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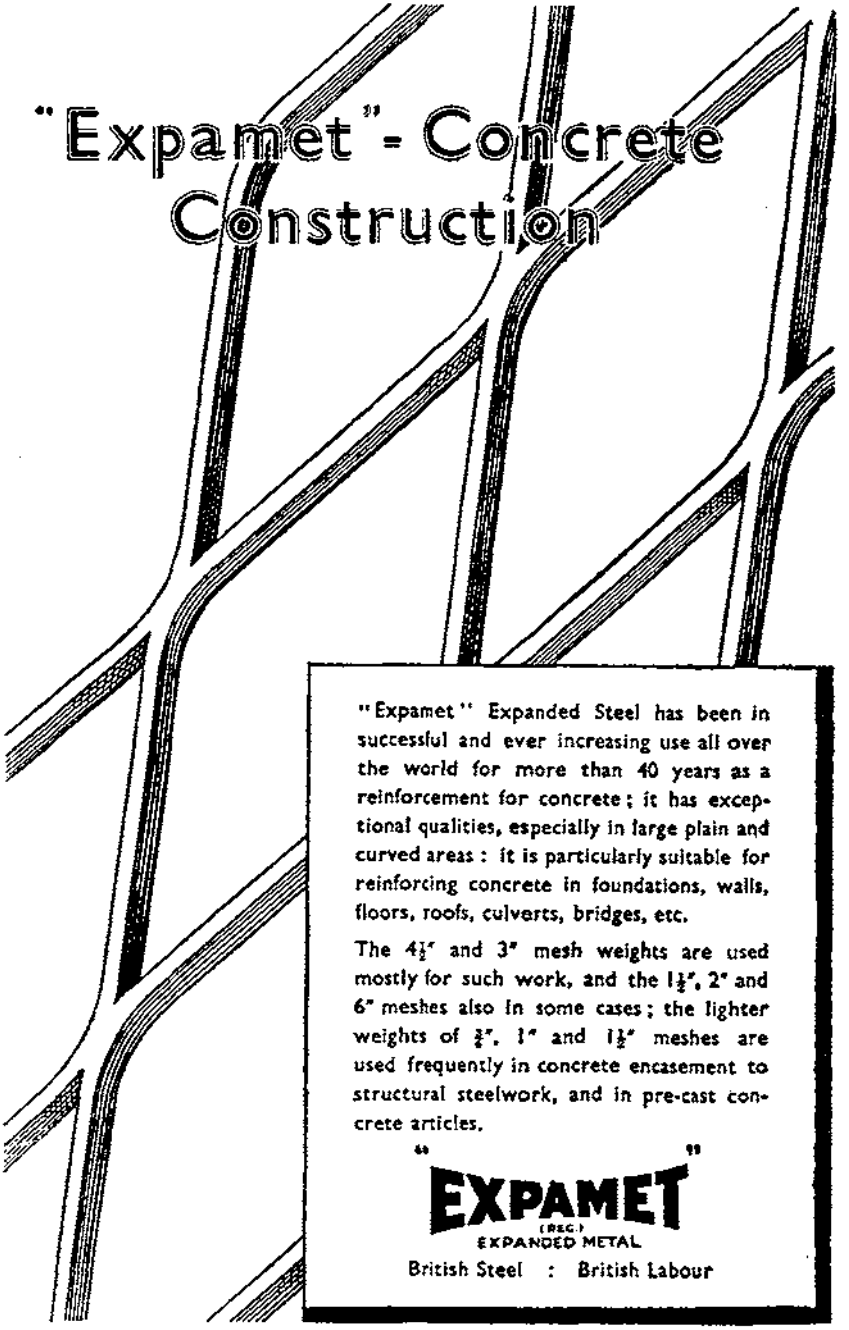

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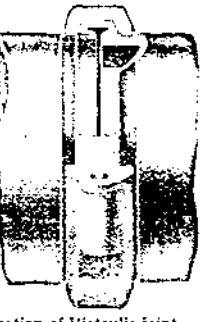

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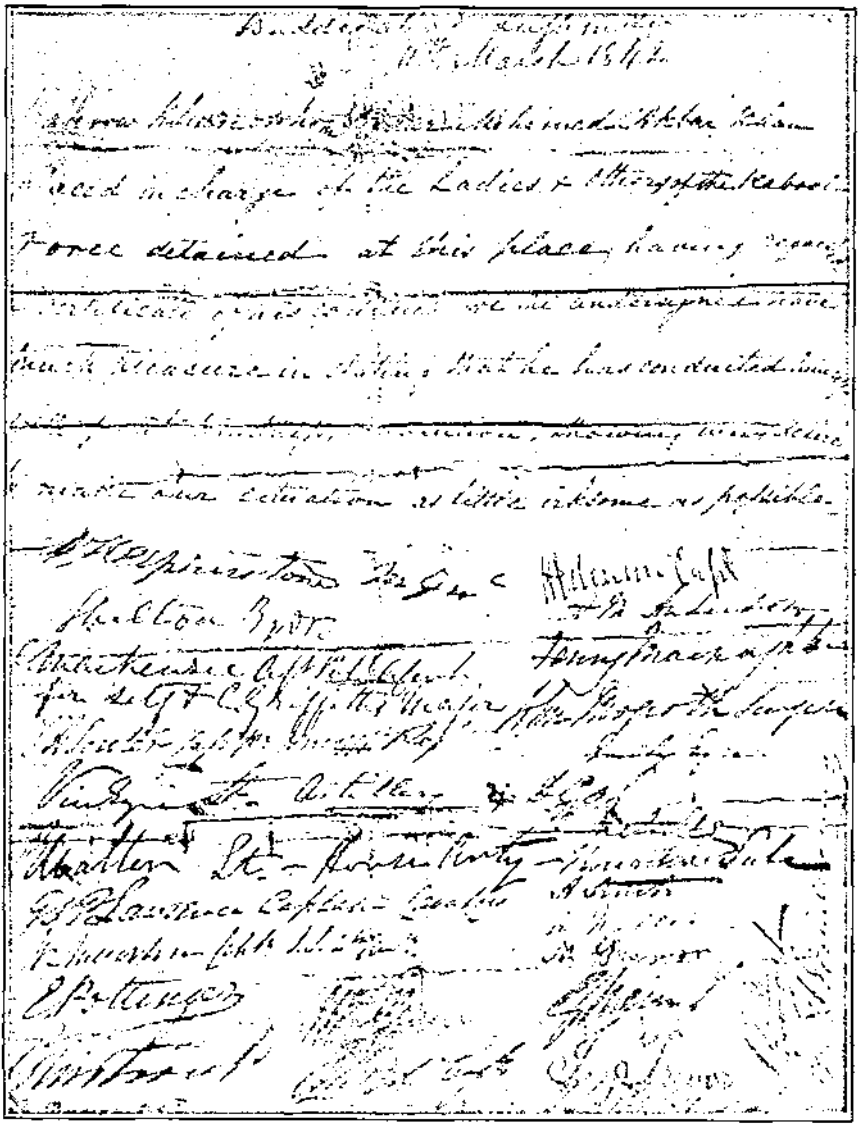
A REMINISCENCE OF THE FIRST AFGHAN WAR.



Certificate given by the British Officers and Ladies held as prisoners by the Afghans, 1842.

says, "The Mirza is a kind of under jailer; to some he is civil and has been so to me; to some he is very rude." He handed over charge on 19th March, and his successor stated that he had been cheating the prisoners of their proper rations.

The signatures on the document include those of :—

Major-General W. G. K. Elphinstone, commanding at Kabul. He was a sick man throughout. He was seized by the Afghans while endeavouring to negotiate during the retreat, and died on April 23rd, while on the journey from Badiabad.

Brigadier J. Shelton, 44th Foot, on whom the actual command of the troops in action fell; seized at the same time as the General; was court-martialled on his return to India and honourably acquitted.

Captain Colin Mackenzie, 48th Madras Infantry, Political Agent, detained as a hostage on the 8th January, during the retreat.

Major C. G. Griffiths, 37th Bengal Infantry, wounded and captured during the retreat.

Captain T. A. Souter, 44th Foot, wounded and captured at the last stand of the survivors of his regiment at Jugdalak. He wound the colour of the regiment round his body and saved it.

Lieut. Vincent Eyre, Bengal Artillery, later Major-General Sir Vincent Eyre; and Mrs. Eyre. They had one child with them. Eyre had been severely wounded in Kabul and accompanied his family when handed over to the *sirdars*. He wrote an account of the Kabul Insurrection.

Lieut. R. Waller, Bengal Artillery, and Mrs. Waller. They had one child with them. Waller had also been wounded in Kabul and accompanied his family. Another child was born at Badiabad.

Captain G. S. P. Lawrence, 2nd Bengal Cavalry, Military Secretary to the Envoy, brother of John and Henry Lawrence; commanded the General's escort; delivered as a hostage with Mackenzie.

Captain W. Anderson, 59th Bengal Infantry, commanding the 2nd Cavalry of Shah Shuja's Army, and Mrs. Anderson. They had two children with them. On the 10th January, Anderson was ordered by the General to leave the Army and join his family. His men, who had done well up to date, then deserted.

Major Eldred Pottinger, Bombay Artillery; famous as the defender of Hirat for the Afghans against the Persians; Political Agent in Kohistan. When the Gurkha regiment in Shah Shuja's service at Charikar (his headquarters) was overwhelmed by the Afghans in November, 1841, Pottinger made a remarkable escape to Kabul. He was surrendered as a hostage with Mackenzie.

Captain Colin Troup, 58th Bengal Infantry, Major of Brigade, Shah Shuja's Force; wounded during the retreat and accompanied the families.

Captain Bygrave (? 5th Bengal Infantry), captured during the retreat and was brought to Badiabad on 22nd January.

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A REMINISCENCE OF THE FIRST AFGHAN WAR.

THE frontispiece of this issue of *The R.E. Journal* is a reproduction of the certificate given to their Afghan guardian by the British officers and ladies who were captured, or given as hostages, during the retreat from Kabul in 1842. An exact copy of the certificate (rather larger than reproduced here) was found in 1897 in the Peshawar *bazar*, and has been sent to the Institution of Royal Engineers by Colonel Sir Sidney Burrard, *Bt.*, K.C.S.I., F.R.S.

It will be remembered that Major-General Elphinstone on 6th January, 1842, set out from Kabul on a promise of safe conduct to India. But the army was treacherously attacked on the march, and, hampered by its multitude of followers, destroyed. During the retreat, the ladies and children were handed over to the Afghan *sirdars*, who had guaranteed the immunity of the force, but were unwilling or unable to fulfil their promises. Certain British officers who had been taken prisoners, or surrendered as hostages, joined them. All were taken to Badiabad, in Lughman, where they remained from 17th January till 11th April, when the defeat of the Afghans at Jalalabad by Sale on 7th April caused their captors to remove them further from hope of rescue, and they were eventually taken to Bamian in the Hindu Kush. After General Pollock had retaken Kabul, they were rescued, and reached Kabul on 27th September, 1842.

The recipient of the *chit*, described as Bohari Khan, appears to be Mirza Bowadin Khan, who was in charge of the prisoners at Badiabad. Lady Sale, in her *Journal of Afghanistan, 1841-2* (11th March), says, " The Mirza Bowadeen Khan is getting a paper signed by us all, to say he has treated us well; from whence we suspect he thinks our party will eventually gain the ascendant." It seems that this must be the document now reproduced. Lady Sale also

Capt. H. Johnson, 26th Bengal Infantry, Paymaster and Commissariat Agent, Shah Shuja's Force. Seized at the same time as the General.

Lady Macnaghten, widow of Sir William Macnaghten, Envoy to Shah Shuja, treacherously murdered on December 26th, 1841, while holding a conference with the Afghan *sirdars*.

John Magrath, Surgeon, 37th Bengal Infantry, captured during the retreat.

Lieut. Melville, 54th Bengal Infantry, wounded and captured during the retreat.

Lady Sale, wife of Major-General Sir Robert Sale, who had marched with his brigade to Jalalabad shortly before the Kabul outbreak. Lady Sale was wounded during the retreat. She kept a Journal which was afterwards published and is very well known.

Mrs. Sturt, widow of Lieut. J. C. D. Sturt, Bengal Engineers. He was mortally wounded during the retreat, and died just before his wife was handed over to the *sirdars*. He had done remarkably well at Kabul, and played very much the same role as Broadfoot at Jalalabad; but his advice was disregarded. Mrs. Sturt was the daughter of Lady Sale, and gave birth to a daughter at Badiabad.

M. and J. Trevor.—Capt. R. S. Trevor, 3rd Bengal Cavalry, in Political employ at Kabul, was murdered at the same time as Sir W. Macnaghten. He left a wife and seven children at Kabul. These signatures are presumably those of Mrs. Trevor and one child.

Lieut. G. Mein, 13th Foot, had been severely wounded in October, 1841, and accompanied the families.

Conductor Ryley, Ordnance Commissariat, and Mrs. Ryley, left the Army with the families. They had three children.

Captain Boyd, Assistant Commissary General, and Mrs. Boyd. They had two children, and a third was born at Badiabad.

Mrs. Mainwaring apparently the widow of an officer who had been killed or died in Kabul; presumably Lieut. J. I. Mainwaring, 42nd Bengal Infantry. She had one child with her.

R.E. CO-OPERATION WITH THE TANK BRIGADE.

By CAPTAIN C. T. EDWARDS, R.E.

INTRODUCTION.

THE Tank Brigade, which was formed in the spring of 1934 from the 1st (Light) Battalion, and the 2nd, 3rd and 5th (Mixed) Battalions, has just completed its second collective training season. No one who has seen the Tank Brigade functioning can fail to be impressed with the tremendous possibilities of such a force, and also with the difficulty of grasping its true functions. The handling of the Tank Brigade, in such a manner as to obtain the best value from its immense offensive and defensive powers, is a matter of extreme interest to all soldiers. But, to the Sapper it is also a matter of considerable personal importance. The operations of the Tank Brigade, whatever form they may take, will call for a certain amount of R.E. co-operation.

Upon the way in which the Tank Brigade is handled will depend the type of R.E. co-operation which it will require.

There is undoubtedly a certain amount of confusion of thought on this subject of R.E. co-operation with the Tank Brigade at the moment. Popular imagination has been captured by the conception of the long-distance strategic role of the Tank Brigade and by the demolition raid. These functions of the latter formation are apt to conjure up ideas of a special R.E. unit, moving in tanks and able to satisfy all the R.E. requirements of the Tank Brigade in a detached role. This article is written with the hope that it may assist in making clear the kind of R.E. assistance that will be required by, and can be supplied to, the Tank Brigade when the latter is detached on an independent role, and to furnish a suggestion as to the best means of providing that assistance.

The writer has just completed a two months' attachment to the Tank Brigade during the period of its company, battalion and brigade training at Tilshead and Hedge End Camps. It must be explained that the exercises carried out by the Tank Brigade during this period were not such as could throw very much light on the subject of R.E. co-operation. They were set with the object of elucidating some of the many other problems in connection with internal organization and control, and the development of tactical methods, with which the Tank Brigade, in this early stage of its evolution, is still engrossed.

The attachment was, nevertheless, of great interest, and gave the writer a very fortunate chance of being able, at close quarters, to study the methods of the Tank Brigade, and of forming some idea of its possibilities and limitations.

This article is based on the concrete study of no particular operations, but represents the conclusions arrived at, as a result of the theoretical study of the R.E. problem of the Tank Brigade during the period of the attachment. The writer wishes to pay his acknowledgments to Captain R. P. G. Anderson, R.E., who was also attached to the Tank Brigade for a portion of its training season, and with whom the subject was exhaustively discussed.

The Method of Tackling the Subject.

The question of the R.E. co-operation that will be required by the Tank Brigade is by no means an easy subject. The principles governing the handling of normal formations are well known, as are also the limitations of the engineer troops which assist them. But in the case of the Tank Brigade, the way in which it should be handled is still a matter of study, and the way in which it can be handled will depend, to no small extent, on the way in which the Royal Engineers are able to satisfy its engineer requirements.

Speaking very generally, the Tank Brigade can be used either as an independent formation, or else in co-operation with other troops. It is clear that the independent role is the one in which the Engineers will find the greatest difficulties in satisfying the demands of the Tank Brigade. When in co-operation with other mobile troops it is evident that the R.E. requirements of the Tank Brigade will not be very different from those of any other mechanized formation, and they can be fulfilled by the engineers of the mobile formation with which it will be working.

In this article we will therefore consider firstly the action of the Tank Brigade on an independent role, and try to supply an answer to the following questions :—

(*a*) What are the R.E. problems of the Tank Brigade when the latter is acting on an independent role?
(*b*) Can these R.E. problems be solved, and, if so, what organization should be provided for doing so?

The subject will be treated on the following lines :—

(*a*) The organization of the Tank Brigade.
(*b*) The way in which the Tank Brigade may be expected to function on an independent role.
(*c*) The attributes of any R.E. that may be required to accompany the Tank Brigade on an independent role.

(*d*) The principles which guide the allotment of engineer troops to formations, and their application to the present case.

(*e*) The various R.E. problems that will arise when the Tank Brigade is acting independently, and what their solution will involve.

(*f*) A suggested organization to meet the R.E. requirements of the Tank Brigade.

The question of the Tank Brigade acting in co-operation with other troops will then be briefly dealt with.

THE ORGANIZATION OF THE TANK BRIGADE.

The Tank Brigade consists of Headquarters, one Light Battalion and three Mixed Battalions.

All wheeled vehicles within the Brigade are organized into the Brigade " B " Echelon, which has its own Commander. Within " B " Echelon vehicles are organized into battalion " packets " for ease of administration and command.

THE WAY IN WHICH THE TANK BRIGADE MAY BE EXPECTED TO FUNCTION IN AN INDEPENDENT ROLE.

When complete with its " B " Echelon, the Tank Brigade is able to function as a self-contained unit for a limited space of time. That is to say, it can remain in enemy occupied country, with no concern as to an L.-of-C., so long as its essential supplies hold out. " A " Echelon of the Brigade, which is all tracked and armoured, is impervious to small arms fire, and fears no lethal ground weapons except well-sited artillery and anti-tank guns. " B " Echelon, on the other hand, is very vulnerable, as it is completely unarmoured, and considerably tied to the roads. It will need protection while on the move, but even so, it will still be vulnerable to the fire of well-placed light automatics to the flank of its route, to a low-flying attack by aircraft, or even to bold unformed enemy bodies.

On an independent role, detached from any L.-of-C., " B " Echelon must be a constant source of concern to the Tank Brigade, and the necessity for its protection might even affect the Brigade Commander's ability to carry out his plan. It is obviously vital, therefore, for " B " Echelon to be kept to an absolute minimum. In an operation, " B " Echelon is likely to be kept as far back as possible, dispersed, and protected as far as possible in suitable lying-up places. When required to attend to the needs of " A " Echelon it will have to join " A " Echelon as rapidly as possible, and it may require a measure of protection as it does so. Having supplied " A " Echelon, it is likely to remain dispersed, stationary and protected, until it is again required to join " A " Echelon.

Even if it retains its own L.-of-C., the speed of action of the Tank Brigade, and the lack of personnel able to fight on foot, will prevent it from mopping up a captured area as it advances through enemy territory. Under these circumstances, and opposed by a stout-hearted enemy, it might not be possible for unarmoured vehicles to move freely in the wake of the leading formations of the Tank Brigade.

The Attributes and Limitations of any R.E. that may be Required to Accompany the Tank Brigade on an Independent Role.

The preceding paragraphs make clear the attributes, and limitations, of any R.E. co-operating with the Tank Brigade in an independent role.

(*a*) Any R.E. that may be required to move with " A " Echelon must be armoured and have cross-country capacity. This is merely in accordance with the general principle that the R.E. of a formation must have at least the same mobility (under all conditions tactical and strategical) as that of the formation itself. It is clearly not possible for unarmoured lorries to accompany " A " Echelon under conditions where they might become exposed to enemy small arms fire. This will necessitate the Sappers moving in some sort of Tanks. Their equipment must accompany them and might suitably move in some form of armoured trailer. Common sense will indicate that only a bare minimum of Sappers can be transported in this manner, as otherwise " A " Echelon would be overweighted with non-fighting tanks.

(*b*) Should unarmoured Sapper vehicles accompany the Tank Brigade, they must move with " B " Echelon. But this would increase the size of " B " Echelon, which is most undesirable. Furthermore there might be considerable delay and difficulty in getting the Sappers, when required, from " B " Echelon to the required site of work. Clearly, any R.E. who might travel with " B " Echelon, can only be few in numbers, and their usefulness will be limited by the fact of this possible time lag.

(*c*) R.E. required to reinforce the Tank Brigade, after it has embarked on its detached role, can only do so if the tactical situation allows. In any case, a reinforcement of this nature will of necessity impose a considerable delay on the Tank Brigade ; which might be most undesirable.

Any R.E. co-operating with the Tank Brigade in an independent mission must fall within one of the above three categories.

THE PRINCIPLE IN ALLOTTING ROYAL ENGINEERS TO FORMATIONS, AND ITS APPLICATION TO THE PRESENT CASE.

It is assumed that the Tank Brigade will not be " a cat that walks by itself," directly administered, as an entirely separate entity, by a Corps or G.H.Q. It will presumably be a portion of some mobile division, probably the most important portion, the rest of the mobile division being all mechanized, but unarmoured. In this case the mobile division will have its Divisional Engineers, made up of one or more Field Squadrons R.E. A special Tank Brigade R.E. unit would, if formed, be a unit of the Mobile Divisional Engineers.

The principle in allotting engineer troops to formations is to group them into a pool under the highest formation practicable, and to organize the pool into a number of self-contained homogeneous units, each capable of being detached with a lower formation if necessary. It is an important principle, and one that every Engineer Commander has frequently to insist upon, that the sub-units of the engineer pool remain under the command of lower formations for as short a time as possible. The object of this method of allotting engineer troops is to achieve flexibility and to ensure that the engineer troops may always be concentrated to tackle the most important engineer problems of the moment.

It appears, therefore, that the engineer troops of the mobile division, referred to above, should be organized according to the above general principles. But between the Infantry Division and this Mobile Division, there is one great difference. All the Brigades of the Infantry Division are the same; the units of this Mobile Division will be different in the important respect of armour. Any Field Company of the Division is capable of being detached with any Brigade. It is so capable because its mobility, under all conditions, is the same as that of the Brigade with which it may be detached. An engineer unit, capable of being detached with the Tank Brigade in independent operations, must, if it is to move with " A " Echelon, be tracked and armoured.

But this will at once transgress the principle of flexibility, in that this Tank Brigade R.E. unit would be different from the other R.E. units of the Mobile Division. It would require different equipment, transport and training, and would not readily function as a unit of the Mobile Division's engineer pool. Such a unit is clearly wasteful of engineer personnel, and would involve considerable difficulties as regards the supply and replacement of engineer personnel and equipment in war.

It may be concluded, therefore, that, provided that the engineer requirements of the Tank Brigade can be otherwise catered for, a special Tank Brigade R.E. unit is to be avoided.

THE VARIOUS R.E. PROBLEMS WHICH WILL ARISE WHEN THE TANK BRIGADE IS ON A DETACHED MISSION, AND WHAT THEIR SOLUTION WILL INVOLVE.

Rafting for Light Tanks.

When confronted with a water obstacle, it is possible that the Tank Brigade might find a proportion of the crossings held and not destroyed. If it could be possible rapidly to pass over a few of the leading light tanks, these might well use their speed and punch to capture one or more of the defended crossings by attacking them from the rear. They might thus be able to forestall the destruction of bridges being prepared for demolition. For this purpose a swimming light tank is obviously the ideal, as it would be able to cross the obstacle without delay and without exposing any personnel to small arms fire.

But it is submitted that it must remain an ideal and nothing else. It would be so dependent on favourable local conditions that it could never be of general application. The leading light tanks must, perforce, depend on rafting for their crossings. For this purpose the improved folding boat equipment is the best solution at present available, although there is no " set " so far designed to meet the especial needs of the Tank Brigade. The Infantry Division set has been designed to cater for a variety of loads; a set designed to cater for light tanks only could be more compact and would require less transport.

Any rafting equipment, however, suffers from the following defects, looked at from the point of view of a fast-moving, armoured force on an independent role:—

(*a*) It requires an appreciable amount of transport for the equipment and rafting party.

(*b*) There will be an appreciable pause while the equipment is brought up to the site and assembled.

(*c*) The rafts must be constructed and worked by unprotected men, *i.e.*, a bridgehead will nearly always be required.

(*d*) The existing equipment is very vulnerable to hostile small arms fire when on the move. (It is not considered a practical proposition to render equipment lorries proof against small arms fire on account of the two objections of (a) special equipment and (b) loss of performance.)

(*e*) The rafting party will also be vulnerable whilst on the move unless it travels in tanks. (Armoured lorries are not practical.) But since some twenty-five Sappers will be required to construct each ferry, and at least two ferries must be allowed for, it is fairly certain that the rafting party must travel, not in tanks, but in unarmoured lorries.

It may be concluded, therefore, that the Royal Engineers can undertake to provide rafts to pass the leading light tanks across a water obstacle, subject to the following limitations:—

(*a*) The equipment and personnel will be unarmoured, and must, consequently, travel with "B" Echelon. They may need protection when moving forward to the rafting site.

(*b*) The Tank Brigade Commander will only be able to use his rafting personnel under conditions such that the rafting can be carried out without undue loss.

This rafting will not call for any special Tank Brigade R.E. unit, but could be carried out by any suitable detachment from the Engineers of the Mobile Division.

Bridging.

To pass the Tank Brigade across a water obstacle must entail the construction of a bridge, as opposed to rafting.

The existing pontoon equipment, as adapted for "heavy" loads, is capable of taking all the loads in the Tank Brigade, and it is sufficiently flexible to apply to any water obstacle that is likely to be met with. Its carriage entails the use of a large amount of M.T., not less than seven or eight 3-ton 6-wheeled lorries, and trailers, per 100′ run of bridge. Its construction will entail a party of not less than 80 Sappers for a bridge of 100′ run or over. Its construction is a comparatively slow process, something in the nature of three hours per 100′ run of bridge if there are no difficulties in getting the equipment to the site. If wheeled vehicles, in addition to tracked vehicles, are to use the bridge, the improvement of the approaches may take as long as, or longer than, the construction of the bridge itself. In view of the concentration of men and vehicles that is inevitable at the bridge site, it is clear that a considerable bridgehead must always be formed before work can be started.

In view of the above facts, it is submitted that a bridging operation, to pass the Tank Brigade over a water obstacle, can never form part of an independent operation carried out by the Tank Brigade. If a bridging operation is necessary in order to enable the Tank Brigade to reach its objectives, this must take place before the Tank Brigade's leash is "slipped." This operation will then be a function of the Engineers of the Mobile Division to which the Tank Brigade will belong. It will be an operation precisely the same, in its main principles, as that envisaged in *Engineer Training*, Vol. II, 1926, paras. 61 and 62.

As pointed out by Captain Daldy in the September, 1935, number of *The R.E. Journal*, the present pontoon equipment was designed mainly for "medium" and not for "heavy" loads. It is possible

that pontoon equipment, designed specifically for "heavy" loads, might be easier to handle, and to transport, than is the existing pontoon equipment, as adapted for heavy loads.

Offensive Demolitions.

It has been suggested that one of the roles of the Tank Brigade might well be a raid, far into enemy occupied territory, with the intention of destroying some installation or object of vital importance to the enemy, or whose destruction might have far-reaching moral or strategic results. In addition to any problems involved in getting there, the Tank Brigade would require of the Royal Engineers, for such a raid, a small highly skilled demolition party, able to carry out the necessary vital damage in a short time and with the minimum of stores.

Investigation has shown that certain installations and organizations lend themselves to a demolition raid of this nature because they possess some vital portion, easy to destroy, whose destruction will prevent the whole installation from functioning for a considerable period.

Where the one vital spot is lacking, the installation will usually not be a suitable objective for a demolition raid, in that its destruction will call for more Sappers, explosives and time than would be available. Among the installations that are suitable for a demolition raid are a railway junction, a power station, a gasworks, a factory which has its own power supply, and a signal centre. Dumps of any description are unsuitable, since the dispersed nature of their layout will necessitate their being attacked in a number of places at once. In any of the cases just mentioned the amount of explosives and stores that would be required will not exceed a total of from 6 to 8 cwt. The use of electrical firing will be normal, that of power tools exceptional.

It is considered that a party of 12 to 16 Engineers will be sufficient to tackle any of the installations mentioned. Their attributes must be:—

(*a*) A high degree of skill in handling explosives.

(*b*) Ability to lay charges of the particular type that will be required.

(*c*) Knowledge of the exact places to lay their charges in order to achieve the maximum damage.

(*d*) A proportion of the party should be familiar with the workings of the installation to be attacked in order to ensure that the parts attacked are really vital.

(*e*) They must move in tanks with "A" Echelon of the Tank Brigade, and their explosives and stores must accompany them.

This task will not call for a separate Tank Brigade R.E. unit. A demolition raid is not likely to be of frequent occurrence: when it does take place, a certain amount of preparation will always be necessary. It should always be possible, therefore, to make up the particular detachment required for a specified raid, out of the resources of the Mobile Divisional Engineers. The latter should therefore contain a pool of officers and men, some of whom are familiar with the workings of all the installations suitable for attack, and all of whom are skilled in handling explosives and know how to lay the particular types of charges that will be called for.

Defensive Demolitions.

The preparation of defensive obstacles to cover a line of withdrawal *e.g.*, craters in defiles, and demolition of bridges may be one of the R.E. tasks required by the Tank Brigade in an independent operation. This will necessitate one or more self-contained " R.E. demolition units " able to move with " A " Echelon of the Tank Brigade.

The " R.E. demolition unit " will consist of about 8 to 10 personnel, power tools, and about 7 to 10 cwt. of explosives and equipment. Three medium tanks with trailers could transport one " unit." A " unit " could only tackle one job at a time, or perhaps two if they were sited close together. If the need for defensive demolitions was likely to be felt, at least two " units " should accompany the Tank Brigade, possibly three, to meet the case of the Tank Brigade retiring with the three Mixed Battalions on separate routes.

The necessary attributes of the " units " would be a high degree of technical skill in carrying out hasty demolitions. In view of the fact that the " units " would usually work independently, each one should be commanded by an officer.

The Removal of Obstacles.

An enemy is extremely likely to try to stop the Tank Brigade by making craters in defiles, and by using other forms of obstacles such as felled trees and telegraph poles, *débris* from a brick arch, loading up and wrecking heavy vehicles, etc., etc.

To take the latter type of obstacles first. If they cannot be dragged out of the way using the power of the tanks, they can only be removed by blowing them up, cutting them with explosives, cutting them up with a power saw, or removal by hand. This will necessitate the presence of R.E. personnel and their equipment, including power tools, with " A " Echelon of the Tank Brigade. The R.E. unit, to tackle a job of this nature, will again be about 8 to 10 men, with power tools, travelling in tanks.

It is not possible, in the absence of a concrete case, to say whether such an R.E. unit would be able rapidly to remove an obstacle. If

the R.E. unit were near the site, and the obstacle were a simple one, no great check need be imposed on the Tank Brigade. But this is the best possible case ; an enterprising enemy is quite likely to erect a number of obstacles in series. Speaking generally, it is a fairly safe assumption that the removal of most obstacles would cause a most undesirable check to the progress of a fast-moving tank force. It would usually be far quicker to try and find a way round. One may conclude, therefore, that an R.E. party of this nature would only be required in the very few cases where it was absolutely essential to clear a certain route. But as the Tank Brigade could scarcely afford to be without the means of clearing obstacles, it is considered that at least two " obstacle clearing parties " should accompany the Tank Brigade when acting independently, or perhaps three to meet the case of the three Mixed Battalions moving on separate routes.

As regards road craters. If there is no way round a crater, the fact must be accepted that to overcome this type of obstacle will take a considerable time. There are merely the three methods of—filling it in, bridging it, or constructing a deviation. The former method will only apply when there is available on the spot local material such as sleepers, logs, fencing or brushwood, etc., but even in this case to cross the crater will be a matter of hours.

To bridge the crater will involve the use of trestles and superstructure, or else some form of box girder equipment. To make a deviation may very likely do so as well. Any bridging equipment would have to travel at least as far back as " B " Echelon, and, during an advance, it might well be some hours distant from where it was required. The bridging equipment might be handled by the obstacle removal parties, but these might well be distributed among two or more separate columns. It would be sounder for the bridging equipment to be handled by separate detachments moving with the equipment. In any case, however, the presence of the bridging equipment and personnel with " B " Echelon would be most unwelcome with that all too large body. The Tank Brigade Commander might well prefer to risk being able to find a way round craters rather than incommode himself to this extent.

It would be possible, of course, to devise some special form of equipment designed to cope with craters, and nothing else. This might take the form of a medium tank carrying two light spans on its back. If a crater was encountered, this tank could slither into it, act as a " pier," and use its two spans to connect with the rear, and the far lips. This method would, of course, involve the disadvantages always connected with " special equipment."

It may be concluded that, it improvisation is not possible, the only method of surmounting a crater obstacle will be to use bridging equipment and a bridging detachment. This would, at the discretion of the Tank Brigade Commander, either move with " B " Echelon,

or be kept ready with the nearest co-operating troops. In any case this task could be carried out by any suitable detachment from the Mobile Divisional Engineers.

R.E. Reconnaissance.

It would be normal for two or more R.E. officers to accompany the Tank Brigade for R.E. reconnaissance. These would normally move with the Light Battalion, and might suitably travel in the tanks of that unit. It is not considered desirable that there should be special R.E. tanks for this purpose. These officers would have to be supplied by the Mobile Divisional Engineers.

Summary.

The following R.E. tasks only will necessitate R.E. personnel travelling with " A " Echelon of the Tank Brigade when the latter is on an independent operation :—

(*a*) Offensive demolitions.
(*b*) Defensive demolitions.
(*c*) The removal, or surmounting of obstacles.

The incidence of these tasks will depend on the role of the Tank Brigade, and on the circumstances and terrain in which it is operating. A detachment of 24 to 30 Engineers, travelling in tanks, with power tools, explosives and other equipment, should normally be sufficient to carry out all of these tasks. The power tools, and other equipment, would be most suitably transported in armoured trailers.

The remaining R.E. tasks, as under, should be carried out by suitable detachments from the Mobile Divisional Engineers, travelling in their own vehicles :—

(*a*) Rafting.
(*b*) Surmounting of craters.

In addition R.E. officers may be required to travel in the tanks of the Light Battalion to carry out R.E. reconnaissance.

A bridging operation, to pass the Tank Brigade across a water obstacle, can never be the responsibility of the Tank Brigade alone. It will be a function of the Mobile Division as a whole, and will be carried out by the latter and its Divisional Engineers.

THE SOURCE OF SUPPLY OF THE ENGINEERS REQUIRED TO TRAVEL WITH " A " ECHELON OF THE TANK BRIGADE.

In designing an R.E. unit it is necessary to cater for the normal, and not the unusual. We have noted that a separate Tank Brigade R.E. unit is most undesirable. Furthermore it will not be warranted unless it will be normal for the Tank Brigade to be detached on an independent operation of such a nature that an R.E. unit is required

to travel with " A " Echelon of the Brigade. As there is no answer, at present, to this question, it will be necessary to make the following assumptions as regards the handling of the Tank Brigade :—

(*a*) That when launched on an independent mission, the Tank Brigade will be supported for as great a distance as possible by the Mobile Division, or elements of the latter, as circumstances may require, in order to conserve the energy of the former until the last possible moment. The major R.E. problems will fall within, and will largely dictate, the period during which the support of the remainder of the Mobile Division is available. These R.E. problems will therefore fall to be dealt with by the Mobile Division through the agency of its Engineer unit, and will not be the responsibility of the Tank Brigade, or of any R.E. personnel who may accompany it.

(*b*) That the Tank Brigade will be finally launched on its independent mission under such circumstances that the R.E. problems it may encounter will be as few as possible.

In view of this conception of the handling of the Tank Brigade, and of the disadvantages inseparable from the establishment of a small " special " unit, it is considered that no permanent allotment of Engineers should be made to the Tank Brigade. Any personnel which may be required to accompany the Tank Brigade from time to time should be drawn from the full resources of the Mobile Divisional Engineers, the necessary tools and stores being drawn from the Headquarters of that unit. Those personnel required to travel with " A " Echelon of the Tank Brigade should travel in tanks, their tools and stores being carried in armoured trailers. This latter should be the normal method of carriage, within the Mobile Divisional Engineers, of these tools and stores.

The tanks, to carry the R.E. personnel, should preferably be box tanks. These, and their drivers, might be provided in one of two ways :—

(*a*) They might be part of the equipment and personnel of the Mobile Divisional Engineers.

(*b*) They might be part of the equipment and personnel of the Tank Brigade.

Each solution has its advantages and disadvantages.

If R.E. vehicles and drivers, they would be available, without delay, the moment the necessity for their use arose. The driver and spare driver, being R.E. personnel, would be included in the numbers required for work on reaching the objective. Since R.E. personnel would have to be trained in the maintenance of the tanks, the incidence of the latter could be shared within the unit. On the other

hand, the tanks would constitute an additional complication in a unit not otherwise concerned with tracked vehicles, and their use, moreover, might well be the exception and not the rule. The personnel driving them would have to spend a considerable portion of their time with the Tank Brigade, in order to be *au fait* with the drill movements, and methods of control, of the latter. Furthermore, the provision and replacement of trained drivers would be a considerable complication in war.

If R.T.C. vehicles and drivers the above complications would not arise. Moreover the vehicles would be available for other purposes when not required for the transport of R.E. personnel. The main disadvantage would be the replacement of two R.E. personnel by the R.T.C. driver and spare driver, involving the provision of more tanks for the transport of R.E. personnel.

On balance it would appear preferable for the box tanks required to be manned, and maintained, by the R.T.C. They would, presumably, be part of Tank Brigade H.Q.

THE ORGANIZATION OF THE MOBILE DIVISIONAL ENGINEERS.

The organization of the Mobile Divisional Engineers should therefore be such that :—

(*a*) For all independent missions of the Tank Brigade, it can readily detach the necessary numbers of personnel, with the requisite technical qualifications, and armed with the necessary tools and stores, to accompany the Tank Brigade.

(*b*) For purposes of command and administration, and the performance of "fieldworks" roles (*e.g.*, bridging, water supply, camp services, etc.), it can readily detach a sub-unit or units (*e.g.*, a section or troop) to carry out R.E. work for the Tank Brigade, or any other unit of the Mobile Division.

In order to achieve flexibility it is considered that the organization should be on the following lines :—

(*a*) Commander.

(*b*) Headquarters Section (includes personnel required to maintain "grouped" stores and to operate "grouped" machinery).
- "A" Group. Administration, Workshop lorry ; Divisional lighting set, if provided.
- "B" Group. Bridging stores.
- "C" Group. General stores, explosives, trailer compressors. Tools for the Tank Brigade detachment.
- "D" Group. Unit "B" Echelon transport.

(*c*) A number of homogeneous sections, each with its own field tools.

The whole to be fully mechanized.

Other points in connection with the Mobile Divisional Engineer unit are as follows :—

(*a*) All personnel of the unit should be trained so that they are capable of being detached with the Tank Brigade if necessary.

(*b*) The officers and N.C.O's of any section could form the nucleus of the Tank Brigade detachment, the other personnel being chosen as required. It is considered that it would be a wrong principle, involving specialization, for any particular section of the Mobile Division R.E. unit to be considered as the normal source of the Tank Brigade R.E. detachment. All the men of the unit should be equally trained in this respect, and it should be left to the unit Commander to choose the most suitable men to meet any particular case.

(*c*) The works to be carried out by the unit would be largely of the "fieldworks" nature. As "fieldworks" training is independent of a man's trade, the trades in the unit should contain a large proportion of the electrical and mechanical type, such as electricians, fitter drivers, fitters, moulders, blacksmiths, drivers (steam engine) and fitters (railway signal). Men of such trades will be most readily afforded the necessary opportunities, in peace, to familiarize themselves with large installations, such as would form the object of a demolition raid.

(*d*) The officers of the unit should have some E. & M. experience, though not necessarily full E. & M. qualifications. In view of the needs for R.E. reconnaissance over a wide front, the proportion of officers must be high.

(*e*) The unit equipment should include folding boat equipment for rafting, and sufficient pontoon equipment to suffice for the crossing of canals and small streams. All box girder equipment, and the majority of the pontoon equipment, should be held in a G.H.Q. Pontoon Bridge Park.

The Training of the Mobile Divisional Engineers.

The attributes of the Mobile Divisional Engineer unit would appear to be :—

As Mobile Divisional Engineers.

A high standard of training in fieldworks.

A high standard of collective training to ensure smooth working in the unit.

Detachments with the Tank Brigade.

Ability to tackle offensive demolitions of all kinds.

A ready wit, and ability to improvise.

Suggested Scope of Training.

During the individual training season, in addition to trades training, facilities should be afforded to officers, and to all ranks of the trades concerned, to become *au fait* with the layout of installations of the types whose destruction may be contemplated in war. The technical methods of carrying out such destruction should be studied and practised by the whole unit.

In the early part of the collective training season, normal field-works, bridging and demolitions should be carried out with special reference to the requirements of the Mobile Division and the Tank Brigade (it should be noted that certain of the training carried out by Field Company Sappers would not be required in the Mobile Divisional Engineers).

During the collective training season the aim should be the closest possible co-operation with the manœuvres of the Mobile Division and the Tank Brigade, irrespective of whether peace-time conditions and facilities make it possible to put fully into practice the technical knowledge and ability gained during the individual training season.

It should be stressed that, though some of the training of the Mobile Divisional Engineers will be common to all field Sappers, yet their training, as a whole, will be different from that of other Royal Engineer units. Frequent changes in the personnel, including officers, is therefore to be deprecated. Officers and other ranks, transferred to the Mobile Division Engineers from other branches of the Corps, would not be efficient members of the unit for a considerable period.

THE TANK BRIGADE IN CO-OPERATION WITH OTHER TROOPS.

If the Tank Brigade is acting as the leading Echelon of the Mobile Division, it may require R.E. assistance. This assistance should not normally, however, require any R.E. personnel to travel in armoured vehicles. If the remainder of the Mobile Division—who will, presumably, all move in unarmoured vehicles—is to follow on in rear of the Tank Brigade, one of the functions of the latter will be to ensure that no enemy bodies are able to surprise the former while on the move. Vehicles of the Mobile Division would thus be able to follow on close behind the Tank Brigade, and could take with them any Engineer personnel required. Any R.E. assistance required by the Tank Brigade under these circumstances could therefore be undertaken by suitable detachments from the Mobile Divisional Engineers, moving in their own vehicles.

THE NORTHERN RHODESIA—BELGIAN CONGO BOUNDARY COMMISSION, 1927-33.

By CAPTAIN A. W. HEAP, R.E.

THE boundary between Northern Rhodesia and the Belgian Congo [see Map] was defined by the Agreement of 12th May, 1894, as follows: "The frontier between the Independent Congo Free State and the British sphere to the north of the Zambezi shall follow a line running direct from the extremity of Cape Akalunga on Lake Tanganyika, situated at the Northernmost point of Cameron Bay at about 8° 15′ South Latitude, to the right bank of the River Luapula, where this river issues from Lake Moero. This line shall then be drawn directly to the entrance of the river into the lake, being, however, deflected towards the South of the lake so as to give the Island of Kilwa to Great Britain. It shall then follow the thalweg of the Luapula up to its issue from Lake Bangweolo. Thence it shall run southwards along the meridian of Longitude of the point where the river leaves the lake to the watershed between the Congo and the Zambezi, which it shall follow until it reaches the Portuguese frontier." Thus the boundary comprises five sections: (i) The Mweru-Tanganyika section, (ii) Lake Mweru, (iii) The Luapula River, (iv) The Meridian section, (v) The Congo-Zambezi Watershed section. Sections (ii) and (iii) obviously require no demarcation; we are here, therefore, concerned only with sections (i), (iv) and (v).

Between September, 1911, and August, 1914, an Anglo-Belgian Boundary Commission carried out a topographical survey, and produced maps, three sheets on a scale of 1/200,000, and the rest on a scale of 1/250,000, covering a belt of approximately ten miles each side of the boundary, for these three sections. Taking into consideration the type of country, which is mostly forest, these maps are excellent, and greatly simplified the work of the 1927-33 Boundary Commission. Though errors of a mile or more in places, and such trifles as a few rivers flowing in the wrong direction and one hill whose printed height differs from its actual height by 500 feet, may seem excessive to those who know only the Ordnance Survey maps of Great Britain. Of the 1911 maps, the 1927-33 Commission found the Belgian version most reliable round the trig. points, and the British version along the main bush paths!

The 1911-14 Commission also erected boundary marks, consisting of 6-foot lengths of iron pipe, with a flange at the end buried in the

ground, along the Congo-Zambezi Watershed section from Boundary Pillar 11 to B.P.46 at average intervals of about 20 miles; and they had also erected a pillar of stones and cement at B.P.1, where the Watershed section and the Meridian section meet (Photo 1): while the Belgians had independently erected huge cairns of stones about eight feet high and twelve feet diameter at the base, to mark B.P's 2 to 10. The completion of the work was presumably interfered with by the outbreak of war in August, 1914. The demarcation on the ground of the Mweru-Tanganyika section was not carried out, largely owing to it being found impossible to locate "Cape Akalunga" with any certainty.

About 1925 or 1926, rich copper deposits were found in Northern Rhodesia and the Katanga province of the Belgian Congo, some of which were very near the boundary. In particular Kipushi mine, which the Belgians were working, was alleged by some Northern Rhodesian copper-mining interests to be in Northern Rhodesia. Clearly, boundary marks at 20-mile intervals are insufficient when valuable mineral deposits are at stake—Kipushi mine was subsequently found to be only 300 to 400 yards inside the Congo. It was, therefore, decided to send out a Boundary Commission, comprising a British and a Belgian section, charged with the "intensive demarcation" of the boundary in the copper belt.

The British section, under Lt.-Col. D. Cree, R.E., arrived in Elisabethville about the end of June, 1927. When approaching the station in the train from Sakania, they heard a band playing on the platform. Hastily tightening belts and polishing buttons, they prepared impromptu speeches in their best French, calculated to suit this enthusiastic welcome. As the train drew up, however, the band was found to be at the other end of the platform, welcoming the return of a victorious football team: and the Commissioners quietly slipped away to their hotel, shepherded by a small boy representing Messrs. Thos. Cook & Son. After a few days had been spent in Elisabethville, in arranging a programme of work in conjunction with Col. Gendarme, the Senior Belgian Commissioner, the Commission started work on the Watershed section, concentrating first on the stretch of boundary in the neighbourhood of Kipushi.

The orders for the demarcation of the Watershed section were, briefly, as follows. The boundary was to be marked on the ground by means of a clearing, five metres wide, through the bush, in a series of dog-legs of average length 500 metres, approximating as closely as possible to the ideal Watershed, in such a way that the give and take of each country should be approximately equal (Photo 3). At the end of each leg a boundary pillar was to be erected; a Main B.P. at approximately every five kilometres; an Auxiliary B.P. at all other points; adjacent pillars to be intervisible. Main B.P's (Photo 2) were concrete pillars, about one and a

THE NORTHERN RHODESIA-BELGIAN CONGO BOUNDARY COMMISSION, 1927-33.

Photo 1.—The old (1914) B.P.1.

Photo 2.—Main boundary pillar—B.P.1.

Northern Rhodesian - Belgian Congo Boundary 1 - 2

Photo 3.—A portion of the boundary clearing and traverse path.

Photo 4.—Auxiliary boundary pillar B.P.1/A.

half metres high, of square plan with a side of one metre at the base, tapering slightly towards the top, with foundations one metre deep. The survey mark consisted of a used cartridge case embedded in the centre of the top of the pillar. An Auxiliary B.P. consisted of a 2-inch iron pipe, two feet long, driven into the ground so as to leave two or three inches above the surface, filled with cement in which the cartridge-case survey mark was fixed: a cairn of stones about one metre diameter and one metre high was then built over the pipe (Photo 4). Around both main and auxiliary B.P's drainage trenches were dug.

The boundary having thus been demarcated on the ground, its position on the surface of the earth was to be fixed: and plans drawn on a scale of 1/10,000, showing the size of the angle at the ends of each leg, the length of each leg, and the position of each B.P. These plans serve not only as a record of the boundary, but also facilitate the replacement of any B.P's which may be destroyed, whether by accident or owing to the value of metal in the eyes of the native population. Arrangements have been made for the boundary to be perambulated periodically, and the 5-metre clearing kept open, by the Governments of Northern Rhodesia and the Belgian Congo.

In May, 1928, Lt.-Col. A. B. Clough, M.C., R.E., took over command of the British section, the other members of which were Capt. D. A. Learmont, R.A., Lt. C. G. Stainer, R.E. (Assistant Commissioners), Dr. Evans (Medical Officer), Mr. Lunn (Geologist), four R.E. N.C.O's (Surveyors), one R.E. N.C.O. (Clerk), and Capt. Graham of the Northern Rhodesian Police (now the Northern Rhodesia Regiment) in charge of the Askari escort. The full story of the first two years of the Commission cannot well be written by one who was not there. We can, therefore, here do no more than record the fact that by November, 1929, the Commission had completely demarcated the boundary, and had erected the boundary pillars, along the Watershed section from B.P. 11 to B.P. 33, both inclusive, and had located the Watershed and cut the 5-metre clearing, between B.P's 33 and 34. Their Major Triangulation control was based on the Tshinsenda Base, measured by the *Comité Spéciale du Katanga* (the " Ordnance Survey " of Katanga), and extended from B.P. 11 to the line Itembe-Chantete. The tenure of the appointments of the members of the Commission had by then expired, and they returned home.

In the meantime it had been decided to demarcate the whole of the boundary, and not to confine the activities of the Commission to the Copper Belt. It therefore became necessary to replace those who were due to return home. Lt. N. A. M. Swettenham, R.E., was sent out as Assistant Commissioner in June, 1929; and he thus formed a link between the old and the new personnel. When

the rest of the Commission went home in November, 1929, he stayed behind with Sjt. Burne of the N.R.P. who had replaced Capt. Graham, and Lce.-Cpl. Biggs, R.E., the Commission clerk.

The new Commission sailed from England at the end of February, 1930, under the command of Lt.-Col. E. R. L. Peake, M.C., R.E., and arrived in Elisabethville on 29th March, with the exception of Col. Peake, who broke his journey at Livingstone for one day to make his bow to the Governor of Northern Rhodesia. It was indeed fortunate that he arrived in Elisabethville a day later than the rest of the Commission, as it was thus possible to send him a telegram to warn him of the right royal reception awaiting him. Not having expected anything of this sort, he was already, by the time he got the telegram at Sakania, the frontier station, attired in bush kit. At Sakania he found waiting for him the special coach normally reserved for the General Manager of the *Chemins de Fer du Katanga :* and on arrival at Elisabethville he was met by the Governor's representative, the British Vice-Consul, Col. Gendarme, who had returned as Senior Belgian Commissioner, and other high Belgian officials—and he had reluctantly changed once more into the uncomfortable clothing of civilization.

Three hectic days were spent in Elisabethville, during which the Commission was given a most hospitable reception by the Belgians, being entertained at luncheon parties, dinner parties and dances; the officers had the honour of dining with His Excellency the Governor of Katanga, who also placed one of his own cars at their disposal, so that they might see in comfort all the sights of Elisabethville. It is a beautiful town, with imposing buildings and wide roads lined with jacarandas and other flowering trees. Luxurious motor-cars are to be seen everywhere, and the up-to-date shops and *cafés* give one the impression of being in a European city rather than in the midst of limitless bush country in " darkest " Africa. One is reminded that one is in Africa on Sunday afternoons, when the native cycling clubs hold bicycle races through the streets of the town, to the accompaniment of wild enthusiasm.

After this round of gaiety in Elisabethville everybody felt that a spot of work would be quite a rest-cure. During the hiatus between the old Commission's departure and the new Commission's arrival, Swettenham had built a new base camp on the Niankasa stream near B.P.34, and about 140 miles from Elisabethville, and had transported the Commission stores from Col. Clough's last camp, Lunda, to Niankasa (*vide* map). He met the new Commission on their arrival at Elisabethville with the Commission's 1½-ton Chevrolet lorry and Morris-Oxford touring car and a hired lorry to take the rest of their three tons of baggage and stores. The journey to Niankasa took two days. To the new arrivals from home, two days

for the journey seemed rather excessive, as also did Swettenham's provision of a week's food at Lunda camp, where they arrived at the end of the first day. It was soon obvious that English ideas of motoring were quite out of place on the Congo-Rhodesia boundary. Once clear of Elisabethville the road ceased to be a road. As far as Kipushi it was reasonably firm, though bumpy: after which it got worse and worse, until it developed into a series of holes filled with mud—the rainy season had not quite finished—through which the car was carried by its momentum, if the driver's luck was in, or into which it sank with spinning back wheels, if his luck was out. It should be explained here that the roads in that part of the world are not, in general, metalled, but are merely clearings through the bush, often undrained, but usually having the tree-stumps and roots removed. That first journey was a lucky one, as no rain fell; and seven m.p.h. was averaged for the journey. After the first 50 miles or so the windscreen of the Morris tourer fell out; whether due to this excessive speed or to other causes it is now too late to surmise. This journey made one begin to realize what Swettenham and Sjt. Burne had had to contend with in moving the stores in the heart of the rainy season; and why the subject of cars and motoring, so popular a topic in England, seemed to fail to rouse any enthusiasm on their part.

On arrival at Niankasa camp, the Commission found everything ready for them: living huts, officers' and N.C.O's messes, store huts, huts for the natives, a medical inspection hut—in fact, accommodation for everyone and everything. The huts (Photo 5) were made of a framework of tree-trunks, thatched with grass which was fastened to the framework by strips of bark from a certain tree whose inner bark is easily stripped in long lengths. The pitch of the roofs had to be very steep to allow rain to run off instead of dripping through the grass thatch. The huts were kept warm by means of charcoal braziers made of old petrol tins with holes punched in their sides; the charcoal being obtained from half-burnt ashes of huge wood fires which were kept burning at a safe distance in front of each hut. In addition to all these arrangements already made for the Commission, each officer was provided with a native batman from the N.R. police escort; while cooks had been engaged for each member of the Commission.

About a month later Dr. F. W. Gilbert, of the Northern Rhodesian Medical Service, joined the Commission, which was now complete, and consisted of Lt.-Col. E. R. L. Peake, M.C., R.E. (Senior British Commissioner), Capt. A. W. Heap, R.E., and Lieut. N. A. M. Swettenham, R.E. (Assistant Commissioners), Dr. F. W. Gilbert (Medical Officer), four N.C.O.'s, R.E. (Surveyors), one N.C.O., R.E. (Clerk), one N.C.O., R.A.S.C. (Mechanic), and Sjt. Burne, N.R.P. (in charge, Police escort).

Work started at once. It was normally organized as follows.

Administrative work was carried out in the base camp, which, as its name implies, functioned as a fixed centre for a period averaging about six months, until the progress of the field work necessitated its move to a new site. Here also was carried out such work as computing, and the drawing of plans, after completion of the field work. The doctor also remained in the Base Camp, and ran the food store in addition to his medical duties. The boundary location work, which is described in Appendix 1 and Appendix 2 was carried out by the four N.C.O's (Surveyors) working in pairs, who also carried out the boundary traverse (Appendix 3). The triangulation, both Major and Minor (Appendix 4) was carried out by the two Assistant Commissioners, working separately, but in close liaison with one another. The British section was responsible for as nearly as possible half the boundary, and the Belgian Section for the other half, each checking the other's work. The Major Triangulation, however, and the Boundary Traverse were carried out by both sides.

The British section started work from B.P.34 to B.P.37. Along this section a road runs very close to the Watershed, so that supplies to the boundary location parties were easily sent by lorry from the base camp: while the trig. parties were able to estimate their progress and ask for supplies to be dumped on specified dates at certain points on the road which had to be crossed *en route* between trig. points. The country on this section was very flat, and the Watershed was often difficult to locate. At one place the location party had to make a sketch contoured at six inches V.I. along about a mile of the boundary, before any ridge could be discovered. Minor trig. points for connecting the Main B.P's to the Major Triangulation were usually located on large ant-hills, which existed in great numbers along this section (Photo 6), and long clearings had to be cut before the major trig. points were visible. For the Major Triangulation, sufficient isolated hills were available; though the new arrivals very soon discovered that working out a trig. scheme on the map is easy, but walking through the bush to find the points is another story. Until one gets accustomed to walking through bush country, with visibility restricted to about 50 yards, one gets a feeling of being hopelessly shut in (Photo 7). There were, however, a few open spaces where one could look round and get one's bearings (Photo 8). Further, we had not by then realized that bush paths shown on the map usually did not exist on the ground. The reason for this is mainly agricultural. The main paths connect up the villages, which consist of grass huts surrounded by gardens. Each year a new garden site is chosen, the trees on this site being cut down and burnt in the dry season, so enriching the soil for the rainy season when the crops are grown. After about five years of this, no fresh

Photo 5.—Officer's living hut—Mandowesa base camp.

