pieces. If cut into sections and mounted on cloth, there is a small gap between the sections, and it is not possible to measure off distances accurately. Large maps cannot conveniently be folded.

The writer has taken out a patent for a new method. A map of any size is cut, horizontally, into two or more strips, about 16 inches wide. Each strip is folded in two, horizontally, with the map on the outside, and then, vertically, concertina-wise, into book shape. Several maps are formed into a pocket-book, and, by turning over the leaves, any portion of the map can be examined.

(The principle appears to be similar to that adopted by the Michelin Tyre Co. for its maps.)

The Civil War in Spain. By Major-General von Lerch.

After the battle of the Ebro the initiative lay with the Nationalists. General Franco detailed six army corps for a general offensive in Catalonia. The Republicans expected an attack on Lerida, as that place offered the best communication with Tarragona and Barcelona. Lerida being strongly fortified, General Franco made his main attack to the south of that place, and another attack to the north of it. The heaviest fighting took place round about Christmas time. The second phase of the battle: the advance of the Nationalist centre, began on the 8th January. By the 15th the resistance of the militia was broken, and the Republicans were in full retreat.

At the beginning of January, General Miaja attempted to retrieve the situation in Catalonia by a counter-offensive on the Estremadura front, but, although his operations met with some initial success, they were of no great importance.—(*To be continued.*)

(*March*, 1939.)—*Questions of Greater Germany's Sea Power.*

In a lecture, delivered at Vienna in January, Admiral Prentzel traced the development of the German and Austrian navies, and described their services during the World War and the lines on which they will be developed in future.

In order to be a world power, it is necessary for Germany to be a sea power. Several years will have elapsed before Germany's naval programme has been worked up to. The development of the air arm will compel warships to operate on the high seas, far from an enemy's air bases. One of the navy's primary duties will be to protect Germany's commerce; the attack of the enemy's merchant ships will be a secondary objective.

Herr Hitler's policy is to avoid competition at sea with Britain. Hence the agreement to restrict ship-building on a 35 per cent basis: even this Germany will find difficult to maintain. Britain is, however, very vulnerable by air. Germany

looks to her navy to keep command of the Baltic, and, with Britain friendly or neutral, of the North Sea as well. She would give support to an ally at sea.

The Austro-Hungarian General Staff.

In a lecture delivered in Vienna in December, 1938, Colonel Zeynek traces the development of the Austro-Hungarian General Staff. The main criticism levelled at the Staff College is that too much stress was laid on technical knowledge and study, and not enough on character and initiative. Colonel Zeynek records with admiration the services of Field-Marshal Conrad as Chief of the General Staff before and during the World War. He also mentions his own personal experiences while serving on the staff during the war.

Germany's Way to Economic Self-Sufficiency.

Major Prokoph describes the methods adopted in Germany to attain economic self-sufficiency and to adjust her adverse trade balance. The greatest economy is enforced in the use of foreign raw materials, old material is re-used extensively, and indigenous material is exploited as far as possible.

Owing to the scarcity of copper, aluminium is being largely used in its place. The question of recovering copper, as well as other products, from sea water, is being investigated. Nickel is being replaced by synthetic metals. It seems likely that sugar produced from wood will eventually oust beet-sugar, and so set free large areas now devoted to the cultivation of sugar-beet for other food crops. Many other changes leading to economy have been made, or will shortly be introduced.

Prize Essay. The Parking of Motor Vehicles of Motorized Troops, when halted during a Fight.

In this article Major von Manteuffel explains the handling of motor vehicles during the portion of an engagement when they are not actually required for use. A series of photographs show how they can take advantage of any available cover so as to be screened from overhead view.

The Civil War in Spain. (Concluded.) By Major-General von Lerch.

This article deals with the period of the Civil War in Spain from the beginning of January till the 20th February, 1939. General Franco's offensive may be divided into four phases: the first from the 23rd December to the 4th January; the second, which led to a great shortening of the Nationalist front, from the 5th to the 20th January. The third phase was the attack on Barcelona itself, which led to its evacuation by the Red Army and its occupation by Nationalist troops on the 26th January. The fourth phase was the occupation of the rest of Catalonia by the Nationalists, and the flight of the remnants of the Red Army across the French border.