Photo 6.—A large ant-hill.

Photo 7.—Typical bush—meridian section.

Photo 8.—An open space, or Dambo—*en route* to Tumba trig. point (in background).

sites are available, and so the whole village moves, and makes new paths, the old ones quickly becoming overgrown. For this same reason it was quite useless to try to find one's way about by going through villages marked on the 1914 map. In any case, the villages in this area were few. Fortunately, the undergrowth was not too thick, and it was, therefore, possible to walk across country.

The Triangulation was carried through to B.P.36, beyond which point the country becomes so flat that further trig. was impossible: though the Belgian section fixed B.P.39 from existing Triangulation in the Congo. It was, therefore, decided to fix the boundary points west of B.P.36 by precise traverse, using invar tapes in catenary (Appendix 5) over a stretch of about 200 miles, the Belgian and British sections each doing about half the distance, and checking each other's work, for gross errors only, by rapid measurement with steel tapes on the ground. This traverse was the most exacting work which we had to carry out, and took five months, working hours being from dawn to dusk, after which the traverse books had to be checked and duplicated. Although this traverse was carried out in the rainy season, astonishingly little time was lost through rain.

The traverse up to B.P.46 (Photo 9) was finished by the end of March, 1931. Swettenham then stayed at B.P.46 and made an astro. fix at that point as a check on the traverse, subsequently working along the boundary to B.P.36, and taking an astro. azimuth at alternate main B.P's to provide an azimuth control for the catenary traverse.

In the meantime, Heap and two N.C.O's were sent to carry out the trig. work between B.P's I and II. Three gangs of carriers met them at Bwana M'Kubwa, and they set to work at once, the two N.C.O's doing the beaconing, and Heap the observing. With no base camp behind them, and with all three parties moving rapidly, intercommunication and the organization of mails and food supplies were interesting problems; but with the aid of a carefully worked out programme, and a new Ford vanette, which Col. Peake had placed at Heap's disposal, and which he was able to use frequently while working between B.P.II and B.P.6, all went well. By the middle of May, Sjt. Burne arrived at B.P.6 to build the new base camp, after which the trig. parties were able to make use of him as a fixed centre for intercommunication: though they still had to organize their own carriers' food arrangements. Although villages were more numerous than in the previous area, it was found impossible to live on the country.

The country in this area was very different from the previous section, being very hilly, with many prominent peaks: so that the Major Triangulation was easy. The work was based on two points of the arc of the 30th Meridian, Chantuntile and Msenguli, which lay about 100 miles east of B.P.I, and was carried through to B.P.II

via two points of Colonel Clough's Triangulation, which was based on the Tshinsenda Base. The difference in the positions of B.P.11 as obtained from the two sets of figures was about 150 metres, which seems reasonably good when one takes into account the distances over which the Triangulation had been carried, and the fact that the Tshinsenda Base and the arc of the 30th Meridian had been measured independently of one another.

The Triangulation had to be carried out very rapidly, as there was a good deal of work involved (over 500 miles' walking for the observer) and visibility starts getting bad as soon as the rains are over, owing to haze and smoke from bush fires, until towards the end of June observation is impossible. The connection between the arc and B.P.11 was completed by the beginning of July, and only two points which were included in the original triangulation scheme had to be omitted owing to haze. These two points were observed the following year when the Meridian section was demarcated.

As soon as the Major Triangulation was completed, boundary location was started, and was well in hand by the time the rest of the Commission arrived at the Base Camp near B.P.6, at the end of July. The boundary in this area, far from being flat as in the previous area, ran for the most part along a sharp, rocky ridge. Location was thus simple, and could usually be done by eye. But the laying out of 500-metre legs, with their ends intervisible, was a different story. While the boundary traverse, with innumerable changes of slope in each leg, became a slow and laborious proceeding.

The Minor Triangulation was carried out by Swettenham, as soon as the rains started in September. In this area, owing to the sharpness of the Watershed ridge, it was found possible to fix most of the minor trig. points actually at the main boundary pillars, and not, as before, only on some adjacent ant-hill. Many of the main B.P's were located on prominent hills, and could be fixed from three or four major trig. points. B.P.4 was in an especially strong position, and Swettenham observed it as a major trig. point. This point proved invaluable the following year for the fixing of about half a dozen main B.P's on the Meridian section.

While in this area the Commission was instrumental in exorcising an evil spirit, which lived on Mumpu, the highest hill in the area, which was the key position for the Major Triangulation. The N.C.O. who went to beacon Mumpu was told by his carriers that he was wasting his time, as the beacon would not stay up. However, he feared the wrath of the spirit less than that of the trig. observer, and erected the beacon. But the natives were right, and the beacon was blown down within 24 hours. In the meantime, the observer had been seeing Mumpu Hill daily and wanted the beacon, which, according to programme, ought to have been up. Finally, when he reached a point where the major trig. would have broken down

without the ray to Mumpu, he went forward to see what had happened. On arrival at the foot of the hill, he saw a white man on top, and immediately rushed up, arriving decidedly out of breath after a 1,500-foot climb, to meet a prospector of one of the copper-mining concessions, who regretted that he had had to push the beacon over, as it had interfered with his geological investigations, and hoped his action had caused no inconvenience. The trig. observer panted out his unflattering opinion of geologists in general, and this one in particular; and stressed his dislike of walking 70 miles in order to express this opinion: by which time his breath had returned, together with his sense of humour; and he set about re-erecting the beacon, determined that it should be fixed so that a hurricane would not blow it down. However, when the Minor Triangulation started, it became apparent that Mumpu beacon was de-centred. Swettenham went to investigate, and found that one of the 8-inch legs had snapped like a match. He rebuilt the beacon; and some months later, when observing from it for the Minor Triangulation of the Meridian section, his natives informed him that the evil spirit had vacated, the proof being the fact of the beacon's survival for twelve months.

After completion of this section, the Commission went to Capetown in December, 1931 for a three months' working recess, during which computations were completed and drawing was started, for the part of the boundary which had already been demarcated and surveyed in the field. This three months' return to civilization also served to fill the personnel of the Commission with fresh energy to tackle the rest of the boundary. During this time Sjt. Burne transported the stores from Mandowesa (B.P.6) and built a new base camp at the source of the Lukushashi River, near B.P.1.

The demarcation of the Meridian section (Appendix 2) proceeded smoothly, the British section demarcating the southern half, from B.P.1 to Mikumbi Hill, and the Belgians the northern half, both sections, as before, carrying out the boundary traverse, which, in the case of the Meridian section, was, of course, a complete check on the accuracy of the demarcation. The two Senior Commissioners had agreed that divergence from the true meridian might be tolerated up to 100 metres: but in fact the divergence did not exceed two metres in the British half, except at one point where a departure of just over 20 metres was deliberately made in order to avoid a precipitous mass of rocks. The northern half of the Meridian section, which was demarcated by the Belgian section, was far more difficult than the southern half. It ran through a flat, marshy area, which necessitated the building of towers for minor trig. points, and where there were no stones for building cairns or main B.P's. The Belgians, therefore, had to transport their stones by barge on the Luapula River, or by carrier, over great distances.

In view of this, it was decided to make the Boundary Pillars in that area about half the size of those erected along the remainder of the boundary.

The northern half also passed through a large game reserve, and our two N.C.O's who did the boundary traverse of that half appear to have had quite a little excitement. One of them was charged by an elephant, and is now quite confident that he is the true holder of the world's 100-yards record. On another occasion they stampeded a herd of buffalo, which was hidden in some thick elephant grass. A pair of leopards killed a buck one morning within a few yards of their tents; while, another day, seven lions delayed the work by selecting the traverse path for their afternoon siesta.

The Meridian section was completed by about the middle of June, and everybody returned to the base camp, and finished all the computations and drawing, while awaiting orders from home regarding the Mweru-Tanganyika section. The 1913 Commission had come to the conclusion, after careful investigations, that Cape Akalunga, which is by definition the eastern end of the straight-line boundary, did not exist, and never had existed. The British view was that a promontory at Moliro was meant, while the Belgians thought that the framers of the Agreement of 1894 intended to refer to Cape Kipimbi, about five miles south of Moliro. Until this point was settled by the two home Governments, it was clearly impossible to demarcate the boundary.

Early in October, orders were received for the Commission to proceed to the lakes area, though no decision had been made regarding Cape "Akalunga." The Commission, therefore, moved north, with a programme of Major Triangulation and Topographical Survey, the latter being intended to elucidate certain discrepancies between the British and Belgian maps of 1913, in case it should be decided to depart from the straight line and to delimit and demarcate a "natural" boundary. The base camp was fixed at Kambole mission, which was the most northerly point which could be reached by road from Abercorn. The base camp was thus four to five days' journey away from the nearest field-work area: the problem of the supply of carriers' food, and other requirements of the field-parties, was therefore more difficult than before. Fortunately, the Mission was able to find a native, Israel by name, who could read and write a certain amount of English. He therefore went forward with Swettenham, who selected a site for an advanced supply base. The Senior Commissioner then sent supplies of carriers' food, mails and so on, from the Base Camp to this advanced base, where Israel looked after them until the field-parties sent men in to him to collect their requirements.

The work in this area was more difficult than on any other section of the boundary. From Lake Tanganyika (approximately 3,000

Photo 9.—B.P. 46: Junction of the Northern Rhodesia, Belgian Congo, and Angola frontiers.

Photo 10.—Kisebwe Tower beacon, 40 ft. to platform, 62 ft. to top of beacon—Mweru-Tanganyika section.

Photo 11.—Typical major triangulation beacon. Height to neck about 20 ft.; to top, 25 ft. Side at base about 12 ft.

Photo 12.—Typical view from a major trig. point.

feet above sea level) a steep escarpment rises to about 4,500 feet: the country then continues westwards in a series of long, flat ridges to the Choma River, about half-way between the two lakes. Thence it rises again fairly steeply to nearly 6,000 feet, and continues in a tangle of hills at about the same height to the vicinity of Lake Mweru. The trees at the western end were bigger than had previously been encountered, while the undergrowth was generally thicker than on the other sections of the boundary, and at the eastern end consisted mostly of thick elephant grass. Trig. work was therefore not too easy. It was found almost impossible to walk across country and it was necessary to stick to native paths as long as possible. The flatness of the high ground necessitated much longer clearings than hitherto: so much so that the beaconing averaged over a week per beacon, whereas previously more than one day had been unusual. At one point a tower had to be built. (Photo 10.)

The Topographical Survey, which was carried out by the N.C.O's, consisted of compass and steel tape traverses, along paths as far as possible between the trig. points; these traverses being then broken down by compass and rope traverses.

To add to the difficulties, the work had to be carried out during the rains—trig. work would in any case have been impossible in the dry season, owing to haze—and the rivers were swollen and most of the countryside was flooded. Clouds and mist often obscured the beacons, sometimes for days at a time. Swarms of mosquitoes and tse-tse fly added their quota to the unpleasant conditions: and there was a good deal of sickness amongst the carriers.

In spite of the conditions, however, the work, especially the Triangulation, was more interesting than on any other section of the boundary. The country was, as already described, not amenable to easy Triangulation, and had to be bullied into giving results by extensive clearing, coupled with much reconnaissance and a good deal of luck. All the 1913 points were used, together with six new points which considerably strengthened the network. At the western end the chain was connected to some Triangulation, carried out by the *Comité Spéciale du Katanga*, which was based on a measured base near Mpeto: at the eastern end a connection was made to the arc of the 30th Meridian, across Lake Tanganyika, by Major M. Hotine, R.E., who was at that time engaged on the Triangulation of the arc.

The topo. work was finished by the end of March, 1933. No orders had been received for the demarcation of the boundary in this section: the N.C.O's therefore returned to the base camp. Swettenham was recalled to the base camp about the middle of March, in order to carry out astronomical observations at four points on the arc near Serenje. Heap, therefore, finished off the

Triangulation by himself by the middle of April, when he, too, returned to Kambole. By that time orders had been received for the Commission to close down, and everyone returned at once to the Lukushashi base camp, which had in the meantime been maintained; with the exception of Swettenham and his astro. party, who returned towards the end of May.

And so, in June, 1933, the Commission sailed for home, glad in many ways to return to the amenities of civilization, but all somewhat sorry to exchange the free life of the bush for the tyranny of the office chair.

This brief story of the Northern Rhodesia—Belgian Congo Boundary Commission would be incomplete without some reference to the natives, without whose help the work would have been impossible. The Askari of the police escort, provided by the Military Division of the Northern Rhodesian Police (now the Northern Rhodesia Regiment), acted as batmen for the officers, and overseers of working parties. They also acted as interpreters when necessary, all of them having been taught Chinyanja, the language of Nyassaland, and the official native language of Northern Rhodesia, which most of the Commission learnt sufficiently to make themselves understood; while quite a number of the Askari had a working knowledge of English.

The carriers were recruited by the District Commissioner, for periods of three months only, from the district in which the Commission was working. They all spoke their several local languages, and the different tribes varied considerably in type and habits. The least civilized were as a rule the best load-carriers, but at the same time the worst workmen. A notable exception was the Awemba tribe, who came from around Abercorn, and who were excellent carriers, good tree-climbers and tree-fellers, and highly intelligent. At the other end of the scale were the Alunda, from the Mwinilunga district, who could carry an 80-lb. load at four and a half miles an hour, but whose intelligence was of a low order, and who considered a meal of rats and white ants to be a great treat.

All the natives were very fond of meat, and would eat it greedily when available. They also had a nauseating habit of smoking any meat they could not consume immediately; and this would be carried round, sometimes for many weeks, until no Englishman without a gas-mask could approach within yards of it.

The normal carrier's load was about 45 lb., in addition to which each man had to carry his own food up to one week's supply, together with his own personal kit—a total of between 60 and 70 lb. It was occasionally necessary to load rather more heavily; but, except for short distances up to six or seven miles, overloading did not pay. On trig. work especially, when camp was moved three or four times a week, loading in excess of 45 lb. slowed down the march

very appreciably. A reasonable day's march was about 15 miles, taking five to six hours: greater distances were often accomplished, but it was very noticeable how speed diminished after about 15 miles.

The climate along the boundary was really good. In the winter, especially in June and July, it could be very cold: frost was not infrequent at night, and large camp fires and charcoal braziers were very popular. The summer coincided with the rainy season, which lasted from September till March, and kept the temperature down. The total rainfall during this period averages 30 to 40 inches. The temperature rarely exceeded 85° by day; and the nights were cold the whole year round.

There seems to be a notion prevalent amongst officers at home, that Boundary Commissions spend most of their time shooting. On the Northern Rhodesia—Belgian Congo boundary this was certainly not the case. The work was usually a race against climatic conditions; and time would not allow the hunting of game seen when on the march, though it was often possible to go out shooting for a few hours on Sundays, which were kept as a day of rest whenever possible. Game was rather scarce at the western end of the Watershed section, but plentiful at the eastern end, on the Meridian section, and in the Mweru-Tanganyika section, where, however, shooting was forbidden as the greater part of this section is a game reserve. This area is famous for elephant: but, curiously, during the six months they were up there, not one of the parties in the field saw an elephant, though fresh elephant tracks were seen frequently.

Fresh meat for food was usually obtained in sufficient quantity, by sending out one of the Askari with a rifle during days on which one's camp was stationary.

Finally, it remains to record the fact that the relations between the Belgian and British sections were always of the most cordial nature, and the very few opportunities which occurred of meeting each other in the field were always welcomed.

It is a pity that more Boundary Commissions are not available. Apart from providing valuable survey experience, so hard to get nowadays, and useful training in organization under primitive conditions, the work can be great fun, and should appeal to all officers who can enjoy a temporary absence from the amenities of civilization.

(*The map is reprinted by kind permission of the Royal Geographical Society from plates published in the "Geographical Journal" by Lt.-Col. E. R. L. Peake, M.C., R.E., on "Northern Rhodesia—Belgian Congo Boundary."*)

APPENDIX 1.

METHOD OF BOUNDARY LOCATION—WATERSHED SECTION.

The party consisted of two N.C.O's and about 70 carriers. One N.C.O. went ahead with a level, and about half a dozen carriers, and located points on the crest of the Watershed ridge, at intervals of about 50 yards. At each of these points he inserted a picket, about five feet long, numbering these pickets consecutively. At the same time he made a compass sketch, showing the bearing and distance of each picket from the previous one, his carriers clearing the bush just sufficiently to enable him to do this. This sketch he then sent back to the second N.C.O.

The second N.C.O. plotted on the sketch the 500-metre legs of which the boundary was to consist, in such a way that the departure from the true Watershed evened up the give-and-take of the two countries as far as possible, the ends of each leg coinciding with one of the pickets marking the ideal Watershed. He then marked out these legs, by means of pickets, on the ground, and set his natives to work, cutting the 5-metre clearing which is now the boundary, hoeing the path for the traverse in the centre of his clearing, and collecting stones at the end of each leg for the construction of the cairns or Main B.P's.

This setting-out of the 500-metre legs was not quite so simple as it sounds, as care had to be taken that the two ends of each leg were intervisible, and this necessitated the avoidance of the numerous ant-hills which were so common along most of the boundary.

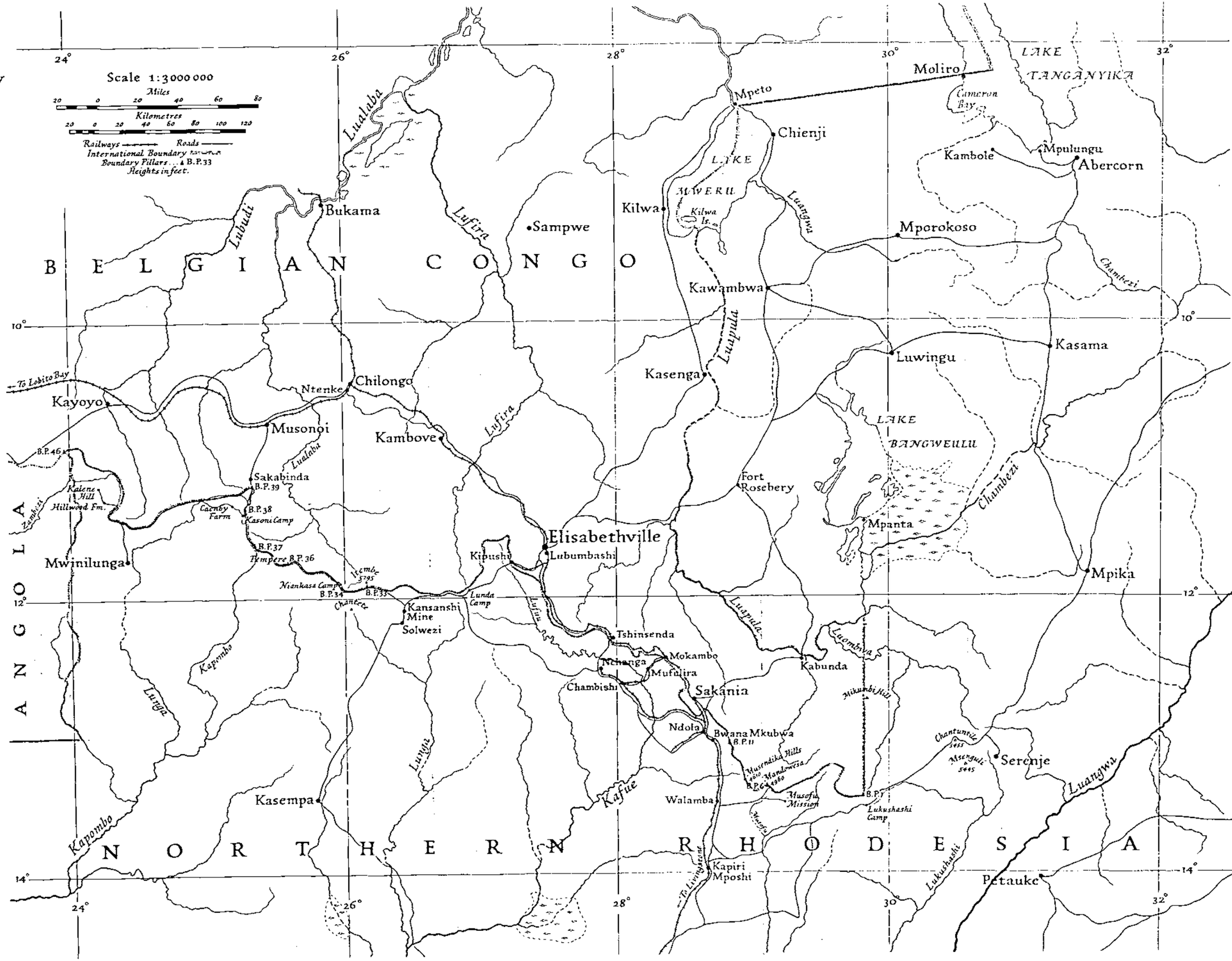
The selection of sites for Main B.P's at an average distance of five kilometres apart had to be carried out with care, as they had to be so sited that they could be connected to the Major Triangulation, by means of a minor trig. point at or near the B.P., the beacon for which was erected by the location party.

APPENDIX 2.

BOUNDARY LOCATION—MERIDIAN SECTION.

The position of B.P.1 having been fixed, azimuths were available to two major trig. points. It was thus easy to set up a theodolite at B.P.1, pointing due north. With the aid of the theodolite a line of pickets was then set out, for as great a distance as possible along the north line. The theodolite was then moved forward and centred over the last picket. A sight was taken on to the farthest visible picket (*i.e.* due south): the instrument was clamped and transited, care being taken to minimize errors due to imperfect horizontal collimation adjustment of the instrument, by transiting on opposite faces at alternate stations: and a further line of pickets was set up.

Rhodesia-Congo Boundary



This was done by two N.C.O's and they were followed up by the other two N.C.O's who cleared the line set out, fixed B.P's, and carried out the traverse.

In the meantime one of the Assistant Commissioners carried out the Major Triangulation, while the other walked due north by compass, from B.P.1 ahead of the location party, and selected minor trig. points as near as possible to the boundary, at about five kilometres apart (*i.e.*, for fixing of Main B.P's). He carried out the trig. observations at these points, from which it was possible to compute a resected position for most of the points—the finally accepted position, of course, having to wait for the complete observation of the Triangulation—from which an azimuth, and a measurement to the true Meridian, were given to the boundary location party, to keep that party on the true line.

APPENDIX 3.

Boundary Traverse.

The boundary traverse was carried out by the N.C.O's, after completion of the location. The angles at the ends of each leg were measured with a 3½-inch Watts theodolite, two rounds on each face for horizontal angles, and one round on each face for vertical angles. Linear measurements were made by steel tapes along the surface of the ground.

The traverse was adjusted, both for distance and azimuth, from the minor trig. points. The errors allowed were: Angular, $30\sqrt{n}$ seconds, where n is the number of angles observed: linear 1/1,000. Except that where any Main B.P. had not been tied in to the Triangulation—this omission was permitted for not more than two consecutive B.P's where the topography made it necessary—these permissible errors were halved.

The method of numbering B.P's was as follows. The main pillars fixed by the 1912-14 Commission kept their original numbers, 1 to 46. The new main pillars between, for example, B.P's 5 and 6, were numbered 5/I, 5/II and so on. The auxiliary pillars were numbered A, B, C, etc. starting afresh at each main B.P. Thus, between B.P's 34/III and 34/IV, came auxiliary pillars 34/III/A, 34/III/B, and so on.

On the Meridian section there were no old B.P's, so the numbering was straightforward. To avoid all possible confusion, Roman numerals were used. So the pillars on this section are numbered B.P.II, B.P.II/A, B.P.II/B, B.P.III and so on.

The accepted positions (the mean of the British and Belgian results) are recorded, in geographical co-ordinate to 0·01 seconds of arc for the main pillars, and for the auxiliary pillars, in rectangular co-ordinates to the nearest centimetre on the Cassini-Soldner projection, referred always to the nearest main pillar to the east as origin, *i.e.*, the position of auxiliary pillars between, for example, B.P's 35/I and 35/II is referred to B.P.35/I.

APPENDIX 4.

THE TRIANGULATION.

The beacons were made of a framework of timber, lashed with bark, and thatched with grass (Photo 11). Where they were not on the skyline, white cloth was fixed from the neck for a few feet downwards—well slashed with a knife to render it valueless to possible thieves. One lesson learnt was that it is advisable always to add white cloth. Even when one is convinced that a beacon will present a skyline view from all other points, it is usually quite certain that it will not do so, and this painful fact is never discovered till one is 50 miles away.

Another important lesson which we all learnt by getting caught out was that, when clearing trees at a trig. point, it is not sufficient to clear towards all other points; but that it is essential to clear in the opposite direction as well; otherwise the beacon disappears into the background.

The triangular error permitted was 12 seconds, both for the major and minor trig. But, whereas the Minor Triangulation consisted usually of single triangles, with one of the major sides as base, in the major network single triangles were rigorously avoided and well-conditioned figures were insisted on. For the major trig. four rounds of horizontal angles on four zeros and two rounds of vertical angles were observed on each face: for the minor trig., two rounds of horizontal and one round of vertical angles, on each face. On the Mweru-Tanganyika section we worked to a permissible triangular error of 5 seconds for the major trig. and observed eight rounds of horizontal angles on each face, with eight zeros.

The main source of error was the beacons. Apart from the error caused by uneven lighting of non-skyline beacons, movement due to high winds could not be completely eliminated: while the green wood of which the beacons were made usually warped as it dried, and the bark lashings loosened as they dried. Where old 1912-14 marks were found, therefore—and very few were found, except on the Mweru Tanganyika section—no attempt was made to centre the beacons: but beacon eccentricities were measured every time a station was visited, and the observations adjusted accordingly. Care was taken to make all the 1927-33 marks as permanent as possible. These consisted usually of a used cartridge case cemented in rock, and from 1931 onwards the date was inscribed in the cement, together with the letters "A.B.B.C." (Anglo-Belgian Boundary Commission) to facilitate future identification.

The instruments used were an 8-inch micro. and a 5-inch micro. by Cooke, Troughton & Simms, and two 3½-inch Zeiss theodolites. They were all very satisfactory (except that the Zeiss diaphragms got covered with condensation in the rains and could not be cleaned), and it would be unfair to make a comparison, as the different instruments were used under different conditions.

APPENDIX 5.

The Catenary Traverse.

The Gold Coast Survey Department had employed long-distance primary traverse for some years, and all their experience was placed at the disposal of the Commission for their catenary traverse from B.P.36 to B.P.46.

The work was organized in three parties:

(1) A setting-out party of two N.C.O's aligned and set out pegs at 300-foot intervals along the traverse legs.

(2) An angle party of one officer and one N.C.O. measured the traverse angles, both horizontal (three rounds on each face on six zeros) and vertical (two rounds on each face). It was found necessary, to prevent movement of the tripod, to drive stout pickets four or five feet in the ground for the tripod to rest on.

(3) A taping party, of one officer and one N.C.O. measured the lengths of the traverse legs. Each tape-length was measured three times, the maximum divergence allowed between the three measurements being 0·002 feet. The tapes used were 301 feet invar, graduated for one foot at each end to 0·01-foot and a 100-foot steel tape for odd lengths at the ends of traverse legs. Readings to the third decimal place were made by means of a micrometer attached to the knife edges on which the tape rested.

The apparatus was specially made, and the removable tribracks which fitted on the tripods were designed to accommodate the optical plummets, the theodolites, targets, and knife edges. Two field tapes and one standard tape were provided, and the field tape was standardized about every ten miles; it was found unnecessary to standardize more frequently, as the field tapes were so good that hardly any variation in length could be detected during the whole of the five months.

Training the carriers was difficult; but a drill was evolved in which each man had his own little job, and the progress increased from about 200 yards a day for the first week to about one and three-quarter miles a day, by the end of the first month. A new gang of carriers joined about the middle of the work: but these were trained by double-banking them with the old gang for a couple of days.

WATER-SUPPLY IN A DESERT COUNTRY.

(Essay adjudged second for the Cooper's Hill War Memorial Prize, 1935.)

By CAPTAIN R. E. BAGNALL-WILD, R.E.

Subject.

1. *Discuss the water-supply problems that will confront a small mechanized force operating in a desert country, and give your views on the organization and equipment of the engineer units that should accompany such a force.*

Background.

The force is of all arms, entirely mechanized and motorized, consisting of 4,000 men and 700 vehicles with water-cooled engines. It is to be concentrated at Port "A," and its role is to relieve as rapidly as possible a force besieged in the town "B," 400 miles distant.

There are well-watered strips of country round "A" and "B," separated by 300 miles of desert. Water exists at two oases, "X" and "Y," 100 miles apart in the desert.

Each of these oases is known to be able to supply a concentration of 1,000 tribesmen and their flocks. Oasis "X" consists of a series of shallow wells, whose rest level is about five feet below ground level. Oasis "Y" consists of a few deep wells, whose rest level is 100 feet below ground level.

No serious opposition is expected from the tribesmen, who are besieging "B," until the fertile area round that town is reached.

1. THE WATER-SUPPLY PROBLEM.

"THE road to glory," said Ewell, "can not be followed with much baggage."* On the other hand, it is an accepted lesson of the Great War that modern warfare imposes on the soldier a continuous physical and mental strain, and, consequently, the road to glory can not nowadays be followed by tired, hungry, or thirsty men. With these two principles in his mind, an officer appreciating any supply problem must make his object the finding of the least amount of "baggage"

* *Stonewall Jackson*, Vol. I, Chap. X.

necessary in order that the striking force may arrive and be maintained at the decisive points fit to deliver an effective blow.

The supply of water for all purposes to an army in the Field is the responsibility of the Royal Engineers, but the problems to be considered do not differ greatly from those involved in any other supply problem. It is true that in most campaigns greater use can be made of local resources of water than of other commodities, and water need not be imported, but this may not always be so ; for instance, in the campaign in South-West Africa large quantities of water had to be imported by ship, until the distillation plant was repaired.

The officer responsible for the supply of water is the Chief Engineer, or C.R.E. of the force. It will be seen in paragraph 2 that the force considered would include one mechanized Field Company, R.E., and, on the analogy of the O.C. Field Squadron in a cavalry division, the O.C. of the Company would act as C.R.E.

In this paper the various factors involved in the water-supply problem of the given expedition will be considered, and from them a plan evolved ; from this plan conclusions will be drawn as to the organization and equipment of the engineer units.

2. The Force.

(a) The Striking Force.

Without knowing the exact nature of the country around " B," or the armament of the tribesmen besieging that town, it is not possible to lay down precisely the composition of the striking force. A possible composition might be :—

Force Headquarters.
1 Armoured Car Regiment.
Brigade Headquarters and 2 Mechanized 3·7" Howitzer Batteries, R.A.
1 Mechanized Field Company, R.E.
Detachment, Field Park Company, R.E.
1 Motorized Infantry Battalion.
1 Light Tank Battalion.
Detachment, Royal Signals.
Detachment, R.A.M.C.

This force, with first line transport, would consist of about 2,650 men and 380 water-cooled vehicles.

The engineer work, in addition to water-supply, might include improvement of communications at " A " and " B," improvements of the track in bad places on the desert route, bridging near " B," demolition of enemy works near " B," clearing of landing grounds for aircraft, accommodation at " A " and " B," and defence works

at " B." For this work a Field Company would be necessary, and should be sufficient provided that a bridging group of a Field Park Company was attached.

No mention is made of the R.A.F. in the situation given, but it is assumed that they are co-operating with the force, that landing grounds are available, or can easily be cleared, and that the hostile tribesmen have no aircraft.

(*b*) *The Lines of Communication.*

The supply system on the L. of C. would probably consist of lorries working in convoys on the endless chain principle outlined in the *Manual of Movement (War)*, 1933, Sec. 96.

The daily requirements of the striking force would be :—

Supplies—at 7 lb. a man, say	8½ tons
Petrol and lubricants, based on 120 miles a day and rates of consumption as laid down in *R.A.S.C. Training*, Vol. II, 1933, App. 12, together with petrol for cooking, say	6 tons
Ammunition, say	3 tons
Ordnance, R.E. and Miscellaneous Stores, say	6 tons

This would need about ten 3-ton lorries. Allowing one lorry for the baggage of the convoy, and one spare lorry, each link would consist of 12 lorries. Assuming a 100-mile march (see paragraph 3) and three spare links to cover time for loading, unloading, and possible delays, nine links would be necessary, or 108 lorries. For the supply of petrol to these lorries and of food for the L. of C. troops, a further 40 lorries would be needed.

It would be necessary to protect the lorry convoys and the posts on the L. of C. from raiding tribesmen. For this purpose one motorized infantry battalion might be used.

Arrangements could probably be made with the R.A.F. to evacuate casualties by air, but otherwise motor ambulances would have to be included in the convoys.

The total numbers on the L. of C. including infantry, supply convoys, mobile water column (see paragraph 7), and detachments of signals, medical, supply and ordnance services, would probably amount to 1,150 men and 220 water-cooled vehicles.

(*c*) *The Base.*

The base installations for an expedition of this size would naturally be as small as possible. For protection, they would probably rely on local levies. The total number might be some 200 men, excluding civil labour, and 100 water-cooled vehicles, including a 10% reserve for the force.

(*d*) *Summary of Probable Distribution of Force.*

	Striking Force.	*L. of C.*	*Base.*
Men	2,650	1,150	200
Water-cooled vehicles ..	380	220	100

3. The Rate of March.

The deserts through which a British force might have to march vary considerably. Some consist of soft sand blown into dunes; some are comparatively flat, gravelly plains; some contain networks of rocky hills intersected with deep sandy wadis; some are plains covered with small basalt boulders.

The type, or types of country between "A" and "B" will, of course, affect the rate of march. This rate would probably not be less than 50 miles a day for a mechanized force, nor is it likely to be much more than 100 miles a day. On account of the spacing of the oases "X" and "Y," 100 miles a day would be a suitable march, and, as the great advantage of a mechanized force is the ability to effect surprise by making full use of mobility, and as "B" is to be relieved as rapidly as possible, every effort would be made to achieve this rate, even at the expense of long marches.

Moreover, many desert routes are now being opened up by motor caravans, and in places where 100 miles a day would have been unthinkable twenty years ago, much higher speeds are possible to-day. For instance, the Nairn Transport convoys on the Damascus-Baghdad route now average over 20 miles an hour on a 470 miles continuous run. A mechanized force such as that considered cannot, of course, be expected to travel as fast as well-established convoys, but the Nairn Company, and others, have shown what is possible across the desert. Night running, however, even for the supply convoys, would not be practicable.

In this paper, a rate of march of 100 miles a day has been assumed as possible for both the striking force and the lorry convoys, though a reference to the arrangements necessary for a shorter day's march will be made in paragraph 7.

A certain period would be necessary for concentration at "A," and the day on which the expedition would leave there can be called Z day. The force, marching with an advance guard in case of tribal raids, would reach "X" on the evening of Z day, and "Y" on the evening of Z + 1 day. It would not be advisable to attack the enemy investing "B" after a long day's march, so the force would probably bivouac on the evening of Z + 2 day a few miles short of "B," protected by outposts, and advance into the fertile strip at dawn on Z + 3 day. It would not be safe to assume complete success on Z + 3 day, or even that a portion of the fertile strip large enough to ensure a sufficient supply of water could be made

good on that day. There is even a possibility that the force would still be fighting on the outskirts of the fertile strip on the evening of Z + 4 day, or that it might fail to relieve "B," and be compelled to withdraw. These are admittedly remote possibilities, but they are factors which must be considered when planning such an operation. An example of a small force that had to withdraw is General Shea's raid against Amman in March, 1918, when bad weather prevented surprise from being complete. General Shea, however, was opposed by Turks and not by tribesmen, and the troops relieving "B" would probably have an easier task.

4. THE WATER RATION; PURIFICATION AND DISTRIBUTION.

Military Engineering, Vol. VI, page 52, gives the following data for estimating consumption of water per man:—

Temporary camp	5 gallons a day.
Absolute minimum at rest	1 gallon a day.
Absolute minimum on the march for periods not longer than three days	½ gallon a day.

Bearing in mind the strain of long marches and the probability of great heat in the day time, every reasonable effort would be made to provide one gallon a day for each man. In an emergency half this ration would suffice. No figures are laid down for the amount of water wasted by a water-cooled vehicle, and this amount must vary to a certain extent according to the difficulties of the march. When estimating for M.T. it must be remembered that unlike men or animals, a "half ration" is not enough. Experience shows that an approximate estimate can be based on half gallon per radiator a day, though this is on the low side for very heavy going in hot weather.

Allowing, therefore, one gallon per man a day, and half gallon per radiator a day, the striking force of 2,650 men and 380 water-cooled vehicles would need 2,840 gallons, say 3,000 gallons a day. A "half ration," that is to say, half gallon a day per man, but still half gallon a day per radiator would be about 1,500 gallons a day. The maximum number of men and vehicles that might take water at any post on the L. of C., exclusive of the striking force, would need about 600 gallons a day.

All supplies of water are liable to be contaminated and, as advice about purification is the responsibility of the medical service, the senior medical officer of the force should be consulted on this question.

Of the various methods of purification of water in the field, described in *Military Engineering*, Vol. VI, the most suitable for mobile troops marching rapidly is the use of units' water trailers. Materials to construct elevated tanks, or other extra "baggage"

are not necessary and, provided the trailers travel full, the distribution of water can start soon after halting for the night.

The water trailer is similar to the water-cart, which is described in *Military Engineering*, Vol. VI., but carries 180 gallons instead of 110. It contains hand pumps and clarifying filters and the clarified water in the tank is purified by adding bleaching powder. The water is fit for drinking after 30 minutes and it takes 30 to 45 minutes to fill the tank.

The number of water trailers with the force is shown in the following table :—

Unit.	*Number of Trailers.*
Force Headquarters	1
1 Armoured Car Regiment	4
2 Batteries, R.A.	2
1 Light Tank Battalion	2
1 Infantry Battalion	2
1 Mechanized Field Co. R.E.	1
Total	12

The L. of C. troops would have a total of four water trailers.

To meet the needs of the men in the striking force (2,650 gallons a day), each trailer would have to be filled once a day and three of them would need a second fill. As, however, the distribution of trailers is not strictly in ratio to the strength of the unit, at least four trailers would need a second fill.

Arrangements would have to be made for small units with no water trailer, such as signal detachments, etc., to be attached for water purposes to another unit, or to force headquarters. Arrangements would also have to be made for men to act as police to control the traffic at water points. Care would have to be taken to see that water personnel of units were thoroughly instructed in chlorination duties (*Military Engineering*, Vol. VI, pages 21 and 223.)

5. The Water Supplies.

(*a*) *At "A."* "A" is a port surrounded by a strip of well-watered country. There is probably a piped supply of potable water at the town. Such a supply would probably be able to meet the requirements of the personnel and vehicles left at the base, as well as the normal civilian demand. At the end of concentration there would be some 4,000 men needing 5 gallons a head, or 20,000 gallons a day. The local water authorities might not be willing or able to meet the whole of this demand. It should not, however,

be difficult to supplement the town supply from streams and shallow wells in the well-watered country.

(*b*) *At "X."* "Oasis 'X' consists of a series of shallow wells whose rest level is five feet below ground level." Wells of this nature in desert country are liable to seasonal fluctuations; they are usually slightly and sometimes highly contaminated. Continuous pumping is apt to make them run dry. The oasis "is known to be able to supply a concentration of 1,000 tribesmen and their flocks." Local information would probably give more details as to the average "flocks," particularly the number of camels, who are heavy drinkers, but it is reasonable to assume that a concentration of 1,000 nomads would use some 8,000 gallons a day. This is more than twice the amount needed by the force, but the tribesmen would spread the drawing of water over a long period of the day, and would use all the wells, which may cover a large area. The local devices for raising water would probably be some form of lever and water-bag.

(*c*) *At "Y."* "Oasis 'Y' consists of a few deep wells, whose rest level is 100 feet below ground level." Reports about water in desert country are usually reliable, but even deep wells vary in depth from time to time, and the rest level at the time of the operations may be several feet more below ground level than the normal for those wells. They are not so liable to be contaminated as shallow wells, but pure water cannot be assumed. As at "X," the wells can probably supply in the day more than twice the quantity needed, but continuous raising of water from any well may lower the level considerably, and the well may take many hours to recover. The local method of raising water from these wells, probably bucket and windlass, would be too slow to provide a full ration for the force in four hours, but a half ration could possibly be drawn.

Deep wells can be blocked by demolishing the heavy stone steining. "No serious opposition is expected from tribesmen until the fertile area is reached." Colonel Lawrence, however, in one of his raids expected no serious opposition until he reached the Hedjaz railway, but he found the wells blocked at the last halt before his objective. Here again the enemy were Turks and not tribesmen, but the possibility of sabotage at "Y," however remote, should not be forgotten.

(*d*) *At "B."* The local water-supply in the town "B" might be a piped supply, but it is more likely that both the inhabitants and the garrison draw water from shallow wells or streams. In either case special arrangements would have to be made for the force. If there are not enough existing sources of water, more could probably be found by digging shallow wells. From various sources, many probably highly contaminated, it might be possible to supply

water to the force at the rate of five gallons a head a day. In case of sabotage, shallow wells can be rapidly excavated, so no serious delay need be expected.

6. Water-Supply Equipment.

(*a*) *Water Trailers.*

These have been discussed in paragraph 4.

(*b*) *Field Company Equipment.*

(i) *One* 1,500-*gallon tank.* A circular, self-supporting, collapsible canvas tank has now been adopted for service use.

(ii) *Six* 350-*gallon waterproof troughs.*

(iii) *Six Pumps, Lift-and-Force, Mk. VI.* These are capable of lifting water from 15 feet, or in emergencies from 28 feet, and forcing it to a total height of 60 feet above its former level. With men working in relays, from 500 to 700 gallons an hour can be raised by each pump.

(iv) *One Pumping Set, Centrifugal No.* 1. This consists of a Rees Roturbo pump with a Watermota two-stroke petrol engine. The set will raise 3,500 gallons an hour against a total head of 100 feet, but the suction lift should not be more than five feet for efficient working.

(v) *One Water Elevator No.*1. This consists of an Aquatole elevator with bed frame and delivery flume, driven by a Watermota engine identical with that used in the pumping set. The bed frame can be used as a beam, cantilever or T-support, according to the size and shape of the well. The set will raise 3,000 gallons an hour from a depth of 100 feet, and works with about three feet of the chain submerged. It can deliver to two tanks not higher than the level of the flume or direct to the suction side of the pumping set.

The elevator is provided with some 250 feet of chain. Allowing for the circumference of the pulleys, the submergence, and the possible height of the top of the well above ground and of the pulley above the top of the well, the elevator should be able to lift water from the wells at " Y," though the yield would be slightly less than 3,000 gallons an hour, but there is not a great margin if the water level should be lower than is reported as normal.

(vi) *One light derrick lorry.* Maximum pull 2½ tons; length of S.W.R. 90 feet. This derrick might be useful in removing masonry if the deep wells had been demolished. By a certain amount of improvisation it might also be used for raising buckets from the deep wells, if the elevator broke down.

(*c*) *Reserve of equipment.*

While the pumping set and elevator are reasonably reliable, they are occasionally liable to break down at the most inconvenient moment, and it must be remembered that sand is always an enemy to the smooth running of machinery. The mechanical equipment of a Field Company has been decided on a divisional basis, spare equipment being carried only by the Field Park Company. The lift-and-force pumps can, of course, be considered as a reserve to cover failure of the pumping set, and similarly the 350-gallon troughs could cover failure of the 1,500-gallon tank. As the Watermota engines of the pumping set and elevator are identical they can be considered as a reserve for each other. There is, however, no reserve for the elevator.

(*d*) *Possible Future Developments.*

The water-supply equipment of a Field Company is fixed for the present, but experiments with other equipment are still continuing. The most likely developments, other than slight improvements of the existing equipment, seem to be the introduction of a submersible electrically-driven pump, or a self-priming pump with flexible drive. As the force needs only some 3,000 gallons a day, the existing equipment can deliver water at a rate faster than necessary, and probably faster than the wells can provide. Whatever the results of the experiments, it seems probable that the Field Company will still have some equipment capable of lifting water from 100 feet below the surface, and also that a portable pump capable of lifting water from a greater depth might be carried by the Field Park Company, in which case it would be advisable to add the latter equipment to the " baggage."

There may also be alterations in the water-carrying vehicles of units' first-line transport ; such alterations would affect the details of distribution, but would probably have little effect on the water-supply plan as a whole.

7. MOBILE WATER COLUMNS.

" For the supply of fast-moving troops through a waterless area in which roads are available, special motor water columns must be formed " (*Military Engineering*, Vol. VI, page 25). It may be necessary to form such columns for the force relieving " B," but they undoubtedly add to the " baggage " and therefore their necessity must be carefully considered before a decision to employ them is made.

It would not be necessary to have a water column to provide for the water level at " Y " being considerably lower than normal,

or for the breakdown of the elevator, because, as stated in paragraph 5, the local methods of raising water could probably provide at least a half ration

There are, however, two events which seem to necessitate the use of water columns. The first is if the wells at " Y " should be blocked by sabotage. Even if they could be cleared in a day, water would be needed near " B " for the evening of Z + 2 day, and the troops could not exist for two nights on the amount carried in the trailers. The second is if the force should fail to secure a source of water at " B " on Z + 3 day, because, as in the previous case, it could not exist for more than one night without fresh supplies of water.

The possibility of boring for water must not be forgotten. A geological report of the neighbourhood would probably enable rough estimates to be made of the drilling difficulties and the yield of a hole. Drilling, however, is uncertain at the best of times, and is a highly technical business, and must be in the hands of experts provided with suitable equipment. Several bores would probably be necessary to obtain the desired yield, and, even with a modern well-boring rig, time would be the ruling factor. Therefore, although the rig and tubes would mean rather less extra " baggage " than a motor water column, it would not be suitable equipment for this expedition.

Before considering the case for a motor water column to be proved, other methods of carrying water to the troops must be considered. The daily supply convoy could carry extra water trailers; for a half ration, eight trailers would have to be added to the small daily supply convoy; as the convoy has to do long marches with full loads, such an addition would not be advisable even if the trailers could be made available. Aircraft might be used, provided landing-grounds were available, or could be easily cleared. Two freight-carrying aircraft could carry enough water for a half ration for the striking force for one day. Aircraft, however, are not used as a normal means of supply, and an emergency that can be overcome by providing a few lorries is not a proper occasion for their use; moreover, it is likely that any available freight-carrying aircraft would be used for taking supplies to the garrison at " B."

A motor water column would therefore be necessary. It is unlikely that specially constructed water-tank lorries would be available and water lorries would have to be improvised as shown in *Military Engineering*, Vol. VI, Plate 9; instead of large tanks it might, however, be easier to provide for carrying water on lorries in 10- or 4-gallon containers. To provide a full ration for the striking force for more than one night from a source 100 miles away would need ten 3-ton lorries. If both the events considered above should

occur, a column of eleven 3-ton lorries could provide, from "X," a half ration for the force outside "B" and for the L. of C. troops and supply columns at "Y."

If the rate of march of the force was only 50 miles a day, or if for some unexpected reason, such as bad sandstorms or sudden spates in a normally dry *wadi*, the full day's march could not be completed, a reduced ration could be issued from the trailers for the intermediate halt; but as a motor water column would still be necessary for the reasons given above, a full ration could be arranged if the water lorries marched with the troops, though this would entail pumping water at the next halt for a longer period than is envisaged in paragraph 9. If the rate of march of the supply convoys was less than 100 miles a day, the number of lorries in the motor water column would have to be increased accordingly.

It may be assumed, therefore, on the basis of a 100-mile march, that the force would include a motor water column of eleven 3-ton improvised water lorries, and arrangements would have to be made with the supply officer for providing petrol to these lorries and rations for the drivers, who would be R.A.S.C. personnel and would move with the daily convoy.

8. RECONNAISSANCE.

It is important to know the exact state of the wells at "Y." If the water is abnormally low, or if they have been demolished, it would be advisable to have a larger motor water column. The sooner this information is obtained the less will be the delay in improvising extra water lorries, if necessary. Another factor, affecting other supply problems as well as water supply, is the actual condition of the tracks across the desert. Unless the route is well known, an early reconnaissance would be desirable in order to find out whether 100 miles a day would be possible.

The C.R.E. would suggest that not only should a reconnaissance be made by an R.E. officer, but also that it might be advisable to send out a small covering party to prevent damage to the wells at "Y" during the concentration period. Aircraft might be used for moving this party to "Y" and maintaining it there.

It is possible that the O.C. force would not allow a covering party to be sent to "Y," or even a reconnaissance to be made of the route, as he might hold the view that news of such activities would reach the enemy and entail the loss of surprise. The C.R.E. would, therefore, have to be prepared to start without accurate knowledge of the state of the wells at "Y."

9. Outline of the Water-Supply Plan.

(i) *At "A."* The following water-supply work might have to be undertaken by the Field Company :—

Extending existing piped supply to camp sites, etc.

Use of the pumping set to supplement existing supply.

It is not possible to lay down in detail the work involved as it depends so much on the conditions at "A." As the camp there would only be a temporary one, there would be little time for elaborate work and only a few stand-pipes would be provided (*Military Engineering*, Vol. VI, page 132), probably entailing a week's work for two sections.

While at "A," a motor water column would be formed of eleven 3-ton lorries, each with two 300-gallon tanks, or the equivalent in smaller containers (see paragraph 7).

On the morning of Z day, the force would leave "A" with all water trailers and water lorries full.

(ii) *At "X."* Owing to the fact that the wells are spread over a wide area, and as each one may dry up quickly, oasis "X" is not a really suitable place for the use of the pumping set. While it could be used to pump from each well in turn to a central tank, it would probably be simpler to follow the procedure outlined below.

A section of the Field Company with the water-supply equipment, having marched with the advanced guard would, on arrival at X, prepare five water points. Each point would consist of one 350-gallon trough so placed that a lift-and-force pump could supply water to it from each of three wells. Assuming that the main body arrived by 1600 hours, one water point would be set aside for the use of the supply convoy, and the time table for the force using the other four points might be :—

1730. First eight trailers empty and ready to fill (two to each trough).
1815. First eight trailers full.
1815–1915. Vehicles refill watercans.
1915. Second four trailers and four of the first eight empty and ready to fill.
2000. All trailers full and ready for next day's march.

That is to say in about three to three and a half hours from the time pumping could start, each point would have supplied four trailers and 95 vehicles ; say 770 gallons or about 250 gallons an hour which is easily within the capacity of the equipment and should be possible at "X" using three wells to each point. Arrangements would have to be made for fatigue parties to work the pumps.

The force would leave on the morning of Z + 1 day, with all water trailers and water lorries full. Two lift-and-force pumps and two

350-gallon troughs would be left behind at "X" for the use of the L. of C. troops and the supply columns. It would probably be advisable to leave a sapper attached to the L. of C. troops at "X" to look after this equipment. The local devices for raising water, if in good order, would be a reserve in case the pumps broke down and would probably be more than sufficient to meet the requirements at this water point.

(iii) *At "Y."* A section of the Field Company, with the water-supply equipment, having marched with the advanced guard would, on arrival at "Y," set up the elevator over a good well. It might be possible to arrange for the elevator to deliver direct into the 1,500-gallon tank, or it might be necessary to use the pumping set. To avoid the crowding of water trailers round the tank, the hose connection of the tank would be used to fill two 350-gallon troughs from which the trailers would get their water.

Assuming that the main body arrived by 1600 hours, the time table for the force might be :—

1730. First six trailers empty and ready to fill (one trough only).
1815. First six trailers full ; second six trailers empty and ready to fill (one trough only).
1900. Second six trailers full.
1730–1900. Vehicles refill water cans at other trough.
1900–2000. One trough set aside for L. of C. troops and supply convoy.
1915. Four of first six trailers empty and ready to fill (one trough only).
2000. All trailers full and ready for next day's march.

At the fastest this is about 1,500 gallons an hour. As the capacity of the elevator is 3,000 gallons per hour at 100 feet and as the tank holds 1,500 gallons there would be a margin of time sufficient to cover the moving of the elevator from well to well if the level should fall rapidly.

The force would leave on the morning of Z + 2 day with all water trailers and lorries full. A detachment of the field company would stay at "Y" with the elevator, the pumping set, the 1,500-gallon tank and two 350-gallon troughs. They would provide water for the L. of C. troops and convoys and would be an initial water point for the motor water column if the force should be held up outside "B." When "B" has been entered, the pumping set would go there and the elevator would stay at "Y" for the L. of C. Either the 1,500-gallon tank or the two troughs would also go to "B" according to the conditions there.

If the elevator broke down, or if the water level was too low for it, water would be raised by the local devices at each well, being spilled

into a 350-gallon trough. As stated previously this rather clumsy method would probably provide more than a half ration in four hours.

If the wells had been blocked and water could not be raised from them, the force would take a full ration from six of the water lorries which would return to "X" on Z + 2 with a section of the field company to form an initial water point there.

(iv) *On the outskirts of "B."* Two 350-gallon troughs would be used for the transfer of water from the water lorries to the trailers, six trailers watering at one time from each trough. If small containers were used in the lorries, the trailers could be filled direct from them. Chlorination would be carried out as usual in the trailers. Two water lorries would supply enough water for six trailers; owing to the small size of the troughs the lorries would only be able to empty at about the same rate as the trailers can fill, but this delay would not be important as the lorries would not be leaving before the next day.

(*a*) If the supply at "Y" is usable the following programme of water-supply would be used:—

Evening of Z + 2 day; full ration from six water lorries.
Z + 3 day; six empty lorries return to "Y" and refill.
Evening of Z + 3 day; full ration from five water lorries.
Z + 4 day; five empty lorries return to "Y" and six refilled lorries arrive from "Y."

and so on for as long as the force was denied access to water at "B."

(*b*) If the supply at "Y" is not usable, the following programme would be used:—

Evening of Z + 2 day; full ration from 5 water lorries; six water lorries refilling at "X" (see (iii)).
Z + 3 day; six full lorries from "X" to "Y"; five empty lorries return to "Y."
Evening of Z + 3 day; force has three-quarters ration from water trailers. One lorry at "Y" refilling supply convoy's water carts.
Z + 4 day; five full lorries from "Y" to outskirts of "B"; six empty lorries return to "X."
Evening of Z + 4 day; five water lorries on outskirts of "B" empty water into water trailers; force has half ration and half ration is left in trailers; six lorries refilling at "X."

and so on with a half ration for as long as the force may be denied access to water at "B."

(v) *In the fertile strip at "B."* As indicated in paragraph 5 the exact nature of the water-supply work to be done in this area is not

known. It might be necessary to establish several separate water points; for this purpose the lift-and-force pumps and 350-gallon troughs would be useful. On the other hand it might be advisable to use the pumping set and to establish a central water point. If the force was to stay at " B " for a long time it might be advisable to provide a piped supply, for which stores would have to be ordered. In any circumstances the water points on the L. of C. would probably be kept open; as stated above, the elevator set and either the 1,500-gallon tank or two of the six 350-gallon troughs would be at " Y " and two of the six lift-and-force pumps and two more troughs would be left at " X."

(vi) A withdrawal either before or after the complete submission of the tribesmen would not present any water-supply problems more difficult than those discussed above.

10. CONCLUSION.

It has been shown that, for the expedition considered, water-supply, although of great importance, is not a factor which limits the mobility or efficiency of the force, and further that the equipment of a mechanized field company is needed to ensure an adequate supply. This equipment, although designed to meet many different conditions, is suitable for this campaign, and as far as can be foreseen any developments likely in the future will not make it unsuitable. A mechanized field company R.E. would probably form part of the force, and as the O.C. company would be acting as C.R.E. of the force, the water-supply organization would be simple.

It has also been shown that to meet certain contingencies a motor water column would have to be improvised. This column must be under the control of the C.R.E. (*Military Engineer*, Vol. VI, page 25), but there is no need for any R.E. personnel to travel with the lorries. An officer of the field company would be left at the initial water point, if formed, and the lorries would march between there and the force with the daily supply convoy. The number of lorries necessary and their equipment has been considered in paragraph 7.

The great mobility of mechanized forces increases the difficulty of solving many supply problems, but it seems that the water-supply problem of such a force operating in a desert country is simpler than that of a non-mechanized force on the same mission. Pictures of endless strings of tank camels, or of thirsty, dying horses, or even of the laborious building of a pipe line need no longer be visualized; normal equipment, supplemented by a few 3-ton lorries, is now sufficient.

THE FEDERATED MALAY STATES VOLUNTEER FORCE.

By M. R. C.

WHEN the writer was offered in 1931 an appointment on the Permanent Staff of the F.M.S. Volunteer Force, he had to admit with shame that he had heard of the existence of neither that Force nor that famous landmark of the Orient, the "Spotted Dog" (or Selangor Club) at Kuala Lumpur! His nearest approach to either had been that promotion exam. chestnut—Singapore!

Considering the importance which Singapore is now assuming and that the Volunteer Forces of the country play a not inconsiderable part in its defence, this ignorance appears most reprehensible, and it is felt that a brief description of part of the country and some of the troops who may be called upon to defend it may be of use to others.