The writer concludes with an account of the incident connected with H.M.S. *Devonshire's* arrival at Port Mahon in Minorca. He infers that it was Britain's object to prevent the Italians from establishing themselves on the Balearic Islands.

A.S.H.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(February, 1939.)—125 Years Ago. Blücher's Crossing of the Rhine at Caub.

Lieut.-Colonel Grosse describes how a group of the Silesian Army under Blücher crossed the Rhine at Caub, on the 1st and 2nd January, 1914, in the face of slight resistance from Napoleon's retreating army.

The Prussians had no pontoons, and few pioneers; they had to rely entirely on Russian pontoons, consisting of wooden frames covered with tarred canvas. The river was 300 metres wide, and there was an island in the middle. The current was very swift.

Prussian troops were ferried across in the night of the 31st December/1st January, and the French retired after slight resistance. The construction of the bridge took far longer than had been anticipated. It was only completed after 30 hours' work. The total length was 312 metres, and 71 pontoons were used. The whole of the army of Silesia crossed over it, with vehicles and guns at long intervals. By the time the army had crossed, the bridge was too unsteady for further use and was replaced by a flying bridge.

125 Years Ago. Wittenberg.

Colonel Heye describes the siege of Wittenberg, on the Elbe, in 1813 and 1814. The place was held by a French garrison, left there by Napoleon's main army.

The operation of the Allies can be divided into three stages :—

(1) Encirclement under General von Kleist. March-April, 1813.
(2) Encirclement from the Armistice until the battle of Leipzig.
(3) Encirclement from the battle of Leipzig until the formal siege and capture. (13th January, 1814.)

German Pioneers in the Battle for Douaumont on the 25th February, 1916.

Major-General Klingbeil describes some personal adventures of pioneers who took part in the assault on Fort Douaumont.

Location of a Communication Gallery in the World War.

Lieut. Pfrengle describes how he solved the problem of aligning an underground communication gallery between a support trench on high ground and an advanced trench in a depression forward of it, the two trenches not being visible from one another.

The correct direction was obtained by firing a series of rockets from the front trench, and aligning a row of stakes on the light. The difference in level was measured by stretching fine wire tightly between the stakes, whose distance apart was known, and noting the angle of inclination with the vertical of each section of wire. The observations were taken at night. The gallery was started from both ends, and the two headings met fairly accurately.

Plan and Execution of Storm-Troop Enterprises.

Captain Pense describes the first attempts to organize storm-troop formations, and the experience gained from mistakes. He next deals with the various points essential to the success of a storm-troop enterprise.

The Czech Bridge Demolition at Breitenfurt. By Captain Gerloff.

An interesting article, of which it is hoped to publish a transcript in *The R.E. Journal* for September, 1939.

A.S.H.

WEHRTECHNISCHE MONATSHEFTE.

(*January*, 1939.)—*A Retrospect of the Means and Methods of Sighting in Light Artillery.*

Lieut.-General Marx describes the methods of sighting (with ordinary and telescopic sights) in use in pre-war days, and considers that the only changes made since then have been in minor details.

The Future of the Propellant Industry. By Dr. Friedensburg.

In 1936 it was calculated by American experts that the world's supply of crude oil would be exhausted in 17 years. No competent authority gives it more than 20 years' life, even allowing for improvements in boring technology.

The question arises : What fuel will ships, aeroplanes, and mechanically-propelled vehicles use when oil is no longer available ? Countries rich in coal will make use of the products of their coal mines. It is probable that there will be an increasing tendency to split coal up into its component parts. One difficulty is that not all

kinds of coal produce coke of commercial value. Experiments have been made with the propulsion of Diesel engines by means of coal dust.

Countries poor in coal, such as Italy and Japan, have endeavoured to supplement their fuel supply by using potato spirit, but the drawback to this source is that no foodstuffs will be available for conversion into alcohol in war time.

The Raw Materials Department of the Prussian War Ministry in the World War. By Major Hedler.