In the past Malaya has been almost entirely concerned with commerce, and questions of Imperial Defence have hardly entered at all into the lives of the inhabitants. With the increased attention which is being paid to the Far East in its relation to Imperial strategy and with the recent development of Singapore as a first-class naval base, however, Malaya is gradually assuming the position of a fortress with the result that the Volunteer Forces in the country are becoming of increased importance.

POLITICAL DIVISION OF THE COUNTRY.

British Malaya consists of:—

(*a*) The Colony of the Straits Settlements (British territory) comprising Singapore, Penang and Province Wellesley, and Malacca.

(*b*) The Federated Malay States of Perak, Selangor, Negri Sembilan and Pahang. (Malay territory, British protected and administered).

(*c*) The Unfederated States of Johore, Kedah, Kelantan, Trengganu and Perlis. (Malay territory, British protected and advised.)

The Governor of the Colony is also High Commissioner for the Federated and Unfederated States.

The four Federated States are nominally independent sovereign States, each with its own Sultan. They are, however, under British

protection and bound together for certain matters by the Treaty of Federation. Each State has a British Resident and the officials of the Civil Service are almost entirely British, though the Service is open to Malays, a number of whom administer small districts.

Legislation is carried out by Federal and State Councils on which are both official and nominated unofficial members, including representatives of the Malay, Chinese and Indian communities.

There is a Federal Secretariat at Kuala Lumpur, dealing with matters of Federal administration and policy, and a State Secretariat in each State. Defence is one of the matters reserved for Federal legislation and the Government deals with the Volunteer Force through Headquarters, Local Forces, Singapore, which is a branch of H.Q. Malaya Command.

The F.M.S.V.F. is maintained entirely from money found from the revenues of the F.M.S. and the Imperial Government does not contribute either money or materials, other than by lending the bodies of certain of its officers and non-commissioned officers for duty!

THE COUNTRY AND PEOPLES.

Apart from Government servants and Police, nearly everybody is concerned, either directly or indirectly, with the production or marketing of tin or rubber. There is a small though gradually increasing amount of *padi* cultivation by Chinese and Malays and the production of copra and palm oil has recently taken the place of some of the rubber.

Rubber estates are found everywhere throughout the country, while the main mining districts are about Ipoh, Taiping and Kuala Lumpur. Where it has not been opened up for mining or planting, the country is covered with a very dense jungle.

Malaya is generally hilly with a main range of mountains, rising to a height of some 5,000 to 6,000 feet, running approximately down the centre. The larger towns and most of the development of the country is on the west of this range, that on the east being less densely populated and containing great areas of jungle.

Roads are extremely good though not very numerous. They are nearly all tar-macadam and, although rather winding on account of the steep hills, their surfaces compare favourably with many main roads at home. The standard of development of the country is high and it is in few places that the modern comforts of electric light and water laid on will not be found.

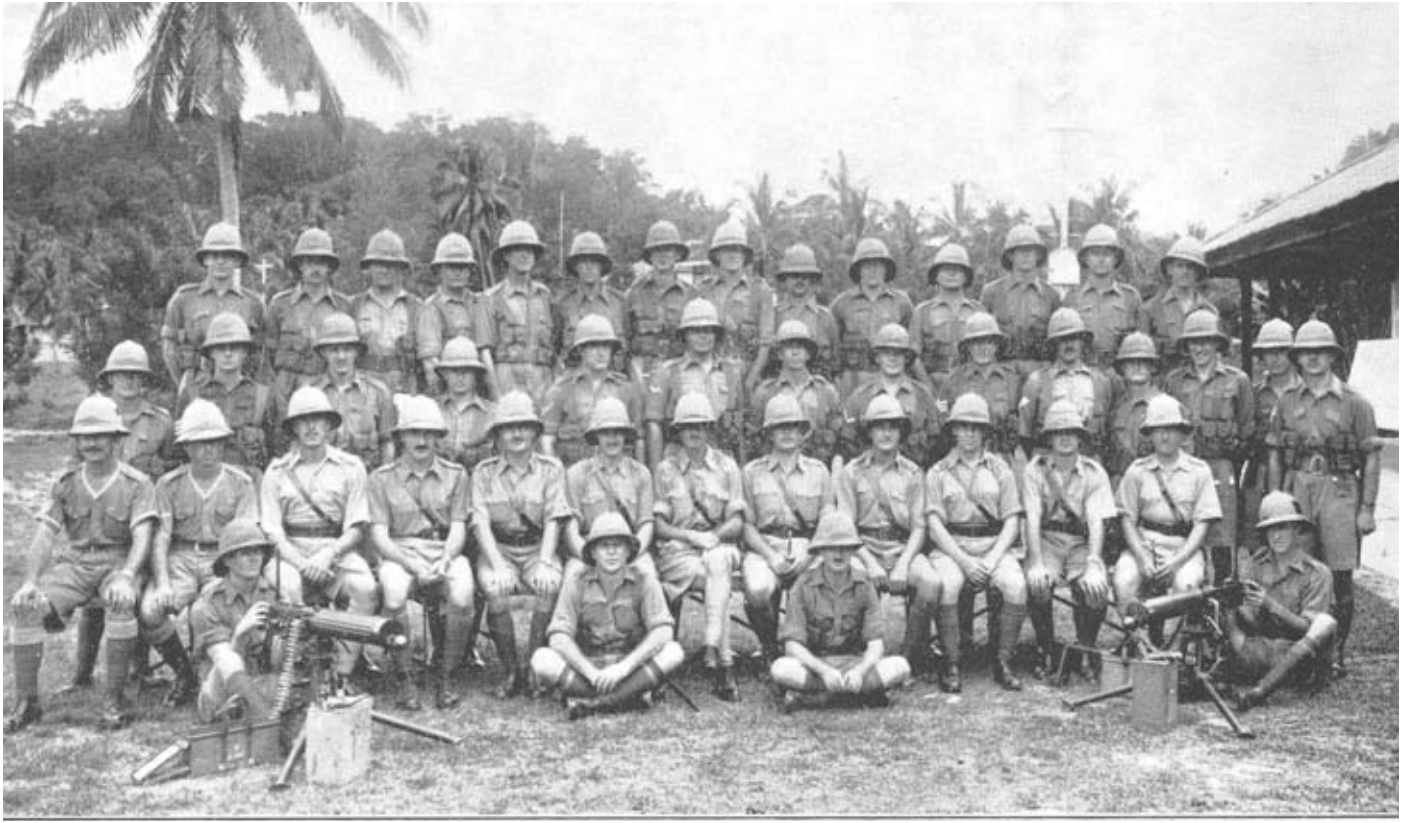
The country is universally green and is exceptionally clean and free from flies and dust, a most pleasant change after Egypt or India in this respect. All vegetation grows with great profusion and most plants flower all the year round.

Although the temperature never rises very high, a little over 90°

Photo 1.—H.Q. Mess. Kuala Lumpur.

Photo 2.—" G " Co. " Training Area," Telok Anson.

Federated Malay States Vol Force 1 - 2



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being the average maximum, the climate is inclined to be somewhat trying after a number of years, owing to its monotony. There are no seasons and the temperature and rainfall vary but little all the year round, while the dampness of the atmosphere causes considerable perspiration on the least exertion. Nights are, however, pleasantly cool and it is really a very healthy country, with few of the diseases which are usually prevalent in the East.

The European population of the F.M.S., amounting to about 6,000 to 7,000, consists mainly of Government servants, planters, miners and members of commercial firms. Owing to the slump and the consequent fall of the axe, the younger Europeans have been greatly reduced in numbers, though there are cheering signs that young men are once more beginning to go out to the F.M.S.

There is a very large Chinese population, among whose numbers are the richest men in the country as well as nearly all the mining coolies, many of those on estates, and a large number of shopkeepers. They are the real workers of the country and the chief money-makers!

In the police there are several units of Sikhs and P.M.'s, and on the majority of rubber estates the coolies are Tamils. What with these and the various clerical staffs the number of Indians and Ceylonese is fairly large.

The Malay, to whom the country nominally belongs, but who forms only about one-third of the population, is a charming, well-mannered person, averse alike to hard words or hard work! He never indulges in vulgar abuse and is best content when sitting smoking on his doorstep what time the women work in the *padi* fields. He is aptly called one of Nature's gentlemen!

He is generally more intelligent and better educated than most Orientals, with the result that he often feels that scholarly or clerkly pursuits are more in accord with his dignity than the coarse manual labour involved in growing one's own food. He is capable, however, of being made into a smart parade soldier and is often an exceptionally good shot, though the lack of physique in many cases militates against proper control of the rifle or Lewis gun.

In the Police Forces of Malaya, which are semi-military, the Malay has shown himself on many occasions possessed of considerable pluck and powers of endurance, so that although he is as yet untried as a soldier, there is every hope that with European training and leading he will acquit himself creditably in war.

Defence.

In spite of the increase of the strategic importance of Malaya in recent years, the regular garrison has not increased in proportion. There is only one British battalion in Singapore (to be increased to

two this year) and one battalion of Burma Rifles in Taiping. A new regular Malay regiment is in the process of formation at Port Dickson in Negri Sembilan, but is still only in the very elementary stages of training and has yet neither the numbers nor the organization of a battalion.

Consequently, considerable dependence has to be placed upon the local Volunteer Forces to supplement the regulars, and they occupy the almost unique position amongst the Auxiliary Forces of the Empire in that they are front line troops and will have to be prepared to take the field as soon as the regulars in case of hostilities against that part of the Empire. This naturally necessitates aiming at a very high standard of training, the attainment of which offers great difficulties in the circumstances.

Besides the F.M.S.V.F., there are Volunteers in the Colony, amounting to a battalion each at Malacca and Penang and two battalions and a number of units of other arms at Singapore, a European Volunteer Field Company in Johore,* an infantry company in Kedah and a small newly-raised volunteer unit in Kelantan.

ORGANIZATION OF THE F.M.S. VOLUNTEER FORCE.

The Force is under the command and control of the General Officer commanding the troops, Malaya, and consists of a Headquarters; four infantry battalions (one in each State); a light battery; a signal company; a "platoon" trained in flying and army co-operation work; and a school of instruction and camp at Port Dickson.

H.Q., F.M.S.V.F. consists of a Commandant (regular Major with local rank of Lieut.-Colonel), a Brigade Major, a Staff Officer and an Armourer (commissioned).

Each battalion is commanded by a Volunteer Lieut.-Colonel with a regular adjutant. There is a number of Company Sergeant-Majors (regular sergeants or lance sergeants) as instructors for the infantry companies, and a Battery-Serjeant-Major for the light battery.

The present organization can best be understood from a brief *résumé* of the history of the Volunteer Force.

Before the war the only volunteers in the F.M.S. were the Malay States Volunteer Rifles, which was a European regiment. This regiment continued in being up to 31st December, 1920, when, after nearly 19 years existence, it was disbanded and another regiment named the Malay States Volunteer Regiment (M.S.V.R.), took its place the next day. The new regiment contained most of the personnel and carried on the old traditions of the Volunteer Rifles. It had a regular Commandant and Adjutant, with Headquarters at Kuala Lumpur.

* See page 590.

At various times the M.S.V.R. have given assistance to the police during internal unrest and a contingent of the Regiment played a considerable part and suffered some casualties in the suppression of the mutiny of the 5th Light Infantry (I.A.) which occurred at Singapore in 1915.

During the war, various native volunteer contingents (Malayan Volunteer Infantry) were raised by the rulers of the States and were entirely State controlled and financed. After the war they continued in being and came, for training only, under the Commandant M.S.V.R., the State still continuing to finance and administer them. After a few years the Government was persuaded that this was a thoroughly inefficient and uneconomical organization and, after some opposition, State Battalions were formed in 1931, the whole being named the "F.M.S.V.F." The Commandant M.S.V.R. became Commandant F.M.S.V.F. and there was a slight increase in the Headquarters Staff, complete administrative control of State M.V.I. contingents being taken over shortly afterwards.

The companies and units which had belonged to the European Regiment did not, however, lose their identity or badges as M.S.V.R. nor did the M.V.I. lose their State identity. We thus find the peculiar situation in which a battalion consists of units of two different corps, the M.S.V.R. companies being still known by their original letters while the M.V.I. are known as "No. 1 or 2 Coy. Perak, etc., M.V.I." In spite of this, battalions are now very definite units with an *esprit de corps* of their own. Perak, Selangor and Negri Sembilan Battalions each have a Regimental Colour. (They are unable to possess a King's Colour as His Majesty exercises no sovereign, but only protective rights in the F.M.S.) Photo No. 5 shows the presentation of the Colour to Perak Battalion, by the High Commissioner on 11th February, 1934.

The detailed organization of the F.M.S.V.F. is given in Appendix "A."

The uniform worn is the ordinary pattern khaki drill.

The M.S.V.R. wear the Wolseley helmet and the M.V.I. the Ghurka hat, each with the Regimental or State flash respectively. For ceremonial, jackets with gold chevrons and badges are worn with shorts and puttees. For training, shorts and shirtsleeves are worn. One platoon of "A" Coy. M.S.V.R. is Scottish and wears the national dress of that race with considerable pride! The kilt is of the Hunting Stewart tartan.

The equipment is the ordinary pattern web and the arms the standard patterns of rifles, bayonets, Lewis and Vickers guns of the British Army.

The Permanent Staff wear their own regimental pattern uniform and, on certain ceremonial occasions, officers wear full-dress (white).

The M.S.V.R. platoons at the larger centres are all machine-

gunners and, at the end of 1934, approximately half the personnel of the M.S.V.R. were being trained in the Vickers gun. In the case of the Scottish platoon the popularity of the kilt for training has waned somewhat since the conversion of that platoon to machine-guns! The temperature which can be reached by a brass cartridge case on ejection from a Vickers machine-gun has to be felt to be believed!

The M.V.I. companies are fairly well up to strength and are reasonably concentrated, but in the M.S.V.R. units the reverse is the case. The strength of the M.S.V.R. fell from over 1,200 (900 effectives)* in 1928 to 800 (600 effectives)* at the end of 1934. This drop is a direct result of the "axe-ing" which occurred in all walks of life during the slump and which not only reduced the number of Europeans in the country but threw so much work on those remaining that many of them found themselves unable to carry out any volunteering.

In some cases, outstation M.S.V.R. platoons have as low an effective strength as 5 or 6 and it can be seen that, with an average attendance at any one drill of 60%, progressive training of a collective nature presents a ticklish problem to a conscientious instructor! M.S.V.R. units are moreover very scattered, the platoons of some companies being 40 or more miles apart ("H" Coy. has platoons at each end of a road 200 miles long!) so that volunteer company commanders have little chance of commanding their units.

At Kuala Lumpur, Ipoh and Seremban there are commodious headquarter buildings which include messes (of which officers and all ranks of the M.S.V.R. are members), M.V.I. recreation rooms, offices and stores. The mess at Seremban also has its own squash court. The interior of the Headquarter Mess at Kuala Lumpur is shown in photo No. 1. At certain other stations there are also smaller headquarter buildings.

Volunteers receive no pay (except the rank and file of the M.V.I. when in camp) but get their travelling expenses to drills, camp, etc. If marked "efficient," however, they get certain concessions for themselves and their families in hospital and are able to get indulgence passages on troopships to China. To be so marked, men have to complete their annual weapon-training course and put in a minimum number of drills: Men of rifle platoons, 18; gunners, machine-gunners and signallers, 24—not an excessive number when one considers the ground to be covered in the training of, say, a machine-gunner! About the number put in by a recruit in half a week at a depot! Many men and nearly all N.C.O's and officers put in far more than their bare minimum, but even so the training programme is no easy task to get out.

* *Note.*—The difference between "strength" and "effective" is roughly those who are on leave out of the country. Usually some 25%.

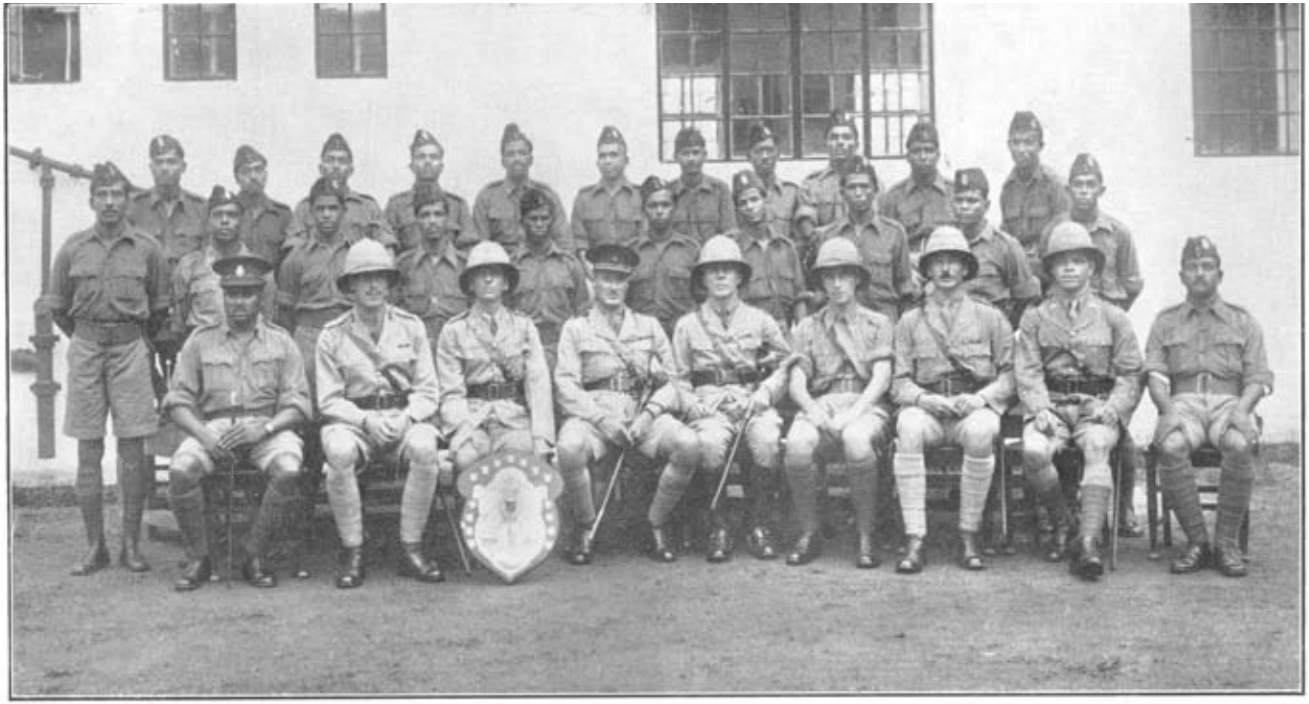

Photo 4.—No. 1 Platoon, Selanger M.V.I., winners, 1931, of the Bromhead Matthews Shield for inter-platoon shooting in the S.S. and F.M.S.V.Fs.

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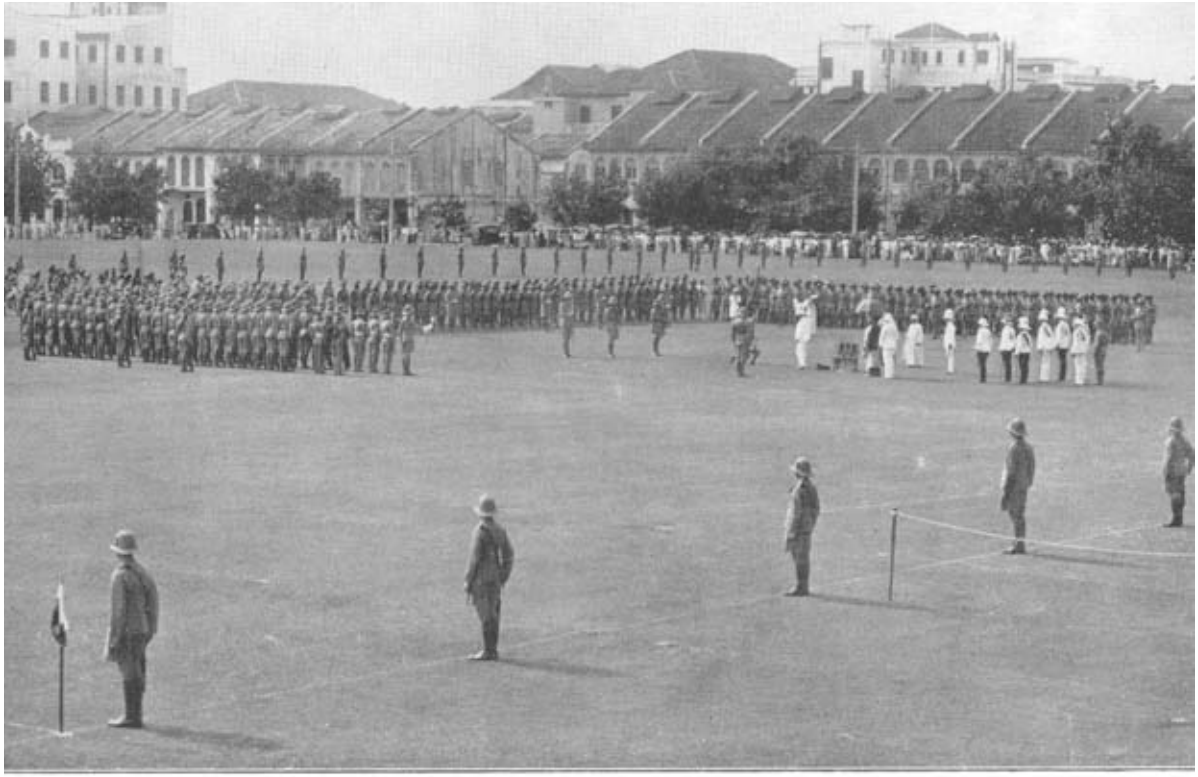

Photo 5.—Presentation of colours—Perak Battalion. 11th February, 1934, at Ipoh.

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A comparatively recent innovation is the "flying platoon" ("X" Platoon, M.S.V.R.), which consists of members of the Regiment who are also members of the Kuala Lumpur Flying Club. This unit is trained in the duties of an army co-operation flight and receives instruction, both from the Permanent Staff and from personnel of the R.A.F. from Singapore, who fly up periodically for this purpose. As the F.M.S.V.F. own no aircraft, all flying which is not done in service aircraft has to be done by volunteers at their own expense as members of the Flying Club.

Personnel.

Officers are normally commissioned after passing through the ranks. Officers of the M.V.I. are either Europeans who have been through the ranks of the M.S.V.R. or Malays from the ranks of the M.V.I.

The rank and file of the M.S.V.R. is a very different type to that found in the ordinary regular or territorial unit at Home and is more akin to the class in the London Scottish, H.A.C., etc. Consequently the standard of intelligence is also much higher, which alone enables any semblance of efficiency to be attained. The keenness of most volunteers is also most admirable. It is quite normal for a man, after a full day's work on an estate, to come in 30 or 40 miles to an evening's instruction and to do this every week during the training season. Many senior Government and other officials and ex-officers with fine war records are to be found serving keenly and cheerfully as private soldiers.

The proportion of men in the country districts who are volunteers is markedly higher than in the towns where, possibly, the counter-attractions of games and clubs somewhat militate against volunteering. Unfortunately, not only is there somewhat of a shortage of young men in the country, but those who are there often show a great reluctance to respond to the numerous recruiting appeals which are made. In consequence the average age of the M.S.V.R. is high, about 25% being 40 or over.

The Malay found in the ranks is usually fairly intelligent and keen, but suffers from one great handicap so far as his military training is concerned—he literally has no conception of the meaning of war or battle. This is understandable when one realizes that the Malays have never been a martial race and have no history behind them in which all the main landmarks are wars, which is what every European child learns at school. This makes extremely hard the task of the instructor who tries to inculcate a spirit of determination, energy and resolution in his tactical training. The Malay has also very little imagination and finds it very difficult to get into the picture when carrying out a field-firing exercise against a few figure-

targets or a T.E.W.T. He responds well to keenness and enthusiasm in an instructor and will make great efforts if properly handled.

He is a good mimic and actor and is as ready to reproduce, when off parade, a caricature of his instructor's pet idiosyncrasies as he is to emulate his method of sloping arms on it!

TRAINING.

The training season is from March to September. In February, cadre classes are held at drill centres and at the School of Instruction at Port Dickson for officers and N.C.O's. Individual and weapon training then follows until about June, the work being carried out as far as possible by the volunteer unit commanders themselves. Training usually consists of either one evening parade a week at the platoon drill centre or a whole Sunday morning's parade once a month at the company headquarters.

The weapon training courses are much on the lines of the T.A. course fired at home both for rifle and automatics.

Collective training can never go above company training and the co-operation of machine-guns and light artillery with a rifle company; firstly, because there is insufficient time to take training beyond this stage, secondly, because it is quite impossible to assemble complete battalions and thirdly, because there are literally only two areas in the F.M.S. where a battalion could be deployed! In one battalion exercise which was attempted close to Kuala Lumpur on one of these areas, the crowd of excited Asiatic sightseers, attracted by the sound of blank firing, was so dense that, in spite of the most sulphurous language, alike from troops and directing staff, threats and even blows, troops were seldom able to see their objectives and machine-gunners hardly once saw a target! After that the unequal contest was given up and only smaller exercises in more secluded spots were attempted.

Photo No. 2 shows a somewhat typical area on which two platoons have to train at Telok Anson.

The season's work usually culminates in a tactical exercise or field-firing scheme for the inspection by H.E. the G.O.C. One such scheme is usually carried out at each of the larger centres.

Camps are held at the School of Instruction at Port Dickson at intervals through the season. M.V.I. companies go to camp as units, but M.S.V.R. units are, unfortunately, unable to do so, as many of the Europeans are never able to spare a complete week away from their work and men in the same unit, often being members of the same firm, cannot get away together. Camp for the M.S.V.R. is therefore kept open for three months or so and a number of courses are run which volunteers attend as they are able to get off. There are usually two or three machine-gun weeks which are the most

popular. On these, M.G. training up to night-firing is carried out, volunteers reaching a very fair standard of efficiency as a result of a week's continuous training.

A typical group of volunteers in camp is shown in photo No. 3.

F.M.S.V.F. Rifle Association.

Considerable keenness is shown in "Bisley" shooting and the Rifle Association, which has branches in most of the larger centres, does much to encourage it by holding shoots most Sunday mornings and meetings and spoon shoots at intervals. The F.M.S. has produced a team to shoot for the Junior Kolapore and Junior MacKinnon Cups at Bisley every year since the start of the competition, from those members of the Rifle Association who are at home on leave. In 1935, with only four available from whom to choose a team of four, the F.M.S. were third in the Junior Kolapore, being only three points behind the winners, the Gold Coast.

Conclusion.

It must be quite obvious that it is practically impossible for a force as badly placed for training and able to do as few drills as the F.M.S.V.F. to attain a cohesion and efficiency even comparable to that of the Territorial Army at Home. In spite of this, however, the proficiency of a very large number of its members is remarkable. The weak spot is, of course, in collective training, in which so little practice can be obtained. Except for the week's camp of the M.V.I. companies, no unit commander has an opportunity of being in charge of his unit continuously for more than about five or six hours at a time. Should they have to take the field without any post-mobilization training, it is in this that they will fail unless able to call for help on the Permanent Staff.

The only possible method of overcoming this difficulty is the introduction of some form of compulsory military service throughout Malaya, which would be welcomed by many and not only members of the Volunteer Forces. Firms and companies would then be compelled to give leave to their employees for training.

It is quite certain, however, that if an emergency does arise the M.S.V.R., particularly the machine-gunners, and the M.V.I., if they are well led by Europeans, will give a very useful account of themselves and will more than justify the money which has been spent upon them.

One cannot conclude without saying what an immense admiration any regular soldier who has been in Malaya must feel for those men who, for no reward, though often over military age and with remarkably little encouragement from the Government, still continue to

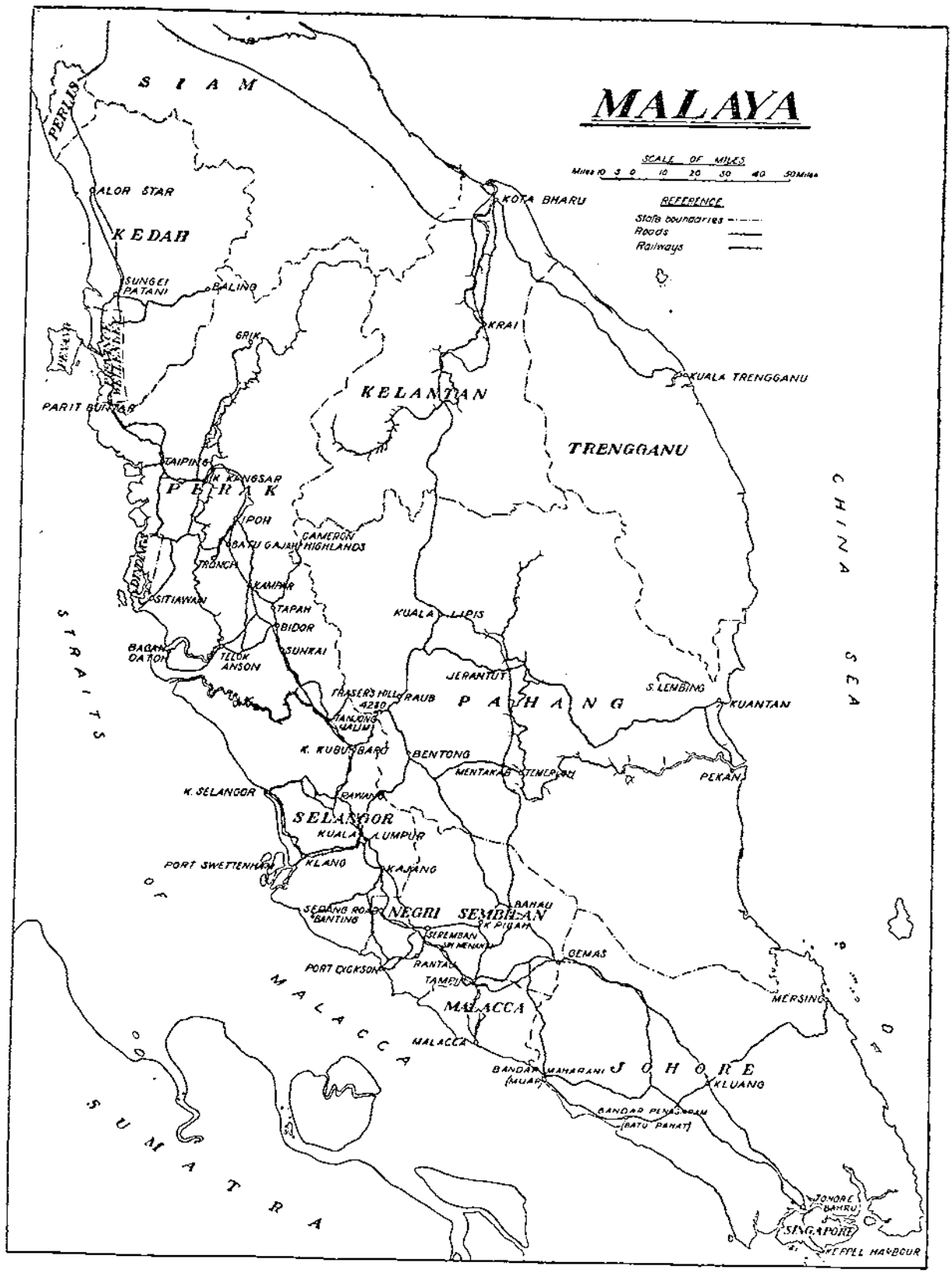
give up most of their few leisure hours to make themselves ready to defend their portion of the British Dominions beyond the Seas.

"It was by blood and sweat and bone that the Empire was won. It is only by blood and sweat and bone that it can be retained."

APPENDIX "A."

ORGANIZATION AND DISTRIBUTION OF UNITS OF THE F.M.S.V.F.

Unit.	*Composition.*	*Location.*	*Remarks.*
H.Q. F.M.S.V.F.	—	Kuala Lumpur.	—
Perak Battalion:			
H.Q.	—	Ipoh.	
"C" Coy. M.S.V.R.	One M.G. pl. Three rifle pls.	Ipoh. Kampar, Batu Gajah, Sungei Siput.	
"D" Coy. M.S.V.R.	One M.G. pl. Two rifle pls.	Taiping. Parit Buntar, Sitiawan.	
"G" Coy. M.S.V.R.	One M.G. pl. Three rifle pls.	Telok Anson. Bagan Datoh, Tapah, Cameron Highlands.	
1 Coy. Perak M.V.I.	Four rifle pls.	Ipoh, Batu Gajah.	
2 Coy. Perak M.V.I	Four rifle pls.	Telok Anson, Tapah, Taiping, Kuala Kangsar.	Two pls. Two pls.
Drums.	—	Ipoh.	M.V.I. personnel.
Selangor Battalion:			
H.Q.	—	Kuala Lumpur.	
"A" Coy. M.S.V.R.	Two M.G. pls. Two rifle pls.	Kuala Lumpur. Kajang, Rawang.	
"B" Coy. M.S.V.R.	Four rifle pls.	Klang, Kuala Selangor, Banting, Port Swettenham.	
"F" (M.G.) Coy. M.S.V.R.	Two M.G. pls.	Kuala Lumpur.	
1 Coy. Selangor M.V.I.	Four rifle pls.	Kuala Lumpur.	
2 Coy. Selangor M.V.I.	Four rifle pls.	Klang.	
Band and Drums.		Kuala Lumpur.	M.V.I. personnel.
Negri Sembilan Battalion:			
H.Q.	—	Seremban.	
"E" Coy. M.S.V.R.	One M.G. pl. Three rifle pls.	Seremban. Sepang, Rantau, Kuala Pilah.	
1 Coy. N.S. M.V.I.	Four rifle pls.	Seremban.	
2 Coy. N.S. M.V.I.	Three rifle pls.	Kuala Pilah, Sri Menanti.	
Band.		Seremban.	M.V.I. personnel.


MALAYA
SCALE OF MILES
Miles 10 5 0 10 20 30 40 50 Miles
REFERENCE
State boundaries
Roads
Railways
SIAM
PERLIS
ALOR STAR
KEDAH
SUNGEI PATANI
BALING
GRIK
KOTA BHARU
KRAI
KUALA TRENGGANU
KELANTAN
TRENGGANU
PARIT BUNTAR
TAIPING
KUALA KANGSAR
PERAK
IPOH
CAMERON HIGHLANDS
BATU GAJAH
TRONOH
KAMPAR
SITIAWAN
TAPAH
BIDOR
KUALA LIPIS
BAGAN DATOH
TELOK ANSON
SUNGKAI
JERANTUT
S. LEMBING
KUANTAN
FRASER'S HILL 4230
RAUB
PAHANG
BANJONG (JALIM)
K. KUBU BARO
BENTONG
MENTAKAB
TEMERLOH
PEKAN
K. SELANGOR
RAWANG
SELANGOR
KUALA LUMPUR
PORT SWETTENHAM
KLANG
KAJANG
SERDANG ROAD
BANTING
NEGRI SEMBILAN
BAHAU
K. PILAH
SEREMBAN
SRI MENANTI
GEMAS
PORT DICKSON
RANTAU
TAMPIN
MERSING
MALACCA
MALACCA
BANDAR MAHARANI (MUAR)
JOHORE
KLUANG
BANDAR PENGGARAM (BATU PAHAT)
JOHORE BAHRU
SINGAPORE
KEPPEL HARBOUR
STRAITS OF MALACCA
SUMATRA
CHINA SEA

Unit.	*Composition.*	*Location.*	*Remarks.*
Pahang Battalion:			
H.Q.	—	Kuala Lipis.	
" H " Coy. M.S.V.R.	Three rifle pls.	Bentong, Kuantan, Sungei, Lembing.	
1 Coy. Pahang M.V.I.	Three rifle pls.	Kuantan, Pekan.	
2 Coy. Pahang M.V.I.	Four rifle pls.	Kuala Lipis, Raub, Bentong.	
Drums.		Pekan.	M.V.I. personnel.
F.M.S. Light Battery.			
H.Q.	Armed with 3.7 How. but also train with 18 pdr.	Kuala Lumpur.	M.S.V.R. personnel.
Right Section.		Kuala Lumpur.	
Left Section.		Ipoh.	
Signal Company.:			
	W/T Sec. Cable Sec. Inf. Bn. Sec. D.R's.	Kuala Lumpur.	Officers and some N.C.O's, M.S.V.R. personnel, remainder rank and file M.V.I.
" X " Platoon M.S.V.R.	Three officers and about 20 O.R.	Kuala Lumpur.	Trained in A.C. work.
Sultan Idris M.V.I.	One rifle coy.	Sultan Idris College, Tanjong Malim.	An independent M.V.I. coy. not part of a State Bn. Composed of students of the College.

THE JOHORE VOLUNTEER ENGINEERS.

By CAPTAIN H. C. T. FAITHFULL, R.E.

1. BRIEF DESCRIPTION OF JOHORE.

THE Unfederated Malay State of Johore is situated at the southern end of the Malay Peninsula, and is separated from the Island of Singapore by the Strait of Johore. A causeway eleven hundred yards long, carrying the road and railway, joins the island to the mainland.

Johore produces about one-eighth of the world's rubber, and the majority of the European population consists of rubber planters and government officials. There are also several large oil palm concerns in the State.

The main line of the F.M.S. Railway runs through the State from Johore Bahru (the capital of the State, where the H.Q. of the Johore Volunteer Engineers is situated) in the south-eastern corner, to Gemas in the north, a distance of roughly 135 miles. There are no branch lines in Johore, but there are a number of good roads, the chief of which are one which follows the railway and another which runs across the middle of the State, from Batu Pahat on the west coast, to Mersing on the east, roughly 100 miles.

The climate, as is generally known, varies but little from one end of the year to the other, and is hot and damp. The maximum day temperature in the shade is seldom over 90° F., but the humidity of the atmosphere makes even that heat oppressive.

The Sultan of Johore, His Highness Sir Ibrahim, G.C.M.G., K.B.E., celebrated the fortieth anniversary of his accession to the throne on September 17th, 1935. His Highness is a keen soldier, and is the Honorary Colonel of the Johore Volunteer Engineers.

2. COMPOSITION OF THE J.V.E.

The unit was first raised in 1916 as the Johore Volunteer Rifles, and it was not until 1928 that the present title was assumed, that the unit was provided with R.E. tools and equipment, and that the training of the personnel as Sappers was begun.

To enrol in the J.V.E. a man must be of pure European descent, and of course physically fit. Naturally, most members are British

subjects (largely North British), but there are a number of foreigners in the Corps, which in recent years has included many Danes, and a few French, Germans, Italians and Norwegians. It may be remarked here that His Highness the Sultan maintains, in addition to the Johore Military Forces, who are Regular troops, the Johore Volunteer Force, which consists entirely of Malays, most of whom are in the civil employ of the Government.

3. Organization and Administration.

The J.V.E. is organized, on paper, as a Field Company. (This statement will be explained later under "Training.") The Officer Commanding, his Second-in-Command and the junior officers are Volunteers, and the O.C. is assisted in his duties by a Regular R.E. Adjutant, who has with him one Regular C.S.M. Instructor. The Officer Commanding is responsible to the G.O.C., Malaya, for the training and discipline of the unit, and the Adjutant, in his capacity as Head of a Government Department, is responsible to the Government of Johore for the administration of the $45,000 (£5,250) which is the average annual cost of the unit. It is also the duty of the Adjutant, with the assistance of his C.S.M.I., to carry out the actual instruction of the personnel.

It is to be emphasized that the Government of Johore provides the total cost of upkeep of the J.V.E. (including the pay of the Adjutant and C.S.M.I.), but that all military control thereof is vested in the G.O.C., Malaya.

4. Training.

The duties which may fall to the lot of the J.V.E. are mainly the safeguarding, in collaboration with the police, of European women and children in the event of internal unrest, and the performance of certain tasks connected with local defence, in the event of invasion.

The annual training programme, which is drawn up by the O.C. and approved by the H.Q. Local Forces (that branch of the G.O.C., Malaya's Staff which deals with all the Volunteer Forces in Malaya), is of course designed accordingly.

Membership of the J.V.E. is of two categories, "Colour Service" and "Auxiliary Service." Members of the latter do practically no training save to fire the annual musketry course. They are mostly men of over forty years old, or younger men who live so far from a drill centre that regular attendance at parades is impossible for them. "Colour Service" men have to attend a fixed minimum number of hours of instruction each training season, fire their musketry course,

and pass an examination in Fieldworks, in order to be classified as "Efficient."

Men classed as "Efficient" at the end of a training season have the privilege of treatment in Government hospitals for themselves and their families during the ensuing year, at the rates applicable to Government officers.

The number of "Colour Service" men present in the State is about 120 at present, and the number of drill centres is ten.

Actually the number of Volunteers attending any one drill centre varies from four to twenty-five. A minimum of three parades a month is held at each place during every month of the training season, which runs from February 1st to October 31st. Either the Adjutant or the C.S.M.I. is present at the majority of these parades, which means that those individuals each travel over a thousand miles, and are away from H.Q. seven or eight nights every month.

Training consists almost entirely of Weapon Training and Fieldworks. The J.V.E. possess, or have the use of, five ranges, and the standard of shooting is definitely high, J.V.E. teams having done consistently well in competitions open to the Regular Garrison of Singapore.

5. Difficulties.

The extremely scattered nature of the unit makes Fieldworks training difficult, as so few men can be got together at any one time, and the length of a parade can seldom exceed one and a half hours, since parades must be held in the evenings (*i.e.*, in the spare time of the Volunteers), and darkness falls at about 6.30 p.m. throughout the year. Moreover, the J.V.E. has only three small stores, besides that at H.Q. in Johore Bahru, in the State, and has only one small lorry. The transport of Fieldworks Stores to and from parades is therefore not always easy. The only occasions on which fairly large numbers of men can be got together for a reasonable length of time is during camp. These camps last for one week, and at present two a year are held, one in Malacca for the benefit of Volunteers in North Johore, and one on the Island of Singapore for the South Johore men.

Most rubber companies operating in Johore have estates in other parts of Malaya as well, and as a consequence men, who go home on leave, frequently do not return to Johore, and are replaced there by others who have probably been excellent Volunteers in one of the infantry units of the F.M.S. or S.S. Volunteer Forces, but who know nothing about Fieldworks. Similarly Government servants, who provide about 25% of the J.V.E., are constantly changing States.

The above disadvantages are felt chiefly in the training of officers

and N.C.O's, but recently N.C.O's' classes have been started during the non-training season, all those N.C.O's resident in one area coming into one drill centre or another for a week-end's instruction by the Adjutant or C.S.M.I. In this connection it is worth mentioning that whereas the Government week-end is Thursday and Friday (Islam being the State religion), the unofficial community observe Saturday and Sunday. This of course causes difficulties where a section is composed partly of Government officials and partly of planters.

6. General.

In spite of the obstacles outlined above, the standard of efficiency of the unit has been steadily improved in recent years, thanks entirely to the keenness shown by all ranks. It is seldom that a man shows any disinclination to do his share of training, and when that does occur, local *esprit de corps* is usually enough to induce him to resign. Should he refuse to do so, pressure can be brought to bear, and in the last resort H.E. the Governor is empowered to dismiss any Volunteer (officer or other rank) with or without giving any reason for his action.

Of the European population of Johore eligible to enrol in the J.V.E., some 80% are members of the unit. This high proportion is perhaps partly due to the lack of distractions, such as cinemas, dancing, etc., which apparently prevent a large number of the citizens of Singapore and other large towns from joining their local Volunteer Force, but it is nevertheless a satisfactory state of affairs, especially since, as already pointed out, it is very rare to find a man who does not pull his weight once he has enrolled.

ARTILLERY SURVEYS.

A REPLY TO "SKEW GUNS AND SURVEY."

By BT. MAJOR M. HOTINE, R.E.

> "For if any man think himself to be something, whereas he is nothing, he deceiveth himself. But let every one prove his own work, and so he shall have glory in himself only, and not in another."—*Galatians*, 6, 3–4.

IN the September, 1935, number of *The R.E. Journal*, "O's R. and B." express their disappointment at receiving no answer to certain questions put forward in their previous article, "Skew Guns and Survey." Here is one of the "questions":—

> "6. If the six hours (for an Artillery Survey) are considered vital to success, and (if) *the Infantry are pushed to the attack unsupported by Artillery*" (my italics), "it would be regrettable in the extreme if the enemy Artillery suddenly discarded survey, and decided to shoot his guns by ground and air observation only."

The answer to this "question," in so far as a concrete answer is possible to so hypothetical a question, is simply that any fool can fail in an attack by not making the most of his material resources, and that it would all be very regrettable anyway, without the last "if." It may have been true a century or more ago that "the moral is to the physical as three is to one," although it may reasonably be doubted whether so exact an arithmetical comparison could have been drawn even then between chalk and cheese. It may even be true that this scale of values holds to-day, but the fact remains that three times very little is still not very much. Moreover, the "question" suggests, rather naïvely, that an Army in war is commanded by a T.E.W.T. syndicate of all arms who, unable to agree on a concerted plan, proceed to carry on independently; the Artillery to their survey, the Infantry to the attack, and the Cavalry and Engineers to the "Shoulder of Mutton." In actual practice, a flesh-

and-blood Commander, who has all the other factors under review, will need to be informed just what time will be required for preparation—survey being only one, and not necessarily the most extensive, source of delay—or what amount of preparation can be done in a given time, and he will then have to decide whether he can, with a balance of advantage, should or must, allow for it in his plan. He will be aided in this decision by the fact that survey does not commence at 09.00 hours on the day of the Exercise, but —at least the reconnaissance part of it—is proceeding all the time.

It may be, then, that the unreal nature of the questions themselves would account for the lack of an answer: to provide one now will require a fresh appreciation. If, in the course of the answer, O's R. and B. seem to be getting a "handful" from their own side, then this is not necessarily due to inaccurate survey, but is intended as an indication that there are *no* sides in this matter. It is not, and should not be, an R.A. *v.* R.E. fixture, but an item of preparation for a war in which we shall both be on the same side. During a recent Artillery Demonstration at Larkhill, a tank enthusiast talked loud and long (before the demonstration against tank targets) about the devastating effects of tank action on open battery positions. A senior Gunner officer listened attentively and then remarked sincerely, "I hope you are right; after all they won't be *our* guns." In the same way, if we Sappers are able to produce rapid triangulation and large-scale mapping, then I am sure that no one will be better pleased than the Gunners. But the fact that we stand a good chance of doing so does not entitle us to belittle their own attempts to introduce survey methods into Artillery tactics on occasions when we have not, or have not yet, been able to assist.

It is fortunately unnecessary for the present purpose to know which arm is now the "Queen of the battlefield." So long as we have Artillery, the problem of accurately concentrating its fire will remain, although the details of the problem will change with a difference in the nature of, and the means of locating, its targets. Whether the Artillery itself is entitled to regal honours or not, I do not suppose any other aspirant would expect to remain crowned for long without Artillery support, whatever platform the gun is carried on or whether it is armoured or not. Even the in-fighting tank enthusiast, who bases himself on the Battle of Cambrai, has presumably studied the *whole* of that battle.

O's R. and B. might perhaps have suffered from less perplexity—real or imaginary—if they had commenced their appreciation with a statement of the objects of Artillery survey, instead of collecting them during the course of the argument. Expressed in the *lingua*

franca of the Principles of War, which we all understand, these objects are as follows:—

1. *Concentration.*

If the relative positions of batteries are unknown, it is necessary for one gun in each battery to range on all targets which that battery is to engage, and such targets cannot be engaged by other batteries unless they also range on them. If, on the other hand, battery positions are surveyed on a common co-ordinate system, or "grid," then any battery can engage at short notice any target registered by any other battery. Apart from overcoming the difficulty of observing the fall of shot when too many batteries are ranging on the same target, this system enables control to be centralized and fire to be concentrated, and the significance of this is obviously increased by the greater range of modern projectiles. It should be noted that this object is secured by a survey of gun positions only, provided that the heights of targets are roughly known from existing maps, or are otherwise determined. In other words, there is a definite advantage in the survey of gun positions even if, at the time, nothing is known of the target area.

2. *Surprise.*

If the topography of the target area can be surveyed in detail, preferably on large-scale maps, prepared or revised from air photographs, and targets located in relation to the topographic features as map references by other arms, then targets can be engaged by "predicted shooting" without any prior registration. The result may be a complete surprise, in either attack or defence. But if the target area cannot be surveyed, and it is necessary in consequence to range targets with the gun, then the fact that all gun positions are surveyed on the same grid enables such prior registration to be reduced to a minimum. The enemy may have no idea of the concentration of Artillery against him, and the result would be a partial surprise. There is yet a third possibility. A battery may range from a surveyed position, during which ranging its position would be disclosed to the enemy, and then move quickly to another surveyed position where it could come into action for "serious business" without any further registration. If this system is applied on a large scale, it might well deceive the enemy as to the direction of attack and completely dislocate his fire plan.

3. *Security.*

The quieter the Artillery keeps during the registration period, the less chance it has of being knocked out by counter-battery fire. Here

again, " a half-loaf " is obtainable by a survey of gun positions alone, enabling targets to be located by unmasking a few batteries only, particularly if the evasion tactics mentioned in para. 2 are employed.

4. *Economy.*

(*a*) *Of men.*

The more efficient tactical handling of the Artillery by survey methods, and the greater concentration and accuracy of its fire, will clearly be more effective in overcoming opposition and so economize in other arms. The stout heart of the British soldier is undoubtedly an asset, but it is more so if it is kept beating. He is more likely to remain alive if he can locate targets under cover for " big brother " and then wait for them to be blown up. *Ce n'est pas magnifique, mais c'est la guerre.* To secure this object to the full requires good communications and large-scale maps, referenced on the survey grid and sufficiently detailed to be easily read.

(*b*) *Of ammunition.*

Apart from economy of ammunition during registration, the greater accuracy of fire, corrected from meteorological data, on surveyed targets will economize when " firing for effect." This is especially so when definite targets can be located by forward troops, or from the air, on large-scale maps, with less necessity for systematically ploughing up the whole countryside by barrage fire or concentrations on " likely " areas.

(*c*) *Of time.*

It is generally assumed that a survey must entail so much delay that its advantages will be lost by giving the enemy sufficient time to prepare to " repel boarders," as O's R. and B. graphically describe it. The fact is that an enemy who decides to defend a position has probably decided to do so in advance, and is falling back on ammunition supplies over previously surveyed country. It would probably suit his book for the attacker to come on sooner than later. Certain it is that no unprepared attack at any stage in the Great War ever succeeded against even hastily organized defences, whatever the odds, whether in the " mobile " or " static " periods, with tanks or without them. We have heard that the Great War was " abnormal "—what *is* a " normal " war ?—and that the next war will be nothing like it. Possibly not, but failing the introduction of some new armament such as the machine-gun was, and on the assumption that we have since merely improved such armaments as were then tried, the best bet is that it will be a concentrated version of that unfortunate affair. In that case, the balance of advantage of this new weapon of survey,

like other new weapons, seems to lie with the defence, and the only chance the attacker has of redressing the balance is to take time for it. But what time? If a "prepared" attack is in prospect, the deciding factor—which so seldom appears in peace-time exercises—will probably be the time required to get forward sufficient ammunition, and by economizing in ammunition a survey will not waste time but will save it. It may also be noted that the *tempo* of peace-time exercises, particularly T.E.W.T's, has never yet been achieved in an "abnormal" war with real bullets in the air. To save O's R. and B. from whetting their axes at this stage, I may say that I refer here only to the "prepared" attack, where a reasonable idea of the enemy's strength and intention to stand has been obtained. I shall refer later to the encounter. By all means let us avoid beating the air, and curbing the superb dash of our troops when there is any chance of it getting them anywhere except underground.

It is just as bad to live with one's head in the clouds of the distant future as with one's feet firmly planted in the midden of the past. But if O's R. and B. will commence a study of military history, in relation to this problem, not too far back, say with the Russo-Japanese War, through the Great War in various theatres, and then prolong the curve just a little into the problematic present, omitting the next generation, which may possibly ride round one another in tanks consuming their own smoke and running on atomic energy, then I feel sure they will agree that operations, particularly offensive operations, against a powerful enemy equipped with modern weapons and the will and ability to use them, have not the slightest chance of success unless at least some of the above measures are introduced (or rather retained and improved) in Artillery tactics. The days when the Artillery could do its job with a single fire order to "cock the old bitch up a bit" are definitely gone. There is still a use for the "half-cock" position, particularly if the earliest opportunity is taken to survey it in, but that, together with any "system" of trial-and-error shooting, may go before very long.

A *complete* answer, which would secure all the above objects, would be to supply accurate, detailed, fully contoured 1/25,000 maps of the whole area of deliberate operations. The maps would need to be based on a triangulated framework, extending, or capable of extension, over the whole theatre of war: they should be projected and referenced on a co-ordinate grid system which introduces no sensible error in minor trigonometrical extensions, observed by angular measurement and computed, simply, on the assumption that the earth is flat. The gun positions should be located on the same co-ordinate system; possibly—if the map is sufficiently detailed—by pin-pointing on the large-scale map grid, but otherwise by minor

instrumental survey from the triangulated framework. The gun bearings, in relation to grid north, should also be determined to an accuracy of about two minutes. If the topography and visibility allow sufficiently long shots, these bearings might also be taken off the map, but must otherwise be taken off the trigonometrical framework or determined by other instrumental means.

How is this measure of perfection to be achieved ? The answer is that, at present, it cannot be got, but that in certain circumstances we may get very near it. In most European theatres the basic triangulation and reasonably good maps—in many cases on large scales—exist, but both would be in need of repair. The maps would need to be revised, and perhaps contoured in detail on an existing height control, and for this purpose we should need air photographs. But the photographs, provided they cover the country, need not be regularly exposed and could therefore presumably be taken in face of air opposition and in spite of anti-aircraft ground defences, provided that we had not definitely lost command of the air. The main difficulty would be lack of cloudless photographic weather in these latitudes, but even that difficulty might be overcome by looking ahead and allotting sufficient resources during fine spells to cover large areas. The task of providing the best possible maps, whether for the use of Artillery or of any other arm, would fall to the Survey Directorate and to the G.H.Q. and Corps Field Survey Companies R.E. ; and since it is imperative that the triangulated framework should be in sympathy with the co-ordinate system of the map, however far the area might eventually be extended, they would also be responsible for the repair of the existing triangulation, whether by extensive re-observation based on such few old points as might be found, and carried forward as operations proceed, or by simple restoration of a sufficient existing control and addition of extra points by interpolation. It should be realized that this work proceeds all the time—whereas most peace-time exercises start the war in the middle—and that it would be unusual for the Survey Directorate to be " caught out " to the extent of having to start a fresh triangulation at any time when deliberate operations are imminent. The R.A. survey of gun positions and bearings comes into action only when deliberate operations are imminent, although their reconnaissance is always proceeding and they should always be in touch with the survey situation. It would usually be possible to indicate to them certain points, which the R.E. will fix and from which the R.A. can break down, during a joint reconnaissance, and although the co-ordinates of these points might not be immediately available, they would be supplied before the Artillery observations were complete. It should *never* be necessary in these circumstances for the Artillery to commence a fresh survey of gun positions without R.E.

assistance; if they do so, there would be a considerable risk of the survey of gun positions being out of sympathy with the large-scale maps, which the R.A. will need for their targets, which are necessary to ensure the co-operation of other arms, and which at that stage might not have been gridded. If a fresh survey should be necessary, then the R.E. should undertake it and again provide a ruling control, which in this case might not be in sympathy with the permanent grid covering the entire theatre; the R.E. are better trained and equipped to do this and, in spite of certain impressions to the contrary, are not so stupid as to do nothing if they have been unable to carry forward or to resurrect the national triangulation. The R.E., or rather the Survey Directorate, would of course be responsible for ensuring sympathy to at least graphical accuracy between any such fresh survey and the map grid.

When we come to previously unmapped theatres of war, the problem is somewhat more difficult but by no means insoluble. Original survey from air photographs requires level flying at a sensibly constant altitude in straight strips; otherwise, whatever method is used to plot the maps, the ground would not be covered systematically by unbroken stereoscopic overlaps. Unfortunately this form of flying—although it would suit us very well if carried out from very high altitudes—is just the answer to the Archie's prayer. It is possible that it could be carried out—always assuming that survey is considered of sufficient importance to devote the necessary air resources to it—by an escorted formation with a few red herrings zig-zagging at lower altitudes. It is also possible that photography might with advantage be carried out some hundreds of miles ahead, on the assumption that the whole of an unmapped theatre cannot be organized for anti-aircraft defence all at once. But it is fairly certain that the type of photography required could not be executed at the last moment by Army Co-operation machines operating in the close reconnaissance zone. The idea of photographing the whole country in advance may seem visionary, but it must be remembered that a very few aircraft could bite off very big areas in a short time. Given the photographs, it is technically possible to produce accurate maps from them quickly, and to expand the scale of these maps rapidly in areas of deliberate operations. Most of the work can be completed long before any ground triangulation in or near the area has been fixed. Quite simple methods may also be used, although in that case, with our present methods, the accuracy of contouring would not be sufficient for such purposes as shrapnel barrages. Failing some guarantee that photographs are likely to be available, we have not yet sufficient personnel and equipment to deal with them in large quantities. In addition to medium- and large-scale mapping, it would be necessary to initiate and to carry forward an entirely

fresh triangulation, both as a framework for the maps and for the survey of gun positions, but this would not be likely to present any difficulty.

All this is actually rather more complicated than it sounds, but fortunately we have a few officers in the Corps who find that surveying is good for their brains, bodies and souls, and have contrived to spend a large wedge of their service in survey employment of some form or another. They are mainly without ambition in the Camberley sense, but nevertheless believe in their destiny, if few others do. It would be quite impossible for an officer to take on a job of, say, Assistant Director of Surveys in war on the strength of a Y.O. course in survey and, as O's R. and B. very rightly say, neither would he find an ex-civilian Corporal to do it for him.

We have so far considered the means of arriving at a perfect solution. Should we refuse to employ this powerful weapon because we cannot at all times achieve perfection? Would O's R. and B. be any more satisfied with the Royal Regiment if they refused to fire because the 100% zone is bigger than the driving band of the shell? It has already been made clear that there are very considerable advantages in a survey of gun positions alone when no maps are available and no information exists, at the time, of the target area. Every round fired provides such information and the survey makes it ten times as useful.

A good example of the "half-loaf" is the advanced guard or encounter action, which seems to bother O's R. and B. so much. Even if the basic survey already exists, it would not in these circumstances be possible to print and distribute large-scale maps in time, and neither could the troops carry sufficient to cover a rapid advance under present arrangements. The first battery to come into action fires entirely by observation, although it may very well get a first approximation off such medium-scale maps as may be available. And, whatever happens on T.E.W.T's, there would be no difficulty whatever in dealing with the machine-gun in a farmhouse, or any question of waiting for a survey to do it. By the time the brigade comes into action, opposition is probably getting serious. *If it is to fight with full effect as a brigade*, the battery positions must be tied together relatively by survey. This will not usually take anything like six hours, but until it is completed there is nothing to stop batteries firing independently by observation. *Faute de mieux*, the survey will necessarily be on a "temporary grid," which, to prevent subsequent corrections becoming unmanageable and to utilize such maps as may be available, is positioned and oriented as nearly as possible to the "permanent grid" of the national survey. But for this purpose, data taken off a medium-scale map are good enough to combine with other data off the same map, and if such data should

be in error by 50 yards and a degree, then what of it? O's R. and B. may have all five of their "inherent weaknesses," but what seriously do they expect the Gunners to do? Refuse to use such information as they have readily available, and revert to "cocking the old bitch up a bit" first, last and all the time?

Either the opposition is now overcome—if before the brigade survey has been completed, then so much the better—and the brigade limbers up and moves on again; or another brigade is deployed and goes through the same process of shooting by observation while it ties up its battery positions by survey. At the same time it endeavours to tie on to the first brigade, and it may succeed in doing so before its own internal survey is complete, so avoiding the introduction of a second temporary grid. It is likely in any case that a bearing traverse could be run quickly between brigade bearing pickets so that both brigades could shoot on the same bearing. This puts them a good half-way into co-operation. All the time the first brigade has been putting targets on its grid, and these are now immediately available for a shoot by both brigades. And so on.

Eventually the whole Corps Artillery may be deployed, but this will almost certainly imply a "prepared" attack, a pause, the time to tie up independent surveys and collect target data from previous registration or fresh survey from O.P's, and the introduction of a concerted fire plan. This is mainly the province of the R.A. and R.E. Survey Companies operating as previously explained, although the R.A. Company may on occasion detach parties earlier to tie up brigades first in action.

Finally, it has been said that truth lies at the bottom of a well. In matters of human co-operation, it may be said that truth lies at the bottom of a glass. Artillery Demonstrations are held yearly at Larkhill, where officers are to be found who know a great deal about gunnery and not a little about survey, and who are quite prepared to discuss these matters in and out of "hours." I suggest that O's R. and B. might attach copies of their articles to an application to attend. They will also find representatives of an earnest body of men known as the Field Survey Association, who are able to explain just what they did in the last war and are prepared to do in the next.

ILEX IN THE FASTNET RACE, 1935.

By CAPTAIN L. R. E. FAYLE, R.E.

Course :—Yarmouth, Isle of Wight—Needles—Channel—Fastnet Rock—Plymouth. 585 sea miles.

Wednesday, August 7th. On the morning of the start of the ninth Fastnet Race, *Ilex* lay at anchor off Yarmouth, Isle of Wight. Her new Bermudian mast, so impressive on the Medway, seemed an insignificant stick beside those of some of the ocean racing fleet anchored around her. The assembly seemed more numerous and more formidable than ever before. Had we converted her to a more efficient rig only to find her outclassed again? On paper, at least, it looked as if we had. There were eighteen entries, and it appeared that all, or practically all of these, would come to the starting line.

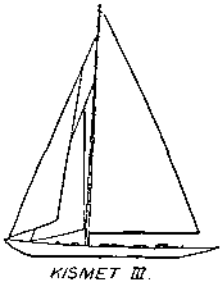
Already many of the yachts had arrived. To the Westward lay the great *Trenchemer*, a new Bermudian yawl of 50 tons, designed by Olin Stephens, but built in Scotland for a British yachtsman. Her graceful scarlet hull and tall white masts gave the impression of great speed and power. Three French yachts were anchored near by—*Hygie*, a powerful-looking Bermudian schooner of 60 tons, *Brise Vent*, a fat, square-sterned cutter of the Boulogne type, and *Isis*, a new Bermudian cutter slightly smaller than *Ilex*. The last named looked a light-weather flyer. To the Eastward were two older ships: *Rose*, a fine large gaff yawl and first British boat to finish in this year's Heligoland Race, and *Banba*, a gaff cutter of about the same size. To seaward lay the black *Tai-Mo-Shan*, the naval entry, an under-canvassed ketch with a fine ocean racing hull. Lastly, there was *Stormy Weather*, a beautiful American Bermudian yawl from the board of Olin Stephens, and skippered by his brother, Rod. An enlarged and improved *Dorade*, she had easily won the Transatlantic Race to Bergen in June, and was regarded by all as the likely winner of the Fastnet.

The crew had all assembled, the last three members having spent an uncomfortable night on the stone verandah of a well-known yacht club: this was due to the fact that *Ilex* had arrived at Yarmouth at about midnight, too late to take them on board, and by that time all the hotels were full: it was only natural, therefore, that these three should arrive on board imbued with the

FASTNET RACE, 1935 - THE STARTERS.

SCALE

FEET 0 5 10 20 30 40 50 60 70 80 90 100 FEET.



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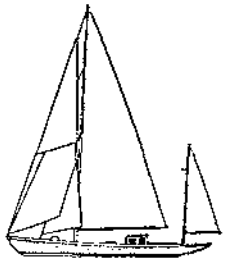
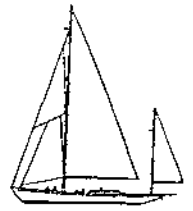


TRENCHEMER



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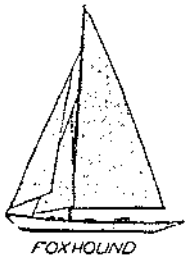
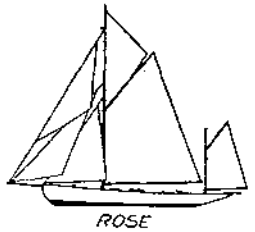


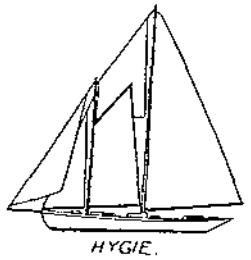
FOXHOUND



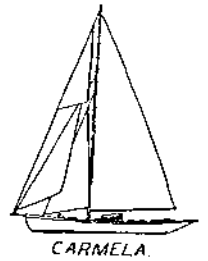
ROSE

ILEX.

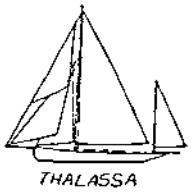
EMMELINE



HYGIE.



CARMELA.

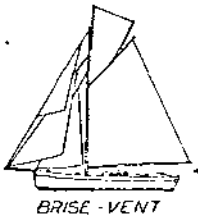


THALASSA

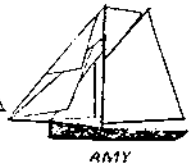
ISIS

MACNAB

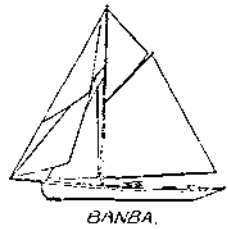
TAI-MO-SHAN



BRISE-VENT



AMY



BANBA.

MAUD

LREF

Communist spirit, to which they gave expression by criticising the very excellent catering arrangements made by other members of the crew. The lack of digestive biscuits nearly caused a mutiny, quelled only by the tactful action of the skipper, who arranged for a shore party to make good the deficiency. The crew, it should be added, was made up as follows:—*Skipper and navigator*—W. M. Blagden; *Port Watch*—H. S. Francis (mate and assistant navigator), K. N. Wylie and A. MacG. Stewart; *Starboard Watch*—H. A. Macdonald (mate), J. de V. Hunt and L. R. E. Fayle; *Spare hand*—J. H. Gillington. Carter once more was making the trip as cook.

During the morning we completed our purchases, and had a look both at the time allowances, which were rather less depressing than usual, and at the rest of the competitors now arriving for the start. *Foxhound* was lying astern of us, a brand new Nicholson Bermudian cutter specially built for ocean racing; with her royal blue hull and tanned sails she is perhaps the most beautiful and taking vessel ever seen in an ocean race. *Emmeline*, an old 12-metre, and *Amy*, an ex-Bristol Channel pilot cutter, had also arrived, and they were joined soon afterwards by *Thalassa*, an oldish Bermudian yawl, *Macnab*, a pretty little modern Bermudian cutter, and the pale blue *Carmela*, our modern rival in the Heligoland races. Last of all came two Fife-designed boats, *Kismet III*, a fine 15-metre with a reduced sail plan roughly similar to that of a modern 12-metre, and *Maud*, an elderly ketch. *Vamarie*, the famous American wishbone ketch, was, to our sorrow, a non-starter.

The start of the race was to be at 3 p.m. and consequently *Ilex* and her crew were ready for sea in plenty of time, a cheering breakaway from R.E.Y.C. tradition. At about 2 p.m. we were under way with full main and staysail, with the double clew jib in stops. A light south-westerly breeze had got up and the seventeen ocean racers commenced to jockey for the start in the bright sunshine. *Kismet III* under mainsail, with headsails in stops, tore past us—with spotless decks and gleaming brass the old racing yacht seemed a picture of Cowes Week rather than of Fastnet racing. Ten minutes to go—*Ilex* continued sailing away to the Eastward and back to the line. Five minutes to go—now only 45 seconds, and the line under 200 yards away: the double clew was broken out, and the old ship gathered speed. Gun! We had made a good start, going well, but down to leeward and clear of the clutter of ships at the windward end of the line. *Kismet III*, well inshore, was shooting ahead like a train, and with her *Stormy Weather*, *Foxhound* and *Trenchemer* went into the lead. *Carmela*, *Rose*, *Banba* and *Emmeline* soon formed a second group, drawing slowly ahead of us, while all the others fell astern. We were down to leeward, however, and a short board put us astern of all except *Amy*, but we soon started to creep ahead again. Clear of the Needles, we were lying seventh

to the four racers and *Carmela* and *Banba*. The wind fell lighter and the double clew was soon replaced by the Genoa, which is, strictly speaking, a bowsprit spinnaker, though we never referred to it as such.

The log had been streamed at the Needles, and our new speedometer attachment, which had been carefully adjusted to read correctly, proved a boon. It showed at once the effects of sheet trimming, and prevented the helmsman from pinching when on a wind. By about 6.30 p.m. we were down to Durlstone Head, and a short board to the southward put us clear of the point. By 7.20 we had passed Anvil Point and stood out to sea again on the starboard tack in a dying breeze. By using the fair tide inshore we had got well ahead of *Carmela* and *Rose;* the latter sailed well out to sea, preferring the mid-channel course, but the former stood in to St. Alban's Head after passing astern of us, and there both she and *Banba* seemed to lose the wind. The breeze had veered to the northwest and was now very light: we crept up on the leaders, and by nightfall were within hailing distance of *Foxhound*. *Kismet III*, *Trenchemer* and *Stormy Weather* were abeam, inshore, and the last spoke us with a lamp. So ended the first day, in which the light weather performance of *Ilex* had been a pleasant surprise.

Thursday, August 8th. During the small hours we had a flat calm, but *Foxhound* got a light air and went ahead, working inshore, while *Emmeline* crept past us. Variable airs from the east followed, and we had gybed and had the spinnaker up and down several times before 8 a.m. Dawn showed *Kismet III* hull down ahead, *Emmeline* half a mile ahead and *Carmela* and *Trenchemer* abeam inshore. We stole across Lyme Bay at two or three knots with much sail trimming and spinnaker drill to take advantage of the variable airs. *Kismet III* drew away, *Trenchemer* went ahead, but we held *Emmeline* and dropped *Carmela* well astern. To the southward, hull down abeam, *Rose* could be seen. At noon the day's run was 70 miles.

Before 6 p.m. we sighted the Start, eight miles distant, and as we closed with the land, *Foxhound* appeared on our starboard beam. By 8.30 p.m. we were down to the Prawle and with a faint breeze of our own we slipped past *Foxhound* as she lay becalmed close by. We hailed her and asked her where *Stormy Weather* was. "A long way ahead," was the depressing reply.

As dusk fell we could see *Kismet* and *Trenchemer* ahead, *Rose* and *Emmeline* abeam to seaward, and *Foxhound* and *Carmela* astern. We were well placed. A breeze came from the north and freshened: soon *Ilex* was making over six knots under Genoa and main, on her course for the Lizard. At 11 p.m. two jarring cracks were heard by the watch below, who turned uneasily in their bunks and assumed that the ship was falling to pieces. Those on deck, however, made

light of these unpleasant sounds and continued driving the ship until ten minutes later, when it became evident that the Genoa was too much for us. Francis, on going forward, announced that the bobstay had broken, so we hove to, while he, now in his element, unearthed steel wire rope, marline, and Handy Billy; he then went over the side to pass the wire through the shackle on the stem, a most unenviable job, and with the aid of his watch, succeeded in rigging a most workmanlike jury bobstay which stood up to its work throughout the remainder of the course. While we were hove to, *Foxhound* and *Carmela* sailed past us and went right ahead.

Friday, August 9th. Soon after midnight the jury bobstay was ready and we were under way once more, now under plain sail, having lost 55 minutes of fair wind by our mishap. The Eddystone was soon abeam and the ship going well. At 4.45 a.m. the double clew replaced the 1st jib and later the Genoa went up. At 6.45 a.m. the Lizard was abeam and we lay close hauled to clear the Seven Stones. But the wind headed us, slowly backing towards the north-west—a dead beat to the Fastnet—and the skipper decided to stand out between the Seven Stones and the Scillies —a wise decision, for the wireless forecast gave us north-westerly winds, moderate to fresh, *backing*. This meant that we must make the best possible westing before the wind backed in earnest.

It was a pleasant sailing morning, sunny and clear, and *Ilex* pushed along to windward at about five and a half knots. Hull down ahead we could see the sails of *Rose*, while on the starboard bow, hurrying seawards, a leaning wedge of canvas, bright in the sun, showed us the position of *Carmela*. At noon the day's run was 122 miles. As we drew clear of the land, the sea got up a little, and the Genoa started shipping more than its fair share of water: we handed it and changed to working headsails, but the wind fell lighter, and at 1.15 p.m. the double clew replaced the working jib. At 2 p.m. Round Island Lighthouse in the Scillies was abeam, and *Carmela*, who had evidently been pinching to clear the Seven Stones, though still to windward, had fallen back. By 5 p.m. we were making a steady six knots, but we had been headed off to a westerly course, and 45 minutes later we went about and stood to the northwards on the port tack. The wind promptly veered a point or so, heading us to N.N.E., but we made a leg of 20 miles till dusk, when we went about again, with none of our rivals in sight. We held our 5-knot gait till midnight.

Saturday, August 10th. At 1 a.m. we went about on the port tack again: the wind had backed considerably, and within an hour we were laying our course for the Fastnet, then about 120 miles distant. The dawn broke cloudy, and a rather lumpy and

confused sea was running, into which *Ilex* drove at well over six knots. As the day continued we were able to check sheets a little. The wind increased, and so did the sea; the ship was making some water, and from now on the deck pump had to be manned every three hours or so to clear the bilge. At noon the day's run was 104 miles made good on our course.

The afternoon was like the morning, dull and overcast, a freshening breeze, and the sea, owing to the shift of wind, getting steeper and more confused. *Ilex*, under double clew jib, staysail and full main, five points off the wind, was going seven to seven and a half knots, and even touching eight for short periods. She lifted to the seas when she had time, and drove through the crests of the remainder. The sea came over everything, but nothing seemed to check her way as she charged ahead with lee rail awash. This, we felt, was real ocean racing. The double clew jib was pulling like a horse, so well in fact, that its upper sheet tore the fairlead (on the counter) through which it led, out of its seating: we led it through a second fairlead. Then the same sheet chafed through on the boom, so we replaced it by the weather sheet, leading the broken one round to windward and making a temporary repair. The skipper, now at the helm, was determined to hang on to that sail at all costs!

At about 5 p.m. the Irish coast was in sight, and after a little navigational excitement it was decided that we were heading straight for the Fastnet. Some minutes later a sail was sighted abeam to leeward. It was *Kismet III*, homeward bound, and ahead of her we could see the tanned sails of *Foxhound*, leading the fleet. Astern of these two we sighted two Bermudian yawls, and assumed correctly that they were *Trenchemer* and *Stormy Weather;* the latter was carrying a big mizzen staysail. We reckoned we were five or six hours behind the leaders: it looked as if we were safe from *Kismet III*. *Stormy Weather* was giving us under three hours so she had outrun our allowance already: *Trenchemer* and *Foxhound* were giving us nine and seven hours respectively, so we still had a slight chance of saving our time on them.

Within an hour the Fastnet Lighthouse showed up, slightly on the weather bow, and a little after 8 p.m. we were flying flag "Z" and bearing away to round. The rock was impressive, standing up clear cut and grim against an uneasy grey sea and dull sky, with the Irish coast line, wild and strangely dreary, showing faintly to the northward. The lighthouse keeper semaphored the news—the four leaders had all rounded between 2.25 and 3 p.m. A grand sight those four fine ships must have made.

As we bore away to round, we handed the double clew and staysail, and set the reaching staysail and 2nd jib—the 1st jib having been badly torn. In deference to the sea we went about rather than gybe, and we were soon reaching homewards on our course for the

ILEX IN THE FASTNET RACE, 1935.

Ilex in her new rig under main and Genoa.

Trenchemer before the start.

The start—left to right :—*Hygie, Trenchemer, Kismet III, Foxhound* and *Stormy Weather.*

Rose changing headsails off the Needles.

Ilex in the Fastnet Race 1 - 4

Foxhound becalmed off Prawle Point.

Ilex coming up to the finish. Left to right: — Gillington, Fayle, Wylie, Blagden, Macdonald.

After the race—wet sails.

Stewart and Wylie at the deck pump.

The naval entry, *Tai-Mo-Shan*, arriving at Plymouth.

Ilex in the Fastnet Race 5-9

Longships. In the growing dusk we sighted *Rose*, two hours behind us, beating up to the rock close in to the cliffs of Cape Clear. On board *Ilex* we were again comfortable, having exchanged the crash and hammer of a head sea for the easy lift and drive of a following one. The medium jib topsail was sent up and we were soon reaching along easily at seven and a half knots and more. Cooking was again possible and Carter supplied the crew with a welcome hot stew. During the day we had eaten little—hard-boiled eggs for breakfast, mostly eaten on deck, and for lunch, bully-beef sandwiches, gallantly cut in the saloon by Dougal and Carter.

Sunday, August 11th. The middle watch was delightful, the moon was bright, and though there was still a moderate sea on the quarter, *Ilex* was sailing beautifully, steering like a lamb and reeling off the knots steadily. Soon after dawn the wind began to ease, and at 8 a.m. we sent up the Genoa and handed the 2nd jib and medium jib topsail. During the morning a series of rain squalls gave us short bursts of speed when the ship worked up to eight and a half knots, but in the lulls we were down to six. At noon, the day's run was 170 miles.

The wind eased still further during the afternoon, but we kept on at over six knots, till at 3.25 p.m. we sighted the Cornish coast, a perfect landfall, and another triumph for our navigators, the Longships being dead ahead. At this time, though we did not know it, *Stormy Weather* was nearing the Lizard, about 44 miles ahead, a few miles astern of *Kismet III* and *Trenchemer*, and *Foxhound* was somewhere off the Runnelstone, less than 30 miles distant. A freshening breeze would have made the finish a close one, but it was not to be. We had brought the Longships abeam by 8.30 p.m., and in the dying breeze had started to creep over the foul tide towards the Runnelstone, when the wind died completely, and we began to fall back. Meanwhile, to our dismay, *Rose*, who had been sighted on the starboard quarter, holding the remains of the breeze out to sea, came slowly up on us and went right ahead. We were being set rapidly on to the Longships, so we bent a couple of long warps on to the kedge, anchored in about 25 fathoms, and handed the Genoa, waiting for a breeze. It was 9.30 p.m. and a deep gloom settled on the ship's company while *Ilex* slatted in the swell. The skipper had stopped whistling, a bad sign; for his whistling had been an index of our luck or otherwise. When we were doing moderately well he gave us Ravel's "Bolero"; in moments of great elation he burst into "The fellow from Upselaa": only in moments of complete hopelessness did he remain silent for very long. The watch on deck sat miserably on the foredeck, munching chocolate and smoking.

Monday, August 12th. At midnight a light air came. Within five minutes the Genoa was drawing and the kedge on deck, and

Ilex started to make slowly over the tide. At 1.10 a.m. the Runnelstone was abeam, and for a time, we were able to lay our course for the Lizard, but the wind fell lighter and headed us. We made several tacks before we finally put the point abeam at 8.45 a.m.—over 12 hours from the Longships! The wind was very light from the northeast, but during the morning it slowly backed and freshened, eventually allowing us to sail on our course for Plymouth. At noon the day's run was 86 miles. Rain started to fall steadily, and by 1 p.m. we were doing seven knots. The wind increased still further and in the squalls during the afternoon we were making eight and a half knots with the Genoa sheeted well home and the lee rail awash. The crew nervously watched the bow wave breaking steadily into the foot of the Genoa and wondered how long the sail would stand it, but the skipper hung on to it. Finally, as we neared Rame Head a fiercer squall hit *Ilex* and the sail was handed. Working headsails were quickly set in its place and at eight knots we sped towards Penlee Point. At this point a perfect gentleman, shaved, wearing a collar and tie, appeared on deck. This prominent member of the crew had rashly accepted an invitation for Monday evening, many miles from Plymouth: thanks to the good breeze we had held during the afternoon, he was presumably able to fulfil his engagements. Soon we had opened up the breakwater, and at 5.7 p.m. we crossed the finishing line, 6th to finish out of 17.

After a fruitless effort, frustrated by railway officials, to anchor in Millbay Docks where *Trenchemer*, *Stormy Weather* and *Rose* were moored, we dropped a hook in the Cattewater. Lying near by were *Foxhound*, *Kismet III* and *Banba*. The last named gave us a shock but we soon learned that she had given up owing to trouble with her topmast. Rumours that *Foxhound* had only finished in the afternoon gave us hopes of a third prize. That evening saw *Emmeline*, *Hygie* and *Carmela* finish within a few hours of us, but we were safe from them. The rest of the evening was spent most pleasantly with our friends, the Royal Marines, who not only entertained us in their Mess but also very kindly put *Ilex* on a mooring near Drake's Island. A more pleasant ending to an ocean race cannot be imagined.

Early next morning we found that *Thalassa* and *Isis* had arrived during the night, too late to save their time on us, and we knew that we were safe for third prize, *Stormy Weather* being an easy winner with *Trenchemer* second, and *Foxhound* fourth. *Kismet III* had been the first boat to finish, but she came out fifth on corrected time. *Maud* had given up as well as *Banba*; and *Macnab*, *Tai-Mo-Shan* and *Brise-Vent* appeared on Tuesday, about mid-day. Only *Amy* was unaccounted for, but she, too, eventually finished—on Wednesday evening. She had been chartered for the race by a party of

keen naval officers who were bent on getting round the course somehow, and her age and build and the condition of her gear were against her: everyone agreed that it had been a stout effort putting her round the course at all, and it is pleasant to record that her crew were presented with tankards as a consolation prize, which they fully deserved. As for us, in addition to the third prize for the Fastnet Cup, we found we had won the Jolie Brise challenge cup, which is given to the winner of the race on a series of handicaps voted for by the entrants. It had been won by *Dorade* in 1933.

It had been a hard sailed and exciting race, and though there had been no foul weather, there had been real racing, and we all want to do the trip again. *Ilex* had surpassed herself in the honest stretch of windward work between the Lizard and the Fastnet, outward bound, in which she lost very little on three new ocean racing yachts and a 15-metre, and gained on all the other competitors. We had been within 40 miles of the Fastnet when the first boat rounded, and at our worst points we were never much more than 60 miles behind the leaders, *Kismet III* and *Trenchemer*. Light airs which persisted for six hours or more after these two had finished robbed us of all hope of second prize, and the fine sailing breeze which continued after we had crossed the line brought the stragglers in fairly close on our heels. But it is this element of luck which in an ocean race between ships of widely varying types adds greatly to its interest and excitement, and it is worth remembering that *Foxhound*, who lost heavily on the run home by making a bad landfall at the Longships, was thereafter even worse served with wind than ourselves. Truly we cannot grumble at the result against such a field. The crew all feel that her new rig has made *Ilex* once more a ship that cannot be ignored entirely, even by modern deep sea racing craft.

The list of starters and times, most of which have already been published in the *Supplement to the R.E. Journal*, are given, for the sake of clearness, on the following pages:—

LIST OF STARTERS.

Rig.	*Yacht.*	*Owner.*	*Thames Tonnage.*	*Length, O.A.*	*Length, W.L.*	*Beam.*	*Draught.*	*Y.R.A. Sail Area.*	*Built in*
				Feet.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	
Bm. Schooner	*Hygie*	A. Verliac (France)	60	67·0	53·0	16·0	10·0	2,620	1930
Bm. Yawl ...	*Trenchemer* ...	W. D. M. Bell	50	72·0	53·5	14·8	10·5	2,217	1934
Bm. Cutter ...	*Kismet III* ...	J. Colin Newman	50	75·0	49·8	13·7	9·5	2,336	1909
Bm. Cutter ...	*Carmela*	G. E. W. Potter	35	59·0	46·6	13·3	7·8	1,900	1934
Cutter ...	*Banba*	A. Rosling	34	64·0	49·0*	12·9	—	2,008	1898
Bm. Cutter ...	*Foxhound* ...	Isaac Bell	33	63·2	45·0	12·5	9·1	1,650	1935
Cutter ...	*Brise-Vent* ...	G. Fortin (France)	33	49·9	45·9	13·8	7·7	1,820	1928
Yawl	*Rose*	C. F. King	32	66·7	47·6	12·1	8·7	2,110	1899
Bm. Ketch ...	*Tai-Mo-Shan* ...	The Admiralty	30	54·7	42·0	12·2	8·4	1,120	1933
Bm. Yawl ...	*Stormy Weather*	P. le Boutillier (U.S.A.)	28	53·9	39·7	12·5	7·9	1,300	1935
Cutter ...	*Amy*	Sub.-Lt. I. L. M. McGeogh, R.N. ...	28	48·0	44·0	13·0	7·5	1,210	1887
Bm. Sloop ...	*Emmeline* ...	F/O. G. R. Canavan, R.A.F.	25	61·0	36·8	11·1	7·8	1,348	1912
Ketch	*Maud*	Gp. Capt. B. A. Playne, R.A.F. ...	21	42·1	35·0	11·4	6·6	1,070*	1899
Bm. Cutter ...	*Ilex*	R.E.Y.C.	20	51·0	41·5	10·4	7·5	1,290	1899
Bm. Cutter ...	*Macnab*	J. J. Joass	18	46·7	35·0	10·7	7·0	990	1935
Bm. Cutter ...	*Isis*	G. Baldenweck (France)	17	48·2	35·1	11·1	7·0	1,005	1935
Bm. Yawl ...	*Thalassa* ...	G. Napier Martin	16	47·5	35·0	10·2	—	1,170*	1906

* Approximate.

TIMES OF ROUNDING THE FASTNET.

1. *Foxhound* ... ... Sat., 10th Aug., 2.25 p.m.
2. *Kismet III* ... ... ,, ,, ,, 2.47 p.m.
3. *Trenchemer* ... ... ,, ,, ,, 2.55 p.m.
4. *Stormy Weather* ... ... ,, ,, ,, 3.0 p.m.
5. *Ilex* ... ... ,, ,, ,, 8.15 p.m.
6. *Rose* ... ... ,, ,, ,, 10.0 p.m.
7. *Hygie* ... ... ,, ,, ,, 11.40 p.m.
8. *Emmeline* ... ... ,, ,, ,, 11.55 p.m.
9. *Isis* ... ... Sat., 10th Aug., 12 midnight.
10. *Carmela* ... ... Sun., 11th Aug., 3.15 a.m.
11. *Thalassa* ... ... ,, ,, ,, 6.30 a.m.
12. *Macnab* ... ... ,, ,, ,, 1.0 p.m.
13. *Tai-Mo-Shan* ... ... ,, ,, ,, 3.45 p.m.
14. *Brise-Vent* ... ... ,, ,, ,, 5.20 p.m.
15. *Amy* ... ... Mon., 12th Aug., 6.30 a.m.

RESULTS—1935 FASTNET RACE.

Order of Finishing.	Yacht.	Finish.	Fastnet Cup.			"Jolie Brise" Cup.		
			Time Allowance	Corrected Time.	Place.	Handicap.	Corrected Time.	Place.
		Day H. M. S.	H. M. S.	Day. H. M. S.		H. M. S.	Day. H. M. S.	
1.	*Kismet III*	12 Aug. 2.1.54	Scratch	12 Aug. 2.1.54	5th	1.21.3	12 Aug. 0.40.51	4th
2.	*Trenchemer*	,, ,, 3.31.58	9.22.35	11 Aug. 18.9.23	2nd prize	3.17.30	,, 0.14.28	3rd
3.	*Stormy Weather* ...	,, ,, 3.44.15	16.3.18	,, ,, 11.40.57	Winner	4.25. 0	11 Aug. 23.19.15	2nd
4.	*Foxhound*	,, ,, 13.32.51	11.33.14	12 Aug. 1.59.37	4th prize	4.27.13	12 Aug. 9.5.38	9th
5.	*Rose*	,, ,, 15.54.59	6.44.38	,, ,, 9.10.21	11th	9.31.15	,, ,, 6.23.44	6th
6.	*Ilex*	,, ,, 17. 7.24	18.54.54	11 Aug. 22.12.30	3rd prize	19.31.15	11 Aug. 21.36. 9	Winner.
7.	*Emmeline*	,, ,, 18.14.18	9. 9.54	12 Aug. 9. 4.24	9th	11.48.20	12 Aug. 6.25.58	7th
8.	*Hygie*	,, ,, 18.40.20	8.57.14	,, ,, 9.43. 6	12th	10. 0. 0	,, ,, 8.40.20	8th
9.	*Carmela*	,, ,, 20.33. 3	12.51.59	,, ,, 7.41. 4	8th	9.30. 0	,, ,, 11. 3. 3	11th
10.	*Thalassa*	13 Aug. 1.38.11	22.59.38	,, ,, 2.38.33	6th	23.37.30	,, ,, 2. 0.41	5th
11.	*Isis*	,, ,, 1.49.48	23. 7.26	,, ,, 2.42.22	7th	15. 3.20	,, ,, 10.46.28	10th
12.	*Macnab*	,, ,, 11.58.46	26.50.42	,, ,, 9. 8. 4	10th	21.22.13	,, ,, 14.36.33	14th
13.	*Tai-Mo-Shan*	,, ,, 11.59. 3	24.31.17	,, ,, 11.27.46	13th	23.15. 0	,, ,, 12.44. 3	12th
14.	*Brise-Vent*	,, ,, 13.28.31	16.43.17	,, ,, 20.45.14	14th	23.31.16	,, ,, 13.57.15	13th
15.	*Amy*	14 Aug. 21. 1.12	?	13 Aug. ?	15th	37.15. 0	13 Aug. 7.46.12	15th
—	*Banba*	Gave up	10.46.26	—	—	?	—	—
—	*Maud*	Gave up	27.8.15	—	—	?	—	—

MODERN BRIDGING EQUIPMENT—PART II.

By CAPTAIN E. V. DALDY, R.E.

I. INTRODUCTION.

IN an article in the September *R.E. Journal*, the writer dealt with the subject of Modern Bridging Equipment in broad outline, leaving details for someone else to fill in. Since then, he has read " J.A.C.'s " article published in the same *Journal* and had certain correspondence with the R.E. Board ; and he wishes in the present article to grapple with some of the details.

There seems to be general agreement that improvement is needed in our heavy bridging equipment, and the following suggestions are accordingly made.

II. CONSIDERATIONS AFFECTING THE DESIGN.

A. Extent of Heavy Loads.

Until a definite maximum load for military bridges is laid down, the designer will be at a disadvantage. Directly one design is complete, loads will be increased, resulting in a makeshift policy in which the designer will always be one jump behind. It is exceedingly difficult for any Staff to lay down a maximum load while there is continuous progress in design of vehicles, but it should be possible to lay down a limit for a fixed period of years. During such a period, the bridging equipment of the Army would remain the same. This would not cause stagnation nor prevent new ideas from materializing, as they would be filed for review at the end of the period. It would result in a saving of money, and would simplify training.

For the moment there appears to be a tendency towards a reduction in weight in the heavier natures of tanks, and an equipment designed to take 20 tons will probably suffice to transport them.

B. Superstructure.

Existing superstructure will take the load, and there appears to be no reason for change in design. It is very simple, and all parts can be manhandled easily. If possible, the roadbearers should be made lighter by using an alloy.

The only objectionable parts of the superstructure are the compound joists. These are heavy, awkward to handle, and only cause

complication, especially at night. They are of no use for any other job and should go.

It was suggested by " J.A.C. " that the superstructure was too heavy, and should be made lighter by a change to gunwale loading. Admittedly this reduces the unsupported length of roadbearer, but this is the only part of the superstructure affected. The existing roadbearer weighs 12 lb. per ft. run, and the smallest R.S.J. quoted in *M.E.*, Vol. II, Table XVI, weighs 10 lb. per ft. run. It is unlikely that any smaller R.S.J. could be used for heavy loads on account of twisting strains, and so any saving in weight on this account is negligible. A change in metal is likely to produce better results.

Apart from this, gunwale loading does not give such good support to the superstructure, and although it may be all right for F.B's and light bridges, its use for heavy bridges would require careful trial before adoption. It is noticeable that foreign pontoon equipment, shown in Appendix I to " J.A.C.'s " article, appears to be designed for light to medium loads, and the change to heavy bridge is made on the principle of " Cock her up a bit, Bill," by putting in more pontoons. In fact, this is the makeshift principle which we are now trying to avoid.

Another small point against gunwale loading is the difficulty of removing a damaged pontoon.

C. Pontoons.

Apart from the question of gunwale loading, it is obvious that a bridge consisting of single piers is likely to be simpler than the present double pier in heavy bridge. If the present length of bay is retained, and only single piers are used, buoyancy will obviously be the key factor. As the 21′ bay is reasonably economical in transport, there seems to be no reason for varying it. The existing pontoon has a weight of 1,350 lb. with a net buoyancy of 6½ tons. I agree with " J.A.C. " that the use of an alloy instead of consuta would be advantageous, but only from the point of view of the weight to be carried. The amount saved could not be sufficient to affect materially the buoyancy, but it would permit an increase in the size, of pontoon which could still be manhandled with comfort. A rough calculation will show that :—

(i) Every 6″ increase in length increases the buoyancy by 2½%.
(ii) Every 6″ increase in width increases the buoyancy by 9%.
(iii) Every 6″ increase in depth increases the buoyancy by 19%.

Of these, the length and width are dependent on transport factors, whereas the depth, which gives the greatest improvement, is not. With very little alteration in size, the pontoon's buoyancy could be increased to eight tons, and by using such an alloy as Birmabright, the weight would actually be less. Another great advantage of using

metal would be that couplings could be strengthened, and fixed securely to the pontoon. Three pontoons of this type coupled together would still be required to give sufficient buoyancy for a single pier. As an alternative to the decked pontoon, " J.A.C. " has suggested a return to the open one, and, although I agree that this has many advantages, it has also the following disadvantages :—

(i) The actual work of constructing bridge is more difficult than working from a deck.
(ii) Coupling pontoons, anchor work and fixing cables and diagonal ties are easier with a deck.
(iii) Decked pontoons can be totally immersed for short periods without harm.

Apart from these, the B.E.F. may be faced with a landing in some country without dock facilities. Pontoons, in such cases, have to be unloaded from a transport into the sea, an unusual and unruly element. Here the decked pontoon has a distinct advantage. Incidentally, some rafts were swamped in Portland Harbour in 1935 in these circumstances, and sank. The casualties with open pontoons would have been very heavy. Again I suggest that change should only be made after careful trial.

D. Raft v. Bridge.

An alternative to the re-design of the heavy bridge is the retention of the medium bridge as at present, and the supply of special superstructure for heavy rafts only. This idea has several disadvantages and I am of the opinion that it is wrong in principle. The main disadvantages are :—

(i) The heavy raft equipment would have only one use, lacking flexibility. We cannot afford to " lock up " too much transport with special stores.
(ii) It would complicate training. The Reservist is the man who will have to do the job in war. He may retain some knowledge of a single simple equipment, but any extras would only cause " fog."
(iii) All heavy rafts are difficult to manœuvre, especially at night.
(iv) In a reasonable sized river (say 150 ft. to 200 ft.) each round trip with a raft will take about 15 minutes in the dark under favourable conditions, and it is doubtful whether this method would be practicable except with small packets of tanks.

It is probable that the most important use of heavy crossings in war will be when tanks in large numbers are used in a timed operation, to increase the size of bridgeheads originally forced. This would be a major operation in which surprise would be an important factor.

Take the case of a tank battalion which has to cross a river in these circumstances. This would need 50 raft crossings, or two hours using six rafts, which is the whole equipment (heavy) of the present P.B. Park. Meanwhile, the enemy have two hours in which to concentrate A.T. Defence in the area threatened, easily located by noise. If a bridge is used, however, the tank battalion can be kept well back. The enemy may discover that bridging operations are in progress, but as this is normal for supply purposes, no special action is disclosed. At the correct time, the tanks advance, crossing the bridge in " line ahead," and can go straight into action in this formation. Admittedly the battalion will take three-quarters of an hour to cross the bridge, but zero can be based on the time of crossing of the first tank and not the last. It follows, therefore, that all efforts should be concentrated on a bridge, leaving rafts to take care of themselves as quite a subsidiary means of crossing a river.

E. Transport.

At present, the standard bridging vehicle is a 3-ton lorry with or without a trailer, depending on the type of bridging unit carried. The reasons for the retention of this vehicle seem to be :—

(i) Cross-country performance.
(ii) Reasonable road speed.
(iii) Heaviest vehicle for existing medium bridge.

It has, of course, an important bearing on the loading of units, and has affected bridge design.

The 3-ton vehicle is, however, not very economical and is rarely used by civilians, so that few will be available for impressment on mobilization. There will be large numbers available in the 5–10 ton class which, with large modern tyres, have a reasonable cross-country performance.

Most military writers lay great stress on the fact that roads are invariably blocked with traffic of various kinds, and that vehicles, however speedy, will rarely be able to move at more than an average of 5 m.p.h., so that speed is not an essential factor. If we, therefore, now propose to build heavy bridges, *ab initio*, the last reason for the retention of the 3-ton lorry has gone. The use of larger vehicles would simplify design and decrease road space.

In my last article, I made some disparaging remarks about trailers, from the point of view of the officer at bridgehead. It should not be forgotten, however, that if any vehicle in the P.B. Park has a trailer, all should have them, in order to maintain a uniform road speed. The trailer has the great advantage that it increases the carrying capacity of a vehicle without affecting road space very much. The ideal loading is, of course, " one heavy unit—one vehicle," but I do not believe that this can be attained without trailers.

III. SUGGESTED DESIGN.

Bearing in mind the considerations discussed above, the writer has come to the conclusion that a simple heavy bridge can be provided on the following lines :—

Superstructure.

As at present with 11 roadbearers, possibly made of some new alloy to reduce weight. No compound joists.

Piers.

To consist of two pontoons, present shape, with one pontoon, both ends square, joined together as shown in Fig. 1. (For alterations to design of pontoon, see II *C.*, page 615.) The buoyancy of such a pier works out at approximately 25 tons, which is roughly the figure required.

The only parts of the equipment likely to cause difficulties are :—

(i) The diagonal ties, which should not be insuperable.

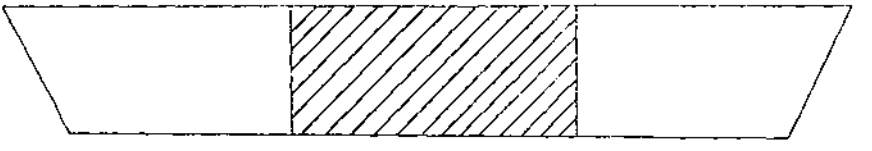
(ii) Pontoon couplings, which would have to be strengthened as suggested.

The advantages of this suggestion are :—

(i) It does away with compound joists.

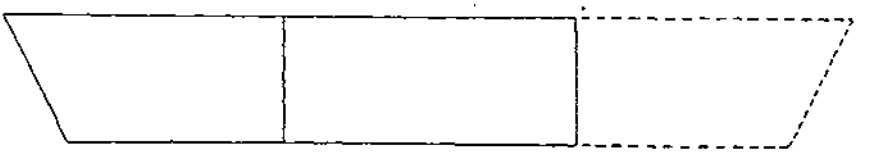
(ii) If medium bridges, and not heavy, are required, as is possible in country unsuitable for tanks, piers can be made up as shown in either Fig. 2 or Fig. 3, so that no equipment is wasted, and there is no " dead weight " in the P.B. Park.

Figure 1.



BRIDGE CENTRAL, ON SQUARE SECTION, SHOWN SHADED.

Figure 2.



FOR USE IN RIVERS WITH FLOW IN ONE DIRECTION ONLY, OR FOR CONVERSION TO HEAVY BRIDGE LATER, AS SHOWN DOTTED.

(iii) If medium bridges are in use, and heavy ones are suddenly required, conversion from Fig. 2 to Fig. 1 is simple by coupling on the additional pontoon. The roadway is centralized by the present method of removing a damaged pontoon.

Figure 3.

FOR USE IN TIDAL RIVERS.

(iv) Very slight re-distribution of units in the Pontoon Bridge Park would produce the results shown in Appendix I.

IV. Conclusion.

There must be many ways of solving the bridging problem. This is one based on a desire to alter the present equipment and drill as little as possible. It may have its snags, constructional or otherwise, but a start must be made somewhere. Here is a cockshy, and I hope many alternatives will be put forward, in order to give our design branch the full benefit of experience gained, and so that a really worthy heavy bridge may be produced.

APPENDIX I.

Pontoon Bridge Park.

1. *Pontoon Units.*

These to remain as at present.

2. *Trestle Units.*

A trailer to be added to each unit. At present, the lorry is absolutely fully loaded. With the trailer, one heavy shore bay per unit can be added and the loading would be :—

Lorry.

27 chesses	2160
Mk. VI trestle	1165
Heavy shore bay	1114
Pickets, lashings, etc.	200
	4639

Trailer.

11 roadbearers	2860
4 ribands	360
	3220

3. *Conversion Units.*

Exactly the same as pontoon units, but with square pontoon. One extra roadbearer per unit (making a total of 8) would be required. This would give 22 roadbearers in 2 pontoon and 1 conversion unit required for 2 heavy bays.

4. *Odd Bay Units.*

No longer required. Shore bays are carried in trestle units. Every bridge has to have " spare " for casualties, and the extra bay will, therefore, be readily available.

There will, therefore, be only three types of units, which will reduce the difficulties of ordering stores.

QUANTITIES.

With the present Pontoon Bridge Park, there are 46 lorries and 25 trailers exclusive of cut bays, motor boats, etc. It is suggested that there should be :—

18 pontoon units 9 conversion units 12 trestle units	39 lorries and trailers.

This shows a reduction of 7 lorries, but an increase of 14 trailers. The net result, with an increased carrying capacity, will be reduction in road space.

This suggested distribution will make the following varieties of bridge, the trestle and shore bay situation remaining the same :—

(*a*) 27 floating bays (medium) in place of 25.
(*b*) 18 floating bays (heavy) in place of 12.

By changing the bridging vehicle, as suggested in II, *E.*, page 617, every unit could carry a full heavy bay of 11 R.B's instead of 7 as at present.

It would also be possible to carry one heavy pier on a lorry and trailer. This would mean forming a pier of two pontoons, present shape, but of increased dimensions.

THE GALLOWAY POWER WORKS.

By CAPTAIN J. H. D. BENNETT, R.E.

THE Galloway Hydro-Electric Power Works, on which the writer had the good fortune to be employed during part of 1933 and 1934, were commenced in 1931 and are scheduled for completion in 1936. The object is to develop the water power resources of the Galloway district of the south-west of Scotland. The area under development comprises the watersheds of the Galloway Dee and Loch Doon, and is shown on Map 1. In all the area is about 400 square miles, and the upper portions of the catchment area include some of the highest parts of the Southern Uplands of Scotland. The characteristics of the district when considered in conjunction with the rainfall make it unsuitable for development as a source of continuous power, but these factors, together with the fact that the run-off in winter is much higher than in summer, make it a district eminently suitable for development from the point of view of the generation of cheap power intermittently, provided a suitable outlet for such power could be obtained. The Electricity Supply Act of 1926, the consequent creation of the Central Electricity Board and the development of the grid provided such an outlet, and by the Galloway Water Power Act of 1929 the necessary parliamentary powers for the construction of the various works were obtained and the Galloway Water Power Company was formed in the same year to carry out necessary construction and to operate the various generating stations and ancillary plant. The works envisaged comprise five generating stations, which are scheduled as " selected stations " by the Central Electricity Board, and having a total available output of 102,000 kw. The stations will normally be operated during periods of peak load on the grid, *i.e.*, during the hours of factory and general industrial load, and although the load factors of the stations themselves will be low, their operation and the supply of electricity to the C.E.B. will improve the general load factor of the steam stations to which they will be connected. Table 1, page 622, gives a list of the stations, together with their installed kw. and other details and the location of the stations is shown on Map 1. Each station is connected to its own reservoir by a pressure conduit, so that there is no waste of water when it is not actually running. In addition to these reservoirs the last and largest station—that at Tongland—has situated a few miles

above it a large natural loch, Loch Ken, which in effect acts as a large storage battery.

TABLE I.

Station.	*Installed kw.*	*Diam. of Conduit.*	*Average head ft.*
Kendoon	21,000	13–14 ft.	132
Carsfad	12,000	two 10′ 6″	65
Earlstoun	12,000	two 10′ 6″	66
Glenlee	24,000	11′	380
Tongland	33,000	18′ 6″–20′	106

Stages of development. The whole work is being carried out in two main stages. The first stage comprises the development of the lower portion of the catchment area, the controlled water from which will be used to operate the Glenlee and the Tongland Power Stations. Among the works involved in this stage are the construction of a dam at Clatteringshaws near the High Bridge of Dee on the New Galloway–Newton Stewart road, the Glenlee Tunnel and power station, the regulating barrage at Glenlochar at the southern end of Loch Ken to control the water stored therein, an arch dam at Tongland together with the Tongland aqueduct and power station, and numerous minor works such as road diversions necessitated by the raising of the river level due to the barrage and dams. The first work to be undertaken was that of the barrage at Glenlochar, as this, when completed, enabled the engineers to control to a large extent the flow in the River Ken at Tongland and thereby materially assisted the operations of the Tongland dam and power station contractors in their foundation work in the river-bed. The works included in the second stage are chiefly the Loch Doon works (Loch Doon dam and the Doon–Deugh tunnels), the dams on the Deugh, Ken and Blackwater Burn for the Kendoon station, the Kendoon station itself, the Carsfad dam and power station, and the Earlstoun dam and power station. The first stage works were scheduled for completion in the latter part of 1934, but owing to unforeseen difficulties the Tongland and Glenlee power stations did not come on load until 1935. The three power stations included in the second stage, it is hoped, will be ready to come on load in time to assist in taking the winter load of 1936. Constructional work on all the second stage works began during the spring and summer of 1934.

Storage sites. From the northern end of the catchment area the storage sites either available or under construction are :—

(*a*) Loch Doon. Available but level to be raised.
(*b*) Clatteringshaws Loch. Formed by Clatteringshaws Dam.
(*c*) Loch Ken. Available but level raised.

The reservoir at Clatteringshaws may, at a later date, if found necessary, be supplemented by an additional reservoir at Loch Grennoch. Table II below gives the main particulars of the reservoirs mentioned above.

TABLE II.

Reservoir.	*Max. Level above O.D.*	*Min. Level. above O.D.*	*Capacity in million cu. ft. between T.W.L. and L.W.L.*
Loch Doon ..	705	665	2900
Clatteringshaws ..	585	545	1250
Loch Grennoch ..	705	668	230
Loch Ken	148	144	320

Loch Doon provides storage for a catchment area of about 50 square miles with an average rainfall of about 60 inches. Before any water can be drawn from Loch Doon, however, a minimum of 30 million gallons a day has to be let down the River Doon as compensation water to the Burgh of Ayr. The level of the Loch is to be raised so as to provide additional storage capacity and this will be accomplished by the construction of a dam at the outlet of the loch, and in this dam will be incorporated a needle valve through which the compensation water will be discharged. The run-off from about 30 square miles of the Water of Deugh watershed will also be collected in Loch Doone. The scheme provides for an open channel from the Water of Deugh to convey the water to the Deugh Tunnel under Lamport Hill. The outlet of this tunnel at Drumjohn on the Cairsphairn road will be connected by a cascade and a steel pipe to the Doon Tunnel. The steel pipe will cross the valley of the Cairsphairn Lane, and where it crosses the Lane itself a valve will be installed, by the operation of which the water from the Water of Deugh may either be transferred to Loch Doon through the Doon Tunnel, or discharged down the Lane into the Kendoon station headpond. The discharge from Loch Doon will also be controlled from this point. The provision of the large storage in Loch Doon is really the secret of the operation of the whole scheme. In winter, when the run-off in the lower areas is sufficient to replenish each station's headpond by the volume of water discharged during the day's operation, the run-off from the upper area will be taken direct to Loch Doon for storage and use in the drier times of year when the run-off in the lower areas is not sufficient to keep each station's headpond full.

Headponds will be provided for each of the stations at Kendoon, Carsfad and Earlstoun by damming the river at a suitable point above each station. In the case of the top station, that of Kendoon, there will be a continuous flow into the headpond, and, although spillways will be provided, the overflow will be restricted to a

minimum and normally water will only escape from this headpond through the aqueduct and pipe line to the power station. Below Kendoon the discharge from the station will be impounded by the Carsfad dam in the Carsfad headpond, and similarly below the Carsfad station the discharge will again be impounded by the Earlstoun dam in the headpond for the Earlstoun station. The discharged water from this station will be taken to Loch Ken, into which will also come the discharge from the Glenlee station. The water stored in Loch Ken will, in its turn, as described later, be used for the operation of the Tongland station.

Kendoon Station.—Headpond. The headpond for this station will be formed by damming the Water of Deugh, the Ken and the Blackwater Burn. The headpond formed by the Deugh dam will be connected to that of the Ken dam by a short canal of about 900 ft. in length through the saddle between the two rivers and this combined headpond will be connected to that of the Blackwater Burn by an open aqueduct. The intake to the station will be located at the Blackwater dam.

Deugh dam. The dam on the Deugh will consist of a central arch section, 220 ft. radius to the upstream face and enclosing an angle of about 90°, and will be sited just below the Tinkers Loup, a well-known beauty spot on this river, which will be submerged when the headpond is filled. The western abutment will be on the cliff face of the gorge, whilst the thrust on the eastern side will be taken by a long tangential gravity haunch in which will be incorporated a spillway section. The whole of the work will be of mass concrete and the arch will be about 80 feet high above river-bed level and the top water-level of the headpond 510 feet above O.D. It is computed that the minimum water-level of the headpond will be 502 O.D. and the invert of the canal cut to the Ken headpond is 496 O.D. This canal cut is to be 95 ft. wide at the bottom with sides at a slope of 1½ to 1, unlined in rock and with a minimum concrete lining of 6 inches in soft.

Ken dam. The Ken dam will also have a central horizontal arch section of 165 ft. radius to the upstream face, about 80 ft. high above river-bed and enclosing an angle of about 85°. The western abutment will consist of 110 ft. of gravity haunch and 200 ft. of embankment with a concrete core wall cut-off. The eastern abutment will consist of a 400-ft. gravity spillway section and 160 ft. of normal gravity dam. From this latter the connecting aqueduct to the Blackwater dam headpond will commence. This will be 2,000 ft. in length and of varying section from 10 ft. wide at the bottom and sides at 1½ to 1 concrete lined in soft soil, to 18 ft. wide and sides at 4 to 1 in rock, all averaging in depth about 10 ft. The total excavation involved in the construction of this open aqueduct is in the order of 50,000 cu. yds.

Blackwater dam. This dam is located on the Blackwater Burn where it runs in a deep narrow gorge just below the Dalry-Cairsphairn road. The central portion of the dam will be of the horizontal arch type of 125-ft. radius to the upstream face and enclosing an angle of about 40° The river at the site of the dam runs east and west and the northern abutment (the open aqueduct side) will consist of a 180-ft.-long concrete gravity spillway section, whilst the southern abutment will be a 60-ft. gravity dam. Normal to the southern end of this dam is the submerged intake to the power station, and this is flanked on its eastern side by an 80-ft. intake retaining wall and 170 ft. of gravity dam. River-bed level at the site of the dam is approximately 460 O.D.

From the intake the water of the combined Deugh, Ken, Blackwater headpond will be conveyed to the turbines in the Kendoon station, situated on the east bank of the Ken, by a reinforced-concrete pressure aqueduct (cut and cover construction) about 3,000 ft. in length and 14 ft. 6 in. in diameter, and by 1,000 ft. of 13 ft. 6 in. diameter steel pipe. At the junction of the aqueduct and steel pipe is located the surge tower, and just below this tower is the main valve house. Both these are similar to those at Tongland and will be described later.

Kendoon power station. The plant to be installed in this station consists of two Francis type vertical shaft water turbines, on top of which are mounted the A.C. generators. These will generate at 11,000 volts and the output will be taken from the station to a C.E.B. sub-station, to be erected close by, where it will be stepped up to 132,000 volts for feeding into the "grid." The machinery and switchgear will be similar to that installed at the Tongland station, which is described later. Particulars of this station, as well as those of the other four stations, are given in Appendix I.

Carsfad station. The tail-water level of the Kendoon station is 342 O.D. and the Carsfad headpond will extend very nearly up to Kendoon. The normal top-water level of the Carsfad headpond will be 338 O.D. and the headpond will be formed by damming the Ken about two miles below the Kendoon station. This dam will, like those in connection with the Kendoon station, consist of a central mass-concrete horizontal arch section about 60 ft. high above river-bed level and with long concrete gravity haunches, in which will be incorporated a spillway section and the intake works. A fish ladder to allow the salmon to get up the river past the dam will also be provided. From the intake the water will be conveyed to the two turbines in the power station through twin steel pipes, 10 ft. 6 in. in diameter, on which will be located the necessary valves, etc. The machinery and switchgear installed in this station will be similar to that at Kendoon, and it is intended that both these stations should be operated by remote control in conjunction with Earlstoun station,

as the operation of an upper station would affect the water-level in the headpond of the stations below that in operation.

Earlstoun station. The tail-water level of the Carsfad station is 270 O.D. and the water discharged therefrom will be again impounded for the operation of the Earlstoun station by an arch dam located on the Ken just above Allangibbon Bridge on the New Galloway–Dalry road. The dam will be similar to that at Carsfad and a fish ladder will again be provided. The turbines, alternators and switchgear will also be similar to those at Kendoon and Carsfad. Work on all of the foregoing has now been commenced, the main contractors being Messrs. Charles Brand and Son, Ltd., Sir Robert McAlpine and Sons, Ltd., and Messrs. A. M. Carmichael and Co., of Edinburgh.