Seven months after the outbreak of the World War, Major Koeth was placed in charge of the Prussian Raw Materials Department. He achieved for the Central Powers what Lloyd George did for Great Britain. Like Lord Kitchener, he foresaw that the war would last several years. The writer describes the organization of the department and the work carried out. When the war ended, Lieut.-Colonel Koeth was able to say that, in spite of shortages, it was not for want of raw materials that the war had been lost.

Saurer Cross-country Vehicles.

Oberregierungsbaurat Liebel describes three types of mechanically-propelled vehicles manufactured by the Swiss firm of *Saurer*. The three types are mainly intended for military purposes, and have two, three and four axles respectively. To economize space the driver's seat is placed alongside the engine, which is tilted over instead of being vertical. There is an ingenious system of springing, which enables the vehicles to travel over the roughest country.

The Grading of Industry of Importance for Warfare. By Dr. Leonhardt.

Owing to deficiency of man-power and shortage of materials it will not be possible, in a future war, to allow industries that have no value for war purposes to continue to exist. The writer points out that all industries will have to be controlled from a common centre.

(*February*, 1939.)—*The British Coal Industry's Contribution to Defence.* By Dr. Friedensburg.

The British coal industry has undergone a complete change since the World War. Between 1913 and 1936 the out-turn of British coal mines has dropped by 21 per cent, their share of the world's production by 23 per cent, and their exports by 40 per cent. Their average profits have dropped from 1s. 6d. per ton in 1922 to 6d., and in many cases they have been run at a loss. This set-back has not taken place in other countries: the Russian, German, Polish, Dutch and Belgian coal industries have all progressed at Britain's expense. The small British coal organizations have not been able to compete with the large protected syndicates in Germany and Poland.

The writer describes the different measures taken to counteract the set-backs in the coal industry. Proposals to subsidize it have failed. There has been a "back to coal" movement. The Fuel Research Board and Coal Utilization Council have turned their attention to the use of colloidal fuel and of coal dust, but the coal-dust motor problem has not yet been satisfactorily settled.

For the production of oil from coal, low temperature carbonization is the only method that has given satisfactory results.

The Prussian State Treasure. By Dr. Meier.

King Frederick William I of Prussia founded the Prussian State Treasure. In 1740 it amounted to ten million thalers. Frederick II (the Great) continued to accumulate funds, which helped him over the Silesian wars, but the third Silesian war practically exhausted his reserves. After Frederick's death the State Treasure fell upon evil days, and between 1806 and 1820 it ceased to exist. In the latter year it was restored by King Frederick William III, and it amounted to 20 million thalers in 1863. Within the following seven years came three wars, against Denmark, Austria and France, respectively, and, in spite of heavy calls upon it, the treasure

stood the strain, and it paid for the mobilization of troops in the Franco-Prussian war.

(*March*, 1939.)—*The Mineral Oil in the Galician Theatre of War*, 1914–18. By Dr. Friedensburg.

At the beginning of the war, the Central Powers had only one large oil-field at their disposal, that of Galicia. The oil-fields extend over a length of 240 miles along the northern edge of the Carpathians. The Austrians did not realize their value sufficiently, and did not include their preservation in their plan of campaign. The oil-fields changed hands several times during the first three years of the war.

When the Russians finally evacuated Galicia in 1917, they only damaged the oil-fields very slightly. If they had carried out demolitions as thoroughly as the British did in Rumania one and a half years later, they would have caused the Central Powers an incalculable amount of damage.

The Cost and the Uses of a Shadow Industry.

Dr. Leonhardt refutes the idea that the cost of a shadow industry, as adopted in Britain, is prohibitive. There are, in Britain, 59 shadow factories whose initial cost is estimated at about £11,000,000. This is not a large proportion of the present annual expenditure on defence.

Their great advantage is that, on the outbreak of war, it will be possible to mobilize industry very rapidly. In the World War, their large reserves of man-power gave the Germans an enormous preponderance; in a future war, the shadow industries will form a similar reserve of industrial power.

Armour in Fortress Construction.