Clatteringshaws dam and Glenlee power station. The next generating station as we come down the Ken is that at Glenlee, situated in Glenlee Park, about two miles to the north of the village of New Galloway. This station is not, however, operated by water from the Ken, but obtains its power from water supplied from a large artificial reservoir constructed in the higher portion of the watershed of the Galloway Dee. The Loch of about 1,000 acres in surface area is formed by the Clatteringshaws dam, which spans the Water of Dee just above the old High Bridge of Dee on the New Galloway–Newton Stewart road. The dam is of the gravity type, upstream face vertical and downstream face at a batter of 0·75 to 1, and is about 1,500 ft. in length. To satisfy the Scenery Committee the dam, instead of being straight, has been constructed to a large radius giving a pleasing æsthetic effect. This alteration, however, added considerably to the difficulties of setting out and also, to a lesser degree, to the cost of the work owing to the necessity of using curved shuttering, etc. The dam is built on an excellent granite foundation and is of mass concrete with displacers. The specification called for an 18-in. skin of rich concrete (1 : 1½ : 2½) on the upstream face of the dam and also in the cut-off and at the abutments. The hearting of the dam is of 1 : 3 : 5 concrete and plums up to 20% of the volume of the dam were permitted, provided no point of rock was less than 18 in. from the face nor from the nearest point of the next plum. Coarse aggregate was obtained from a quarry which the contractors, Messrs. Shanks and McEwan and Co., Ltd., opened up on the hillside near the east abutment. The stone was extracted by normal quarrying methods, the larger sound boulders being set aside for use as displacers, whilst the remainder of the produce of the quarry was transferred by crane direct to a central crushing and grading and concrete-mixing plant. Some of the stone was crushed to sand and mixed with the main sand supplies obtained from Newton Stewart, in order to give a sand with a suitable fineness modulus and concrete that was not too harsh. The mixed concrete was conveyed from the mixer in 2 cu. yd. skips by standard-gauge loco. to one of seven

10- or 15-ton steam derricks on the downstream side of the dam, which actually placed the concrete in the forms and also handled the plums, some of which weighed as much as 10 tons. The total yardage of concrete in the dam is in the order of 76,000 cu. yds. In order to allow for the shrinkage of such a large mass of concrete in setting, the dam was constructed in a series of bays, closing spaces being left to be filled up towards the end of the work. Two temporary openings 18 ft. square were also left in the base of the dam at the level of the original river-bed to allow of the passage of river water during the period of construction. The crest of the dam carries a footway 5 ft. wide on a series of arches. At either end of the dam these arches are filled up solid, whilst those in the central portion are left unfilled and the crest below the arches rounded off to form a spillway section. At either end of this section buttresses run down the downstream face of the dam, partly for architectural effect and chiefly to restrict the spill water to the central section. At the base of the dam a Glenfield and Kennedy 60-in. needle valve has been built in and a free roller type of gate provided at the entrance to the iron valve culvert on the upstream face. Access to the valve-operating gear is provided by a series of steps down the downstream face of the dam and the operating gear for the roller gate is housed in a motor house built up over the footway. The valve is of the piston type, hand operated, and provided with a series of curved disperser vanes, so that the water being discharged under considerable head, instead of coming out in a solid jet causing erosion of the river downstream of the dam, comes out in a swirling spray and with the energy entirely dispersed. This valve can be used either for the purpose of drawing down the Loch should it be necessary to undertake repair works at the submerged intake, or for augmenting the flow in the lower portions of the Dee in dry weather up to the minimum flow stipulated in the Galloway Water Power Act. Much pressure grouting and cementation work similar to that done at Tongland was carried out during construction, and it is extremely creditable to both the engineers and the contractors to note that no serious leaks were to be seen after the Loch had been filled.

The overflow from Loch Grennock is also collected and run into the Clatteringshaws reservoir. The necessary intake works have been constructed on the Pullagh Burn, about half a mile from the dam, and from here the water is led in a concrete pipe under the main road and thence by open aqueduct to the reservoir.

The construction of this reservoir necessitated a road diversion of about ¾ of a mile in length round the eastern abutment, cut in places through solid granite. The old High Bridge of Dee, a picturesque bridge in rubble masonry, situated just below the dam, also had to be replaced, as it was considered that it was not in a sufficiently good state of repair to withstand the possible maximum spillway

discharge, and a new R.C. bridge carrying the road diversion has been constructed just downstream of the old bridge.

The whole of the works at Clatteringshaws have been carried out by Messrs. Shanks and McEwan, of Glasgow, as main contractors, in a period of about two years.

The intake works to the tunnel to the power station at Glenlee are situated about a mile and a half to the N.E. of the dam. A short intake canal, concrete lined, leads the water from the reservoir to the tunnel and at the tunnel end two stop-log gates are provided so as to permit of the water being shut off if repairs, etc., become necessary to the actual tunnel gate. From the stop-logs the intake channel falls steeply to the tunnel entrance, which is normally submerged about 20 ft. A Glenfield and Kennedy free roller type of gate is provided here. The gate is 15 ft. in depth and 8 ft. 6 in. wide, built up of mild steel sections with bronze rubbing strips. It is normally electrically operated, being remote controlled from the power station at Glenlee, though hand operated gear is also provided for use in case of emergency. The gate operates against a maximum unbalanced head of 35 ft., the water load being taken by trains of free rollers through special roller paths, which are housed in special grooves to protect them from the high velocity of the water entering the tunnel. The formation of ice, which might prevent the free operation of the gate, is guarded against by the installation of a compressed-air plant, from which air under pressure can be injected into the water at the gate to keep it in a state of turbulence, thus preventing freezing.

The tunnel itself is about 19,050 ft. in length and oval in section. The major portion is at a grade of 1 in 100, the grade being steepened up for the last few hundred feet. The grade has been determined chiefly from a consideration of the minimum rock cover required to resist the pressure of water in the tunnel at any point in its length. The tunnel is driven through a poor type of granite known as "Greywache." Constructional operations were carried on from six faces—from the intake itself, outwards from the base of a shaft sunk about 110 ft. at Craigshinnie (about 10,000 ft. from the intake), outwards from the end of a side adit driven in from one side of the tunnel centre line about 5,000 ft. from the portal, and from the portal itself. Downhill faces were driven with a bench whilst the uphill faces were worked in one. Consolidated Pneumatic Co. drifters, supplied with air from temporary compressor stations at the surface, were used throughout, the normal round for an uphill face consisting of some 26 holes, 8 in the cut, 10 in the inner ring, 5 in the outer ring and 3 in the invert. On the average four drills, each with a crew of a driller and a spanner man, completed the set of holes in about four and a half hours. Charging the holes, firing and waiting for the gases to clear, occupied another hour and a half and "mucking-out" with Sullivan air-

operated scrapers was done in an hour and a half to two hours, the whole round of operations being completed in one eight-hour shift. Spoil was removed in Hudson skips hauled by battery locos., the skips being directly loaded by the scraper. An average of seven feet of driving per shift was obtained and three eight-hour shifts were worked daily except from 6 p.m. on Saturday nights to 10 a.m. on Sundays, during which hours the engineers carried out the necessary survey work. A Tavistock theodolite was used by the Resident Engineer's Staff, and the last junction, that of Craigshinnie West intake, was blown by the Chairman of the C.E.B. on 13th November, 1933, the closing errors being in the order of $\frac{3}{4}$-in. both for line and also for level.

The tunnel is completely lined with concrete, a travelling Parry shutter 120 ft. long being used on the straight and a similar form 30 ft. long being used on the curved portions. After the curves were lined the two forms were joined together, the resulting 150-ft. form being filled in a period of 24–36 hours' continuous work. For the later stages of the work one of the cages in the Craigshinnie shaft was removed, the space thus released being divided vertically into a coarse aggregate and a sand bin. Coarse aggregate was obtained by crushing the tunnel spoil, the correct proportions of sand and stone drawn off from the bottom of the bins into skips in the tunnel, two bags of cement from an underground cement store added on top and a train of eight skips hauled at one time to the mixer at the form. Here the concrete was mixed, elevated by an electric hoist to a skip running along a platform in the centre of the form, and then tipped direct into the form itself.

At a point a few hundred feet from the tunnel portal a vertical shaft has been sunk to meet the tunnel and connected at the top to a concrete-lined basin, to form a surge shaft and tank to take up the surge that would be experienced if the portal gate or the valves on the pipe line lower down were closed rapidly, as might be necessary in case of emergency. The existence of this shaft also permits the full pressure of water being thrown on the turbines rapidly when the valves are opened.

At the portal a Glenfield and Kennedy gate is provided, and from here an 8 ft. 9 in. diam. steel pipe runs down the hill to the power station at a grade of about 1 in 3. Some distance from the power station this pipe bifurcates to two pipes 6 ft. in diam., and these two pipes run under the station wall to the turbines. The pipes were supplied and erected by Sir W. Arrol and Co., each length being delivered to site in welded sections, the sections then being site-riveted together. Heavily reinforced anchor blocks and expansion joints are provided and between blocks the pipes are carried on special sliding bed plates in concrete saddles to permit free expansion and contraction.

The turbines, generators and switchgear are all similar to those at Tongland, the main point of difference being that owing to the higher working head at Glenlee the diameters of the runners and alternators are considerably smaller.

From the turbine house the water is led off in an excavated and unlined tail race channel to the River Ken and the electrical output of the station is fed into a C.E.B. sub-station which has been erected close to the power station itself. Electrical power for use during the period of construction was taken through this sub-station from the grid. The contractors, Messrs. A. M. Carmichael and Co., of Edinburgh, also had a standby station of their own at the adit, where two alternators driven by Ruston and Hornsby 4VER heavy, oil engines were installed. Here also were located the main camp and workshops, smaller shops and camps being maintained at the intake and at Craigshinnie shaft.

Just below its junction with the Glenlee tail race the River Ken broadens out into Loch Ken, a long narrow loch about 10 miles in length and averaging about $\frac{3}{4}$-mile in width. About half-way down the Loch it is joined by the River Dee, which has been dammed at Clatteringshaws, and at its southern extremity a barrage has been constructed at Glenlochar. This barrage consists of six lifting gates and a fish pass. The gates are of the free roller type, fully balanced, and giving a clear opening of 45 ft. between concrete piers. Three gates are 10 ft. in depth and the other three 9 ft. deep, all to suit the river-bed, and at the eastern end a short length of spillway has been constructed. The motors and winding gears are carried on a series of decked girders spanning from pier to pier, access to which is obtained by means of a ladder at the western end, where are located the gatekeeper's cottage and the switch house. The gates are normally electrically operated by remote control from the control room in the Tongland power station, but both push button and hand control are also provided at the barrage itself for use in case of emergency.

The barrage will allow of the level of Loch Ken being raised by 4 ft. and storage for 320 million cu. ft. will become available in this top 4 ft. The water stored here will be used to augment the head-pond of the Tongland dam as required. The barrage was one of the first works in the whole scheme to be constructed in order that it might be used to control the water in the river at Tongland, thereby materially assisting the operation of the contractors at the dam and power station there. The main contractors were Messrs. John Howard and Co., of Poole, and the gates were manufactured by Messrs. Glenfield and Kennedy.

Tongland works. The Tongland station is the largest as regards installed kw. of all five stations in the scheme, three 11,000 kw. machines, together with a 250-kw. auxiliary being installed. The

mean head of 106 ft. is obtained by damming the River Dee where it runs through a narrow gorge about ¾-mile upstream of the power station site, which itself is some 350 yd. above the old Telford Bridge over the estuary of the Dee at the limit of the tidal waters. The dam will form a narrow headpond about 2½ miles long, having a capacity in its top 10 feet of about 31 million cu. ft. Supply of water to the station will be taken from the headpond, partly by tunnel, partly by R.C. pressure aqueduct and partly by steel pipe. The main conduit will have a diameter of 18 ft. 6 in. to 20 ft. The reservoir in the gorge would maintain the station on full load for only a restricted period of about six hours, so that it will be necessary to operate the barrage at Glenlochar when the station is on load so as to provide the additional water required. The normal method of operating the station in taking a winter's day load will be as follows: at the end of the previous day's operation the headpond will have been drawn down by about ten feet and during the night the gates at Glenlochar will be operated, so as to let down sufficient water to refill the headpond before the station comes on morning load. This nightly discharge will be about half the average flow. The gates of the barrage will be further operated in the early morning, so that an increased flow reaches the station at starting time, and the gates will be opened farther still during the morning, so that a peak flow is available at the station at the time of peak load during the afternoon. Normally no water will flow past the dam other than through the intake except for that necessary to operate the fish ladder, which will also serve as compensation water. During times of heavy flood the station will be run all out if necessary, so as to reduce the waste of water over the spillway and through the flood channel to a minimum.

Tongland dam. The dam consists of an arch section across the river-bed of 135-ft. radius to the upstream face and enclosing an angle of 113½°, which on the western side abuts on the cliff face of the gorge and on the other side abuts on a long gravity haunch. The dam is of mass concrete 1 : 2 : 5 hearting with the cut-off, 18 in. at the base and 18 in. on the upstream face, of richer mix of 1 : 1½ : 2½ concrete. The footway level is 125 O.D. and the river-bed about 50 O.D., and it was found necessary to excavate some 30 ft. into the river-bed to obtain a satisfactory foundation. The arch was constructed in two main portions, each inside a sheet-steel piled coffer dam, and in the base of the eastern half—the first to be constructed—two temporary openings 16 ft. x 18 ft. were formed to provide a passage for the river water when the western half of the river was closed off for the construction of the second half of the dam. The ground on the eastern bank is about 40 ft. lower than on the western side, and this fact has been made use of in the provision of flood and spill-water channels. The end of the gravity haunch is returned across this depression and a pair of flood gates 31 ft. high and 25 ft.

wide are installed in this return. Beyond these gates the dam is again returned by a reverse gravity dam to connect with the spillway wall, over which spill water will discharge at 120 O.D. to a concrete lined spillway, and eventually discharge down a steep slope to a stilling pool and thence to the river. Besides these means of discharge near the base of the arch a 6-ft. diam. pipe is built into the dam, having on its downstream end a 60-in. Glenfield and Kennedy disperser valve exactly similar to that in the Clatteringshaws dam. Water is also discharged down the fish ladder which connects at the flood gate end of the gravity haunch.

The flood gates are built up out of a series of eleven bow-string girders and steel plates, the girders being so spaced as to equalize the load due to the varying head of water on the gates. They are of the free roller type and the roller paths on the gates attached to the end posts are articulated, to compensate for the deflection due to the variation in the amount of water impounded and to ensure contact across the whole width of the roller face under all conditions. The gates are suspended on roller chains and are connected to cast-iron counterweights housed in pockets in the concrete piers. They are operated by a 6-h.p. motor located on the superstructure footbridge, the motor being normally remote controlled from the power station, though interlocked hand control is also provided. Electrically-heated tubular elements extend the full height of the gates in grooves in the concrete piers, to obviate the risk of the gates being jammed by freezing.

The fish ladder consists of a series of thirty-one rectangular concrete chambers, 16 ft. x 10 ft., each one two feet above the one below. Three resting pools are also provided in the length of the ladder, and in these as well as in the chambers themselves there will always be a depth of water of 6 ft. The chambers and resting pools are interconnected by submerged openings through the cross walls. The last five chambers are incorporated in the gravity dam and all openings are controlled by penstock gates (Messrs. Guest and Chrimes), through which the flow of water can be regulated from nothing up to 15 million gallons per day. The penstock gates are manually operated except for those to the chambers in the gravity dam, where the control is by float operating the switches of the operating motors.

The intake to the tunnel to the power station is located at the western extremity of the arch section of the dam. The actual tunnel entrance is rectangular and this gradually changes to an oval section of 20 ft. equivalent diameter. A gate similar to the one at the intake of the Glenlee tunnel is provided, and at the entrance to the short intake channel a series of screens carried on R.C. piers is fixed to exclude trash from the tunnel. A rack cleaning machine capable of traversing the length of the screens is also installed. As the intake is not tangential to the dam the floor and wall are constructed

to a curved shape with the object of ensuring that all water entering the tunnel does so at a uniform velocity and that all swirling and eddies at the entrance are avoided. The tunnel is 477 ft. in length and driven to a radius of 900 ft. It is concrete lined throughout, and the lining is reinforced at both the intake and the portal as the rock cover is comparatively small. The portal reinforcement also meshes in with that of the aqueduct.

The aqueduct is of the pressure type and connects the tunnel to the steel pipe serving the three generators. It is of reinforced concrete and of cut and cover construction, its general line following the contours of the ground. It is of a varying oval shape for the majority of its length, becoming circular in section just before it joins the steel pipe. The main shell is only 11 inches in thickness, heavily reinforced with inner and outer layers of both circumferential and horizontal rods. The variation in cross-section of the aqueduct is due to the fact that the shell is designed so as to eliminate all bending stress in the shell as far as possible. The length is approx. 3,408 ft. and at its termination it joins the 18 ft. 6 in. diam. steel pipe at a heavily reinforced junction. This main pipe is provided with a large rectangular opening in the top about 60 ft. below the junction to connect it to a 100-ft. diameter steel-plated surge tower, carried on a very heavily reinforced-concrete floor and a concrete arcade. Immediately below this opening the steel pipe trifurcates to three pipes, each 11 ft. 6 in. in diameter and a short distance downstream of this trifurcation is located the main valve house. Here are located the three Glenfield and Kennedy 11 ft. 6 in. hydraulically operated, remote controlled, balanced disc butterfly valves. The valve for the 2 ft. 8 in. supply pipe to the auxiliary set is also located in this valve house, the 2 ft. 8 in. pipe being taken off one of the outer main supply pipes just below the trifurcation. Downstream of the valve house the supply pipes dip sharply downhill and enter the power station through the north wall and connect to the spiral casings of the turbines, whose centre lines are at + 18 O.D. The discharge from the draught tubes is through the south wall of the station to the river, the bed of which has been excavated to − 7 ft. 6 in. O.D. at the station and on a rising grade to O.D. at the railway bridge 350 yd. farther downstream. This lowering of the river at the station has necessitated the construction of a short fish ladder to allow the salmon to get up the river.

The power station itself is T-shaped, the generators being situated in the longer portion of the building and the switchgear and offices in the T-head portion at the west end, which abuts the main Kirkcudbright–Castle Douglas road. The building is a steel-framed and reinforced concrete one and its architecture is simple but impressive.

The spiral casings are of mild steel plate butt-welded in twelve

sections each, and all welded to a central cast-steel speed ring, and tested to 90 lb. per sq. in., working pressure being half that figure. The usual stay vanes are provided to guide the water into the runner and to take up the hydraulic stresses. The runner is a one-piece steel casting and the flow of water into it is controlled by twenty-four cast-steel vanes working in grease-gun lubricated bronze bushes. These vanes are all connected to a regulating ring of fabricated construction by offset links, which are half-cut through so that if any vane is prevented from closing by an obstruction the link will fracture before the elastic limit of any portion of the guide mechanism is reached.

The spiral casing is encased in concrete and mounted on top of a mild-steel draught tube of fabricated construction. The draught tube is divided both horizontally and vertically so as to reduce eddies in the discharged water and the bottom of the tube is tilted upwards so as to reduce the risk of scour. Stop log gates and a dewatering pump are incorporated in each draught tube to permit the spiral casing and draught tube to be emptied for inspection and repair.

Above the spiral casing is mounted the generator barrel, also encased in concrete, and on top of this is mounted the stator frame. The vertical shaft of the turbine runner is carried up through the top cover of the turbine and inside the barrel to join the rotor shaft, and in between these is located the drive to the governor gear. Governor control is provided by a servo motor-operated oil-pressure speed governor. Oil is provided at 220 lb. per sq. in. from an accumulator mounted on top of the oil sump and served by an oil pump driven by a 22-h.p. motor. Cushioning air is provided by a separate air compressor under normal conditions, but the oil pump is so arranged as to be able to provide this air in case of emergency.

The weight of the exciter, rotor and runner, about 100 tons in all, is carried by a Michell thrust block held in a fabricated six-legged spider bolted to the top of the generator barrel. The twenty-eight pole rotor is about 14 ft. 6 in. in diameter and has a peripheral speed of about 10,000 ft. per min. It can be brought to rest from synchronous speed in about five minutes by a system of air braking. The stator is built up of three C.I. sections and the exciter is carried on an extension of the rotor shaft, the whole generator and exciter being enclosed in a sheet-steel casing. Ventilation is provided by a fan mounted on the rotor shaft and six coolers located outside the stator frame and inside the generator casing. Electric heaters are also provided for use in winter when the machines are not running.

Details of each of the three main generators are as follows :—

17,500 h.p. 13,750 K.V.A. ·8 P.F. 3-phase 50-cycle.
11,000 volt. 1,000 amps. Synchronous speed 214 r.p.m.

The auxiliary set, installed at the east end of the station, is a 250-kw., 400-volt, 3-phase, 50-cycle set, and provision has been made for

the installation of a second set of the same size at a later date if required.

The switchgear is of the horizontal draw-out type oil immersed solenoid operated with a rupturing capacity of 750,000 K.V.A. and controls the three generators and the two C.E.B. feeders. The 11 K.V.A. local supply board is fed from the main board through current limiting reactors and from the auxiliary set. Supply from this board is to be taken for the local supply to the Kirkcudbright County Council and Glenlee and for Glenlochar.

Supply to the auxiliary board can also be taken from two 300 K.V.A. 11,000/400 volt transformers, and a D.C. supply is obtained from two motor generator sets at 110 volts. In conjunction with these sets a 500 A.H. battery is installed in the power house for the operation of the valve control solenoids, etc.

The switch house and office block, at the west end of the turbine room, contains a cable basement, three switch rooms divided by fire-proof partitions on the next floor, the main offices and the control room and battery rooms on the floor above, whilst the living accommodation for the station staff is on the top floor. The control panels are of the desk type, with miniature switches, tell-tale lamps, water-level indicators, diagrams and instruments on vertical back panels. All the necessary switches for the control of the valves and gates from the power station up to and including Glenlochar barrage are located here. The whole of the electrical installation was carried out by the English Electric Company. The C.E.B. sub-station, which receives the Tongland station output, is situated immediately opposite the station on the other side of the Kirkcudbright–Castle Douglas road. Supply is taken at 11,000 volts and the C.E.B. step it up to 132,000 volts for distribution by the main grid overhead lines to Kilmarnock and Carlisle. This sub-station was constructed before the commencement of the Tongland works and it was used to supply power to the contractors for the actual execution of these works.

The electrical and mechanical works were carried out under the supervision of Messrs. Merz and McLennan, whilst all the civil engineering works were under the control of Sir Alexander Gibb and Partners, who were responsible also for all the design work. The writer wishes to take this opportunity of thanking this latter firm for not only the facilities they afforded him to see the Galloway Power Works in all its stages, but also for allowing him to take a definite part in the actual execution of these works.

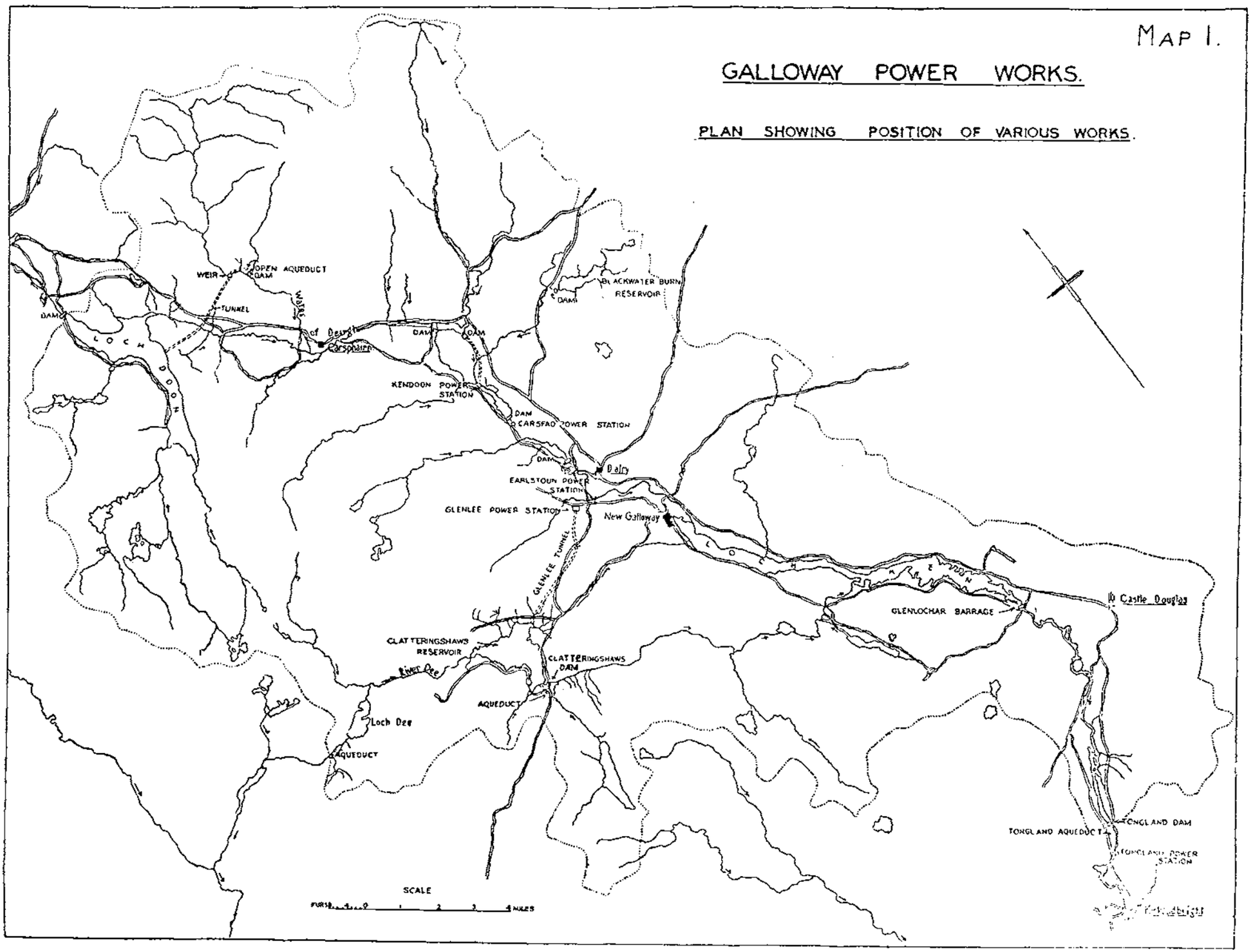
APPENDIX I

		KENDOON.	CARSFAD.	EARLSTOUN.	GLENLEE.	TONGLAND.
Catchment area without storage	sq. miles.	66	85	86	—	—
Catchment area with storage	sq. miles.	86	86	107	—	—
Total catchment area	sq. miles.	152	171	193	49	—
Average rainfall	inches.	56-66	55-66	53-66	57-70	43-70
Estimated run-off	inches.	44-56	43-56	41-56	45-60	29-59
Top W.L. of headpond above O.D. ...		510	338	245	585	120
Low W.L. of headpond above O.D. ...		502	—	—	540	110
Mean W.L. of headpond above O.D. ...		506	337	244	562	115
Tail W.L. of station above O.D. ...		342	270	175	168	6
Gross fall	feet.	168	68	70	417	114
Average net fall	feet.	150	65	66	380	106
Pipe line length	feet.	1000	two 220	two 270	1400	102
Pipe line diameter		13′ 6″	10′ 6″	10′ 6″	1 at 8′ 9″, then 2 at 6′	18′ 6″ and 3 at 11′ 6″
Aqueduct length	feet.	3000	—	—	—	3408
Aqueduct diameter		14′ 6″ to 13′ 6″	—	—	—	20′ to 18′ 6″
Tunnel length	feet.	—	—	—	19050	477
Tunnel diameter		—	—	—	11′ 0″	20′ equivalent.
Average flow (estimated) available for power	cusecs.	390	433	500	220	1050
Max. flow (estimated) available for power	cusecs.	1900	2400	2400	900	4500
Power installed	kw.	two at 10,500	two at 6,000	two at 6,000	two at 12,000	three at 11,000
Units per annum	millions.	37	18	20	52	70
Load factor		20	17	19	22	22
Station auxiliaries	kw.	—	—	—	two at 250	one at 250

MAP 1.

GALLOWAY POWER WORKS.

PLAN SHOWING POSITION OF VARIOUS WORKS.



THE QUESTION OF PROTECTION AGAINST LIGHTNING AS AFFECTED BY EARTH-RAYS.

By Colonel F. A. Iles, C.B.E., D.S.O., *late* R.E.

The original idea of protection against lightning by means of lightning conductors appears to have been that a thunder cloud, or cloud charged with electricity, would upon its approaching be tapped by the lightning conductor, and its charge would thus be led harmlessly to earth. Or, failing this, the lightning finding an easier path to earth than through the building would strike the conductor instead.

It came to be realized very soon that the lightning conductor's part in the proceedings might not always be so passive as this. Ganot says that the cardinal fact regarding atmospheric electricity is, as Peltier discovered, that the electricity of the ground is always negative, while the atmosphere and clouds, visible and invisible, are generally positively charged. Hence there is generally between cloud and earth a state of electrical strain. Owing to a medium which, because of the moisture it contains, is but an imperfect insulator, and owing to the phenomenon known as brush discharge, the lightning conductor plays a more active part than was at first believed, in that it leads continuously negative electricity away from the earth and discharges it to the sky, thus tending to bring about a state of electrostatic equilibrium, and to prevent the lightning discharge by neutralizing the positive cloud. This action was regarded as definitely established before physical theory had embraced the electron, and it found expression in a change of design, the simple point of the finial being sometimes replaced by a sphere from which spikes radiated, a form recognized as increasing the amount of brush discharge.

The origin of the atmosphere's positive electrification is by no means clear. Evaporation (Volta and Pouillet) and friction (Faraday and Gaugoin), the latter due to water and ice co-existing in the upper regions (Hörbinger, Sohncke and Luvini), have been suggested as sources. The origin of the excess of electrons on the earth's surface is even less clear. Elster and Geitel pointed out that, owing to imperfect insulation and brush discharge, the total negative

charge on the earth's surface would be dissipated in a few minutes, were it not in process of constant renewal "by some means unknown to us."

The questions of origin and of renewal are discussed in Baron Pohl's *Earth-Rays as Promotors of Disease*, published by J. C. Huber, Diessen vor München. This book, written as a general contribution to science, and particularly for doctors and the suffering public, places the origin of the earth's surface negative charge in physical changes taking place within the earth's molten interior, or at least in that portion of it which volcanic evidence shows to be molten. In its final chapter it advances a theory connecting the behaviour of lightning with the existence, and indeed with the exact situation, of earth-rays. It thus becomes of interest to all whose business it is to design and build barracks, quarters, hospitals, etc., especially in neighbourhoods where owing to frequent thunderstorms one cannot afford to neglect the chance of their being struck by lightning. The author says that physicists have up to now explained the constant renewal of the earth's surface negative charge only by radio-activity, an explanation to which he takes exception for the following reasons. The original material from which radio-active earth-rays emanate is uranium ore. The rays emitted by uranium in its many derivative transformations are of three kinds, as Becquerel discovered in 1896. Of these, the α-rays (better, particles) are composed of positive helium atoms, or helium atoms each short of two electrons. They can therefore be struck off as a possible source of a negative charge. In any case their range is very short and they are absorbed even by paper and the thinnest of foil. β-rays (better, particles) are composed of electrons, and will therefore charge bodies negatively. They have, however, very poor penetrating power, only slightly greater than that of α-rays, and cannot pass through concrete floors, etc. γ-rays are very short ether waves and cannot be deflected by magnets like the other two kinds. They resemble very hard Röntgen-rays, and have very good penetration, but they carry no charge. All of which reasons go to indicate that a source other than radio-activity must be found to account for the earth's negative charge.

Baron Pohl has an explanation ready. It is based upon the fact that when the disruptive discharge occurs the positive spark does not suddenly jump to the negative pole, but that an impulse of electrons first streams to the positive pole, and then the leap of the spark takes place. Franklin himself was the first to establish a complete parallelism between the spark discharge and lightning. Accordingly we might expect that when lightning strikes, an impulse of electrons from the earth to the cloud will have preceded the discharge. In other words, that the lightning does not strike blindly at any spot,

but according to law only at spots whence a conductive path of electrons is flowing to the charged cloud.

The results are given in this chapter of Baron Pohl's thirty years' experience as a highly successful water diviner, including the examination of hundreds of spots, buildings, trees, etc., which have been struck by lightning. In all these instances he claims never once to have failed to find the underground stream or streams, whence the radiation of negative particles issued which determined the course of the lightning stroke.

As regards the vexed question of water divining, there are indications that this subject (at which Horatios have ever scoffed, placing it in the same category as table-turning and telling fortunes by cards), is nevertheless beginning to claim the attention of practical people. To the general disbelief, and disinclination even to consider the subject, there is a personal and temperamental side, and the man who has always looked upon water divining as humbug will quite possibly continue to do so even after it has produced for him money-saving results. "As a land agent, I have always employed a diviner when I have had to find water, but I don't believe in it all the same, because I don't understand how it works," is a genuine remark, and reveals a typical attitude. Converts are not easily made, but the fact remains that water divining produces results, and hence cannot be disregarded with impunity. It is an art, in that, given the aptitude, a great deal depends upon the experience and skill of the diviner, but it is an art resting upon a scientific basis, which is more and more disclosed by such recently published researches as those of Henri Mager in France (English translation published by Bell) and of Pohl in Germany.

The latter found in his first attempt at water divining, which occurred about the year 1900, that a plum tree, which had been struck by lightning, stood directly over the course of the first underground stream he ever followed with the divining rod. Further, to his surprise, he found that the tree was growing over the spot where the stream he was following was crossed, either over or under, by another underground stream. In later trials he found from the behaviour of the rod that wherever such intersections occurred there was an increase of radiation strength or a summing together of the effects of the two emanations. As from his observations it soon became evident that the lightning preferred to strike at such crossings, it was a fair deduction that they must give off an abundance of negative particles. Other discoveries were that the breadth of the strip along which radiation occurred was always most clearly defined, and indicated the exact breadth of the stream which gave rise to it: and that besides these vertical rays there were always, according to the depth of the conductor and its radiation strength,

two weaker parallel bands, one on either side. As the rays causing these bands are inclined at 45° on either side of the vertical rays, the diviner measures at once from them the depth of the surface of the stream below the surface of the ground. Baron Pohl also found that the emanation from underground streams and other conductors of electricity, like veins of ore, is not of poor penetrating power like the α-rays and β-rays, but of immense penetrating power; that, although, like the lightning stroke it will often pierce masonry rather than go round it, unlike the highly penetrating γ-rays it is easily deflectable, and will turn aside to pierce masonry and concrete in order to get at a conductor. It would be a great mistake to imagine that all places under which underground streams cross each other are equally dangerous. Baron Pohl was once called upon by the anxious proprietor of a glass-factory to examine his works, and report what steps would be necessary to render it lightning-proof. He found within an area of two-and-a-half acres no less than eight different streams with thirteen separate crossings. Of these he selected as the most dangerous the crossing of a deeper, specially powerful stream by a weak stream running close under the surface. This crossing happened to be under the garage. He was then informed that the garage had been struck by lightning and burnt down once, that lightning had struck the conductor subsequently provided on several times since, but nowhere else in the factory. He was able to assure the proprietor that the works were now efficiently protected. He was able to do so with confidence, because decades of experience had taught him that no ordinary crossing of underground streams is dangerous when it is within hundreds of yards of a crossing of the particular type found under the garage, *viz.*, a powerful stream below crossed by a weak stream close to the surface.

The author gives in this chapter many interesting experiences of the connection between the lightning stroke and the spot where a skilled water diviner finds the maximum amount of earth radiation. One of these instances is selected for quoting as illustrative of several points, especially of how little a lightning conductor really protects when the conditions are against it. A factory in Munich has two chimneys, about 40 metres apart, one 40 metres high and the other 23 metres. Both were provided with lightning conductors and earths. During a storm, lightning struck the switchboard for light and power in a small building lying between the two lightning conductors, and did great havoc. This occurred at a spot which, according to the well-known teaching that a lightning conductor protects a cone, the base of which has a radius equal to the height of the conductor, was well within the area theoretically doubly protected, *viz.*, not only by the lightning conductor on the 23-metre

high chimney, to which it was quite close (10 metres' distance), but also by the lightning conductor on the 40-metre high chimney (30 metres' distance). Baron Pohl found very strong earth-radiation in the switchboard-room, such as would emanate from the crossing of a large underground stream. The owner then told him that lightning had struck more than once before, but never before inside the factory. Where it had struck before was close outside the factory, but still within the supposed protected area of the conductor on the smaller chimney. Baron Pohl asked to be allowed to find this place without being told where it was, and on the other side of the main building he found a spot in the open where he diagnosed two underground streams as crossing. He was told that he had found the spot correctly, and that formerly a mast of the H.T. line had stood there, which had been struck more than once. Although the diviner had been successful so far he was by no means satisfied, since the radiation from that spot, instead of being greater than that of either of the two streams which caused it, was unaccountably weaker. While he was puzzling over this, the owner went on to relate that when it had been decided to remove the mast from that spot, owing to its being struck, the overhead H.T. route had been replaced by a cable into the switch-room. This explained all. It showed why the amount of radiation fell off, instead of increasing, where the streams crossed, for the extra amount of radiation was certainly being carried away by the cable, a fact which was immediately verified with the rod. Also it explained why the lightning had struck the switchboard instead of the old spot outside the factory. In fact, the substitution of the overhead lead-in by an underground cable had served to transfer the centre of attraction for the lightning stroke from the crossing under the pole outside to the switchboard inside the factory.

The foregoing is only one of a succession of impressive instances related. Theory is supported by plenty of evidence. Either this account is *tota kahani*, or it is worth the serious attention of all who build houses. In the latter case how will it affect those who are responsible for the safety of the houses they build? In neighbourhoods where thunderstorms are infrequent and there is a negligible amount of radiation from underground streams, practically not at all. They will continue to put up lightning conductors and provide them with earths as heretofore. In districts, however, which are much troubled by thunderstorms, and where there are many underground streams, it is a different proposition. The reality of the danger can be very great. In Germany, for instance, in one year close on 30 million marks were paid out by fire-insurance companies for damage caused by lightning alone, a sum which does not represent the total damage done in this manner, as it does not cover the losses

of the uninsured. In such districts those responsible, unless they risk the chance of the lightning conductors they provide being no more than comforting ornaments, will avoid building on any spot where lightning has once struck, and will select precisely such spots for the burying of their lightning conductor earths, or, failing that, will bury them at the point of maximum earth-radiation, as indicated by an expert water diviner. A caution is added that it would be as wrong to imagine that all water diviners are equally skilled as it would be to assume that all schoolboys alike can solve difficult mathematical problems.

It is only fair to the author to state that the measures indicated do not exhaust the weapons in his armoury. He has also made a special study of the screening question.

It so happens that a check on Baron Pohl's theory is afforded by a note in *Nature*, 28th July, 1934, p. 136, in which Professor Schonland, of Cape Town University, describes a lightning discharge in detail in its several stages as revealed by photography. His description ends with the words, " The full mechanism of this phenomenon is not yet understood." The pre-supposition made by Baron Pohl of the formation of a pillar or column of electrically negative particles reaching from the ground to the cloud before the lightning strikes, seems to furnish the missing key to what happens, from the " first little tongue of light stretching earthwards," to the " final brilliant flame sweeping upwards from the ground."

HIGH ROAD TO INDIA.

SOME IMPRESSIONS OF A MOTOR TOUR FROM LONDON TO CALCUTTA

By LIEUTENANT H. P. DRAYSON, R.E.

"WHEN you can fly to India in six days without any trouble, or you can travel overland to Marseilles and thence by boat to Bombay in a fortnight in comparative comfort, why do you wish to spend three months motoring over bad roads, tracks and deserts, with all the discomforts that such travel entails?" The unimaginative questioner had never longed to leave the amenities of civilization or to visit places which lie off the beaten tourist track. The answer to this question was that, though Calcutta was our ultimate goal, it was in order to see the intervening territories and their inhabitants that the trip was planned.

In the winter of 1933–4, Captain and Mrs. E. O. Kellett had motored from London to Capetown and had had a very successful and enjoyable tour. Encouraged by this, they planned for the following winter a longer and more ambitious trip to India, through Europe, Western Asia, Persia and Afghanistan, including as the *pièce de résistance* a detour southwards from Jerusalem into Arabia, and thence across the great Nefud, the little-known desert of North Arabia.

The first necessity was to make the number of the party up to four, because in order to carry out such a trip meant that two cars would be necessary, with two drivers per car. The party was completed by the inclusion of Lieut. P. H. C. Atkins, R.A., who had just been posted to Singapore from a mechanized field brigade at Deepcut, and of the author, who was fortunate enough to be granted leave to take part in the trip.

All four of the party were available as drivers, and in addition, Kellett was the organizer and leader of the party, Mrs. Kellett took very able charge of the messing arrangements, Atkins was responsible for the maintenance of the cars, and the author was charged with the duties of finding the way and of carrying out such survey work as should be possible in Arabia.

Arrangements for a long motor tour in undeveloped countries are very numerous, and five months elapsed between the conception of the tour and the actual start. Preparations had to be made for a 9,000-mile journey, during which the climatic range would be

considerable; heat and cold, fine weather, rain and snow would be encountered, and our equipment had to provide for a thousand miles of desert travel, during which we could not rely on obtaining food, water, petrol, or supplies of any sort.

The main consideration was to obtain suitable motor-cars, and the choice fell on Hillman 20/70 touring cars, specially adapted for the purpose. The cars were identical, and were painted a serviceable pale buff colour. The upholstery was stripped from the rear portion of each car and a plywood lining was substituted, thus providing considerable space for luggage. Easily accessible boxes for carrying tools were provided in the sides of the rear portion, and well-boxes for stores, etc., were sunk in the floor on either side of the propeller shaft. A large box was carried on the off-side running board and held spare tins of petrol and oil, jacks, wheel-braces, etc., as well as a supply of tinned food. The bumpers were replaced by spare springs, and each car carried two spare wheels. 7·00 × 16 oversize tyres were fitted to all wheels, including those of the trailers.

The chassis frame of each car was extended to take the tow-bar of a light, two-wheeled trailer carrying a 100-gallon petrol tank, and behind the front squab a tank capable of carrying 24 gallons of water was fitted. In order to prevent damage by rocks or stones, the batteries were covered with steel plates, and the petrol tanks were protected by wooden battens. Numerous other modifications were made and a comprehensive collection of spare parts to cover all normal breakdowns was carried in a specially partitioned box in the rear of one car. In addition a carefully selected kit of tools was carried.

The cars thus equipped could carry enough petrol, oil and water for a journey of a thousand miles, as well as a month's supply of food and a fortnight's supply of water for the party. Means were available for remedying all normal mechanical breakdowns that could be expected, and, in the case of one of the cars having an irreparable breakdown, it could be abandoned and the whole party carried in the other.

For navigation purposes a P.4 Type aero-compass, lent by the Air Ministry, was fitted to one of the cars, and the G.S.G.S. Branch of the War Office kindly supplied a comprehensive collection of mapsheets. It was hoped that some astronomical fixings of latitude and longitude would be obtained in Arabia. For this purpose theodolite, barometer, thermometer, and chronometer watches were lent by the War Office, and a specially-constructed two-valve short-wave wireless set was purchased for receiving time signals. These instruments, together with the trailers and a crate of pistols, sporting rifles and guns, were shipped direct to Haifa in order to save trouble at the frontiers. Personal equipment and clothing had to cater

for fair weather and foul, the heat of Arabia and the cold of Persia, the tidiness demanded by European civilization, and the utility required for desert travel. Camp-beds, valises and cooking gear had to find their way into the now over-loaded cars.

After the approximate route had been chosen there came the task of obtaining sufficient information about the various countries to enable us to select a definite itinerary, to estimate the probable rate of progress, and to formulate a time-table which would enable us to keep clear of the rainy and snowy seasons. In this connection there was no dearth of information, but unfortunately much of it was indefinite or unreliable.

However, at the beginning of October we were armed with numerous letters of introduction, travellers' cheques and letters of credit, and with passports whose *visas* covered all the countries on our proposed route except one, because after five months' negotiations we still had not received permission to travel in Arabia, although there seemed to be every possibility of such permission being granted eventually.

At eight o'clock on the morning of October 4th, the pre-arranged starting-time, we started off from London. A force eight gale in the Channel did not add to the comfort of the first day's journey, but when we were once more on *terra firma* we had few troubles. The good roads and the excellent hotels of western and central Europe gave us a chance of settling down quietly to the routine of long-distance driving, and to the constant unpacking and packing.

The journey through Rheims, Strasbourg, the Black Forest, Munich and Vienna to Budapest was uneventful. It was a week-end when we were in Munich, and we had good opportunity of seeing how widespread is the Nazi influence. Swastika flags and emblems were displayed everywhere, and few men were not dressed in brown-shirt uniform. Saluting was at a premium. We passed many lorry-loads of brown-shirted youths throughout Bavaria, where wide, well-engineered roads were being constructed extensively.

On the eve of our departure from Budapest the news reached us of the assassination of King Alexander and M. Barthou at Marseilles. We wondered what the reaction in Yugo-Slavia would be. It was apparent on the following day, when we entered Yugo-Slavia after a delay of three hours at the frontier customs post, that the whole nation was staggered by the news. In all towns black flags were hanging from the public buildings, and in nearly every shop there was displayed a photograph of the dead King, draped in black crepe. One emotional butcher had even hung a string of black sausages above his photograph. Wireless vans were seen in many places broadcasting the news to the villagers. The whole atmosphere was one of gloom and great depression. Added to this the

day was wet, and the excellent roads over which we had travelled so far had now given place to rough roads covered with mud, which was so bad in places that it completely obscured the wind-screens and blocked up the exhaust pipes, so that we had to stop frequently to clear them.

It was dark before we reached Zemun, a village on the right bank of the river Sava, opposite Belgrade. The new suspension bridge across the Sava had not yet been completed, and the last car-ferry that day had already crossed. We were fortunate in finding a garage in Zemun, where we could leave the cars for the night, and we crossed over by the passenger ferry to Belgrade, where we spent the night. The next morning we re-crossed to Zemun, and with great difficulty drove the cars for four miles along a track of heavy mud across a meadow to the ferry, which, arriving an hour later, grounded under the weight of the cars, but eventually completed the crossing to Belgrade without mishap.

On the following day the weather improved, and we had a fairly easy run to Niska Banya, where we stayed in a new and comparatively clean hotel, though it boasted few comforts. We were now approximately 500 miles from Constantinople, and we decided to drive through in one stretch, in order to avoid the risk of exposing ourselves to the depredations of the numerous insects which are reputed to abound in Balkan hotels.

After some delay at the Bulgarian frontier at Czaribrod, we crossed the Dragoman pass and, after passing through Sofia, had a most delightful afternoon drive through mountainous country, covered with beech woods, whose autumnal tints in the changing lights were quite magnificent.

After a poor meal in a dirty restaurant at Philippopolis and an hour's rest, we continued our journey and reached the Turkish frontier at Virant Teke at daybreak. It was still early for the customs officials, but after a delay of three hours we were once more on the road. Fourteen miles farther on we had another delay to report our arrival at Adrianople, but then had a comparatively clear run on very bumpy mud tracks across rolling plains to Silivri. Here extracts were copied from our passports of such passages as the official could understand, and even more, for he made an attempt on an Afghan *visa* and tried to read a Persian *visa* upside down.

At this point we entered a militarized zone, and were obliged to carry a Turkish soldier in one of the cars. He succeeded in taking us over the wrong road, and had difficulty in getting us back to the right road again, selecting a route consisting mainly of sharp jagged rocks and enormous pot-holes.

At Kucuk Cekmece, where the soldier left us, there was a further delay while our passports were examined again. From this point the road improved, and at 10 o'clock in the evening we arrived at

Constantinople, having completed the first stage of the journey. We stayed in Constantinople (or Istanbul, as it is now called) for four days, during which time we gave the cars a thorough greasing and the general maintenance which by this time was well due, for we had travelled some 2,000 miles. We now received news that Ibn Saud had definitely refused to allow us to enter Arabia. This was a bitter disappointment to us, but there appeared to be no way of getting over the difficulty, as we had already tried every channel of approach.

We crossed the Sea of Marmora in a small ferry-boat in company with horses, goats, chickens and a miscellaneous cargo of all sorts. We had some anxious moments while the cars were being loaded and unloaded, because the slinging arrangements were rudimentary and it seemed as though the ropes might slip at any moment. But on landing at Mudania we found the cars intact except for a few bent spokes, and continued our journey at once.

We had intended to spend the night at Brusa, but, as the hotels did not appear to be clean, we decided to drive straight through to Angora. We stopped for about three hours during the night and slept in the cars. Continuing our journey at 2 a.m., we reached Eskeshir at daybreak, after driving over a very bumpy road. From now on conditions became even worse. The road was dusty, and a following wind blew the dust forward faster than we could travel, so that we were continually being covered with our own dust, which at times was so bad that we had to stop and wait for it to clear. The dust covered us from head to foot, smothered the engine, found its way into our suitcases and even entered the petrol pump, so that we had to stop twice to clear it.

As we approached Angora the road improved, and the last fifty miles were quite good going. We saw the lights of the city from some distance away. It was a welcome sight, and it was a relief to find that the Angora Palace Hotel was a comfortable first-class hotel with modern refinements.

We stayed the following day at Angora, which is probably a unique city inasmuch as it is completely modern. Public buildings, legations, barracks, schools and hospitals are up-to-date modern buildings on the side of a hill overlooking a barren, arid plain. There are three statues in the city, all portraying Kemel Ataturk, who certainly has been successful in building his new capital in the middle of a desert waste.

Unfortunately for motorists, most of his attention as regards communications has been concentrated on the railways, and he has not yet produced any co-ordinated road scheme. Responsibility for the roads lies solely with the local authorities; consequently the type of road construction varies in every *villayet*, according to the amount of money available and the inclination of the local authorities.

There is no definite high road through Turkey and the roads and tracks merely connect adjacent towns and villages. There are two types of road in general use, namely, metalled and unmetalled. The metalled roads are normally full of pot-holes except where they have been recently repaired. Such repair consists of spreading about six inches of metal over the road-surface and relying on the traffic to roll it in. The result is that deep ruts are formed and the road is unpleasant to drive over. The unmetalled roads are usually earth tracks cleared across the grassy plains and roughly levelled. In dry weather these roads are firm and the going is reasonably good, though the dust is appalling; in wet weather they become very muddy and are often impassable. But in general the earth tracks are preferable to the bumpy metalled roads, and are frequently used as detours to avoid the worst stretches of metalled road. Another drawback to motoring in Turkey is the stoppage at every town through which one passes, in order to have passports examined and extracts taken from them, usually causing a delay of about half an hour. But there is the consolation that the numerous gendarmerie who inspect the passports have effectively done away with banditry in this part of the world, and travelling is perfectly safe.

We were now faced with a long stretch before we were likely to find again a comfortable resting-place, and we decided to drive more or less continuously until we could do so. After we had left Angora, 202 miles behind us, we called a halt for the night at the foot of Mount Erdjias Dagh, a snow-capped peak, 12,500 feet high. We were about 3,500 feet up and it was a bitterly cold night, so that we were glad to set off again at 3.15 a.m. Just before daybreak we reached the village of Urgub, built on the side and summit of a rocky hill, with caves in the rock where the early Christians had hidden to evade their persecutors.

All that day we drove along a rough road across barren undulating plains until we began to cross the Taurus Mountains. The views and the colouring of the hills at sunset were worth all the discomfort of the journey across Anatolia. After a short rest and some supper, eaten by the side of a little stream which was shining like silver in the light of the full moon, we continued the descent along a tortuous road with a cliff towering above us on one side and what appeared in the darkness to be a bottomless precipice on the other.

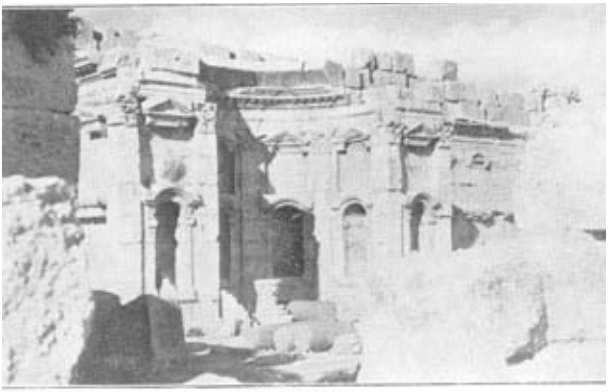
From the foot of the mountains we followed an earth track skirting Tarsus, St. Paul's birthplace, and running through Adana to the Syrian frontier at Payas. After a delay of two hours here and a further hour's delay at Alexandretta for customs and passport formalities, we had a good run over an absolutely first-class road to Antioch, where we arrived at six o'clock, having covered the 557 miles from Angora over extremely bad roads in three days. Over-

1.—New bridge over R. Sava at Belgrade.

2.—Unloading the cars from the ferry boat at Mudania.

3.—Angora. Statue of Kemal Ataturk.

High Road to India 1 - 3



4.—Baalbek.

5.—Petra.

6.—In the Transjordan desert.

joyed at being on good roads once more, we started out the following day for Beirut with hopes of a good day's run, but, after we had travelled twenty miles and were winding up a mountain road, the leading car was run into by a large bus which was coming round a blind corner on the wrong side of the road at a rate of approximately forty miles an hour. Fortunately we were on the hill side, as otherwise we should have had an uninterrupted fall over a 500-foot precipice. As it was, the bus pushed us into a ditch and the native driver, having kept his wheels on the road, drove on without stopping. With the help of the other car and the tow-rope, we got the damaged car out of the ditch and, after an examination, discovered that the front axle and the track-rod were bent, a spring and a shock-absorber were broken, and the near-side wing was crumpled around the wheel. Fortunately the radiator was untouched and no one was hurt. We took off the wing, tied up the spring with a length of copper-wire and wedged it up with wooden blocks sufficiently well to enable us to drive slowly on into Latakia, where we spent the night. In the morning we improved on our makeshift repairs, and drove the remaining 150 miles to Beirut. As we were entering the towns we were spotted by the local Hillman agent, who, attracted by our new-model cars, came up to talk to us. We told him of our accident, and he immediately took the damaged car to a garage to be repaired. While the repairs were being carried out we spent three days resting, bathing, canoeing and sightseeing, including a visit to the old Roman ruins at Baalbek.

From Beirut we travelled down the *corniche* road to Haifa, where we were to pick up our trailers and the instruments which had been sent on by sea. Unfortunately, they had not yet been cleared through the customs, and there were certain difficulties about the formalities. So, leaving the matter in the hands of the Hillman agent at Haifa, we went on to Jerusalem, where we stayed for the next few days. During this time we made arrangements for the next part of our trip and prepared a new itinerary, which unfortunately now had to exclude Arabia. We replenished our food supplies at the N.A.A.F.I., and in addition to an orgy of sightseeing, found time to bathe in the Dead Sea, where the water is so salt that it is impossible to sink and almost impossible to swim.

By this time the trailers were ready, so we drove back to Haifa, picked them up, and continued through Amman to Maan, where Major Goodwin and the officers of the Trans-Jordan Frontier Force entertained us nobly. During our stay we took the opportunity of driving over to Petra, where there still remain the ruins of a rock city built by the Nabataeans about two thousand years ago. Buildings and temples are carved out of the solid pink-veined rock, and some of these, notably Pharoah's Treasury, which one approaches

through a narrow gorge, remain in a remarkably good state of preservation.

From Maan our selected route lay across the desert towards Baghdad, through Qasr el Azraq and thence parallel with the Iraq Petroleum Company's pipe-line, recently completed at a cost of ten million pounds.

At Qasr el Azraq there is a fort very reminiscent of those described by Wren in *Beau Geste*, and it was here we met an officer of the Trans-Jordan Police, who told us that the route we were proposing to take through the lava belt was by no means the best, and that he would lend us a guide to lead us by a shorter and better route to H-5 pumping station on the pipe-line. Although we professed that we did not need a guide, we were eventually persuaded to take with us a fine-looking Arab named Bargis. The lava belt consists of an uninterrupted expanse of basalt boulders up to three feet in diameter, stretching for a distance of about sixty miles. It is impossible to cross this belt by car except along cleared tracks. We set off with our guide, but, as so often happens in similar circumstances, he was unable to maintain his direction at the increased speed at which cars travel compared with camels. Nightfall found us on a comparatively clear patch in the middle of the lava belt, having travelled for three miles in bottom gear over country far worse than the " gizzu " area in the western Sudan. We camped for the night, and in the morning Bargis told us that he had found two tracks, either of which looked as if it would lead us to H-5 pumping station, which we could see in the distance. We chose one of the tracks and followed it for about two miles over extremely rough country, only to find that it came to a dead end, so that we had to retrace our tracks. The other track, however, proved to be the correct one, and we shortly arrived at the pumping station and said good-bye to Bargis.

From here on we followed close beside the pipe-line, at first along a reasonable road which the I.P.C. have made through the lava belt for their maintenance lorries, and then over a flat gravel plain. At mid-day we ran into a cloud-burst, and the plain, which a minute previously had been good firm going, was now covered with a sheet of water. Water and sand were thrown up over the windscreen, so that it was almost impossible to see. In these conditions the author drove one of the cars into a boggy patch so that it sank up to the axles. We placed under the rear wheels some duralumin channels which we carried for such emergencies, and managed to tow the car out backwards on to firm ground. It is at times like this that the necessity of a second car becomes apparent. During this desert running we were refuelling the cars from the petrol tanks in the trailers. The trailers were proving eminently satisfactory. They followed well in the tracks of the cars, and did not seem to

detract from the performance of the cars in any marked degree, even over very rough country.

We spent that night at H-2 pumping station, where we received a warm welcome from the station engineers, and went on the next day to Hit, on the river Euphrates, across an absolutely flat gravel plain, over which one could travel at fifty miles an hour in any direction. From Hit we followed the right bank of the Euphrates to Ramadi, where we had our passports examined and should, as it appeared later, have gone through the customs. However, it was getting dark and we understood that we could carry out the customs formalities at Baghdad. So we went on, crossed the Euphrates at Falluja, and came to Baghdad, which from a distance gave every indication of being as picturesque and romantic as one would imagine from the stories in the *Arabian Nights*, but at close quarters the dirt and smells immediately shattered all ideas of romance.

On the following morning we went to see about the customs formalities, and found that we had committed a serious misdemeanour in not having arranged about them at Ramadi. The customs officers were uncompromising, and we were faced with the prospect of having the cars confiscated and being fined £75 into the bargain, but after a good deal of argument and persuasion we managed to get the matter settled satisfactorily. Altogether we stayed four days at Baghdad, and took the opportunity of carrying out some maintenance to the cars, which had covered approximately 1,000 miles from Jerusalem. At Hinaidi, the Air Force Camp just outside Baghdad, we found that Captain N. Wilson, R.E., was Master of the Exodus Hunt, and was making the jackals cry "Capevi." Before we left Baghdad we disposed of the trailers and the wireless set, which were no longer wanted, and sent the firearms and the survey instruments home. We found that the firearms caused so much trouble at the frontiers that we decided not to take them any farther.

We travelled from Baghdad through Khaniqin, where we stayed the night, to Kermanshah. We passed *en route* a new pipe-line which is being laid by the Anglo-Persion Oil Company from the oil-field at Naft Khana to Kermanshah, where a refinery is to be built. This will serve central and northern Persia, and will obviate considerable road transport of oil and petrol from Abadan.

We had intended to drive through to Hamadan, but on reaching Kermanshah we heard that a recent fall of snow had blocked the Assadabad Pass, so we decided to stay the night and tackle the pass in the morning. The driver of a lorry which arrived early in the morning said that there had been three inches of snow on the pass overnight, but that it had started to thaw. We had got Parsons

chains with us, so we were not afraid of a snowy track in daylight, but we did not actually need to use the chains. Snow was still lying at the top of the pass, which is about 8,700 feet above sea-level, and there was a thick mist. As we came down the far side we would suddenly come upon droves of pack-donkeys, which would loom up through the mist at a distance of about twenty yards, and we were lucky not to hit any of them. Just before we reached Hamadan we ran into a snowstorm, but five miles later it stopped as quickly as it had begun.

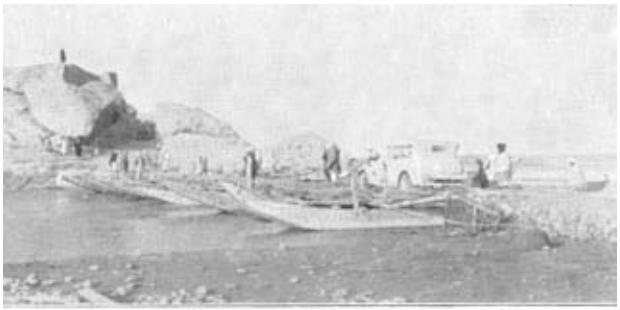
The road from Hamadan to Kazvin was in good condition, and we covered a distance of 145 miles at an average speed of 37 miles an hour, including the crossing of the Aveh Pass, which is about 8,000 feet high, but which was fortunately free from snow. At Kazvin, the road grew worse, as it was running parallel with the Elburz Mountains and was continually crossing water-courses flowing from the mountains. We reached Tehran that evening, having covered 361 miles during the day at an average speed of thirty miles an hour. This was our best day's run during the trip, and gives an indication that Persian roads are on the whole fairly well engineered and maintained. We did not find a suitable garage in Tehran that evening, so we left the cars in the garden of the Hotel Naderi, where we were staying, but when we awoke the next morning we found to our horror that there had been a heavy fall of snow during the night, that it was still snowing, and that the cars were covered to a depth of about two inches. It was still about three weeks earlier than snow usually falls in this part of Persia, and we had not anticipated it. It took us some time that morning to start up the cars, which were practically frozen, but by robbing the hotel laundry of most of its hot water and pouring it through the cooling systems of the engines, we managed eventually to get them going, and took the cars to a garage, where they received their periodical greasing and maintenance.

At Tehran we were told that the roads in Afghanistan were probably impassable owing to early snow and rain, and also that the southern route through Baluchistan was at the moment beset by bandits. However, when we left Tehran three days later it seemed probable that the road through Afghanistan would be passable. A two-days run took us through Shahrud and Nishapur (where we made a detour to see Omar Khayyam's tomb) to Meshed, where we were able to get definite news of our subsequent route. We learned that the road through Afghanistan was still open, but that there were definitely bandits on the southern road, as the British Vice-Consul had been attacked by Baluchis a few days previously, but had managed to get away and return to Meshed. So we decided to carry out our original intention of taking the northern route through

7.—Filling up with petrol from the tanks in the trailers.

8.—The Iraq desert after rain.

9.—Snow in Persia. The Assadabad Pass.



10.—An Afghan pontoon bridge.

11.—The Khurd Kabul Pass.

12.—A road fork on the Khaibar Pass.

Afghanistan to India. We left Meshed expecting to reach Herat the same evening. The drive started uneventfully and there was no trouble at the frontier, but when we were about forty miles short of Herat a misfortune occurred. Daylight was just fading when the leading car, which was crossing a mud bank through a flooded area where an irrigation channel had burst its banks, skidded and the near hind wheel dropped into a water-filled ditch about three feet deep. The car was completely stuck, as it had grounded on the differential casing, battery box, and propeller shaft. Efforts to tow it out with the other car nearly succeeded in ditching that one as well. We tried to lift the sunken wheel a performance which necessitated stripping to the waist and paddling in the very cold water. This also was unavailing, and, as it was now dark, the only course was to spend the night there and try to get help in the morning. Camping by the wayside is not encouraged in Afghanistan, and we took turns during the night keeping watch, but we were completely undisturbed. In the morning two of us went off in the other car, and about ten miles along the road we found a shepherd's encampment. Unfortunately neither of us could speak Pushtu or Urdu, and had only a few words of Persian which we had picked up on the way. Accordingly it was difficult to make ourselves understood, but by means of gesticulations and signs and some odd Arabic words we managed to arouse the enthusiasm of these Afghans, who thereupon all wanted to come and help. About twenty of them climbed into the car, but, as it was impossible to take this number, we selected six of the strongest-looking men and took them back. The water, which had been cold the night before, was bitterly cold in the morning, and all efforts of the combined parties failed to move the car. So the other car went back to the encampment and fetched a further eight men. Then with the fourteen Afghans and ourselves lifting and the other car towing, we managed to move the ditched car on to firm ground. Again our lack of knowledge of the language was a difficulty. We wanted to reward our helpers for their trouble, but had difficulty in making them understand our intentions. At this juncture the Governor of Herat, who was going on a shooting trip, happened to come by. He spoke perfect English and was most helpful in settling the matter satisfactorily. The journey on to Herat was without incident.

Herat is comparatively close to the Russian frontier, and Russian influence has permeated the bazaars and the population, amongst whom Mongol types are prevalent. Russian petrol is sold through western Afghanistan in twelve-gallon drums, a most inconvenient size. Cheap Japanese goods are also finding a market in this part.

On the outskirts of Herat it was necessary to ford the river Hari Rud, as one of the twenty-five arches of the road bridge was under

repair. Several more rivers also had to be forded, but the water was only about a foot deep, as the rains had not yet started.

The road was mainly a gravel track with a poor surface, winding along valleys between mountain ranges, crossing numerous streams over which there were usually hog-backed bridges. Soft sand extended for the last twenty miles into Farrah, where we stayed the night in a modern *caravanserai*, with shelters for cars and a number of bedrooms situated round a large courtyard. This type of rest-house is quite common in western Afghanistan and Eastern Persia.

The next day's run, to Girishk, lay partly over flat open desert country, and partly over a gently-sloping scrub-covered plateau, with ranges of rugged hills on either side. At Girishk there is a Government rest-house, which was clean and where food was obtainable, though we found it preferable to eat our own.

Just beyond Girishk there was a newly-constructed bridge of boats about 120 feet long across the river Helmand. Although it was not a very safe-looking structure it carried the cars quite easily. The road then lay mostly through cultivated land, intersected by numerous irrigation channels and canals, to Kandahar. After spending the night at the British Consulate we took two days travelling from Kandahar to Kabul. The road, which follows at first the valley of the river Tarnak, passes partly through cultivated land and partly over a scrub-covered plain, with ranges of hills on either side. From Ghazni onwards the country becomes hilly and the road tortuous.

At Kabul, Sir Richard Maconochie, the British Minister, and Lady Maconochie, very kindly entertained us at the Legation during our two days' stay there. After the discomforts of the journey from Tehran, it was very pleasant to be once more in comfortable surroundings. From Kabul the road led through the Khurd Kabul and Haft passes, the former of which is a bad defile where the British Forces, retreating from Kabul in 1842, were practically annihilated. The road was extremely tortuous, with numerous hairpin bends, but the surface was on the whole fairly good. After staying the night at the British Consulate at Jalalabad, we came shortly to the Indian frontier at Landi Khana, after which the road surface was once again first class.

Approaching India during the winter from this quarter is probably the most attractive way of entering the country, as one comes from the wild and rugged country of Afghanistan through the Khaibar Pass into increasing civilization as one travels farther into India.

India is so well known to the majority of soldiers that no attempt will be made to describe it here. Suffice it to say that our route followed the Grand Trunk road through Peshawar and Lahore to

Delhi, whence after a stay of some days we continued our sightseeing tour through Agra and Lucknow to Benares. The last stretch of the journey was a non-stop run from Benares to Calcutta, where we arrived on the morning of December 20th, exactly eleven weeks after we had left London. The roads in India had been a welcome change after the rough tracks of eastern Europe and western Asia, and we were able to average 35 miles an hour, from Peshawar to Calcutta. The only trouble encountered along these roads came from the numerous bullock carts, which kept to the middle of the road and left behind them a trail of cast nails, which caused a number of punctures.

We had now travelled over nine thousand miles at an average running speed of twenty-five miles per hour. We had had few mechanical troubles in spite of the fact that the cars were heavily overloaded. We had travelled fast when we were on the road in order to avoid the rains and snows which were imminent in Persia and Afghanistan and also in order to provide time for a certain amount of sightseeing and rest. Under these conditions the cars had done extraordinarily well and were still looking fresh and in good condition when we handed them over to be sold in Calcutta.

In Calcutta, after a short stay during the Christmas period, with its attendant festivities, the party broke up to go their several ways. The Kelletts went on by air, sea and rail *via* Australia, New Zealand and America back to England, thus completing a circuit of the globe; Atkins went on to join his unit at Singapore; and the author returned to England by the next boat from Bombay, taking only eighteen days over the journey. Between the dull sea voyage and the intensely interesting motor tour there was no semblance of comparison.

PRE-CAST (POST AND PANEL) CONCRETE WALLS.

By CAPTAIN T. GROVE-WHITE, R.E.

THE post and panel wall is often the most suitable type of solid fence. A short description, with plans, specification and photographs of a typical design may assist anyone who contemplates building one.

The wall described has already been put up at the Stadium, Shorncliffe Camp. This kind of wall is very economical in materials; the panels are just thick enough to resist the roughest ordinary use and the posts stout enough to hold up the panels against wind pressure on the panels, calculated at 15 lb. per square foot.

The panelling is made of slabs of reinforced concrete which slide into slots in the posts. The slabs are not too large to handle easily. The posts of reinforced concrete are put up first and are fixed in the ground in a weak P.C. concrete foundation. The wall is capped with a coping to improve its appearance.

The distance apart and the width of the posts, the width of the slabs and the design of the coping make pleasing proportions; the aggregate, the surface finish and the colour of the cement provide texture and control of colour which can be made to blend with any kind of surroundings.

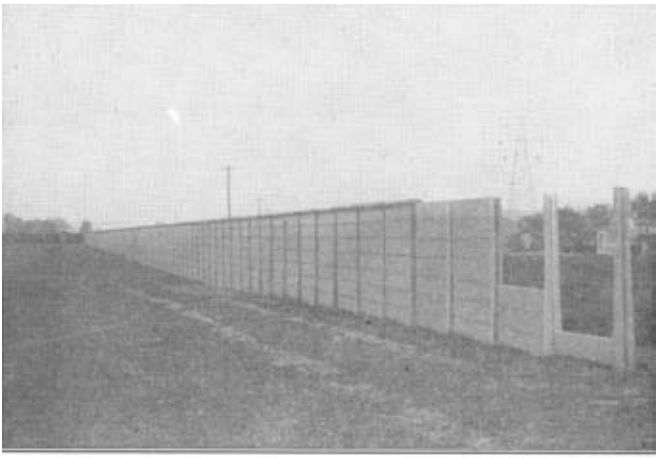
At Shorncliffe, 3/8″ pea beach (locally available), reddish golden pit sand and "Colorcrete" were used. The red colour of this wall harmonized with the red buildings of the camp.

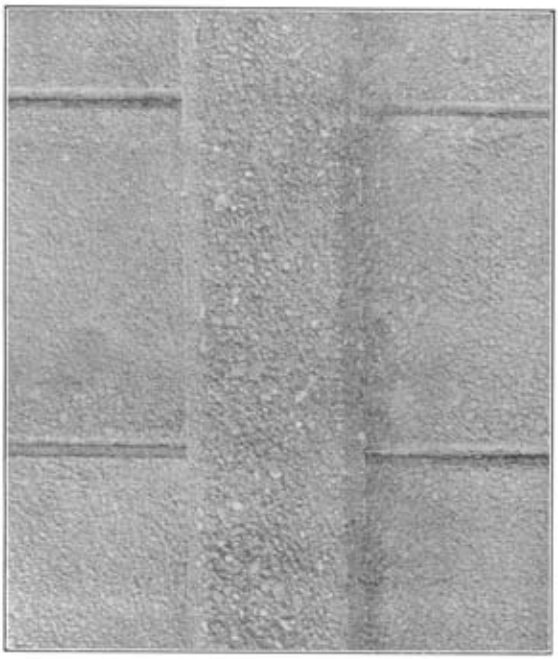
Grey aggregate and cement and buff aggregate with buff "Colorcrete" would tone in on other sites and can easily be made.

"Wire brushing," which removes the surface cement and sand while green and exposes the aggregate, is a successful and easily worked finish. It gives a rough texture which deepens the colour and reduces the visible effects of efflorescence. Some slabs were more affected than others and those similarly affected were kept together as far as possible in the panels.

It has been thought that the appearance of this design would be improved by increasing the width of the slabs.

The first cost of this pre-cast walling depends on cement and aggregate costs and the facilities for working. Where moulds have to be made for short lengths it is, of course, not economical. In





Pre-cast (post & panel) concrete walls

most districts for long lengths it is cheaper than nine-inch brickwork. At Shorncliffe the wall was seven feet high and cost 12s. per foot run, including the cost of the moulds.

It can be made of any height up to eight or nine feet. The same design and moulds can be used up to this height, as the posts can be cast shorter and fewer panels can be placed between to reduce the height.

Special posts for corners and gateways will have to be cast: drawings for these will be modifications of the normal posts. On an incline the posts are vertical but the slabs can be on the slant, although vertical posts and horizontal slabs can be stepped in the normal way to follow the ground. At Shorncliffe the first alternative has been most successful across gentle undulations: on steep slopes it is not suitable. For a stepped wall the coping requires slight alterations.

Pre-cast and panel walls are sometimes seen in civil practice; the Southern Railway has a stock pattern which is cast at their central works for pre-cast concrete.

For military use in the larger Garrisons a stock pattern could be very cheaply produced by directly employed labour in the central R.E. yard.

Considerable lengths of wall were put up in Malta to a design which was the forerunner of this pattern.

Pre-cast concrete manufacturers do not appear to stock anything of this kind or it might be cheaper to buy in the open markets.

There must be many stations where this would be not only an efficient but cheap kind of obstacle, if made by day labour.

Specification of Shorncliffe Stadium Fence.

SPECIFICATION.

Aggregate.—Pea Beach about 3/8″ gauge, obtained locally.

Sand.—Red pit sand, clean and sharp, obtained locally.

Cement.—Red Colorcrete obtained from Cement Marketing Co.

Mix.—1 : 2 : 4 by volume.

Mixing boxes.—Aggregate, 18″ x 18″ x 21½″; Sand, 15″ x 15″ x 15½″; Cement, 12″ x 12″ x 12″.

Casing.—All wrought tongued and grooved deal, angle pieces oak.

Mixing.—Aggregates to be measured first on banker and mixed and cement added. Turn over three times dry and thoroughly mix. Add water slowly whilst mixing until the right consistency is obtained, which is fairly stiff to allow ramming into moulds without becoming too wet.

Preparing moulds.—Thoroughly clean surfaces free from dust and coat over with " Redalon " grade " B " before concreting. This material applied to the casing retards the setting of the cement to the depth of 1/8". It is obtained from Redalon, Ltd., Mansfield House, Strand, at £3 3s. per five gallons.

Placing in moulds.—Place concrete in moulds and ram until half the depth is reached, place in reinforcement, then complete filling with concrete.

Preparing surfaces.—Slabs and posts, etc. First or second day after moulding, steelwire brush surfaces exposed until the aggregate appears. *On Slabs.* Third or fourth day according to weather conditions, turn over and brush with a soft brush remaining surfaces. *Posts.* Turn over on the sixth or seventh day and brush with soft brush.

Maturing.—After seven to ten days move out in the open to mature; whole will be ready for erecting after 14 days. In hot weather, slabs, etc., should be kept moist.

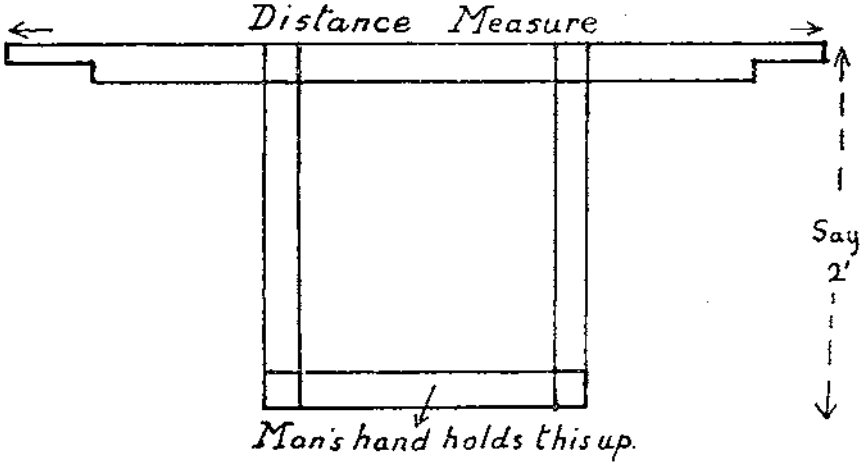
ESTIMATE OF 8-FOOT WALL OR FENCE FOR SHORNCLIFFE STADIUM.

	£ s. d.	Totals. £ s. d.
(*a*) *Approximate cost of materials per panel.*		
(1) Pea Beach (½ y.c. at 12s. y.c.)	0 6 0	
(2) Coarse Beach (1 y.c. at 8s. y.c.)	0 8 0	
(3) Red Sand (7/12 y.c. at 6s. y.c.)	0 3 6	
(4) Red Colorcrete (3 bags at 3s. 4d. bag) ...	0 10 0	
(5) Portland Cement (2½ bags at 2s. bag) ...	0 5 0	
(6) Reinforcement for posts (36 lb. at 10s. cwt.)	0 3 3	
(7) Ditto for slabs (BRC 6 y.c. at 5d. y.c. and say 8d. carriage)...	0 3 2	
(8) Redalon 1/3rd gall. at 12s. 6d. a gall. ...	0 4 2	
	2 3 1	
Contingencies 10%... ...	0 5 0	
		2 8 1
(*b*) *Maintenance and renewal of shuttering.* ...	...	0 1 0
(*c*) *Labour per panel.*		
Casting, say	0 16 0	
Erection	0 12 0	
Reinforcement	0 2 0	
	1 10 0	
Contingencies 20% ...	0 6 0	
		1 16 0
Total cost panel	...	4 5 1

This is equivalent to 13s. per foot run.

NOTES.

Erecting.—Positions of posts are measured out and holes dug to required depth. They are then levelled by means of boning rods and the concrete base, 18″ x 18″ x 6″ of 1 : 4 : 12 mix, laid. Posts are held in position whilst concreting in. Distance pieces are used between the posts, consisting of a straight rod at base and a rod at top as per sketch.



This allows a man standing on the ground to reach top of post. A 1 : 4 : 12 P.C.C. mix is used to fill up the holes. Slabs are lifted and worked down the grooves and pointed with a mortar, one " colorcrete " and two sand. Copings and post caps are cemented on.

PROFESSIONAL NOTE.

QUETTA RECONSTRUCTION.

IT has been decided that the whole of the reconstruction works, both military and civil, at Quetta, shall be entrusted to the Military Engineer Services. The following technical rules, which have been approved for the guidance of contractors and others in preparing designs, have been communicated by the Engineer-in-Chief, A.H.Q., India :—

1. GENERAL.

(*a*) Symmetry of plan, elevation and foundation loads are of fundamental importance.

(*b*) Mass and rigidity should be as nearly uniform as possible.

(*c*) Excessive length in proportion to width is undesirable. A square or compact rectangular plan is desirable.

(*d*) Buildings should be as light as engineering considerations and considerations of health and comfort permit.

(*e*) The centre of gravity should be kept as low as possible.

(*f*) (i) Adjacent buildings having different natural periods or amplitudes should be separated by a sufficient distance to prevent their hammering one another.

(ii) When connections such as passages are used they should be flexible.

(iii) When adjacent buildings cannot be sited sufficiently far apart to prevent their hammering one another, they must be rigidly interconnected.

(*g*) Sites should be, as far as possible, on level, homogeneous and firm ground.

Sites near abrupt changes in the surface level or in the strata should be avoided.

2. FOUNDATIONS.

(*a*) Foundation pressures are not to exceed 70% of the safe bearing pressure.

(*b*) Foundations must be solid mats or continuous beams or so strongly tied together that they act as one unit ; this includes the footings of columns.

(*c*) Foundations must be stiff enough to transmit lateral seismic forces in any direction without distortion.

(*d*) A reinforced concrete beam-and-slab mat poured integrally is an ideal aseismic foundation. Where the soil is not uniform, or where the soil yields excessively under pressure, such a foundation should be used.

(*e*) As far as possible foundations should be free to move horizontally on the supporting subsoil. It is very desirable that the bottom surfaces of all parts of the foundations of one structure should be on the same level. When beam foundations are used, the whole foundation area should be excavated.

(3) Superstructure.

(*a*) Every room, which is to be occupied simultaneously by 10 or more persons and which is 20 feet or more in length or breadth, and every dwellinghouse with a plinth area of 800 sq. ft. or more, is to have a structural frame of either steel or reinforced concrete.

(*b*) Frames must be sufficiently rigid to withstand distortion; diagonal or knee bracing must be used where necessary to ensure the necessary rigidity. They must be rigidly interconnected and must be rigidly fixed to the foundations in such a way that the foundations and the frames form one integral unit.

(*c*) Every building shall have all its parts tied together in such a manner that the structure will react to seismic forces as one unit, the connections being strong enough to overcome the inertia of the various parts.

(*d*) Parapet walls, cornices and ornamental details should be avoided as far as possible. If used they must be firmly attached to the structure so as to form an integral part of it. Chimneys should generally be of reinforced concrete or of sheet metal or cement asbestos.

(*e*) It is desirable that internal partition walls should meet at a common vertical.

(*f*) Doors and windows should be kept away from corner columns; they should be so arranged as to avoid planes of weakness. An opening for a door or window will necessitate special reinforcement around it.

(*g*) At all floor and roof levels horizontal rigidity must be ensured, either by partition walls or by beams and diagonal bracing or slabs.

(*h*) (i) Brickwork or unit masonry is to be adequately reinforced horizontally, the reinforcement being firmly fixed to vertical columns or end walls at both ends.

Special care is necessary to ensure that tension stresses in a vertical plane, in excess of those for which provision has been made, are avoided.

(ii) Walls of brick or unit masonry shall at all floor and roof levels be adequately tied together longitudinally from outside to outside of the structure by continuous metal rods or other bonds of continuous strength, and shall be tied to all intervening partition walls.

Such rods or bonds shall be embedded in one continuous course adequately fixed to the walls.

(iii) Mortar is to be of 1 cement to 3 sand.

(*i*) Doors should open outwards in rooms which may be occupied by 20 persons or more. In such cases the door frame is to be on the outside of the wall.

4. SEISMIC AND WIND FORCES.

(*a*) Every building and every portion of a building shall be so designed and constructed as to withstand the bending moments due to a continuously applied horizontal force in any direction equal to at least 12½% of the weight of the building or portion of the building acting where the weight is located.

(*b*) The horizontal shear to be designed against at any level of a building shall be not less than 12½% of the total weight of the building above that level.

(*c*) The weight of a building for the purpose of calculating seismic forces shall be taken as :—

(i) The dead weight of the building and all fixtures, together with

(ii) an allowance for transient live or floor loads equal to one-third of the equivalent dead floor load which the floor is designed to bear, subject (except in the case of storerooms) to a minimum allowance of 20 lb. to the square foot.

All transient live or floor loads shall be treated as acting at the level of the floor on which they are carried or, when not carried on a floor, at the level of the floor immediately below them.

(*d*) Wind loads, when less than the loads due to the above horizontal seismic forces, may be neglected.

(*e*) In the event of these rules being adopted as the basis of bye-laws applicable to the public, it will be necessary to lay down rules for use in calculations as regards :—

(i) extent to which tensile and compressive strength of panels may be allowed for in calculating the rigidity of the building in resisting horizontal forces,

(ii) end conditions of beams and columns,

(iii) assumptions that may be made in respect of a resultant horizontal force equivalent to the horizontal seismic forces as to magnitude and point of application.

5. Working Stresses.

(*a*) Working stresses in columns under combined vertical and horizontal forces, including seismic forces, may not exceed those allowed for vertical load alone by more than the following percentages :—

(i) In a steel framework 50%

(ii) In a reinforced-concrete framework 25%

(*b*) Working stresses for steel shall be those laid down in British Standard Specification No. 449 of 1932, and all steel, in accordance with clause 2 thereof, shall comply with British Standard Specification No. 15 of 1930.

(*c*) When special high tensile steel is used, evidence as to its safe working stresses must be forthcoming.

6. Miscellaneous.

(*a*) The difference in cost between a building constructed to resist seismic forces and a normally constructed building increases rapidly with height. In Baluchistan the value of land is so low that it can rarely be economical to build a high building.

(*b*) In single storey buildings designed against a seismic factor of 4 ft. per second, the natural period of oscillation is so low that the possibility of an approximation to the period of a dangerous earthquake can be neglected.

(*c*) There are two aspects of considerable importance from which designs for buildings to resist earthquakes must be examined. These are :—

(i) The extent to which heat will be transmitted through the walls and roofs.

(ii) The extent to which special steps are necessary to prevent excessive echo and reverberation.

MEMOIR.

LIEUT.-GENERAL SIR FENTON J. AYLMER, BART., V.C., K.C.B., COLONEL COMMANDANT R.E.

FENTON JOHN AYLMER, the third son of the late Captain F. J. Aylmer, 97th Regiment, was born at Hastings on the 5th April, 1862, and came of an old Irish family. He received his commission in the Royal Engineers in 1880, the second of his batch, after having been Senior Under-Officer at the Royal Military Academy. On leaving Chatham, after a few months with the Submarine Miners at Devonport, he went to India, where the greater part of his service was to be spent. He was with the Bengal Sappers and Miners from 1883 to 1897, seeing service during this period in Burma, 1886-88, Hazara, 1891, Hunza-Nagar, 1891-92, Isazai, 1892, and with the Chitral Relief Force, 1895.

It was for blowing in the gate of Nilt Fort on the 2nd December, 1891, during the Hunza-Nagar Expedition, that he received the Victoria Cross, to be followed by a brevet majority. The charge failing to explode on the first attempt, during which he was wounded, he returned, re-arranged and relighted the charge, being again hit. Though severely wounded, he accompanied the storming party which entered the fort after the gate was blown in. During the Chitral Expedition, Aylmer's pluck and resource came again prominently to notice by the manner in which he saved the life of a soldier who was being carried away downstream on an overturned raft.

From 1897 onwards he held a number of staff appointments. He was, in turn, S.S.O. at Fyzabad, D.A.A.G. at Calcutta and Simla and A.A.G at Madras and Rangoon. After a short spell with the Military Works Services he returned, in 1901, to the Staff as A.Q.M.G. of the Madras Command at Ootacamund. In 1904 he was given command of the Bannu Brigade on the N.W. Frontier. In 1907 he was transferred to Quetta, where he commanded the Infantry Brigade until 1910. After a brief period of unemployment, he was appointed Adjutant-General in India in 1912. In 1915 he was sent to Mesopotamia as an Army Corps Commander, charged with the operations for the relief of Kut-el-Amara. After the surrender of Kut he returned to India, where, for a time, he commanded the Mhow Divisional Area. On the conclusion of the Great War, he retired from the Service.

Lieut Gen Sir Fenton John Aylmer, VC KCB

He received a brevet majority after the Hunza-Nagar Expedition and a brevet lieut.-colonelcy after the Chitral relief operations. He was promoted Colonel in 1901, Major-General in 1909 and Lieut.-General in 1915. He was made a C.B. in 1907 and promoted K.C.B. in 1916. In 1922 he became a Colonel Commandant R.E. He succeeded to the baronetcy (thirteenth baronet of Donadea, Co. Kildare) on the death of his elder brother in 1928. In 1913 he married the widow of Sir H. H. Risley, K.C.I.E., C.S.I.

Since his retirement he has lived at Wimbledon, where he died on September 3rd. He leaves no children and the title passes to his cousin, Mr. G. A. E. F. Aylmer.

If any of those who knew him well were to be asked what it was about Aylmer that left the strongest impression, the reply would probably be, his commanding personality. During his service with the Bengal Sappers and Miners he was, to the younger officers of his time, the " spot man " of the Corps, an oracle to be referred to in cases of doubt or difficulty. The native soldier of India is very quick at recognizing instinctively the born leader, and no one could wish for a finer tribute than the terms in which old soldiers who had served with him in the 4th Company used always to speak of their former " Kaptan sahib."

During his service with the Bengal Sappers, Aylmer was noted for his fertility of resource as an engineer. While stationed with his company at Rawal Pindi, the bridge over the Jhelum at Kohala on the main Rawal Pindi–Kashmir road was washed away by floods and Aylmer was asked to restore communication as quickly as possible. He constructed a remarkable field suspension bridge of considerable size, using telegraph wire, a material of which supplies happened to be available locally. His bridge carried the whole traffic of the road for some months until the permanent bridge could be restored. Aylmer's method of using telegraph wire for this purpose became a regular item of training in the Bengal Sappers, and was employed successfully on several occasions subsequently, notably in Chitral.

But it was on the military side of his work that Aylmer's interest was chiefly centred. He was heart and soul a soldier, one of whom it might be said that he made a hobby of his profession. A voracious student of the art of war, he possessed a vivid imagination which was a great asset in imparting to others the knowledge he had acquired himself. In all his tactical exercises he made a practice of selecting some one point or feature that he desired that particular exercise to impress on those taking part. And the originality and imagination which he brought into his schemes not only enhanced their instructional value, but aroused a general interest such as was but too often lacking in what it was the fashion, at that time, usually to regard as boresome episodes incidental to a soldier's life. Aylmer's

schemes and ideas were treasured by his Staff officers and were often a source of benefit, nay credit, to other G.O.C's whom these Staff officers subsequently served under.

Aylmer never allowed his absorbing interest in the art of war to diminish the attention which he paid to those administrative and routine duties, " scrub deck work " as the Navy call it, which must necessarily fill up so large a part of a soldier's time. At Simla, the knowledge of, and attention to, detail of their Chief was a subject of comment in the Adjutant-General's Branch during the time Aylmer was A.G. Those who were " Y.O's " in the early nineties may remember on the square at Chatham, a certain drill instructor with a strong Scotch accent, whose slogan was " every motion as if your life depended on it." Aylmer's career may be said to have been a living example of this precept being put into practice. One with so strong a sense of duty himself naturally expected the same in others. While very tolerant of all ordinary human peccadilloes, he was adamant where anything savouring of neglect of duty was concerned.

In the days before the War, there was in India a widespread prejudice, one might almost say resentment, at the employment of R.E. officers in capacities other than what was popularly supposed to be their only legitimate sphere, that of bricks and mortar. Such a prejudice was particularly strong in those areas, like the Frontier, where troops were, at that time, localized and where such localization produced (as has since been recognized) a certain narrowness of outlook. In such circumstances, it was only to be expected that when Aylmer, an R.E., took up his first command, that of a frontier brigade, he would be met by a considerable head wind. To the thinly veiled sneers of those who regarded his presence as their G.O.C. as an intrusion, he replied with a calm dignity and a quiet demonstration of his own knowledge and abilities that won the admiration, and was indeed an education, to those who were associated with him. By the time he left the Bannu Brigade, the head wind had completely died down.

When Aylmer eventually attained to what must be the goal of every keen soldier, an independent command on active service, it was to be confronted with one of the hardest tasks that can fall to the lot of a commander in the field, the relief, with inadequate resources, of a beleaguered garrison. On taking over command of the operations for the relief of Kut-el-Amara, Aylmer was met by urgent S.O.S. messages from Kut, which compelled hurried measures that would have been unnecessary had he been made aware that the garrison was capable of holding out as long as it did, and time was consequently available for those preparations necessary to ensure success. It is believed that Khalil Pasha has left on record the fact that, of all the commanders that were opposed to him, the one he feared most was Aylmer, one who, he admits, was at one time within an ace of success. Had Fate seen fit, on this occasion, to alter slightly

the balance of those small things that sway events in war, it is probable that Aylmer's name would have been written large in the subsequent history of the Great War.

Bitter as must have been his disappointment at the failure of the task entrusted to him in Mesopotamia, he bore it with a characteristic stoicism. He certainly never allowed it to colour, in the slightest degree, the performance of those duties which fell to his lot during the remainder of the time he was on the active list.

A complete stranger to any sensation of fear, Aylmer was also gifted, in a remarkable degree, with that characteristic commonly described as " a head." A small incident illustrating this is worth recalling here. In the summer of 1894 severe floods had caused a breach in the railway near Roorkee. A considerable portion of the embankment had been washed away, leaving the rails unsupported over the gap. The railway authorities asked for a pontoon detachment to ferry passengers over, until the breach could be repaired. Aylmer, who took the detachment down, found it necessary, on arrival, to get to the other side of the gap. He tripped over himself on one of the rails. To walk along a rail on terra firma is not an easy thing to do, to do so when suspended in mid-air over a raging torrent, was a Blondin-like feat which none of his subordinates could venture to emulate. As might be expected, Aylmer was a very bold rider. This was, on one occasion, a source of considerable perturbation to a certain cavalry colonel who, having perforce to follow where the general led, remarked that Aylmer evidently expected his horses to possess the agility of cats.

Shortly after his retirement Aylmer was crippled, as the result of an accident; and thereafter any kind of work calling for physical activity was denied him.

Always a keen and able mathematician, he took up the study of Relativity, and in 1924 gave two public lectures in Wimbledon on the subject.

In 1931 he published *The Aylmers of Ireland*, a history of his family, which had entailed years of patient research; and at the time of his death he had almost finished another book, on the Great Thegns (Thanes) of the tenth century and their families.

He took a deep and practical interest in charitable work of all kinds, and particularly in the work of ex-Service men's organizations. His last public act was to take the salute at a parade of the " Old Contemptibles " Association, only a few days before his death. Letters received after his death bear testimony to the esteem and affection with which he was regarded by the many old Service men whom he had befriended.

To those who knew Aylmer well, and particularly those who had the privilege of serving on his staff, his memory will always be that of the beau-ideal of a British soldier.

W.E.R.D.

CORRESPONDENCE.

SIMPLICITY AND FLEXIBILITY OF OUR SERVICE PONTOON EQUIPMENT.

WITH regard to the article on " Simplicity for our Service Pontoon Equipment " in *The R.E. Journal* for September, 1935, a reference is made to fire risks with magnesium alloys on page 425 and in the tables on page 429. A correspondent points out that this risk, though present in the factory, does not exist in the field, and sends the following account of experiments carried out to illustrate this point.

THE FIRE RISK FROM MAGNESIUM.

Test No. 1.

The materials used were pure magnesium, Elektron A.Z. 91, Elektron A.8, and iron. A small quantity (about as much as would lie on a sixpenny piece) of filings freshly prepared from each of these materials, was heated on an iron plate, the temperature being measured by means of a thermo-couple inserted in a hole in the plate close to the filings. For each material the temperature was observed at which ignition occurred, and the results, checked by duplicate tests, were as follows :—

Elektron A.Z. 91	475 deg. C.
Elektron A.8	500 deg. C.
Pure Magnesium	550 deg. C.

The iron filings become oxidized superficially and sintered together. Heating even to 850 deg. C. did not cause ignition. These results confirm in a quantitative way what we have all known for some time, namely, that filings of magnesium and magnesium-base alloys can be ignited below their melting temperature.

Test No. 2.

An arc was struck between two rods of Elektron. It was found that while a flaming arc could be maintained, the pieces of Elektron did not continue to burn when the current was switched off. Small particles of the molten metal which had been splashed from the arc on to an asbestos covered bench continued to burn for one or two minutes, but these were only of about the size of a pinhead.

The reasonable deductions from these two tests are that any fire risk is confined to the fabricational operation on Magnesium and that from a user point of view the risk is non-existent. In short, the fire risk is present in the factory but not in the field.

AN ACCIDENT IN CALCUTTA

The following is a letter written by an Indian gentleman to his insurance company and sent to the Editor by Captain E. H. T. Gayer :—

GENTLEMEN :

The soullessness of Corporations such as yours is astounding. Let me review my case. I carry an accident policy in your Company by the terms of which you agreed to pay me Rs. 60 a week during such time as I was prevented from working because of accidents.

A week ago I went around on Sunday morning to inspect a new house that is being built for me. I climbed the stairs, or rather the ladder now located where the stairs will be when the house is finished and on the top floor I found a pile of bricks which were not needed there. Feeling industrious, I decided to remove the bricks. In the elevator shaft was a rope and pulley and on one end of the rope was a barrel. I pulled the barrel up to the top floor, and after walking down the ladder, fastened the rope firmly at the bottom of the shaft. Then I climbed up the ladder again and filled the barrel with bricks. Down the ladder I went again, five storeys mind you, and untied the rope to let the barrel down. The barrel was heavier than I was, and before I had time to study the proposition, I was going up the shaft with my speed increasing every minute. I thought of letting go of the rope, but before I had decided to do so I was so high up that it seemed more dangerous to let go than to hang on. So I held on.

Half-way up the elevator shaft I met the barrel of bricks coming down. The encounter was brief but spirited ; I got the worst of it and continued my way towards the roof. This is, most of me went on, but my epidermis clung to the barrel and returned to earth. Then I struck the roof at the same time as the barrel struck the cellar. The shock knocked the breath out of me and the bottom of the barrel.

Then I was heavier than the empty barrel, and I started down the shaft while the barrel started up. We met in the middle of the journey, and again the barrel uppercut me, pounded my solar plexus, barked my shins, bruised my body and skinned my face. When we became disentangled, I resumed my downward journey and the barrel went higher. Soon I was at the bottom and stopped so suddenly that I lost my remarkable presence of mind and let go of the rope. This released the barrel which had reached the top of me, and it landed hard too.

Consider the heartlessness of your Company. I sustained five accidents within two minutes. One on my journey up the shaft when I met the barrel of bricks. The second when I struck the roof. The third when I met the empty barrel. The fourth when I struck the bottom. The fifth when the barrel struck me.

Your agent states that it was only one accident, not five, and instead of receiving a payment at the rate of five times Rs. 60 I am only entitled to one accident at the rate of one alone. I therefore request you to cancel my policy as I have made up my mind that I will not be skinned either by a barrel or an Insurance Company.

All Reviews of Books on military subjects are included in the provisions of K.R. 522c.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

PLUMER OF MESSINES.

By General Sir Charles Harington, G.C.B., C.B.E.

(John Murray, London. 1935. Price 12s. 6d.)

This Memoir of the late Field-Marshal Lord Plumer by his Chief of Staff, 1916-1918, will be eagerly read by thousands of men who served under him and by many others who knew of him only by name. They will not be disappointed when they read it, for it is written by one who was in position to know him intimately and so to arrive at a true estimate of his outstanding character. In it military history is lightened by many anecdotes illustrating the quiet humour of the Commander of the Second Army in France, which throw a sidelight on the qualities which gained him the respect and affection of the British soldier.

It was a difficult book to write because Lord Plumer kept no diary and few records, and his letters home were guarded. Knowing his views on the rigid interpretation of orders and regulations, it is not difficult to understand why the material and biography is so limited. The author has, however, been able to get first-hand information about Lord Plumer's achievements in Malta and in Palestine from those who are best qualified to furnish details.

There were several distinct phases in Lord Plumer's public life. The Matabeleland Relief Expedition: the South African War: his service as Q.M.G., as a member of the first Army Council, 1904–5: his peace-time commands, training the Army for war: the Great War: Malta, as Governor and C.-in-C., 1919–24: Palestine, as High Commissioner and C.-in-C., 1924–28.

He refused the appointment of C.I.G.S., which was offered to him by Lord Derby, because the conditions imposed did not give him a free hand over the Committee at Versailles devised by Mr. Lloyd George. He would have made a most popular Governor-General in Australia, had his means allowed him to accept the offer. It was not a mere accident that the Australian Divisions were sent to the Second Army on their arrival in France in 1915. He had gained the confidence of the Australians in South Africa and it was felt that they would be assured of a sympathetic welcome at his hands.

Of his experiences in the Matabele War of 1896, Lord Plumer has left a modest account in his book—*An Irregular Corps in Matabeleland*. Considerations of space, no doubt, prevented Sir Charles Harington giving more than a summary of this and the South African Campaign. But as it was South Africa which gave Lord (then Major) Plumer his first opportunity for command in war and for showing his talent for organization, it will not be out of place to fill up some of the gaps in the Memoir. The reputation with which Lt.-Col. Plumer left Rhodesia and the friends he made there in 1896 assured him of a warm welcome when he returned to Buluwayo to take command of the Rhodesian Regiment on its formation two months before the outbreak of the war against the Boers. Little is generally known of the splendid work of his small force during the first seven months of that campaign. With a

maximum of 600 mounted men and a couple of seven-pounder guns of the B.S.A. Police, Lt.-Col. Plumer prevented General Delarey going south with some five or six thousand mounted men to swell the main Boer forces in the Orange Free State. In fact, with 600 men he contained 6,000, aided by the bait of Mafeking. That the force was active goes without saying. The secret of his success lay in the fact that he had been given a few (only eight) of the best young cavalry and mounted infantry officers of the regular army to help him; and that the local officers and the rank and file were volunteers from the best type of Colonials, self-reliant, good shots and good horsemen, many of whom had seen active service in 1893 and 1896. The regular officers were qualified to train them, instil discipline and teach them horse-mastership. It was said that when a horse fell sick the whole regiment stood by to tender advice and hold him up till he recovered, for they all knew that there were no remounts available. Sir Charles Harington gives substance to the story when he writes—"One particularly long reconnaissance was made due "east with the idea of destroying Boer ammunition at Zeerust in the N.W. Transvaal. "Though it failed in its object it is remarkable for the fact that a distance of 70 "miles was covered by the (Rhodesian) Regiment, although it was during the horse-"sickness season, in twenty-six hours, without a single animal being lost. An out-"standing achievement of animals in war." Later in the war when General Plumer commanded a mounted column* consisting of two lately raised Queensland and New Zealand Mounted Rifles, 200 West Australian "veterans" under Lt.-Col. Vialls (C.B., 14th Foot, retd.) and a Regular Field Battery in the Northern Transvaal, he must have regretted the absence of those Regular Officers, for after a six weeks trek, during which he captured Nylstroom and Pietersburg, the last towns held by the Boers, he found that the newly-arrived Queenslanders—many of them city-bred, not back-block men like the West Australians—had lost 400 and the New Zealanders 200 out of their complements of 600 horses, whereas the battery had only lost 5 out of 210. The casualties were nearly all due to horse-sickness and bad horsemastership, as the losses in action were trifling.

Lord Plumer would have been the first to acknowledge what he owed to his "Intelligence crowd"—a motley band, consisting of three whites, expert scouts and trackers (including a surrendered Boer who had been wounded in an attack on Mafeking), about 20 natives (scouts, runners and police) and a varying number of captured Boer horses, under the I.O., Captain Frank Smitheman, Rhodesian Regiment. Lt.-Col. Plumer had had considerable experience of Intelligence work in S. Africa and was *p.s.c.*, and the combination of his military experience with the local knowledge of an exceptional Rhodesian Scout, versed in every dialect of the native languages, Sesuto, Zulu and Kaffir, was most fortunate. Captain Smitheman, British born, had been brought up from boyhood among the natives by his father, a trader in the Zambesi country. He had a commanding personality, which later on commended itself to Lord Kitchener, and was known to every native through the length and breadth of the land by the name of Ramalele (Long Legs). He made his way into Mafeking during the siege with a message from Lt.-Col. Plumer and persuaded the queen of the local tribe to follow him out of the township with nearly a thousand of her people, thus relieving General Baden-Powell, who had failed to move the lady, of the necessity of feeding these extra mouths. His influence with his natives was such that he could always rely on getting a runner through the Boers and getting him to come back, or on picketing the camp far outside the outpost line to give him warning of Boer movements. It is a fact that at no time was General Plumer unaware of the proximity of any body of Boers, other than small patrols, within miles of his camp or bivouac while Captain

* The statement on p. 339 that General Plumer "commanded a Corps of Mounted Rifles which he raised in S. Africa, 1899–1902," is incorrect. The Rhodesians left him in the middle of 1900, and subsequently his column included at various times Australians, New Zealanders, British M.I., 2/Imperial Light Horse, and other S. African Corps and British Cavalry (King's Dragoon Guards).

Smitheman was working with him. It is needless to say that if there was any danger of attack, Plumer's column never bivouacked two nights in the same place, thus giving the enemy no time to reconnoitre their position. Captain Smitheman was awarded the D.S.O.

This happy combination, or co-operation, of a Commander and his Intelligence Officer was not unique. General Bruce Hamilton and Colonel Wools-Sampson, and General Mike Rimington and the late Captain H. R. Gale, R.E., Rimington's Guides, were other examples, and they had equally successful results, one with a group of columns in 1901, the other with his own column throughout the war. [It may be a surprise to Sappers to know that H. R. Gale worked as a navvy on the Pretoria Forts for some months shortly before war.]

Intelligence work under conditions such as existed in France and Belgium during sedentary warfare comes under quite a different category, but here again Lord Plumer was fortunate in his choice and could hardly have been better served than he was by Lt.-Col. Mitchell, an officer of the Canadian Militia, and his staff. As a Divisional General on the Second Army Front during the whole of the Paschendaele offensive in 1917, the writer can vouch for this as far as the information furnished to troops on the line was concerned, and Sir Charles Harington makes special mention of his exceptional ability in his book.

Sir Charles tells us—for the first time—of the actual circumstances under which Sir Herbert Plumer ceased to be Q.M.G. on the appointment of Mr. Haldane as Secretary of State for War. General Plumer sent for the writer to come and see him at his house on the afternoon of the day when it happened. He told him that, on going to his office at 10 a.m. that morning, he had found a letter from the S. of S. awaiting his arrival on the stand-up desk at which he always worked. It was a brief note. He read it:—it contained not a word of regret, or appreciation of his work, and he left the W.O. never to return. General Plumer felt it very deeply, but there was not a word of recrimination or anger, then or later. But Lord Plumer was a gentleman, if ever there was one. The lines quoted by the Archbishop of Canterbury in his Foreword to the Memoir ring in one's ears—

"*This is he*
That every man in arms should wish to be."

The episode recalls another. In the spring of 1916, General Plumer, who then commanded the Second Army, was taken suddenly ill one night and was in extreme pain for several hours. The doctor was sent for at 6 a.m. and was able gradually to relieve the cause. Two or three days later, while the General was still in bed and very weak, the C.-in-C. came in alone to see him. There had been some loss of ground on the St. Eloi front and some misrepresentation of the facts at G.H.Q. Sir Douglas possibly had it in his mind to suggest that the Army Commander should go home and recuperate in England. General Plumer forestalled him and offered to resign if Sir Douglas thought he was not fit to continue in command. It was left for Sir Douglas to decide. The writer accompanied the C.-in-C. in his car when he left to visit some headquarters. Sir Douglas was silent for ten minutes: then he turned and said, "Plumer *is* a white man. Isn't he?" The Army Commander was not sent home, and was soon able to resume his work. Sir Douglas, too, was a white man, and had the kindest of hearts. He was very much affected by the interview.

The account of the Battle of Paschendaele, covering the period from July 31 to November 10, 1917, appears at an opportune moment in view of the discussions which have been rife in the last few years. They will, no doubt, be dealt with by the Military Historian when the *Official History* reaches the period, but in the meantime it puts a stop to much ignorant criticism. The writer can add one useful opinion as to whether the offensive should not have been stopped earlier. The late Field-Marshal Sir William Robertson once asked the writer, in 1921, when he thought the offensive should have ceased. He answered, "At 2

"p.m. on July 31 (the opening day of the offensive) when the rain began." "Hardly that," said Sir William. "I think about September 24, when the French had their first success after their troubles in the Army in June and July." But it is now known that the main reason for continuing was the fact that the C.-in-C. wished to keep up the pressure in the north, until everything was ready for General Byng's Cambrai offensive with the tanks.

The writer is aware of Lord Plumer's feelings at the time from day to day, and it is immensely to his credit—and so like him—that not knowing what was in the C.-in-C.'s mind, for Sir Douglas kept it a close secret and told no one at the time, Lord Plumer should have had the courage to persevere in face of the tremendous difficulties of the advance. This is borne out in General Harington's book.

The accounts of Lord Plumer's great work and the success he achieved in Malta and in Palestine will come as an eye-opener to many readers who knew of him only as a great leader. His reputation as a Pro-Consul of the British Empire will go down to posterity almost as certainly as his fame as a soldier.

It was sad to see him return home finally from Palestine a much aged man. The strain of the work and the unhealthiness of Jerusalem after the earthquake had tried him greatly.

To be invited to come and sit beside the great man to watch the cricket at Lord's when he was President of the M.C.C., and after, was a great privilege. His mind was as clear as ever but in body he was frail. He had hosts of friends and no enemies. There were men whom he did not like, could not bear, but not one of them had any cause to know it. His self-control and dignity were perfect.

It only remains to congratulate the author on his first, and successful effort as a biographer. The book is illustrated with some excellent photographs, particularly that of "His Majesty the King with His Generals." A name is missing on that opposite page 30. It is Major Bethell, R.E. Staff Officer, R.E. There is only a name-index, which might be amplified in any subsequent edition. The maps are hardly sufficient. One is needed to enable the reader to follow the narrative of the Paschendaele operations. But it must be remembered that the book is a memoir and not a volume of the *Official Military History*, the compiler of which will have reason to be grateful, as we all must be, to General Sir Charles Harington.

H.B-W.

HAIG.

By DUFF COOPER.

Volume I.

(Faber and Faber. Price 25s.)

The first volume of Mr. Duff Cooper's *Haig* is a biography very largely composed of extracts from Lord Haig's personal diaries. These diaries were written every day, with very few breaks, throughout the Field-Marshal's military career. He wrote as he thought, and for his own benefit alone. He wrote with no lure of vast sums offered to him for publication; there was no thought of so much a word for sensation; he was under no contract except with himself. His diaries are the more valuable for this. They record his plain, untouched-up thoughts and opinions, uncoloured by subsequent events, untempered by personal animosities. There are no bitter recriminations. When he felt that an uncomfortable truth must be recorded he wrote it down—not with a view to attack, but in order to formulate his opinions. It is true that he distrusted the capacity of Sir John French, but he made no public attack. He confided his misgivings only to those of the Cabinet who asked for his views, and to Lord Kitchener, who knew them already.

The amount of detail with which he wrote is remarkable, particularly during the stress of war. The quickness of decision, and clear grasp of a situation, which

were two of his chief characteristics, were without doubt due to this life-long habit of setting down his views and impressions.

Lord Haig was in earnest throughout his military career. Comfortably endowed as a young man, he went through three years at Oxford, gaining friends, living a pleasant life, and becoming a keen rider. But he had already made up his mind to a military career, and no amount of well-to-do, easy-going life at Oxford could deter him from serious work. Entering Sandhurst at the age of 22, with the University training behind him, he passed out first in 1884, with the Sword of Honour as Senior Under Officer. He was commissioned in the 7th Hussars.

Haig's career now became a continuous success. His skill at polo, his love of riding, and his early influential friends cleared his path as a subaltern. He became Adjutant to his regiment in India, and a keen student of military science. He spent his leave in France and Germany, studying the languages, and observing the manœuvres of troops, especially the cavalry. In January, 1896, he entered the Staff College, and here, among his contemporaries, were many men whose names became famous during the Great War, under his leadership.

Captain Haig's reports on cavalry matters abroad had attracted the notice of Sir Evelyn Wood, and the latter proved of valuable help in securing for him an appointment in the Egyptian Army just at the time when Sir Herbert Kitchener was preparing his expedition up the Nile. Nothing escaped Haig's notice, and his diary contains some well-founded criticisms of the tactics which he observed during that brief compaign. Encouraged by Sir Evelyn Wood, who was no stickler for etiquette where the interests of the Service were concerned, Haig sent him long reports on the Battles of Atbara and Omdurman. As soon as the campaign was over, he resigned from the Egyptian Army and returned to the 7th Hussars, then at Norwich. Shortly afterwards he was posted to Aldershot, and appointed Brigade Major, 1st Cavalry Brigade.

Next came the South African War. In September, 1899, Haig was selected as Chief Staff Officer to Colonel French, commanding the cavalry force sent to Natal. In South Africa he quickly made a name, and learned to appreciate the qualities of his Chief, as well as his limitations. Sir John French came through the South African War with the highest reputation as a cavalry leader; his Staff Officer came through with what was equally valuable, a rich experience of practical staff work in the field, which still further developed his already keen knowledge of military science.

The South African War roused the British Army from its long enervation, and brought it into contact with the increased power of the modern firearms. It was a fine school for men who were keen to learn.

After a period of leave, Colonel Haig was sent to Edinburgh, to command the 17th Lancers. He was now aged 41, and had established himself on the path of certain promotion to high rank. Through the influence of a brother-in-law he had already been received by the Prince of Wales, who, as King Edward VII, always took a great interest in him. When, in October, 1903, Colonel Haig was selected for appointment as Inspector-General of Cavalry in India, King Edward invited him to Balmoral, and presented him with the C.V.O.

As Inspector-General of Cavalry, Haig came again under Lord Kitchener, who was then Commander-in-Chief in India. His cavalry inspections were more than the tiresome disturbances to routine which such occasions had come to mean. If he criticized, he also explained what improvements were required, and he took particular pains to become acquainted with every regiment of cavalry. On his return from India, he wrote a little book, *Cavalry Studies*, which embodied accounts of a series of Staff Rides, which he had conducted in India. This book contains teaching which is of value to all military students, even if its publication preceded the age of tanks and armoured-cars by some ten or fifteen years. It shows the author's keen appreciation of the problems he studied.

In 1905, he came home on leave, and in that year he married Miss Dorothy Vivian,

who was acting as one of the Queen's Maids of Honour. Together, they returned to India, where Haig completed his tenure of the post of Inspector of Cavalry. In June, 1906, he was appointed Director of Military Training at the War Office. Mr. Haldane had recently become Secretary of State, and the wave of enthusiasm inspired by that great reformer was permeating all branches of the headquarters of the Army, which had only lately moved from Pall Mall into the new building in Whitehall. Henceforward, the Army was prepared for war, and Haig's share was represented by his work, first as Director of Military Training and then as Director of Staff Duties. In both of these posts he had a great deal to do with military policy and organization for war.

In 1909, he was appointed Chief-of-Staff in India, under Sir O'Moore Creagh. Before he left England, the King received him at Balmoral, and conferred the K.C.V.O. on him. He now had an opportunity of carrying still further the work of re-organization, for he was responsible for the scheme for the employment of the Indian Army outside India in the event of a great war. This important work, the suppression of which Lord Morley, as Secretary of State, was short-sighted enough to order, was of great value in 1914 when the Indian Corps was dispatched to France. "The blind eye to the telescope" in this case, saved much trouble for the authorities in India, for Sir Douglas Haig's work largely accounted for the smoothness and rapidity of the mobilization of the Indian Corps.