In this first instalment Colonel Heye traces the development of the use of steel armour in fortress construction, from the first adoption of iron in forts by the French in 1829, until the introduction of nickel-steel in modern times. The struggle between guns and armour continued the whole time.

In 1914, the fate of the Belgian fortresses: Liége, Namur and Maubeuge, showed that steel armour was incapable of standing up against 21 cm. shells, and still less against the 30 cm. and 42 cm. mortar batteries brought up by the Germans. The forts were built of unreinforced concrete and were badly ventilated.

On the other hand, the Verdun forts of Douaumont and Vaux proved, in 1916, that forts were able to withstand a heavy bombardment successfully.

Models and the Rules applied to them.

Dr. Fuesgen explains the relationship between small-scale models of one, two or three dimensions and the originals that they represent.

A.S.H.

THE INDIAN FORESTER.

(*January*, 1939.)—Mr. Van Haeften of the Punjab Forest Service describes *A Day in the Black Forest*, which day was four days before Hitler's Nuremberg speech. He was delighted at everything he saw—people, forest and food. In Germany state forests are treated very much as public parks, and there are few in any restrictions as to the movement of visitors.

Sal sleepers relates the difficulty of Forest Officers in providing sleepers which will be passed by railway officers; the article could, with advantage be studied by such.

More and more do the evils of disforestment and its sequels find a place in this paper. Parts of the Konkan—the flat country between the Western Ghats and the sea—which formerly grew a rich forest covering, are now bare rock, and the soil which covered them has been washed off and irretrievably lost in the sea. From another article we learn that the Ganges, with one-third of the catchment area of the Mississippi, takes to the Bay of Bengal eight times the quantity of silt.

Editorial notes comment on the use of *bagasse* (crushed sugar-cane) for insulation and wall boards. The notes refer also to the forest survey operations carried out from the air by the Survey of India; and to the survey, apparently by ground methods, of 344 square miles in all, in Bengal and Bombay, plus an area in Garhwal, U.P., the area of which is not given.

(*February*, 1939.)—Mr. N. C. Roy supplies an ingenious chart for finding the height of a tree, given its distance from the observer, from angles taken by an Abney to its tip and base.

Rao Sahib S. Rangaswami's article on *Utilization of Forest Wealth* deserves study. The sources of wealth include not only timber, but numerous side-lines such as resin and lac. He draws attention to the fact that in a densely populated country, such as Japan, 55·7 per cent of the total land area is under forest. The author has, by the way, arrived at the quantity of 67·2 per cent, but this enormous figure is apparently obtained by adding to the 55·7 per cent some 20 million acres of waste land, which, according to Bor and Sparhawk's *Forest Resources of the World* are included in that figure, which is, however, striking enough. The article further states that Japan is the second most densely populated country in the world, Belgium with 702 to the square mile being the first. This, however, is not the case; Great Britain and the Netherlands are both more densely peopled.

(*March*, 1939.)—The importance of the origin of seed for forest trees is stressed in an article. Characteristics such as fluted and twisted stems are often inherited, and the same can be said of good qualities such as immunity to fungus attack.

A Day at the Sonepore Mela, *mela* meaning "fair," is amusing. It would hardly be thought possible to fake elephants for sale, but that it can be and is done is supported by indubitable evidence.

A German publication on Foreign and Colonial Forestry is reviewed, which deals principally with West Africa. It would be interesting to know whether this part of the world is considered foreign or colonial territory.

The subject of *Erosion and Floods* is again to the fore, in an able article by Mr. E. A. Smythies.

Here is a recipe for a cheap method of weatherproofing *kacha* walls. "To the soil used for making *gara*, add sodium carbonate at the rate of 20 pounds for every 100 cubic ft. The *gara* is then made by puddling and the addition of wheat straw. Just before plastering, add cement at the rate of 5 per cent by weight of the original soil. Apply the mixture as a plaster." Tests have shown that it is not only impermeable, but does not erode under the heaviest rains likely in the Punjab. It is not stated whether it is sufficiently potent to keep a flat roof rain-tight.

F.C.M.

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