In December, 1911, Haig left India, in order to take up the Aldershot Command, succeeding Sir Horace Smith-Dorrien. He assumed command on March 1st, 1912, and spent the next two and a half years in training the troops who were to become the 1st Corps of the British Expeditionary Force. He set himself out to make the acquaintance of as many as possible of the officers in his Command, and there is no doubt that the subsequent successes of the 1st Corps were largely due to this mutual acquaintance, and the confidence it inspired. Sir Douglas Haig embarked for France on August 14th, 1914.

Such, in brief, is the outline of Lord Haig's military career up to the outbreak of the Great War. It is from this point onwards that the chief interest of the reader will be attracted; and Mr. Duff Cooper has wisely devoted more than half this volume to Sir Douglas Haig's service in the war up to, and including the Battle of the Somme.

Sir Douglas Haig began the war as the most proficient of our fighting Generals. He was physically very fit; he had kept himself trained in body as well as in mind for the hard work which he always knew was ahead of him. It was the 1st Corps which bore the brunt of the heavy German attacks during the first Battle of Ypres; it was the First Army which fought Neuve Chapelle; it was the First Army which fought Loos.

The diary shows that the confidence which Sir Douglas Haig had in Sir John French's fitness for the chief command was shaken even before the Expeditionary Force started. At the Council of War held in London on August 4th, Haig had expressed his opinion that the war would be long, and advocated the immediate raising of a new army of a million men. Sir John French pointed out that our mobilization was later than was expected, and doubted whether the Expeditionary Force could now concentrate behind the French left. He thought it would be better to disembark the force at Antwerp, and operate on the German flank. Haig was strongly opposed to this advice, and did his best to combat it.

There are several criticisms of the Commander-in-Chief, but in no case were they written with any object save that of making a personal record.

> "In my own heart, I know that French is quite unfit for this great Command "at a time of crisis in our nation's history."—(*Diary*, Aug. 11th.)
>
> ". . . With all this knowledge of the Chief behind me, I have grave reason "for being anxious about what happens to us in the great adventure upon which "we are now to start this very night. However, I am determined to behave "as I did in the South African War, namely, to be thoroughly loyal, and do my

" duty as a subordinate should, trying all the time to see Sir John's good qualities, " and not his weak ones. For most certainly French and Murray have much " to commend them, although neither in my opinion is at all fitted for the appoint- " ment which he now holds at this moment of crisis in our country's history." —(*Diary*, Aug. 13th.)

Haig's distrust of his former Chief's capacity was born of his consciousness of deeper thought and study. Nobody who reads this book can avoid the impression of thoroughness which he exhibited. His grasp of a situation was always quicker than the Commander-in-Chief's.

The unfortunate first meeting between Sir John French and General Lanrezac led to recriminations against the French Fifth Army which were not shared by Sir Douglas Haig.

But in spite of the unfortunate opinions which Sir Douglas Haig held regarding the Commander-in-Chief, he never allowed them public expression, nor did he relax in his efforts to carry out his orders loyally and completely. Sir John French repeatedly recorded his satisfaction with the work of the 1st Corps Commander and his troops.

When the British Army was transferred from the Aisne to Flanders, the 1st Corps was the last to move, but as soon as it reached the new ground it was pushed forward in a last endeavour to outflank the German right. Haig was ordered to move towards Bruges, *via* Thorout, to defeat the enemy and drive him on Ghent. Sir John French estimated the enemy's forces between Menin and the sea " at about one Corps, not more." Actually there were five German Corps advancing westwards in that region. Sir Douglas Haig's Corps was still on its way from the Aisne; by October 20th only the 2nd Division had crossed the Ypres-Comines Canal; the 1st Division was concentrated in the Poperinghe-Elverdinghe area. The strength of the advancing German host (the new Fourth Army) was skilfully hidden behind the attenuated divisions of the German 3rd Reserve Corps. The presence of four new Reserve Corps was totally unsuspected.

Sir Douglas Haig had scarcely put his Corps in motion when the presence of these new enemy forces began to make itself felt. Sir H. Rawlinson, whose 3rd Cavalry Division and 7th Division were on the right of the 1st Corps, came to tell him of the extra weight now appearing from the direction of Menin and Comines.

De Mitry's French Cavalry Corps, on his left, was retiring without warning the 1st Corps. Haig could not do otherwise than check his own advance, and order his divisions to entrench themselves where they were. The first Battle of Ypres then began, and for many days a desperate battle ensued, the Germans hurling their new Reserve Corps chiefly against Ypres. Haig kept his calm control all through, and by frequent personal visits to the battle line, saw for himself the heroic resistance of his men. The Divisions had no rest; they stood their ground without relief, for there were no reserves left to relieve them.

Haig's natural reserve and aloofness did not prevent him from feeling deeply the trials and sufferings of his men, but a Commander has to suppress these feelings in order to show a calm exterior. Shallow critics have put this calmness down to indifference or callousness, but in reality no man was more solicitous for his men, nor cared more for their interests than Lord Haig, witness his work for the British Legion.

By November 11th, the long struggle had reached its close. Ypres was still unconquered, and the 1st Corps had had the honour of beginning the long tale of its defence, which has added lustre for all time to the British arms.

On December 25th, 1914, the British Expeditionary Force was re-organized into two Armies, and the command of the First Army was given to Sir Douglas Haig.

While the new Armies at home were being trained, the spring of 1915 approached, and with it came renewed hopes of a general advance. It was unthinkable that the Allies could remain in their trenches until exhaustion wore down their enemy. But while many politicians were already beginning to cast around for some new

flank to assail, or some spot elsewhere for a renewed effort, Sir Douglas Haig remained a firm believer in the strategical necessity of beating the main enemy's main army. Whatever problematical prizes might offer themselves in the Near East or the Middle East—and the arguments were indeed powerful—Haig held the view, shared by nearly all professional soldiers, that if the German Army in France was defeated, or even only driven back to its frontier, all other objects would be achieved, and all other prizes would fall in at once. But how to move the Germans back? The great superiority of the German guns in numbers and weight of shell had brought down on the Allies a rain of missiles with which they could not yet compete, but great efforts were being made to speed up the output, and the French at any rate were already being supplied with adequate quantities—adequate, that is, according to the standards of early 1915.

It was clear that with the spring a new effort must be made. As soon as the ground and weather became favourable, the First Army was ordered to prepare an attack.

> "Neuve Chapelle was to be the first of those long-prepared, carefully co-ordi-
> "nated offensives which were to prove the principal feature of the war"

writes Mr. Duff-Cooper. Haig's preparations for it were worked out in the greatest detail, and every probability was carefully provided for. The resulting battle was the model upon which several of the succeeding offensives were formed. The preliminary bombardment was the most intense that had yet been rained upon the Germans. Yet it was insignificant when measured by the later overtures. The battle, so far as it went, was a complete success. Next day, the weather was less favourable, and the Germans brought up reserves and counter-attacked. The British line held, but no further advance was possible.

Neuve Chapelle showed that, given enough guns and ammunition, the German lines could be broken; if the attack could be sustained and carried out on a sufficiently wide front, a complete break-through seemed possible. The British Infantry had proved themselves fully capable of the task. It must be remembered that, at the date of Neuve Chapelle, the German lines had not reached anything like the degree of strength or depth which they developed very soon after. Neuve Chapelle led to an intensification of their trench system, and the Germans went deeper underground for shelter, placing machine-guns in protected positions in advance of the front-line trench, whence their crews, rushing up from the deep dug-outs the moment the bombardment lifted, could sweep the ground over which our men must advance.

The French paid Sir Douglas Haig the compliment of studying the Neuve Chapelle tactics throughout their Army.

It was not the policy of the Commander-in-Chief to remain in a state of passive defence, and Haig was soon engaged in the preparation of another attack. This time, his attack was to be made in co-operation with the French Tenth Army on his right. The preparations were as thorough as before, but the Germans had had time to strengthen their defences. The passing of winter had enabled work to be carried out with greater intensity, and the First Army was unable to gain any of its objectives. The Battle of Aubers Ridge (May 9th-10th) was a failure; the supply of ammunition was totally inadequate for the necessary destruction of the enemy's works, and was the direct cause of Sir John French's campaign for more shells. Yet the attack had to be continued in order to co-operate with the French, who were conducting a neighbouring offensive against the Vimy Ridge. Minor successes were gained here or there, but the Battle of Festubert (May 13th–27th) as the fort-night's operations were called, did not result in any appreciable change in the lines.

Haig has been assailed as one who obstinately persevered in attacks when reason would have called them off, but how unjustified the charges are can be seen from the diaries. The detractors never take into account the military situation as a whole. Time and again the British Army had to persist beyond the design of its Commander, in order to carry out obligations to its Ally, and to relieve pressure on other parts.

Haig was always in favour of young, active commanders. After pressing for more heavy guns, he wrote in a letter to Mr. Asquith :

" But even if ample guns and ample ammunition, etc., be provided, progress " will be disappointing unless young, capable commanders are brought up to the " front. Some of the present Captains should be chosen to command Battalions, " Majors Brigades, etc."

He pressed this subject again on the Prime Minister in a later interview.

The next great battle in which Haig was engaged was the Battle of Loos. General Joffre had planned a great offensive for the early autumn and proposed to strike the Germans in two directions—northwards from Champagne, and eastwards from Artois. He asked Sir John French to co-operate by attacking north of La Bassée in conjunction with the French Tenth Army. The project was submitted to Haig, whose Army would have to carry out the attack. Haig was uncompromising in his objections to the scheme. He knew the ground, and the strength of the enemy's defences. Good artillery observation was lacking, and the ammunition supply was too scanty. But Joffre continued to urge Sir John French to co-operate ; nor can he be blamed for doing so. Hitherto, the French Army had made the largest sacrifices, and held by far the longer frontage. The British Army was continually growing, and our Ally looked for further effort from it.

It was therefore decided to prepare an attack south of the La Bassée Canal, with a view to

" . . . taking Hill 70 and the ridge to the north of it near Hulluch. This will " cover the left flank of the French Tenth Army in its attack on the Vimy plateau. " My attack is to be made chiefly with Artillery, and I am not to launch a large " force of infantry to the attack of objectives which are so strongly held as to be " liable to result only in the sacrifice of many lives. That is to say, I am to " assist the French by neutralizing the enemy's artillery, and by holding the " hostile infantry on my front."—(*Diary*, Aug. 7th, 1915.)

But this limited support was most strongly objected to by Joffre, who pressed for a British attack with the maximum forces available. He envisaged a break-through on both the fronts of attack, and cavalry in masses cutting 50 miles into the German rear. However fantastic such optimism seems in the light of subsequent events, it was by no means so unfounded under the circumstances of the time. The width of frontage to be attacked, the quantities of guns and ammunition accumulated, the masses of troops assembled, and the pre-occupation of the Germans on the Russian front, all contributed to the favourable prospects which presented themselves to General Joffre.

Lord Kitchener and Sir John French wished to wait until the spring of 1916, when the new British Armies would be ready to take the field. But the overwhelming successes of the German armies against the Russians, and the pressure upon the Western allies to make a move to relieve the situation, made it impossible for the British Cabinet to refuse its support in full measure to the French plans. The Loos project, therefore, expanded into a larger operation than any which had yet been attempted by the British. Again the task was entrusted to Sir Douglas Haig, and again the preparations were worked out with the greatest care. It was decided to use gas as a retaliation for the German gas attack at Ypres on April 22nd. This added considerably to Haig's anxiety, for it involved waiting for exactly the right wind. He tells us how he spent the night before the battle started,

" wondering all the time what the wind would be in the morning. The greatest " battle in the world's history begins to-day. Some 800,000 French and British " troops will actually attack to-day. . . . At one time, owing to the calm I feared " the gas might simply hang about our trenches. However, at 5.15 a.m. I said " ' Carry on.' I went to the top of our wooden look-out tower. The wind came " gently from S.W., and by 5.40 a.m. had increased slightly. The leaves " of the poplar trees gently rustled. This seemed satisfactory. But what a

"risk I had run of gas blowing back upon our own dense masses of troops." —(*Diary*, Sept. 25th, 1915.)

The battle, several times postponed to meet the French plans, at last opened on September 25th. The first stages were carried through with great success. The German first line was broken into on a wide front, and the enemy were taken completely by surprise. But the moment came, as come it must, when fresh impetus was necessary, and the reserves were not at hand.

The mis-handling of the reserves at Loos is by now familiar to most readers. Sir Douglas Haig tells the story plainly and fairly. During the preliminary conferences at G.H.Q. he had urged in the most emphatic manner that the general reserves, comprising the newly-formed XI Corps under Lt.-General Haking (Guards 21st and 24th Divisions) should be pushed well forward before the battle, and placed under his command. Sir John French hesitated to do so, and put off acceding to Haig's request.

"At 8.45 a.m. an officer arrived from the Commander-in-Chief with his con-
"gratulations. I sent him back at once to tell Sir John that the reserve Brigades
"of the 1st and 4th Corps had already reached the German trenches, and to beg
"him to place Haking's Corps under my orders. Reserves must be pushed on
"at once."—(*Diary*.)

"But still no action was taken to grant this urgent request, and about 11.30 a.m.
"French himself arrived at Haig's headquarters and only then said he would put
"two of Haking's three divisions under Haig's orders. It was not until 2 p.m.
"that Haig heard definitely from Haking, and was able to give him orders."—
(*Duff Cooper*.)

The result was that the two divisions were unable to reach the battlefield before nightfall, and they had to bivouac on the shell-torn ground to await daybreak. Meanwhile, of course, the Germans, finding that the initial success was not being followed up, recovered, and quickly brought up reinforcements. Next day they counter-attacked heavily, and recaptured some of the lost positions. The 21st and 24th Divisions, brought up under the worst conditions for untried troops, with their cookers sent back out of reach, failed to make any impression when they attacked on the 26th, and were soon afterwards withdrawn for further training. Haig's disappointment was bitter. He knew, and it was indeed true, that a great opportunity had been missed owing to the Commander-in-Chief's refusal to give him the reserves in good time. And not only had Sir John French failed in this respect, but the reports drawn up at G.H.Q. soon after the battle contained inaccurate statements as to the hour at which the reserves were placed at Haig's disposal.

Sir Douglas Haig, whose sense of duty to his country came before his personal loyalty to his Chief, could no longer allow his convictions to remain concealed. He wrote to Lord Kitchener and told him his views about the battle, and later, in reply to Lord Haldane's questions, gave the latter all the facts. Haig's diary is conspicuously honest about this unfortunate situation. He was the last man to wish to be disloyal to the Commander-in-Chief, but his duty to his country prevailed. Members of the Cabinet came to the same conclusions, and early in December, 1915, Sir John French resigned. Haig became Commander-in-Chief on December 19th.

The British Army in France was now being reinforced with the new Kitchener divisions from England, and within the next six months was to receive strong reinforcements of seasoned troops from Egypt and Gallipoli. During that time seven new Army Corps were formed in France.

Haig had his first interview as Commander-in-Chief with Joffre on December 23rd, and his reception by the French Generalissimo was most cordial and sincere. Even Mr. Lloyd George expressed himself pleased with the new spirit he found, and in a letter to Haig, wrote ". . . and whether we win through, or whether we fail, "I have a feeling that everything which the assiduity, the care, and the trained "thought of a great soldier can accomplish, is being done."

A great Allied offensive was projected for the spring of 1916. Joffre, whose hopes of an overwhelming victory always ran high, planned a series of great attacks by the French on several fronts, and the French Government expected that the British Army would take a much larger share in the efforts than it had done hitherto. Before the French main attacks, the German reserves were to be exhausted by preliminary attacks, and Joffre asked that not only should a further portion of the line be taken over by the British Army, but a simultaneous British offensive should be made between the Somme and Arras. Haig had already given instructions that an attack north of the Somme should be studied by the Third Army (Allenby), and he informed Joffre that he would co-operate in a general offensive if the situation in Russia demanded it, but he did not agree to the British Army fighting a series of attrition-battles long before the main attack. He was convinced that such attacks, having no apparent reason, would lower the fighting spirit of the troops, and would be regarded as failures. He would not make useless sacrifices of his troops. He would have preferred an attack by the British Army in the north, with a view to getting round the German flank; but Joffre's plans could not be set aside, and it was decided to make the main British effort on the Somme, in conjunction with a French attack south of the river.

But before the Allies could carry their preparations far the Germans launched their great attack on Verdun, and thereafter the French Army became absorbed in the tremendous struggle which forms such a brilliant page in French history. Sir Douglas Haig at once gave his loyal support to Joffre in every possible way, and as soon as he felt assured that the Germans were not likely to make another great attack on his own front, he set about offering effective help.

> " I telephoned to General Joffre that I had arranged to relieve all his Tenth Army,
> " and that I would come to Chantilly to-morrow to shake him by the hand, and
> " to place myself and troops at his disposition."—(*Diary*, February 27th, 1916.)

This fine soldierly attitude was never forgotten by General Joffre, who, in his brusque way, had a great personal liking for Haig.

The relief of the French Tenth Army was effected by extending inwards the flanks of the Third and First Armies, and a new Army, the Fourth, under Rawlinson was brought in, thus forming a completely British front from the Somme to Ypres.

The French predicament at Verdun caused great anxiety to Haig, who had now to carry on his own preparations, and yet be ready to throw his whole weight in to relieve the pressure on Joffre's troops. The scale of the proposed British attack continued to expand, and in the meantime several minor operations were successfully carried out. Mining operations were continued, and developed incessantly, and the preparations for the Somme Battle were carefully concealed up to the last possible minute. The newly-arrived divisions had to be trained and put through a period in the trenches; new Corps and Staffs had to be formed. All the preparations were on a scale quite unprecedented for the British Army.

Haig held continued conferences with his Army Commanders and made personal contacts with all the principal officers who were to take part in the coming battle. In all that he did he was thorough, and all through the strain of that time he was cool and confident.

Haig has been blamed for making premature use of the tanks before sufficient numbers of them were ready, or their crews fully trained. But he saw that if the tanks were going to save his infantry, they must be used in the first attacks, and before the Germans had time to prepare counter-measures. He knew that the secret of the tanks had already leaked out at home. He would therefore, either have to postpone his attacks indefinitely, which Joffre would never agree to, or else attack without the tanks.

The opening of the Somme Battle was continually altered, as was the case with most of the combined Allied operations. It is natural that details in Armies, of different

nationalities, should require different lengths of time for adjustment, but it is fair to say that the British were more often ready for action by a pre-arranged date than was the case with our Allies.

The 1st July was finally settled. By that date, the Russians under Brussiloff had already made a great advance through the Austrian lines, and it was known that Germany's reserves were mostly absorbed. It is not necessary to give an outline here of the great battle which continued, with intervals for re-organization and replenishment, up to November 18th, when operations had to cease on account of bad weather.

Mr. Lloyd George, with the wisdom that follows the event, has written with great bitterness of the futility of the Somme, but he was not of the same opinion at the time. Nor has he ever explained what other action he would have proposed in order to relieve the strain on the French at Verdun. Was France's British Ally, with five large Armies, equipped with ever-increasing supplies of men, guns and ammunition, to stand idly by? And when the moment for active help did arrive, was the action to be halting, feeble, purposeless? If the British Army was to attack at all, it had to be on a great scale, to draw the Germans away from Verdun, to relieve Russia, and to aim at a complete break-through.

The Germans, at any rate, were under no delusions as to the effects of the battle. Ludendorff wrote in his *War Memories*,

> " We were completely exhausted on the Western Front. . . . If the war lasted
> " our defeat seemed inevitable . . . I cannot see as I look back how the German
> " G.H.Q. could have mastered the situation if the Allies had continued their blows
> " as they did in 1916."

The Allied blows in 1916 were Haig's Somme battle, and the French defence at Verdun. Many other German writers have testified to the same effect.

Haig went from strength to strength; as his responsibilities of command widened, so did his capacity seem to expand easily and naturally to meet them. In sixteen months he had advanced from Corps Commander with two Divisions, to Commander-in-Chief, with five Armies of 20 Corps. He became the Commander of the largest British Army ever seen in the field, or ever likely to be. His responsibilities were greater than those of any other individual on the British side. How he shouldered them, how bravely he met them, how steadfastly he preserved his faith, are clear from the reading of this book. We do not have to wait for the second volume to see how unjustifiable are Mr. Lloyd George's bitter words against him, or to see the magnitude of the statesman's misjudgment of the soldier; the ephemeral attempt of the one to do damage, and the perfect steadfastness of the other.

There are few references to Mr. Lloyd George in the diaries. Haig's impressions of his detractor were not in his favour.

> " Lloyd George seems to be astute and cunning, with much energy and push;
> " but I should think shifty and unreliable."
>
> " He seems to me to be so flighty—makes plans and is always changing them
> "and his mind."

These are two of the opinions in the diary.

Mr. Duff Cooper's editing of the diaries is admirably in keeping with their character —simple, straightforward and sufficient. He uses very few footnotes or references; he gives us Haig as he was. The diary extracts are printed in the same type as the author's text, necessitating a careful watch on the quotation marks. The marginal insertion of dates would have been an improvement to the book. There is a small mistake on page 296; the Third Army was under Sir Edmund Allenby, and not Sir William Pulteney.

The second volume, dealing with the much-debated operations of 1917, and the trials and eventual victory of 1918 will be eagerly awaited.

W.H.K.

WAR LETTERS OF GENERAL MONASH.

Edited by F. M. CUTLACK.

(Angus and Robertson, Ltd. Price 8s. 6d.)

To appreciate the value and perspective of this book it is necessary to call to mind the history of the writer of the letters, the conditions under which they were written, and to whom the majority were addressed.

Sir John Monash was at the outbreak of the war a citizen soldier, and an already distinguished business man and engineer. He was early appointed to the command of the 4th Australian Infantry Brigade, and it was during the time that he was forming and training that brigade at Melbourne that the writer of this review met him. What struck one about him then was his wonderful grasp of detail, his realization of the importance of knowledge of the soldier's job, and his pride in his but recently formed command.

These qualities are clearly reflected in his letters which were written while in command successively of the 4th Australian Infantry Brigade, the 3rd Australian Division, and the Australian Corps, in Egypt, Gallipoli, England and France; and they are almost without exception addressed to his wife or daughter. It is important to remember this last point when reading the letters, and also that all letters from the front had a very local viewpoint; otherwise one might be tempted to take exception to the continuous adulation of the Australian forces in general, and of his own command in particular, to the exclusion, and even at the expense of other Imperial troops. Bearing this in mind, one will place in their proper perspective the panegyrics on the performances, for instance, of the troops at Anzac, who might, from the letters, have had no gallant comrades from the home country nearby at Helles. Intensely proud of his command and his country, he is ever anxious that their true worth should be recognized.

Throughout these letters, the efficient business man is reflected. In his detailed account of organizations, written in a style simple and wonderfully clear; in his pride in the working together of the various parts of the machine; and even in his appreciation of the £ s. d. of war—he works out that the convoy, in which his brigade sails, costs £8 a minute.

Under the circumstances one will not expect any technical descriptions of battle plans, or appreciations of strategic action, but one does find vivid word pictures of events, from the sailing of the convoy from Australia, to the hectic scenes at Doullens on March 26th, 1918, and the conference of all the "Great Ones" under the trees of Villers-Bretonneux on 11th August, 1918.

There is a refreshing and boyish naïveté in his descriptions of more intimate events, Paris leave, luncheons with *grandes dames* of France or Belgium in battered châteaux, and the bestowal of the accolade of knighthood.

Through it all one gets a clear picture of the man of whom Captain Liddell Hart wrote, "He probably had the greatest capacity for command in modern war of all who held command," and to whom it is alleged that Mr. Lloyd George referred to when he wrote, "I have been told . . . that the only soldier thrown up by the war on the British side, who possessed the necessary qualifications for the position, was a Dominion general." Whatever value may be put on these judgments, the character, outlook, and ideas, so clearly indicated in this book, of the man who called them forth deserve the most careful study by all soldiers.

R.P.P-W.

"WE WERE ONE."

(G. Bell and Sons, Ltd. Price 15s.)

This biography of W. L. Wyllie, R.A., by his wife, is a very attractive account of the life and work of the artist. It makes a wide appeal. Mr. Wyllie had a very

numerous acquaintance; it must be interesting to all painters or those interested in contemporary art. But it must especially appeal to all yachtsmen, particularly to those who sail in small boats.

It begins with a charming account of the early acquaintance of Mr. and Mrs. Wyllie at Boulogne and Wimereux, introducing us at once to a life in which sailing took no small part, and leading up naturally to their courtship and marriage. It might be a high-class novel, this story, but instead of finishing like the fairy stories with "so they lived happily ever after," here we have the story of a happy marriage continued beyond the golden-wedding day.

With regard to his art we find Mrs. Wyllie a just and appreciative critic; whilst with regard to his favourite sport of small-boat racing, it is very rare to find a woman able to take part on equal terms. When sailing against them, to see Mrs. Wyllie at the helm, if anything, reduced one's chance against them; whilst when in their crew one was quite content with her at the helm.

Here I should pause to explain that I saw a good deal of Mr. and Mrs. Wyllie during the three years before the Boer War, during which period I often raced both with and against them, and I also had the opportunity of often seeing Mr. Wyllie painting in both oils and water-colours.

As appears more than once in the book, Wyllie never had the slightest objection to having his work watched. In fact he seemed to like it. Certainly it was a pleasure to the onlooker. Every stroke of his brush was firm, every stroke had meaning; yet, in spite of meticulous accuracy, he never fell into the snare of the pre-Rafaelites of losing the effect of the whole by an over-emphasis of detail.

His accuracy also appears in his perspective, which is always correct. If you examine any of his sea-pieces from this point of view you will see that he never confuses the sea horizon with the perspective horizon, thus giving that roundness to the world which can just be seen in real life if you look for it.

Many of his sketches were made with the aid of a large telescope mounted at the top of his house, but as he once told me he corrected the telescopic perspective to what it would be from a nearer point of view. This difference is not obvious, but nevertheless is there.

If a criticism struck him as just, he had a charming way of adopting it at once. Watching him paint "The Battle of the Nile," I remarked that his crescent moon was not at the right angle for the latitude. "By Jove, that's true," he said, and the next time I saw the picture it was corrected.

He drew quickly and with equal precision with brush, pencil or pen, whether putting on or removing colour. And he was always sketching on every possible occasion and also on many which others would have considered impossible. We others, amateurs, find our paper nearly always too wet or too dry. With him it was always right. He began with very wet paper, and never a pencil line to guide him. In went colour for the sky and anywhere else that he wanted wetness. In went some smoke, out came some white clouds—then perhaps some distant hills—then the smoke stack and masts of his tug—then other things; and the rest of his tug went in when the paper was just the right dryness. He did not mind any interruption in drawing an object, and at the end it was all drawn right.

Mrs. Wyllie gives excellent accounts of many races. In particular I notice the races of *The Maid of Kent* against the Australian challenge of Mark Foy with his Sydney Harbour boat the *Irex*. Here I must quote from the book. Before the races Mr. Foy and one of his crew, a boat builder, dined with the Wyllies. "That evening . . . Mr. Mark Foy remarked to Bill, 'I suppose, Mr. Wyllie, you will be the helmsman?' Bill answered, holding his hand out towards me, 'No; my wife always steers.' Mr. Foy turned quickly towards me, saying 'WHAT!!' And the boat builder said with a jeer, 'Why, if you win, they will say in Sydney, "He only beat a woman!" and if she wins, they will say, "Beaten by a woman!" and you won't be able to hold your head up.'"

Nevertheless, we had the best hand at the helm we could get, and Mrs. Wyllie steered us to a series of victories.

I was bow hand in that crew, and well I remember how wet I got! After the first race was over there was some delay about getting ashore, so at Wyllie's suggestion I jumped overboard and swam for it; the Medway seemed quite warm.

In that race in changing jibs we lost time by getting one of them under the fore-foot of the *Maid of Kent*. I suppose as bow hand it was I who made the bungle; I regret to confess that I had entirely forgotten the incident. It was great fun.

Mrs. Wyllie is very correct in describing this boating. All the technical terms come to her naturally. But as a conscientious reviewer I must find one fault. Of the crew, acting as live ballast, she says "when they set (sic) her up in a breeze." I should say "sit." That is the only technicality with which I disagree.

There are many excellent illustrations, which add very much to the pleasure of the reader.

I have thoroughly enjoyed reading this book, and strongly recommend it to others.

G.E.S.

FLASH-SPOTTERS AND SOUND-RANGERS.

(George Allen & Unwin, Ltd. Price 10s. 6d. net.)

It is claimed for this book, with some justice, that it is a serious contribution to the history of the war. It has also something of a history of its own. Field Survey, as most people know, was a new development in the Great War, and the growth of its organization—which started as one officer and one clerk at G.H.Q., and with a similar establishment on the L. of C., and finished eventually as a body of between 4,000 and 5,000 officers and men, comprising an astonishing variety of new trades and performing an almost equally varied assortment of duties—has never been recorded in published histories. Nor is there very much to be learnt about it from Earl Haig's dispatches. The members of this organization formed very close attachments during the war, and, since its conclusion, have kept in touch with one another by means of annual dinners and similar functions, at which regrets have frequently been expressed at the lack of any published record of their work. Eventually a few of them decided to try and make good the omission and this book is the result of their efforts. It is the work of several different individuals, edited and compiled by the Adjutant of one of the Field Survey Battalions. It deals with only one branch of Field Survey work and describes the growth and activities of that branch as they appeared from within.

In a prologue, Captain Innes discusses the tactical effect of the work of the Field Survey organization as a whole. He draws attention to the omission of any serious reference to its activities in Earl Haig's dispatches and cites a number of significant, and in some cases hitherto unrecorded facts, to prove that the influence of their work was much greater than the rather scanty reference to it that Earl Haig's dispatches would suggest. He quotes also from Lord Cavan's dispatches from the Italian front to support his opinion that on the Western Front at any rate its work was never appreciated in high quarters at its true value. He is at pains to disclaim any desire to disparage the work of other arms, but shows fairly clearly that others have often been, in ignorance, credited with successes really due to the work of the Field Survey units.

After the prologue, which is worth careful study, the author gets down to his description of the development of Flash-Spotting and Sound-Ranging, recording the growth of the establishments and the development of the technique in detail. It is difficult to say how far these chapters will appeal to the lay reader, but to "Survey men" (as the editor calls them) for whom the book was really written, they are full of interest. The principles and problems of sound-ranging are briefly described in non-technical language, though the essential problem of the flash-spotter,

namely that of selecting and concentrating several observers on to one out of many visible flashes, is not quite so clearly brought out. The book is not intended, however, to be a manual of technique, but a record of personal experiences. Its contributors, who include N.C.O's as well as officers, deal with the ordinary day to day work of their Units and give a most instructive and intriguing picture of the Great War from an altogether new angle.

The impression left upon the reader is decidedly pleasant. These "Survey men" were all evidently keen as mustard and quite enjoyed their war. They lived with congenial companions and in more than ordinary freedom and comfort; casualties, though frequent enough, were not excessive; and their work was novel, and almost always interesting. Small wonder then that to most of them the Great War was something of a joyous adventure. At all events their account of it, even the chapters dealing with the interlude of Carey's force, gives that impression!

M.N.M.

THE CRIMEA IN PERSPECTIVE.

By Lieut.-General Sir GEORGE MACMUNN.

(G. Bell and Sons, Ltd. Price 15s. net.)

As a result of the comprehensive works of Kinglake and Hamley on the Crimea, more modern historians have rather ignored the campaign, in spite of the fact that, since those early classics, a considerable amount of new evidence has become available. One must therefore welcome this new study by Sir George MacMunn.

The author has not produced any sensational new evidence, nor does he pronounce any serious reversals of judgment on the well known incidents and personalities of that rather strange war. Unlike most other historians, he considers that the plan to seize Sebastopol by a *coup de main* was feasible and quite sound. The landing was unopposed and there were few defences on the landward side; but he is unconvincing in his arguments on the subsequent decision not to assault the town at once, and he defends the flank march to the southern side. Yet the whole campaign rested on this idea of a quick assault and capture of the town and harbour and then a withdrawal before the rigours of winter set in. The accounts of the battles are clearly given, but suffer from lack of adequate maps, and he relegates the stories of the charges of the Heavy and Light Brigades to their proper place in the military history of the campaign, though it is strange to find a soldier placing the whole responsibility of the Light Brigade incident on Lord Lucan in the face of the wording of the actual order sent by Lord Raglan.

The author paints a very endearing picture of Lord Raglan, oblivious of the obloquy poured on him from those at home who were really responsible for most of the trouble, endlessly and patiently combating the supineness of St. Arnaud and Canrobert, encouraging the energetic Pelissier when he, too, found himself fettered by Napoleon at the end of a telegraph wire, and doing all he could for the welfare of his troops with quite inadequate means—a great-natured man with really astonishingly sound military ideas in view of his lack of real experience. In this lack of experience of the political machinery for war, of military administrative organization and of the tactical handling of troops, lay all the troubles of the Crimea. As the author points out, it is surprising that, with this lack of experience, the tactical handling throughout the campaign was as good as it was.

The author unfortunately has a somewhat irritating style, which is aggravated by his habit of printing innumerable notes, which could be perfectly simply incorporated in the text; and it is a great pity to see a work of this type produced without a single adequate map folding out clear of the text. The book is one, however, which most students of military history will wish to possess.

A STUDY OF THE STRATEGY AND TACTICS OF THE RUSSO-JAPANESE WAR, 1904.

By Lieut.-Colonel A. KEARSEY, D.S.O., O.B.E., *p.s.c.*

(Gale and Polden. Price 5s.)

This book, another in the now lengthy series of similar works produced by this author, has been prepared especially for the Military History paper in the March, 1937, Promotion Examination, so the account is only continued to August 24th. As in the previous volumes, the author analyzes the whole conception of the campaign and the details of the battles in relation to *F.S.R.*, Vol. II, to which there are copious references, though at times the reader's imagination is considerably strained to connect these references with the facts of the campaign being analyzed. The maps are excellent.

Those who have neither time nor desire to read a standard history and analyze the campaign for themselves will owe a debt of gratitude to Lieut.-Colonel Kearsey.

"DIE DICKE BERTA UND DER KRIEG."

By OBERSTLEUTNANT KARL JUSTROW.

(H.P.V., Berlin. G.M.B.H. 1935.)

This book of one hundred-odd pages purports from the title to be an account of the "Thick Bertha" or German 42-cm. (17-inch) howitzer and its use in the Great War. The author is unable, however, to put aside the temptation to digress from his subject, and chapters are allotted to matters such as the German conduct of the war in 1914, war guilt and the Paris gun, which could with advantage have been left out.

The author appears to have been connected both with the experimental work upon heavy howitzers before the war and with their action in the war, and is obviously an authority upon his subject. Much of this book is devoted to technical gunnery and gun construction problems which should be of interest to R.A. officers. There are parts, however, of interest to Sappers in particular and some facts of general interest.

Justrow maintains that though the Germans were ahead in their possession of heavier natures of artillery, their Higher Command did not really understand the limitations and possibilities of their weapons. He considers that their General Staff were insufficiently educated in the technical knowledge essential to the proper formation of their plans, partly because of the excessive secrecy in which new weapons were shrouded. He states that they failed to appreciate the limitations of railway-mounting batteries in face of demolitions and poor networks of lines, and that they had small idea of the power of their medium artillery. With the latter, Justrow claims that Verdun and a front of 30 miles each side of it in the fortress belt could have been forced in the first week of war as Liège was, by bombardment combined with penetration between the forts. This, he thinks, could have been done without his 42-cm. howitzers, before the French field defences were installed between the forts.

Krupp's firm appear to have been entirely responsible for the earlier experiments and construction of heavy artillery under an Artillery Committee. Justrow describes the race between fortification and artillery prior to the war. In 1908 he states that the 30-cm. (12-inch) howitzer was considered insufficient against 1·5 metres of concrete. In 1910 a 42-cm. mortar was tried but was clumsy and tied to railways. From 1909, work was started on the "Dicke Berta," which eventually evolved as a 42-cm. howitzer, range 9,300 metres, tractor-drawn and relatively mobile, firing a 930-kilogm. shell. Even this, it was found in the war, was no match for the powers of fortification. Justrow's conclusions on this point are as follows:—"From war experiences it is possible to say to-day that, in the struggle between concrete and

shell, the reinforced-concrete casemate sunk *in the earth* has proved its efficacy against any shell, but that the 42-cm. howitzer has shown that it can destroy any concrete defences, O.P's, etc., *above ground*. Apart from the cost, there is practically no limit to the possibilities of improving the resistance of the sunken R.C. casemates, whereas a limit has been reached in the matter of producing a reasonably mobile and handy howitzer for the attack, which in the war was shown to be the 42-cm."

The author outlines the many difficulties of evolution and manufacture and states that the 42-cm. howitzer went untested into the war. There were on the outbreak of the war only one 28-cm., five 30-cm. and three-and-a-half 42-cm. batteries in existence. Striking at right angles, the 42-cm. shell was found to penetrate one metre into uncovered reinforced concrete. The 42-cm. howitzer was most effective against the old Belgian and French forts in 1914, but of little value against the modern deeply-sunk defences of Verdun later. A shell cost £50 to £75 in pre-war currency.

In a chapter devoted to the Laon long gun which shelled Paris, the author gives a few figures of interest. This gun was of 21-cm. calibre, had a barrel 35 metres long, and fired a shell of about 115 kilograms 128 kilometres into Paris. It had a life, however, of only 50 to 100 rounds compared to the 2,000 rounds of the "Dicke Berta."

B.C.D.

HEIGL'S TASCHENBUCH DER TANKS.

(1935 Edition.)

Revised and brought up to date by O. H. HACKER, R. J. ICKS, O. MERKER and G. P. v. ZEZSCHWITZ.

Part II.

(J. F. Lehmann, München. Price 10 marks.)

Part I of this publication came out at the end of 1934 and was reviewed in *The R.E. Journal* for March, 1935.

Part II deals with the tanks of all countries in alphabetical order, from Greece to the United States, and concludes with a short chapter on armoured trains. The editors explain in the preface that they had intended to include a chapter on tank warfare, but that owing to the extraordinary development of tanks in Russia, lack of space prevented them from carrying out their intention. "Tank Warfare" will now be issued, in a separate volume, as Part III. This book, by G. P. von Zezschwitz, is expected to appear at the end of 1935, price about 10 marks.

The book under review is profusely illustrated with 334 photographs and 67 tables. With so much material to choose from, it is only possible to select very few items for mention. Of the countries included in this volume, Italy, Japan, Russia, Sweden and the United States have taken a leading part in the development of tanks.

Special interest is attached to Italian armoured vehicles, now being put to a practical test in Abyssinia and Somaliland. Not much is known about the very latest types. The Fiat M 1934 armoured car, with a 4·7 cm. gun, or two machine-guns, in a revolving turret, appears to be top-heavy and overloaded. Italy has gone in largely for armoured cars and tractors with high wheels, on the Pavesi system. The writers do not consider this type suitable for a fighting vehicle, and the steering is very heavy. As regards light tanks, Italy has experimented with many types. Latterly, influenced by the Carden-Loyd Mk. VI tank, the Italians have adopted the new light tank, Fiat-Ansaldo M. 1933. By abandoning a revolving turret, the speed has been increased to 42 km. per hour. A heavy tank, weighing 35 tons, is under trial. There are several special vehicles of interest. The "*Guzzi*" partly armoured tri-car is intended for use in the mountains. The Fiat "autocarretta" is a light lorry with a narrow wheel-track, and four-wheel drive, suitable for hill roads. Light and heavy artillery tractors on the Pavesi system have been introduced.

After the war the Japanese took over from Russia some armoured cars of British manufacture (Austin and Vickers-Crossley). After the experience gained in Shanghai in 1932, they took up the manufacture of armoured vehicles seriously. Specially noteworthy are the six-wheel Sumida armoured car (1933) with interchangeable rims for use on rails, the Issikawadsima (1932) light tank, based on the Carden-Loyd, and several types of medium tanks. One feature of all Japanese armoured vehicles is that they differ in appearance, especially in the front view, from all other foreign vehicles.

The Russian red army has made enormous strides in mechanization during the past three years. It now possesses about 10,000 tanks, 1,000 armoured cars, 150,000 tractors, and 100,000 lorries and other vehicles. Armoured cars are employed for three different purposes :—(*a*) co-operation with aircraft, (*b*) tactical reconnaissance in co-operation with tanks, (*c*) protection of troops on the march. The latest types for these different objects are : (*a*) the six-wheel Ford armoured car, (*b*) the six-wheel amphibious Ford, (*c*) the light "Bronieford" and the light "B.A. 27" armoured cars.

As regards tanks, the Russians have steered a course midway between the British and French ideas. They distinguish two classes of tanks : those for distant fighting (D.D.), and those for infantry support. The latter are sub-divided into tanks for general support (D.P.P.), and those for close support (N.P.P.). For "D.D." purposes there is the medium high-speed Christie tank, with alternate wheel and caterpillar track, and two amphibious tanks : the Vickers-Carden-Loyd and the Vickers-Russkij. Of the latter two, the Russian type appears to be an improvement on the British. "D.P.P." tanks are required to advance into the artillery zone, and consist of heavy, medium and light types. The heavy tanks are copied from the British Vickers, the medium are of the Christie type, the light are Vickers-Armstrong 6-ton tanks "T 26" of Russian manufacture.

Owing to army reductions, there is no Tank Corps in Sweden. Armoured cars are attached to the cavalry and tanks to the infantry. The Swedish firm of "Landsverk" is known all over the world and is comparable to Renault and Vickers-Armstrong. Several of their types of cars and tanks are in use for commercial purposes.

The mechanization of the United States army has not progressed as rapidly as might have been expected in the land of Henry Ford and the General Motors Company. The writers consider that the technician is not fully in accord with the fighting spirit of the army. It is a remarkable fact that the most outstanding American production—the Christie tank—has become not so much a weapon for the defence of the capitalist land of peace and plenty, as a weapon of attack for the fanatical anti-capitalist of Soviet Russia. The writers have classified American armoured vehicles under the heads of armoured cars (converted commercial vehicles by Ford, Overland, Chevrolet, etc.), Christie vehicles of various types, tanks of various types, and special vehicles. The one-man tank has not caught on much in the States.

A.S.H.

GENERAL REPORT, 1934, SURVEY OF INDIA.

Published by order of Brigadier H. J. COUCHMAN, D.S.O., M.C., Surveyor-General of India.

(Price 2s. 6d.)

The cost and out-turn of work remains much the same as last year. One quarter of the higher appointments to the department are, in future, to be reserved for Indian officers holding King's commissions in accordance with the scheme for the Indianization of the services, the remainder will be Royal Engineer officers.

Levelling operations were undertaken to ascertain alterations consequent on the Bihar earthquake, the chief object being to enable the authorities to predict monsoon

flooding. Most of the bench-marks were found to have sunk from two to four feet. In cases of this kind, where the earthquake has affected a large area, without extensive levelling which is not always possible, it is never certain that the bench-marks of reference are themselves outside the affected area. Similar operations were carried out in Burma in connection with the Pegu earthquake, but very little alteration of level was found.

An interesting part of the report is concerned with the continued development of air survey. For some ten years there has been an air survey party as part of the regular establishment of the Survey of India. Experiments have been tried and every endeavour has been made to improve the technique of this important branch of the service. It has been extensively employed both on the N.W. Frontier and in the East. In the former it is specially useful where ground surveys cannot be carried out without provoking the hostility of the local inhabitants, and in the latter on account of the expense and time involved in surveying densely wooded areas from the ground. Another application is the provision of large scale (16 inches to the mile) maps for the revenue department showing boundaries of fields to be assessed for taxation. In this case the maps can be made without disturbing the crops and with the minimum of interference with the cultivator. There are not a few people interested in the cost of air survey. We know from experience how difficult it is to compare survey cost-rates owing to the variety of conditions which present themselves and the influence they have on the work. It is, however, not easy to understand why 1½-inch original air survey in Mohmand and Bijaur cost for "Field work" Rs. 56·6 per sq. mile while for the same scale of survey in Tripura State costs only Rs. 4·6 per sq. mile. It is true that in the former the area was only 167, while the latter was 1,412 sq. miles. Still, without some explanation which is not forthcoming in the report, the great difference in these figures is remarkable. We should like to know also if overhead charges are included in the cost-rates.

H.L.C.

SURVEY OF INDIA, GEODETIC REPORT, 1935.

Published by order of Brig. H. J. COUCHMAN, D.S.O., M.C., Surveyor-General of India.

(Price Rs. 3 or 5s. 3d.)

This report, as usual, contains a great deal of interesting and valuable information on the scientific side of the activities of the Survey of India.

Three bases were measured during the year, one in Baluchistan, one at Poona, and one in Assam. Invar wires were used. Full details are given in Chapter I. The Baluchistan base is about 45 miles east of Dalbandin and is probably within the Quetta earthquake area; it would be interesting to remeasure it to ascertain if there has been any alteration in length. While on the subject of earthquakes, which have assumed such tragic importance in India, we note a remark in the report to the effect that certain irregularities found when observing for deviation from the vertical "can only be caused by widespread departure from isostatic equilibrium." Now if isostatic equilibrium implies equilibrium in the earth's crust, one would imagine, where there was a departure from this, the crust would be in a state of strain which might be a contributory cause of earth movements. It would be interesting to consider whether places which show large departure from isostasy might be considered as lying in areas specially subject to earthquakes. If so observations of this kind might serve a useful economic purpose as indicating probable earthquake areas, and would, therefore, justify an intensive search for such areas. We believe something of the kind has been done in Japan.

During the year the levelling party investigated two earthquake areas. Pegu in Burma, where some local changes were reported, and the great earthquake in Bihar

of 15th January, 1934. In the former case very slight changes were found, while in the latter bench-marks were found to have sunk, some by as much as four feet. There are tabular statements showing the differences found.

The triangulation carried out in connection with the bases afforded an opportunity for an investigation into the best times for observing horizontal angles. The results are fully reported.

Pendulum observations were carried down the east coast of India and in Ceylon, also through the facilities offered by the John Murray Expedition a series of observations were made in the Maldive and Laccadive Islands. These latter observations seem to confirm the subsidence theory of the formation of coral islands. In all, 72 stations were visited during the season, 42 in India, 21 in Ceylon, 8 in the Maldive Islands and one in Minicoy. The large out-turn was due to the use of motor transport.

The Dehra Dun observatory took part in the International Longitude Project in October and November, 1933. The final value is not likely to differ by more than 0·01 or 0·02 seconds from the value 5h. 12m. 11·78 secs. It agrees very well with the electro-telegraphic value of 11·77 sec. obtained in 1894-96 and also with 11·75 obtained in 1926. These figures do not suggest any progressive change and "it is accordingly concluded the differences are due entirely to instrumental error and that the 1894 value of 11·77 sec. is still well applicable," that is the adopted value of the Survey of India.

In standardizing the invar levelling staves it has been found "that greater changes of length occur as the result of use in the field if the staff is standardized between its 0 to 10-foot marks than when standardized between 2 and 10-foot marks. Since observations are seldom on the bottom foot, on account of the risks of refraction, it has been decided to standardize between the 2 and 10-foot marks and to accept 10/8 of this distance as the length of the 10-foot staff."

During the period October 2nd, 1933, to August 31st, 1934, no less than 63 earthquakes were recorded on the Omori seismograph at Dehra Dun. Most of them were slight or moderate, except in the case of the Bihar earthquake, which caused too violent a movement of the pen to give any information beyond the time of arrival of the shock.

H.L.C.

MAGAZINES.

SOLDER.

BULLETIN NO. 2 OF THE INTERNATIONAL TIN RESEARCH AND DEVELOPMENT COUNCIL, SEPTEMBER, 1935.

(*Free of charge on application to the International Tin Research and Development Council, Manfield House, 378, Strand, W.C.2.*)

The second bulletin issued by the International Tin Research and Development Council contains a good deal of matter useful to military plumbers and tinsmiths, in addition to much interesting information and statistics regarding specialized industries in which solder plays a part.

A preamble consists of an editorial and an historical note. The first definite evidence of the use of solder appears in the Roman times. Pliny refers to two compositions, "tertiarium" and "argentarium." The former, two parts lead to one of tin, was similar to the modern plumber's pot metal, while the latter, of equal parts of lead and tin, is still used for many soldering operations. For jointing lead pipes, however, the Romans used pure lead, and it was not until the fifteenth century that the wiped

joint of plumber's solder made its appearance. The present century saw the improvement of the purity of the solders used, and the introduction of machine soldering.

The third chapter, that on methods of soft soldering, should be of great use as a trade instruction pamphlet for military workshops. Some aspects of present-day knowledge of the properties of solders are expressed by diagrams, fully explained, which show how the peculiar stage of "pastiness" in solders is obtained. The melting point of lead is 327°C, and that of tin 232°C. An alloy containing 63% of tin and 37% of lead is known as the "eutectic" and has a melting point of 183°C. For solders containing an excess of lead, the surplus gradually solidifies out after the temperature falls below the M.P. of lead, and being carried in the still liquid eutectic, produces the pasty stage which occurs until 183°C is reached, when the eutectic solidifies, and thus the whole mass. A similar state of affairs occurs with solders containing excess tin. A table of properties of solders is given. Antimony, soluble in solder to the extent of 6% of the tin content, is used in some solders up to this extent, and its effect on the mechanical properties of the solder is being investigated.

The importance of the purity of the solder is stressed, and impurities are limited by a B.S.S. Sub-chapters on solder sticks, cored solders, solder pastes and powders, and fluxes, follow: in the last a very complete list of fluxes for use with various metals and solders is given. It is pointed out that though fluxes are divided broadly into two classes, namely those (such as tallow or resin) which are used on relatively clean surfaces to exclude air and thus prevent oxidation, and the chemical types which can remove oxide films already formed, it is probable that the former type does actually remove an oxide film to some extent.

The soldering of aluminium presents a special problem owing to the rapidity with which an oxide film is formed and to the tenaciousness of the film. It is considered that the effectiveness of the operation depends on the removal of the film by mechanical means during soldering. It is essential to tin the surfaces to be joined before soldering.

The remainder of the chapter deals with the practical side of making soldered joints. Bit soldering, blowlamp soldering, dipping, wiping and sweating are all covered in detail, together with particular applications of the methods referred to, such as the joints in lead pipes and in lead-sheathed cables.

A chapter on soldering machines for cans and boxes, though of little practical use for the military reader, is interesting. The main functions of most of the machines are: to pass the surfaces to be joined through a bath of flux, and thence through a bath of molten solder. Finally a buff wipes off the excess of solder and the finished article is passed out. It is estimated that 4,500 tons of tin in solder alone is used by this industry annually.

Solder for I.C. engine radiators is next dealt with. The chapter describes the evolution of the motor-car radiator from its introduction. Finally a description of the manufacture of tubular type radiators in the Ford works, and of honeycomb type radiators in the Morris works, is given. Immersion in solder baths is the method used in each case.

A short description of the use of solder in automatic telephone exchanges follows. It is estimated that in an automatic exchange serving 10,000 stations the number of soldered connections exceeds 8,000,000.

The last chapter—General Uses of Solder—is of little practical value, but merely a brief description of the other industries making use of solder, including plumbing, the manufacture of refrigerators, central heating apparatus, air-conditioning units, and dairy equipment, and for sheet metal work including car bodies. With regard to the last, it has been found that welds result in superficial damage to the metal work, and while beating and filing will restore the desired contour, they weaken the metal and it has been found more satisfactory to build up the shape with solder, an economical and strong method.

The bulletin concludes with a very complete bibliography on solders and soldering.

L.R.E.F.

REVUE MILITAIRE SUISSE.

(*July*, 1935.)—1. *Jomini et Napoléon.* By Lieut.-Colonel Mayer.

This is a review of a book, recently published, entitled *Jomini, ou le devin de Napoléon*, by X. de Courville, a great-grandson of Jomini. The information is gleaned from diaries and recollections published by Jomini himself, some of them many years after the events recorded had actually occurred. Colonel Mayer's criticism of the book is that the titles of the chapters and the general style are too like those of a sensational novel, and the phrases employed are more those of a journalist than of a serious writer. He then picks out some of the main incidents in Jomini's life.

Jomini, a young Swiss, was intended for a business career. At the age of sixteen he became clerk in a bank. By a remarkable chain of circumstances he became aide-de-camp to a minister of the new Swiss republic, and at the age of nineteen he was head of the war secretariat. He was keenly interested in military matters and made a special study of Napoleon's Italian campaigns. At the age of 22 he wrote a book : *Traité des grandes opérations militaires*, but could not afford to publish it.

It was Marshal Ney who took him up, provided the means to enable him to publish his book, and got him to join the French Army by taking him on his staff. Jomini's introduction to Napoleon and his subsequent relations with the emperor form interesting reading. He rose to the rank of Corps Commander in the French Army. His last interview with Napoleon was at the crossing of the Beresina ; he had been instrumental in persuading the emperor to order the retreat. On the 20th June, 1813, he was placed under arrest for delay in furnishing a return. This led him to accept an offer, already made to him repeatedly, to take service under the Czar of Russia. Years later, at St. Helena, when discussing his defection, Napoleon cleared him of blame. Jomini was not a Frenchman, and was not kept back by love of his country.

2. *Note sur les dispositions pénales du projet d'arrêté fédéral " tendant à garantir la sureté de la Confédération et renforçant le ministère public fédéral."* By Emile Thilo.

A note on the penalties for espionage and counter-espionage in Switzerland.

3. *L'organisation des batteries et des états-majors de l'artillerie de campagne.*

Lieut.-Colonel de Montmollin concludes his article on field artillery organization. He compares the composition of the regimental and brigade artillery staffs in four different countries (Switzerland, Germany, France and Italy) before and after the war, and, in the latter portion of the article, he deals with ammunition supply. In this respect the Swiss artillery has not kept up-to-date, as compared with its neighbouring armies. Batteries are still hampered with ten ammunition wagons apiece ; the writer would like to see the number reduced to six, or even four.

4. *L'éducation du soldat.*

Lieut.-Colonel Walter considers that there is a subtle influence at work nowadays, encouraging slackness and undermining discipline in the army. Discipline is inculcated by patriotism, which should be taught in the family, the school, and in society. The soldier should be taught that he must be prepared to sacrifice himself for his country. In a visit to the United States the writer was impressed with the fact that in all schools the national flag is always given the place of honour. He would like to see a similar spirit prevail in Switzerland.

(*August-September*, 1935.)—1. *Défense aérienne.*

Colonel Bandi here deals with the aerial defence of Switzerland. He explains that the views expressed are his own personal views and are not given in his capacity of member of the federal commission of aerial protection. Switzerland's geographical advantages no longer count against attack from the air ; she is also handicapped by the country's lack of depth.

A good observation service forms the base of all aerial defence : observation posts have been placed all along the frontier, provided with listening instruments for use in fog or at night. An important task for these instruments is the furnishing of the required information to anti-aircraft guns without the use of searchlights. Searchlights should be spaced at intervals not exceeding 3 to 3·5 km.

Anti-aircraft guns should be of 7·5 cm. calibre or over, for high altitudes; special machine-guns are more suitable for low altitudes. Guns are expensive, since at least twelve are needed to form a ring round a point that is to be protected.

A barrage of balloons or kites is sometimes useful at night, but is very vulnerable.

Fighting planes are of value in a system of defence, but they are handicapped by the smallness of the country and the inferiority of their armament to that of bombing planes. Specialists consider a fleet of bombers to be the best aerial arm, but Switzerland is too poor to afford many planes of this class.

As methods of passive defence there are: (1) the instruction of the population, (2) preventive measures, such as camouflage, artificial fog, extinction of lights, etc., (3) shelters, all of which will have to be arranged for.

The writer considers that the aerial defence of Switzerland compares unfavourably with that of Belgium, whose geographical conditions are very similar.

2. *La mission éducatrice de l'armée.*

Colonel Martin would sub-divide the education of the soldier into three parts: individual instruction, moral education, and, last but not least, the teaching of *esprit de corps*.

3. *Fortifications.* By Colonel Lecomte.

The *Journal Militaire Suisse* has recently published an article by Colonel Rebold on the history of Swiss fortifications since 1815. Colonel Rebold held the post of chief of the construction branch of fortifications from 1906 to 1921. Colonel Lecomte here gives us a résumé of the author's views.

France and Belgium have fortified their frontiers very solidly against Germany. It is to be feared, therefore, that in a future war, an attempt may be made to turn these fortifications by passing through Switzerland. This is why Switzerland intends to complete her system of fortifications by new works.

The official view appears to be that a series of permanent works should be built along the north, east, and west frontiers. Colonel Rebold considers that such isolated works would neither prevent, nor even retard the advance of a foreign army across the Swiss Plateau and the Jura. He advocates the construction of a barrage from Bâle to Lucerne, facing both east and west, and some permanent works to complete the defence of the southern front.

Colonel Lecomte disagrees with these views, but thinks that they have their good points. To fall back on the Bâle–Lucerne line would mean abandoning a large part of the country, which would have a bad moral effect. He advocates a system, which he has previously sketched, of fortifying certain places in the interior, such as Morat, Olten, Brugg, and Zurich. This, he considers, would answer better than a central barrage on the Bâle–Olten line.

4. *Prophéties sur la guerre de* 1914–1918.

Lieut.-Colonel Mayer quotes from various works written before the World War, in which the authors attempted to forecast the form that a great European war would take. A forecast by H. G. Wells, written in 1902, allowed for the great advance made in aviation, for the social repercussions of war, and for the relative position of combatant and non-combatant, but he was wide of the mark in belittling the value of submarines and the strength of the defensive.

Other writers quoted are the Russian economist Jean de Bloch, and the Belgian novelists, the brothers Rosny. The views of the latter were based on the Boer War.

Of military writers, some three or four showed remarkable foresight. Lieut.-Colonel Verraux and Colonel Montaigne, of the French Army, were fairly near the mark in forecasting the development of the Great War.

5. *Guerre de papiers.*

Lieut.-Colonel Montfort complains of the excessive number of regulations, and changes in regulations, that hamper the work and the initiative of officers and other ranks.

6. *Études sur le combat.*

Captain R. Frick gives us an insight into the writings of Colonel Ardant du Picq, who wrote, amongst other studies, a book entitled *Études sur le combat*, that was published in the 'sixties of last century. Colonel du Picq was born in 1821, and, in the course of a long military career, took part in the campaigns of the Crimea, Syria, and Africa, and was mortally wounded at Gravelotte in 1870.

As a regimental officer he considered it of greater value to know minor details of what actually occurred on the field of battle than to study the works of Thiers or Jomini. His remarks on the psychology of the soldier are interesting. Centuries have not changed human nature. Arms being equal, surprise is necessary for victory. The surprised party requires an instant in which to defend himself; if, during that instant, he does not run, he is a dead man. Almost invariably a man who is taken by surprise will run.

Reverting to ancient history, the Romans were no better fighters than their opponents, the Gauls or Teutons. But they had been subjected to a severe discipline, and their leaders understood human nature. They only employed a minimum number of men in the front line. The front line consisted of young and impetuous, but easily impressionable soldiers; but, some distance behind, were supports and reserves, who were seasoned troops. The Greeks understood the value of supports and reserves, but made the mistake of keeping them too close to the front line.

There is an interesting account of the battle of Cannæ, which shows that Hannibal, who understood the value of his troops, was the greatest leader of ancient times. The article concludes with a study of the modern soldier. Although written before 1869, most of the remarks hold good for the present day.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

(*June*, 1935.)—1. *La scienza, l'industria e la tecnica militare.* By Colonel Sarracino.

A brief dissertation on the advance made in recent years in science and industry, as affecting the army, and particularly the artillery.

2. *La telegrafia a correnti vettrici nei collegamenti delle grandi unità mobilitate.* By Lieut.-Colonel Gatta.

The signalling systems in current use in the Italian Army are the Morse and the Hughes systems. After having been in use for 70 years, the Morse system has been superseded in the London central office. The Hughes system has also been replaced by modern telescript methods. To cope with modern military requirements, more rapid methods are needed.

The Baudot and Siemens systems, which can be worked in duplicate, quadruplicate or sextuplicate, would be an improvement on the above, but the writer recommends a telegraph system operated by "vector currents." He explains his proposal in detail in this article.

"Vector currents" can be generated either by thermionic valves, as in the "Page" system operating on the Paris–Le Havre circuit, or by a special multiple-frequency alternator, as adopted in the "Standard" and "Siemens" systems. Thirty telegrams can be sent simultaneously along one line by this method.

3. *Individuazione degli obiettivi e tiro con osservazione aerea.*

This is a criticism, by Lieut.-Colonel Liuzzi, of an article in the January number by Major Verney on aerial observation for artillery targets.

4. *Costruzione di travate continue a cerniera con materiale Kohn.*

The instructions for the erection of "Kohn" bridging material, which is made up in sections, assume that the girders have been calculated as merely supported. Captain Montezemolo shows, in this article, how these girders can be used for longer

spans if treated as fixed. He has worked out several examples of assumed spans and shows that the girders are capable of withstanding the required stresses during erection.

5. *A proposito di calcolatori per tiro contra aerei.*

Lieut.-General Buffi refers to an article that appeared in the February number on the subject of " calculators " for anti-aircraft gunnery and adds some remarks in explanation.

6. *Il gruppo come unità di tiro.*

Major Raudino discusses the merits of a proposal made by certain French writers to adopt the group of three batteries as the fire unit, instead of the battery. He shows that such concentration is possible and often convenient. But the battery remains the fundamental unit, even if the tendency is to keep fire control in the hands of the group commander.

7. *Sulla velocità delle schegge nella esplosione dei proietti.* By Captains Cavicchioli and Ravelli.

Formulæ for ascertaining the theoretical velocity of splinters in the bursting of a shell.

8. *L'artiglieria del Giappone.*

A description of the Japanese artillery, gleaned from Russian sources.

The fundamental major unit in the Japanese Army is the division; the next largest is the army. There are no army corps. Each division consists of two brigades, each consisting of four infantry regiments, one cavalry regiment, a regiment of light field artillery, a battalion of engineers, a battalion of armoured cars, and auxiliary services.

It is impossible to mention here all the different types of guns used. In the new reorganization it is proposed to introduce into each battalion a company of heavy machine-guns (six to eight), and a battery of battalion artillery (two 37-mm. guns and two 70-mm. Stokes mortars). Each regiment is to have a four-gun battery of regimental artillery.

The divisional artillery has two types of weapons, a 75-mm. gun and a 105-mm. howitzer. Some divisions have a regiment of mountain artillery with 75-mm. guns.

The armament of the army artillery consists mainly of 105-mm. guns, 150-mm. howitzers and 240-mm. heavy howitzers. The greater part of the artillery is to be motorized.

(*July*, 1935.)—1. *La grande unità coloniale e la sua artiglieria.*

Brig.-General Nasi here considers the organization and the tactical employment of a colonial division and its artillery, against an enemy who is assumed to be weak in artillery and is likely to indulge in guerilla warfare.

Ordinarily, only pack artillery will be allotted to divisions. Where the nature of the country permits, light motorized artillery will form the corps artillery, but circumstances may determine that corps artillery should consist of pack artillery only.

2. *Le inondazioni in montagna.* By Major Montanari.

The most celebrated instance of an inundation during the Great War was that carried out in the Nieuport–Dixmude zone on the 30th October, 1914. With the object of forcing a passage to Calais, the III German Reserve Corps, supported by the 44th Reserve Division, captured the Nieuport-Dixmude railway and the villages of Ramscapelle and Pervyse. During the night of the 29th/30th, at high tide, a detachment of Belgian engineers opened the sluices at Nieuport and allowed the sea to pour in behind the German position. The Germans found themselves in a critical situation; not only was their advance stopped, but they were obliged to fall back behind the Yser with considerable loss. It is interesting to note that the success of the inundation depended upon a spring tide; had the attack taken place a week

sooner or a week later, the effect of the flood would have been comparatively slight.

In the north of Italy there are numerous hydro-electric works, in which large masonry dams hold back huge volumes of water. It is of paramount importance that these dams should not be allowed to fall into the hands of the enemy in war-time. By the demolition of a dam a vast flood can be released, and if the course of the river-bed flows towards the enemy, it may be possible to inflict severe damage to his communications. Everything depends, however, on the suitable timing of a demolition of this nature.

3. *L'artiglieria tedesca nella grande guerra.*

Major Raudino has gleaned his information regarding the German artillery during the Great War from various sources. At the beginning of the war the German artillery differed, in several respects, from that of the Allies. The whole of the artillery was allotted to divisions, even the heaviest guns. There was no higher artillery command than the divisional artillery commander. The field artillery was armed with a 77-mm. field gun (1896 pattern) and a 105-mm. light field howitzer (1898 pattern). In addition, there was a powerful artillery of heavy mobile howitzers for the reduction of fortresses. On the completion of mobilization, the artillery consisted of 1,069 batteries with 6,326 pieces, which comprised 5,096 guns and 1,230 howitzers.

Many comparisons have been made between the German 77-mm. field gun and the French 75-mm. gun. The German gun appears to have given better results in mobile warfare, while the longer trajectory of the French 75 gave the latter an advantage in position warfare. In 1916 the Germans adopted a new field gun and a new field howitzer whose trajectories were considerably longer than those of the older models.

A detail is given of other types of guns in use in the German Army, and in the latter part of the article the writer deals with the employment of artillery. From the outset the Germans dwelt on the importance of surprise, and their preliminary bombardments were much shorter in duration than those of the Allies. As the war dragged on, the views of the Allies changed in this respect, and preliminary bombardments were shortened and, in some instances, omitted altogether.

4. *Il contributo di resistenza delle travicelle di ghindamento nei ponti militari.*

Major-General Giamberini discusses the relative merits of joists with fixed ends and joists with supported ends in a military bridge, and works out two examples to show that, by adopting a rigid framework, the load can be distributed fairly evenly over the road-bearers, and not concentrated entirely on those immediately below the load.

5. *Gli effetti della temperatura sulla resistenza dell' aria.* By Major Moricone and Captain Cavicchioli.

An article explaining the effects of temperature on the resistance of the air to the flight of a projectile, and showing how the necessary correction should be applied.

6. *La morte dei cannoni sul campo di battaglia.*

This is a *résumé* of an article that appeared recently in the *Mémorial de l'Artillerie Française*, on the damage done during the war to guns by (*a*) direct enemy action, (*b*) accidents during firing, (*c*) wear and tear. Up to the 17th December, 1914, most of the damage was caused by enemy action, the proportion of (*b*) and (*c*) being comparatively small. After that date the percentage of guns damaged by enemy fire gradually diminished, while that of accidents tended to increase. The guns referred to are mainly French 75's. The article is illustrated by 17 photographs.

7. *Il saggio di Lécorché e Jovinet applicato alla verifica delle moderne polveri a centralite.* By Messrs. Tonegutti and Brandimarte.

Smokeless powders with a low proportion of nitro-glycerine are divided into two classes: those that are prepared with a volatile gelatinizing agent, such as cordite, and those with a non-volatile gelatinizer, such as di-ethyl-di-phenyl-urea. This

latter explosive, used by the Germans for their heavy naval ordnance, is commonly known as "centralite." In this article the writers discuss certain colour tests made by Lécorché and Jovinet for ascertaining the condition of samples of "centralite."

8. *L'artiglieria nel combattimento di Montrus-Nero.* By Lieut.-Colonel Gatti.

An account of an engagement that took place in Tripolitania, in March, 1913, between an Italian column under Colonel Fabbri and rebel Arabs. In the course of the engagement, the native troops that formed part of the column broke, and the brunt of the fighting fell on the camel battery. The battery kept the enemy at bay during the heat of the day, until obliged to fall back to a strong position at nightfall. The behaviour and staunchness of the camels come in for high praise.

Technical Supplement. (*August*, 1935.)

The supplement contains technical articles on the following subjects:—

1. *Formulæ for variations and correction coefficients in firing at aerial targets.* Captains Bruno and Cavicchioli.

2. *The rational mounting of a continuous girder having a constant cross-section.* Major del Bello and Lieut. Betocchi.

The writers take the example of a girder continuous over two spans, and show by calculations how an increased strength can be obtained from it by lowering the central support. Referring to the table on pp. 80 and 81, it will be seen that in a bridge with reinforced-concrete girders extending over two spans of 10 metres, the lowering of the central support by 2·12 cm. will increase the carrying capacity of the girder by 5%, by reducing the shear at the points of support.

3. *A contribution to the solution of some technical artillery problems.* Major Lintès (of the Rumanian Army).

4. *Determination of the motive power in an aerial ropeway, and a rapid calculation for the supports.* Major Vincenzo.

5. *A comparison of the experiments made by Taliani and by Thomas for determining the stabilizing effect of various compounds.* Dr. Tonegutti.

(*August–September*, 1935.)—1. *Le grandi manovre dell'anno XIII.*

Colonel Biondi-Morra gives a brief account of the Italian army manœuvres held during August, 1935, in four different sectors, *i.e.*, the Sannio, Friuli, the Bergamo Alps, and the Trentine Alps. Six sketch plans and a photograph of the "Duce" accompany the article. Most of the operations were carried out in difficult, mountainous country, and all branches of the service were put to a severe test. A point on which foreign observers commented was the effective concealment of the troops during the manœuvres.

2. *Le comunicazioni radioelettriche, ottiche, fotofoniche, e mezzi di fotografia a distanza nell'esercito.*

In this article Lieut.-General Guasco refers to the part taken by military engineers in the first national exhibition of inventions. The inventions shown relate to radio stations, photo-telephonic stations, and photography with invisible rays. With regard to the latter, photography with ultra-violet rays gives the best results by night, that with infra-red rays the best results by day.

3. *Alcune considerazioni sull' attendibilità delle serie di esatezza.* By Capts. Cavicchioli and Ravelli.

A technical article on accuracy in gun ranging.

4. *La tecnica della lubrificazione e l'impiego dei lubricanti vegetali.*

Major Girola begins this article by discussing the theory of friction in its relationship to lubrication, and then deals with the properties of lubricants.

The value of an oil as a lubricant is determined by its three characteristics: viscosity, adhesiveness, and unctuosity. The writer explains the difference between the last two properties, and also the relationship between the first and last.

A brief allusion is made to solid lubricants, of which graphite is the best known. In Germany preparations have been placed on the market consisting of a colloidal solution of graphite in either water or oil. Graphite is, in some respects, an excellent lubricant; its main disadvantage is its sensitiveness to electrolytic action. Traces of H_2SO_4 will soon produce flocculence in graphitic oils.

Of vegetable oils, the two most important, as regards the lubrication of internal-combustion engines, are olive oil and castor oil. Olive oil has the drawbacks of solidifying at a comparatively high temperature, and of having a high degree of acidity. On the other hand, it mixes well with mineral oil, and mixtures containing from 25% to 50% of olive oil have given satisfactory results. This is an important point for a country like Italy, with its extensive olive-yards.

Castor oil has been in use as a lubricant for many years. It is specially suitable for aeroplane engines. It is the only oil that is soluble in alcohol and insoluble in petrol. Some of its disadvantages are that it will not mix with mineral oil—mineral oil cannot absorb more than 3% of castor oil—and its smell is nauseating. It is unsuitable for use in motor-cars, especially in crowded streets.

5. *Considerazioni sull'impiego dei mezzi per l'alimentazione delle stazioni radio campali.* By Captain Malerba.

The sources of electrical energy for radio transmitting stations, in the field, are :—

(*a*) Dry batteries. These are suitable for outputs not exceeding 20 watts.

(*b*) Hand-driven dynamos. These are not a practical proposition, except as a reserve in case of batteries giving out.

(*c*) Accumulators. These are suitable for outputs between 20 and 60 watts.

(*d*) Power-driven dynamo sets, with accumulators. These are suitable for outputs exceeding 60 watts.

6. *Note sul tiro di sbarramento controaerei.* Lieut. Borsani.

Notes, for battery commanders, on a graphic method for an anti-aircraft barrage.

7. *L'artiglieria di accompagnamento del reggimento di fanteria.*

This is a review, by the editor, of two articles by General Challéat, that appeared in the *Revue d'Infanterie* in August, 1933, and July, 1935, respectively. General Challéat would reserve the term " supporting artillery " for motorized artillery only; he would use the term " artillery of the infantry regiment " for the material placed unrestrictedly at the disposal of the regimental commander.

For the latter artillery he would specify a gun of 75 mm. calibre, firing a projectile weighing 4½ kg. at a rate of 20 rounds per minute, and having a range of at least 5 km., and, if possible, 6 or even 7 km.

For anti-tank work there should be a gun with a calibre of 37 to 47 mm., with an initial velocity sufficient to perforate a 40- to 50-mm. steel plate at a range of 1,000 m.

Batteries should be served by gunners and not by infantrymen.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*May–June*, 1935.)—1. *Passage de vive force du canal de l'Yser.*

Captain Simon gives an account of the crossing of the Yser canal on the 31st July, 1917, by the 1st Corps, which was holding a portion of the front line between the Belgian and British armies.

Twenty-six footbridges were constructed by three of the Engineer companies; another three companies were entrusted with the construction of four heavy bridges for the artillery and heavy transport. The light bridges over the main canal, which was nowhere more than 25 metres wide, were of the floating type, the piers consisting of cork rafts. For crossing secondary water channels beyond the main canal, light bow-string girders, of pine wood, with wire ties, were used. Three of the heavy bridges were boat-bridges, the fourth bridge (at Boesinghe) was a trestle bridge designed by a Belgian officer, resting on a mattress of fascines stretching across the canal.

A map shows the position of the heavy bridges. Details are given on other plates of the different types of light bridge, and of the Boesinghe bridge. Though erected under fire, the bridges were put up and the crossing was effected without heavy loss.

2. *L'escalade de Tagountsa.* By Chef-de-bataillon Michelet.

An account of the construction of a road crossing the Djebel Tagountsa ridge in the Grand Atlas massif, on the Algero-Moroccan boundary, in the spring of 1933.

The labour employed on this work consisted of two companies of Engineers (the 31/3 and 31/4), a company of sapper-pioneers of the foreign legion, and about 750 native workmen. The time available for reconnaissance—in a hostile country—was limited, the only maps procurable having been prepared from aerial photographs. Four alternative alignments suggested themselves, the first two were hastily reconnoitred, the third seemed promising, but would have necessitated a reconnaissance in force; finally, the fourth alignment was decided upon.

The ascent of the main ridge of the Tagountsa involved a rise of 400 m. The ruling gradient was 8%. There were six hair-pin bends, at each of which 200 m. were level; the total length of the ascent was therefore 6,700 m. One of the bends formed a complete loop, in which the road passed through a curved tunnel, and crossed its own alignment by a bridge.

A detailed account is given of the work, the labour and material used, and the expenditure of explosives and petrol. Many difficulties were encountered, the scarcity of water not being the least. The construction of the road was of material importance to the success of the campaign.

3. *Où en est la radiesthésie.*

Lieut.-Colonel Correnson gives us his last instalment of this interesting, but hitherto neglected, subject. Continuing his study of the pendulum, he explains how a pendulum, having been suitably regulated for a particular substance, begins to revolve when placed over that substance. If it is given a jerk, it will stop, and then again continue to revolve. After a certain number of jerks, which is constant for each substance, the pendulum will refuse to revolve, and will oscillate in a fixed direction, which is that of the "fundamental ray" of the substance. The number of jerks that stops the gyratory movement is known as the "series number" of the substance, and is positive or negative according to the direction of gyration. The following series numbers, amongst others, have been established: Silver, + 2; Gold, + 11; Zinc, + 3; Water, + 2; Oxygen, − 1.

Every mineral body emits a radiation in a fixed direction, known as the "fundamental ray" of the body. For iron, this direction is the magnetic south.

Space does not allow us to follow the writer through the intricacies of "radiesthésie," a term for which, as far as I am aware, we have no equivalent in the English language. It can be of value to the "dowser" in search of water or minerals, as well as in medical research work.

According to Dr. Leprince, the human body is the seat of an infinity of different radiations, whose resultant, which he calls the human wave, is in the infra-red region. In a healthy individual the wave-length is 9·48 metres, and the frequency 300 billions a second. Persons who are ultra-sensitive to nervous radiations are known as "hyper-sourciers." In their hands a divining-rod or pendulum responds readily to outside influences. This sensitiveness is inborn and is sometimes hereditary. The Abbé Mermet, who has made some of the greatest modern discoveries in this subject, is a hereditary "hyper-sourcier."

An allusion is made to "harmful rays," and there is evidence to show that what is known to the superstitious as the "evil eye," has some foundation in fact. The writer concludes by hoping that fresh studies will lead to further discoveries.

(*July–August*, 1935.)—1. *Le raid du capitaine Pichery en Macédoine.*

This is an account of a reconnaissance carried out by Captain Pichery, chief of the wireless service in the French Army, at the end of September, 1918. The Bulgar Army was in full retreat, with the French cavalry brigade, under General Jouinot-

Gambetta, in pursuit. The radio post of the brigade had been out of order for some days, and Captain Pichery was instructed to go and repair it, and to transmit news of the brigade to the commander-in-chief of the allied forces. The report describes how, after spending practically thirty hours in the saddle, and meeting with numerous adventures, Captain Pichery met the brigade commander at Uskub, just after the town had been taken by the Allies. He returned to Salonica by aeroplane, and there submitted a verbal report of the state of affairs at the front.

2. *Le chauffage par le sol et le chauffage des grands locaux industriels.*

Chef-de-bataillon Allard has made a special study of the heating of large industrial buildings, such as hangars and aviation workshops, in which the floor area is extensive and the height considerable. It is difficult to obtain an even temperature and to avoid draughts by using ordinary radiators or by forcing hot air into a room from a level at or near the floor. These systems lead to a concentration of hot air at the top of the building, and a consequent waste of heat.

The system advocated by the writer is that of heating the floor by a method adopted in 1923 in the nave of Rheims Cathedral. The floor consists of slightly arched slabs of reinforced concrete, covered with a layer of mortar and slabs of limestone. The heating apparatus is installed in subterranean chambers under the floor, and consists of three low-pressure boilers supplying steam to batteries of pipes distributed over the underground chambers. One, two, or three boilers can be used at a time, according to requirements. The heated floor surface measures about 1,200 square metres. During one winter season of six months 55 tons of anthracite were used.

The advantages claimed for the system are: (1) that a uniform temperature is maintained, with freedom from draughts, (2) little supervision is necessary, (3) no electrical energy need be provided, (4) the occupants' feet are kept warm, (5) the system is economical, and the loss of heat is small.

In the last part of the article the writer describes how a similar heating apparatus was installed in the hangar-workshop at Metz-Frescati.

3. *Les peintures au brai à la poudre aluminium et la protection des constructions métalliques.*

M. Vila, head of the paint and varnish section in the national office of research and invention, describes a series of tests that have been made with an anti-rust paint consisting of pitch, obtained by the high-temperature distillation of coal tar, to which has been added 15% of powdered aluminium. The tests have been eminently satisfactory, and show better results than have been obtained with white or red lead in protecting steel when immersed in fresh or salt water, or exposed to the weather. After numerous experiments a type of paint has been produced that can be sprayed on a metal surface and has a pleasing appearance when dry.

4. *Enquête sur la radiesthésie.*

In this article replies are given by four leading authorities on *radiesthésie* to a series of questions compiled by the editor of the *Revue du Génie Militaire*. Some of the writers have replied at great length. A few of the salient points on which they all agree are that the science has a great future before it, but that it has only made great strides during the past five or six years. The name *radiesthésie* is not a good one, but any suggestion of divination or second sight should be avoided. "Dowsers" have no supernatural powers; there is nothing occult or magical about their work. What has handicapped progress hitherto is that there has been little or no collaboration amongst them, and that a study of their methods has only been taken up seriously in recent years. The science is one in which a little knowledge can be dangerous, and it may lead to serious mistakes.

A.S.H.

REVUE MILITAIRE FRANÇAISE.

(*July*, 1935.)—*Notes sur la Guerre de Mouvement*, by Colonel Didelet, is a thoughtful article, with many very pertinent remarks. It condenses a great deal of sound reason-

ing in a few pages, and gives a mental picture of the type of moving warfare which may without doubt be expected.

After discussing the lessons to be drawn from the open warfare experiences of the Great War, the author enlarges on six principal features, which have been so greatly developed since 1918: namely, the sudden attack, wide frontages, camouflage, motor transport, chemical warfare and radio-telephony. The article concludes with a concrete case worked out with three rather primitive sketch maps, discussing the action of a motorized infantry division reinforced with a tank battalion against an enemy hastily prepared to encounter it.

In his preliminary remarks, the author upholds the traditional French partiality for the attack. Even if the new French fortifications sufficed to bring up an assailant short and sharp, it would still be necessary to advance beyond the fortified positions in order to gain the decision.

Difficult as it was in the last war to locate with exactitude any centres of resistance, it will be still more difficult in the future. With smoke, with gas, with land-mines against them, how are the infantry going to identify exactly the positions which they have reached, so as to keep the supporting artillery informed? In all advances to the assault, there have been units which have pushed well ahead, with plenty of energy left in them, but they have halted with a feeling that they were in the air, and were unsupported by their unseen neighbours. With modern appliances, these situations will be more frequent, and it will be increasingly difficult for a Divisional Commander to keep in touch with his troops, or to influence the battle once begun. One or two enemy tanks breaking through and turning into raiders will cause serious disturbance to the rearward organization. Those objectives hitherto neatly marked in coloured lines on the Staff maps—who will be able to say when the troops are exactly on them? Colonel Didelet prefers to give the attacking troops directions of march rather than zones of action. He advises the limiting of "bounds" by time rather than by space.

It would be a grave error to overload the infantry in an effort to convert them into light artillerymen. For moving warfare the infantry must be mobile, and it is for the artillery to develop their fire power. The fire power of infantry on the move cannot be decisive. The development of more mobile artillery is required rather than the burdening of infantry with weapons they can scarcely carry.

This reflection leads naturally to the question of centralization or decentralization of the artillery. The adjustment between the two cannot be made during the battle; therefore the ideal is to give the maximum of centralization to part of the artillery and the maximum of decentralization to the other part. In the concrete case given as an appendix to this article, Colonel Didelet allots a battery to each battalion in the front line. The commanders of batteries thus allotted cannot be under the orders of the infantry battalions; they must themselves judge their roles and locate the objectives. This is sound sense, for who is better fitted to direct the supporting guns than the artillery observers in the front line? Flexibility in the artillery organization is an essential, but the majority of the guns must still be held under the divisional control. Flexibility in the distribution of the artillery also requires flexibility in the ammunition supply, and this is more difficult to achieve.

The example at the end of the article is not fully worked out, and is rather too fictitious to be of much practical value. It would be better to take an actual engagement and work it out on these modern lines, but that would require a separate article.

L'Économie Allemande dans ses rapports avec la Défense Nationale, by Commandant Lelarge D'Ervau, is a continuation of the article which appeared in the April number of this review. It discusses the present economic situation in Germany, and the various measures which have recently been adopted to organize the nation's resources.

The German economic situation to-day is anything but stable; and the author points out that what he has written applies to the period at which he wrote, namely,

December, 1934, and that many adjustments may be necessary to keep pace with to-day's situation.

The article is limited to the food problem and to the industrial output.

Since the war, Germany has made very great efforts to increase her own agriculture and reduce the importation of foreign foodstuffs. With a population practically equal to that of 1914, she has to feed it from a territory reduced by 13%. But the rate of increase of the population has declined, and the curve of agricultural production, continually rising, is approaching the curve of consumption, which is tending to become horizontal. In 1932 and 1933 the harvests of cereals exceeded the nation's requirements. Not only is more land under corn, but the productivity per acre is greater than before the war.

Rye, which was the chief constituent of German bread before the war, has fallen; the people are taking more wheat. The potato crops yield some 16% more than the demand. The production of beef and mutton has also increased.

But there are large deficiencies in other directions. Butter, fat, lard and other foods derived from oil have to be imported largely, and must necessarily continue to be. About 15% of the milk consumed has to be imported. Green forage is short and could only be increased by reducing the production of human necessities.

On the whole, therefore, Germany is much more self-supporting than before the Great War, and such deficiencies as there are to-day could be overcome without the imposition of very severe restrictions.

In the industrial sphere, Germany is more insecure. For raw materials of many kinds she is still dependent on imports. Of coal and lignite she has more than she needs, and the latter product has been greatly substituted for the former since 1913. In iron ores she has lost three-quarters of her resources with the Lorraine reductions; and she has to import the differences from Sweden, France, Spain and North Africa. 70% of her zinc was lost with Upper Silesia, and she now obtains this from Greece, Russia, Mexico and Bolivia. Nine-tenths of her copper come from abroad. Aluminium, which she uses in far greater quantities than formerly, has to be imported from France, Hungary, Yugo-Slavia and Italy. She can only produce one-third of the lead she consumes. In leather and textiles she is very much below her needs.

On the other hand, she has developed her oil and petrol industry, and is in a fair way to making herself independent of outside sources. This is a point of special importance. In nitrogen and the artificial production of nitrates, she is now far more than self-supporting; she turns out 30% of the whole world's output.

It is therefore only in metals that Germany finds herself hard put to it to furnish all that she needs, and to strengthen her position in any future conflict she is making igantic efforts to provide for every contingency.

Her industrial equipment has made enormous strides, especially in electrical plant; her production of current now exceeds 25 milliards of kilowatt-hours per annum, compared with France's 14 milliards. This is five times as much as in 1913. The lines of electrical communication are 30 times as long. A huge system of motor transport roads, begun in 1933, is in process of rapid development; and the strategic importance of this network is noteworthy.

All Germany is in fact being developed with intense earnestness. Her economic recovery is now an actuality; her continued development is a certainty. All the measures that she takes are directed with a view to national defence and the development of warlike strength. The concentration of all direction in the hands of the State is obvious. The organization of industry established during the war has been carried on during the years of peace. It seems as if every department of the national machine had become militarized; each with its "Front" and its staff.

The author gives a very good account of the economic organization of Germany to-day, with tables of comparison between 1913 and recent years; and he winds up with the remark that Germany is now in such a state of industrial mobilization that little would remain to do when war breaks out.

Ce qu'il faut savoir de la Turquie et de l'Armée Turque, by X... concludes this number. After giving an outline of the geography and orography, the article describes the present economic situation of Turkey. It is essentially an agricultural country, and 68% of its population are engaged in cultivation of the soil. It is amply self-supporting so far as agriculture is concerned. The soil is very productive, but hitherto the lack of communications, of capital, and especially of good government, has prevented anything like the full development of the land. Under the Republican Government, many improvements are taking place, and a virile agricultural policy is transforming the country.

Anatolia is rich in minerals; oil, coal, copper, zinc, gold, and silver are being worked in various regions.

The financial situation is sound, and the Budgets have been balanced for several years past.

The population, about 12,600,000, consists of some 10,000,000 Turks, and the remainder of Kurds, Lazes, Turcomans, Circassians, Greeks, Armenians and Jews. The Kurds are a nomadic race, and are fomenters of trouble. The rest are honestly attempting to settle down to national development.

The author then describes the Turkish Army, which has been thoroughly reorganized. In peace-time, the Army is commanded by the Chief of the General Staff; in war, by an officer to be selected by the President of the Republic on the proposal of the Council of Ministers. There is a Ministry of National Defence, comprising the three departments: Army, Navy, Aviation, each under a Sub-Secretary of State; and a General Staff, organized in 13 bureaux.

Under the Military Law of 1927, service is compulsory. Service covers a period of 26 years, beginning on January 1st of the year in which the recruit enters his twentieth year, and ending on January 1st of the year in which he reaches forty-six. This period is divided into three parts: training, about 10 months; active service, varying from 18 months in the infantry to 3 years in the Navy; and the rest of the time in the Reserve. There are, of course, certain exceptions to these rules. The annual contingent of recruits is about 70,000 men, but the regular forces, owing to budgetary reasons, have not exceeded 120,000 to 130,000 men, including gendarmerie, aviation and the Navy.

The Turkish Army, in time of war, is organized in 9 Corps, and a special force of 2 divisions called the Military Command of Stamboul. Six of the Army Corps have 2 infantry divisions each, the other three each have a Cavalry division as well. There are also 3 mountain brigades, 1 fortress brigade and some other special troops.

The infantry comprises 20 divisions, 3 mountain brigades, 1 fortress brigade, 1 regiment of the Republican Guard and 17 battalions of Frontier Guards. The division has 3 infantry regiments, each of 3 battalions and 1 section of 37 mm. guns, and 1 brigade of artillery (4 groups). The cavalry has 3 divisions of 4 regiments each.

Details of the various armaments are given.

Behind this apparently small force, there lies the national will to develop the country under the very able guidance of Mustapha Kemel. Turkey must always be an object of military interest while she is in possession of the Dardanelles. She is now an ardent supporter of the League of Nations, and has thrown herself into the work of rejuvenation with a zeal which must have beneficial results, both for her and the rest of the world.

(*August*, 1935.)—The concluding instalment of *Trois débarquements en présence de l'ennemi*, by Commandant de Périer, describes in detail the landing of Spanish troops at Alhucemas Bay on 8th September, 1925. This example is given by the author, not on account of its scale, but because it is the most recent example of a landing. The troops were entirely Spanish; the naval protection was both French and Spanish. As the enemy in this case had neither fleet nor regular army, the preliminary operations appeared to present no difficulty. A revival of Riffian aggression in the spring of 1925 on the northern frontier of French Morocco caused the French

Government to negotiate with Madrid for Spanish co-operation. It was agreed that a Spanish force should land in Alhucemas Bay, capture Ajdir, the headquarters of Abd-el-Krim, establish an entrenched camp there, and co-operate with the French by striking out from Melilla. The French, meanwhile, were to make a move northwards from Taza. All preparations were made for a landing on Sept. 7th, but the Riffians did not wait to be attacked. They forestalled the Spaniards, directed by General Primo de Rivera himself, the Spanish Dictator, by penetrating the Spanish lines and surrounding Koudia Tahar during the night of Sept. 2nd/3rd. To recall the troops already embarked for Alhucemas would play the enemy's game. General de Rivera therefore carried on with the project and informed the Spanish commander at Koudia Tahar that he must do the best he could with his own reserves. However, the Riffs pressed their investment, and it became necessary to detach 3 battalions, not yet disembarked at Alhucemas Bay, to relieve the situation. These troops relieved Koudia Tahar on the 13th. The Riffs had scored a point.

The selection of the landing-place was made by General de Rivera himself. The Riffs were very much on the alert, and had dug trenches along the bay wherever the beaches seemed suitable for landing. The spot selected, contrary to the advice of the Spanish admirals, outside Alhucemas Bay, to the west of Cape Frailes, was a very restricted site, offering a strip of sand 100 metres long and 30 wide, dominated by cliffs 10 metres high. But it was undefended, and a very unlikely spot for a landing, so that surprise was almost assured. Some 4,000 Riffs, with 30 guns of various calibres, and 12 machine-guns, were expected to be at hand.

Full details are given of the organization of the landing. The naval forces covering the operation were sufficient to blow the 4,000 Riffs away from any temporary earthworks, and the technical auxiliaries accompanying the infantry were on an equally lavish scale. About 18,000 men were to be landed, in two echelons, corresponding to the two mixed brigades into which they had been formed. The troops had been exercised for several days on a shore similar in character to the spot selected. This preliminary work has a particular value in such operations.

The troops were sent ashore in armoured barges, holding 300 men. Only 400 animals were included, so there was no great difficulty to be anticipated with them. But there was no surprise landing. The intention was to disembark before daylight on Sept. 7th, but owing to mist, to a mistake in the time-tables, and to the effect of strong currents, the convoy and its escort did not arrive on the scene until 11 a.m. General de Rivera, thus foiled in his surprise, decided to postpone the landing for 24 hours, using the ships in the meantime to bombard the enemy's works ashore.

Two columns were employed, each of practically a brigade, one escorted by Spanish ships and the other by French vessels. Further difficulties with the mist and currents carried the transports away from the shore, and daybreak on the 8th found the ships and barges scattered, and it was nearly mid-day before the first troops got ashore. Under protection of the low cliffs, the disembarkation proceeded with practically no opposition. By 7 p.m. the whole of the column—General Saro's brigade (7,000 men and 3 batteries)—was ashore and entrenched, with a casualty list of only 100.

The second column—General Perez' brigade—was to have landed in Alhucemas Bay—on the opposite side of the Morro Nuevo to that of the first column's landing-place—but de Rivera decided that he would not risk his boats on a fresh site, but put the second brigade ashore under cover of the foothold secured by the first. He also detached 3 battalions of Perez' brigade to go off to the relief of Koudia Tahar, mentioned above.

General de Rivera—who was here, there, and everywhere, and, indeed, seems to have left nothing to his subordinates—now hurried off to see to the relief of Koudia Tahar, leaving General Sanjurjo in charge at the landing-place. A strong wind now sprang up from the east and blew for the next 8 days, thoroughly hampering the landing of the second column, and the large quantities of stores still awaiting disembarkation. Rations and water were running short, and General Sanjurjo hesitated

to enlarge the perimeter of his foothold until everybody and everything was ashore. Meanwhile, the Riffs became bolder, and harassed the Spaniards severely. Casualties began to mount up.

On the 20th Sept., General de Rivera hastened back from Tetouan and took charge again. It was apparent that he was the mainspring of the whole venture. He fixed Sept. 23rd for a general advance, to be supported by the ships' fire. The attack was successful, and all objectives were gained. Next day the Dictator returned to Tetouan, leaving Sanjurjo to carry on once more. The latter seems to have suffered under an unlucky star, for once again a gale sprang up, driving 20 barges ashore and stopping operations. Again Primo de Rivera returned to take charge, and again the advance was successful. This time, the Spaniards gained their final objective, Ajdir, and its capture—without resistance—closed the campaign until the following spring.

The moral of the story appears to lie in the value of personal initiative. The Spanish troops were well armed, almost lavishly equipped, and well in hand. The Spanish brigadiers, however, appear to have been lacking in energy. Without General Primo de Rivera, the landing might well have been a disaster. On the other hand, it is not improbable that where a very imperious personality dominates and takes charge of every detail, the subordinates first find themselves left without command, and next fall into a condition in which they either dare not act without higher authority or lose all the edge of their enthusiasm. The happy mean is only achieved by the soundness of General Staff training.

Les Armées Françaises dans les operations offensives de 1918, by General Fournier, is concluded in this number. The instalment is little more than a catalogue of the bewildering movements of the French divisions during Marshal Foch's masterly handling of the Allied offensives between July and November, 1918; but it gives the student much useful material in a compact form. It helps to convey some idea of the colossal efforts made by the Allies. The stage-management behind the lines was on such a gigantic scale that a full description will be a baffling task for historians. The author makes no attempt at comment, nor does he describe the German reactions, their plans, their dispositions or their reserves. He makes little mention of the Allies. He limited himself to a summary of the French offensives.

The article does, however, induce the reflection that the system of successive punches directed by Marshal Foch could not have been more ably managed or more effective.

La Sécurité des Arrières, by Commandant Villatte, is a capital account of the activities of a few German demolition parties behind the Allied line in September, 1914. In these days of highly-developed aviation, such raids will probably be much more frequent, and difficult to guard against; but in 1914 the raiders were confined to roads and motor-cars or lorries.

Raids behind the lines were made by both sides, and the French even got a cavalry division (5th) into von Kluck's rear in the Foret de Villers-Coterets which had an adventurous career for three days, without, however, doing any damage to the enemy. The author has gone to much trouble to seek out the information on which his article is based.

The open warfare which still prevailed in September, 1914, presented easy opportunities for such raids, and the Germans sent off a number of small parties of pioneers to destroy railway bridges behind the French lines in the region north of Paris. One of the most important of these bridges was that at Oissel on the Paris-Rouen line, by which Joffre was bringing round troops from Lorraine to extend his front to the north. The raiding party sent off to carry out this demolition had a very adventurous career, but was eventually captured by gendarmes before it could achieve its purpose. Other raiders were more successful, notably around Amiens, where the railways converging on that important centre were so effectually cut that Amiens was isolated for several days; the two demolition parties met with no obstruction whatever, all the gendarmes and civil authorities having been withdrawn. Amiens was, however, hardly to be described as behind the Allied lines at that time.

On Sept. 13th no less than 7 parties were sent off to cut railways running from the coast to the interior, in order to hamper the communications of the B.E.F., but they achieved very little.

There were countless stories circulating at the time of Germans in cars careering about behind the Allied lines. Some of them were genuine, but many were fictitious. The authentic instances served to multiply the imaginary. To prevent these happenings, the author proposes a considerable extension of the gendarmerie system, requiring a large increase in the force. Volunteers from the civil population would doubtless be forthcoming; their organization would have to be prepared before their services were called upon.

In the notes at the end of this number of the *Révue* there is an account of the *Ethiopian Army*, which is of interest just now. The war strength is estimated at 300,000 men, a figure which has been mentioned several times, from different sources. The Emperor's *levée en masse*, however, seems to have yielded a larger total than this: although all reports as to numbers must be cautiously received. The infantry have some 200 machine-guns; the artillery about 50 guns fit for use. Aeroplanes number eight, of six different marks. The troops are loosely organized, and of course have never been trained to act together. They have even had no regular rifle practice. Their strength lies in the formidable nature of their country, in their power of harassing lines of communication, and of dispersing to meet again elsewhere.

(*September*, 1935.)—*Passage de vive force du San en Mai* 1915, by General Bailly, describes in detail the operations by which the Austro-German forces crossed the River San after the battle of Gorlice. The article is mainly a transcription of a corresponding German article by Major-General Hess, which appeared in the *Militar-wissenschaftliche Mitteilungen*, September, 1934.

The break-through at Gorlice opened up the Russian South-Western Front, and full advantage of the victory was taken by the Austro-Germans under General Mackensen. The 4th Austrian and 11th German Armies pushed forward, and after fourteen days' strenuous marching and fighting reached the San. The Austrian VIth Corps, with the Prussian Guard Corps on its left, arrived at Jaroslau on the 14th-15th May, and drove out the Russians, who, however, destroyed the bridges before they went. The town of Jaroslau lay on the western bank of the San, which here swept in a semi-circle, the diameter of which was about two kilometres; the river was about 100 to 120 metres wide, and 1½ metres deep.

While the Austrian VIth Corps was hesitating between an immediate attempt at crossing or allowing the tired troops to rest for a day, the Prussian 2nd Guard Division announced its intention of crossing the same night (May 16th), and the Austrians had to follow suit. All the available bridging equipment had been brought well forward, and plenty of information had already been collected as to the possible crossing places. The VIth Corps had the following technical troops available: in the 12th Division, one company of Sappers and the Divisional Engineer Park; in the 39th Honved Division, two sections of a company of Sappers, an improvised Divisional Park, and a detachment of pioneers formed by collecting artisans from all regiments in the division under a Sapper officer; in VIth Corps Troops, one company of Pioneers, one company of a Landsturm Labour battalion, with the equivalent of four divisional bridging trains, each of 8 pontoons, and an improvised Corps Engineer Park. There were thus four pontoon units within reach, and as soon as Jaroslau was captured, these were brought up to the outskirts of the town. Telephonic communication was established with all these technical units, and they were even furnished with small detachments of Dragoons and Hussars for orderly work in case of a failure of communication.

The Austrian 12th Division was ordered to co-operate with the Prussian 2nd Guard Division in an attempt to force the passage during the night of the 16th/17th. Preparations began at 3 p.m., and by 5.15 p.m., parties from the 2nd Guard Division were being ferried across, 20 men at a time. The 12th Division began two bridges, one on each side of the main road destroyed by the Russians, and the Guards another

below the Austrians. By 8.30 p.m., 2 Austrian regiments had crossed over, and an hour and a half later 5 Prussian battalions were across.

Details of the bridges built are given in four hour-by-hour time-tables. Altogether, the Sappers and Pioneers of the VIth Corps built two pontoon bridges, dismantled one of these and rebuilt it on a new site, two light and two heavy transport bridges, as well as several footbridges, in five days.

In his commentary and conclusions, General Bailly remarks on the facility with which the 2nd Prussian Guard Division got their leading units across. The Russians had done nothing to defend the thickly covered banks on their side, where much might have been done with a few well-posted infantry, or a few motor-cyclists with machine-guns. He emphasizes the importance of having Sappers trained to the highest degree, and equipping them with the most up-to-date apparatus, if they are to keep up with the pace of modern military development. Bridging material must be pushed forward in plenty of time, if river-passages are to be negotiated at short notice.

The Austro-Hungarian Sappers in this case were fully equal to their task.

Influence des modifications de l'armament ou de la tactique sur l'organization du Service de santé en guerre is the lengthy title of a short article by Médecin Général Inspecteur Toubert. It is chiefly of interest to medical readers. Some interesting facts are included. From March to November, 1918, the French Medical Service transported more than 2,000,000 wounded or gassed men. Of these, 900,000 were carried by rail. During the whole of the war, out of a total French wounded of about 3,000,000, more than 1,500,000 went back to the front twice; 300,000 went back four times. Out of every 100 evacuated only 10 died or were invalided out. Of the 90 cured, 60 recovered within one month, and the remainder averaged five months.

Les systèmes fortifiés dans la défense de la France depuis 300 ans, by Commandant Montigny, is the first instalment of a long article giving an outline of the development of French fortification systems during a very crowded period of military history. It is an ambitious project for a review article, but the fresh aspect assumed by fortification on the French frontiers gives the subject a renewed interest.

The first period dealt with is from 1628 to 1642, when Richelieu began to organize the military strength of France. Instead of covering the country with strongholds, Richelieu, with De Ville (1596-1657), Errard and Pagan, set about limiting the fortified towns to those on or near the frontiers or on the principal communications. In these fortresses, garrisons would be economized, and stores and food collected. Defence, in fact, became a national system.

Next comes an account of Vauban's work, from 1670 to 1707. Vauban carried the economy of military force still further, by creating "camps retranchés" alongside his fortresses. These entrenched camps were under the protection of the fortress armament, and were intended to protect parts of the field army, and enable them to sally forth against the invader, or to provide winter quarters where stores, etc., could be replenished. The investment of such places would require large forces, which would diminish the assailant's field army.

As a result of Vauban's work, the northern frontier of France was guarded by a double line of forts, from the coast at Dunkerque to the Meuse at Charleville. In the front line were the familiar names of Furnes, Ypres, Menin, Lille, Condé, Maubeuge, Valenciennes and Dinant; while in the second line were Gravelines, St. Omer, Aire, Béthune, Arras, Douai, Cambrai, Landrécies, Rocroi and Charleville.

But Vauban never pretended that his forts could close a frontier. They were supports to enable an inferior force to resist a superior one, to hinder an invader, and give opportunities for his discomfiture while advancing. Although he effected many economies, there was still a force of 150,000 men absorbed in garrisons when Vauban died (1703).

The mutual support shared by fortresses and field armies continued to develop during the interval from Vauban to Napoleon. Many generals achieved reputations during this period by slowly and methodically laying siege to fortresses and creating

a sort of chess-board strategy by move and counter-move, conducted by both sides with an excess of polite manœuvre.

Then came the Napoleonic period, when the necessities of the Dictator drove him to wage eternal wars in far-off theatres, to defend ever-expanding frontiers; a period in which anything like permanence in frontier-fortification was out of the question. With Napoleon, the home frontiers were no longer threatened; he carried the war into the enemy's country. He had no need to spend vast sums on fortifications.

After the Napoleonic wars, there followed a period of retrenchment, but the weakened state of France called for the consideration once more of frontier defence, and under the guidance of Marescot, President of the Committee of Defence, advised by the Engineer Maureillan (1772-1829), the whole scheme of fortification was revised. Maureillan made a very thorough study of the problems, but his proposals were not published. The author of the article under review has given a summary of his projects. Briefly, Maureillan, recognizing that France must, for the time being at least, act on the defensive, proposed "fortress systems" which would shelter large field armies, and provide obstacles to the invader. The defending army must have a central position organized for defence, covering its arsenals and depots. Here was still the old idea of attaching field armies to fortresses, but with the improvement that the fortresses were not single localities but "systems," carefully chosen with regard to natural obstacles, lines of communication, etc.

Maureillan made full use of the natural obstacles, such as the Rhine, the Moselle and the Meuse, with the forests which separated them. He proposed 3 armies for the defence of the north-eastern frontier: the Army of Flanders, from the sea to the Meuse, the Army of the Centre, between Mezieres and the Moselle, the Army of Alsace, between the Moselle and the Rhine, on the crest of the Vosges. These armies were to stand on the defensive until the enemy had disclosed his intentions. There were only two routes of invasion: Sedan–Rheims–Château-Thierry, and Chimay–Hirson–Vervins–Soissons. The project worked out a complete plan of concentration and initial operations.

These plans were the forerunners of those of General Séré de Rivières in 1873. They showed a fine combination between permanent fortification and the elasticity which must be left to the field army.

Contemporary with Maureillan came Rogniat, another celebrated engineer, who published *Considerations sur l'Art de la Guerre* in 1816. Napoleon did not think much of him, but Brialmont apparently did. He sought to reduce the number of frontier fortresses, and substitute for these a few "entrenched camps" at intervals of 60 or 80 kilometres. The entrenched camps were to have a central fort or citadel, and an enceinte of other forts about 4 to 6 kilometres diameter, and about 3 kilometres from the centre. There was to be a line of such camps along the frontier, supported by a similar line about 80 kilometres in rear, and isolated forts on the principal mountain passes and on the routes through the forests.

Rogniat, some years later, modified his system. However unsuitable such a system appears to be, it must be remembered that the probable enemy forces likely to invade France at that time were inconsiderable, and their leaders were imbued with much the same ideas. It all seems to show how much in advance of his time Napoleon was.

A strong Committee of Defence, of which Maureillan was the most earnest member, and which included Marshals Gouvion St. Cyr, Nugues and Pelet, worked at the problem in 1818–1819 and drew up a report, but for want of money their recommendations remained a dead letter.

Further proposals in 1867—when the Prussian menace was becoming acute—were made by Marshal Niel and a Committee of Engineers, but again very little was done, and when the Prussian invasion of 1870 took place the existing French fortresses had fallen into bad order, and no plan existed for the fulfilment of their purposes. The fortified camp of Metz sheltered Bazaine and his 180,000 men for ten weeks, but three

months sufficed for the destruction of the French regular army. Belfort, held by a Colonel of Engineers, was the only fortress which held out to the end.

The *débâcle* of 1870–71 put permanent fortification into universal disfavour; the system of entrenched camps in particular was denounced. The tools were blamed to excuse the workmen. Fortresses were looked upon as traps into which weak generals were enticed, and field armies absorbed. The value of fortification had been misunderstood. During the long period from 1818 to 1870 the recommendations of the engineers had been pigeonholed. All the changes and developments of artillery—greater ranges, greater power, high-angle fire, increase of ammunition supply due to the growth of railways—had been allowed to pass without corresponding development in counter-measures.

The author closes this instalment with an analysis of the causes of the failure of entrenched camps in 1870.

Liaison des Armes: *La Liaison Intellectuelle*, by Lieut.-Colonel Aubert, deals with a theme well worn but none the less important. He emphasizes the necessity for a much more thorough understanding of each other's work by the officers of the different arms. The liaison between infantry and artillery is still insufficiently close, he says, and not much is known about the rôle of engineers. Service in the French Army is so short that there is little time for practice in the close co-operation of the different arms, and for want of money there is too little manœuvring with troops and consequent practice for the Staff. Staff officers who spend their lives in staff billets are numerous in the French Army as well as in others; and it would be well if the principle—too often a dead letter—were revived of returning them to their regiments occasionally. This closer liaison, the author urges, is of supreme importance. The complications of modern warfare require a much readier comprehension of the capabilities of the component parts, and now that combatants may no longer see each other until the actual assault and the supporting artillery cannot see their own infantry, swift action—born of intimate knowledge of each other's work—is more than ever imperative.

The various methods by which this mutual comprehension can be fostered are examined by the author; the difficulties of practising them are familiar to us all. He suggests that little brochures describing for each arm what it should know of the others, with concrete cases worked out with actual orders, might be issued officially, instead of being left to private enterprise.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*August*, 1935.)—1. *Les fêtes du centenaire à l'École Militaire. Mémento des fêtes du Centenaire* (*30 juin au 7 juillet* 1935).

The whole of this number is devoted to an account of the celebration of the centenary of the Military School at Brussels. The King and Queen of the Belgians and the Count of Flanders visited the School on the 4th July, and reviewed the cadets. A detailed account is given of the proceedings, and the speeches of Lieut.-General Neef (the Commandant), H.M. the King, the Minister of National Defence, and others, are given in full.

Delegations attended the festivities from the R.M.A., Woolwich, the R.M.C., Sandhurst, the three French military schools and the Dutch Military Academy at Breda. Several photographs illustrate the proceedings.

(*September*, 1935.)—This number contains a portrait and an "In Memoriam" notice of the late Queen Astrid.

1. *Les origines de la vélocipédie militaire en Belgique.*

Captain Corvilain gives an account of the introduction of cyclist troops in the Belgian Army. When the modern bicycle first came into general use, there was great opposition to its adoption in the army. That this opposition was eventually

overcome is due to the strenuous efforts of a lieutenant of Carabiniers, Gaston Beirlaen, who edited a paper: *La Pédale Militaire.* He eventually became the first president of the "Touring-Club de Belgique."

For six years Lieut. Beirlaen encountered opposition and ridicule. It was not until the grand manœuvres of 1896 that he was permitted to raise a provisional cyclist company, and allowed six days in which to train it. The value of this company was, however, so marked, that cyclist companies were subsequently introduced into the army.

The services that cyclist companies afterwards rendered during the Great War were invaluable.

2. *Un exercice de compagnie en garnison.* By Major X.

A tactical scheme in wooded country.

3. *Quelques enseignements d'ordre technique tirés de passages de rivières executés par l'armée allemande dans la guerre mondiale.* By Major-General Piérard.

This is a brief review of two recent German publications on river crossings, one by General Königsdorfer (which was reviewed in *The R.E. Journal* for March, 1935), the other by Major von Bose. The writer considers the former to be of greater interest, as it deals with eight separate river crossings executed in mobile warfare. Major von Bose only describes two river crossings: that of the Save in October, 1915, and that of the Danube in November, 1916.

The main points brought out in General Königsdorfer's book are the insufficiency of divisional and corps bridging equipment, as well as of pioneers. For a preliminary crossing it is advisable to make use of assault bridges, as well as of boats or rafts. Once the enemy has discovered the site of a bridge, it becomes useless, and troops must be ferried across under cover. Floating bridges are only intended for temporary use, and must be replaced by pile bridges, which are less vulnerable.

Major von Bose's book confirms these opinions. In the examples that he quotes, the Save (which flows into the Danube at Belgrade) was 750 m. wide, the Danube was 1,000 m. wide. Both crossings were carried out in circumstances that appeared insurmountable. On the Danube there was an intense and persistent fog, which rendered all artillery and aviation work useless: on the Save the approaches were as bad as they could be, the darkness was intense, there was a strong current, and the passage was begun in torrential rain. And yet both crossings succeeded, owing to careful preparation and a strict maintenance of secrecy. The main points that Major von Bose brings out are: a feint to deceive the enemy as to the intended point of crossing, the necessity for communication between bank and bank (by submarine cable or radio), the desirability of providing a compass in each boat (some of the boats lost their direction in the fog), and a well-controlled regulation of all traffic converging on the bridge.

(*October*, 1935.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914-18. By Lieut.-Colonel Brabant.

This is an account of the part taken by the 1/13th battalion in the recapture and defence of Keyem, on the Yser River, on the 18th and 19th October, 1914. This exploit was carried out in spite of heavy losses, and, although the Belgians eventually had to retire and Keyem fell into German hands, the enemy's advance across the Yser was delayed.

2. *Le roi Albert Ier et l'infanterie belge.*

An address delivered by General Weygand at Brussels on the 1st May. It is an appreciation of the part taken in the Great War by the Belgian Army under its King and Commander-in-Chief, by a distinguished French officer.

Long before the war broke out, King Albert knew it was coming, and knew of the Schlieffen plan to invade France through Belgium. During a visit to Potsdam in 1913, both the Kaiser and von Moltke assured him that war with France was imminent, and he was faced with the alternative of becoming an accomplice or an enemy of

Germany. It was then that he made up his mind which course he would take. The rest of the story of King Albert at the head of his army is a matter of history.

3. *Liaison et observation de l'appui direct dans l'attaque.*

The continuity of liaison and of observation of direct support during an attack in progress is a delicate question. In this article Lieut.-Colonel Melen endeavours to find a solution to the problem.

4. *Quelques idées sur la guerre de demain.*

Captain Defraiteur gives us his views, mainly gleaned from German sources, of what a future war will be like. A slow, protracted war, that exhausts both conquerors and conquered, is to be avoided at all costs. The question is one of gaining a crushing victory by brutal, rapid, and sudden aggression.

The situation has changed since 1914. It took time to manœuvre the huge armies that formed the peace strength of continental nations. All frontiers are now solid fortified walls, against which a frontal attack must be made. It would be a waste of time to attempt to turn their flank.

A proposal made in the *Militär Wochenblatt* for March, 1935, is that the German Army should consist of three parts :—

(1) Attack troops for piercing the enemy's front, consisting of armoured cars, tanks and a powerful air force.

(2) Mobile troops, consisting of divisions carried in lorries, together with armoured cars capable of travelling across country.

(3) Defence troops, consisting of divisions of the old pattern.

5. *L'origine du relief de la Belgique.*

A lecture by Professor Stevens on the geological history of Belgium. It is believed that the Icenian Sea, which formerly covered the country, retreated about 600,000 years ago. During these 600,000 years there have been four glacial periods, with long, warmer, periods intervening. The present sea coast is of recent origin. About 20,000 years ago the southern boundary of the North Sea was near the Dogger Bank, approximately at the latitude of the northern point of Denmark, and England was joined to the Continent. In more recent geological times the Straits of Dover were pierced, and the subsidence of Zeeland set in, with a corresponding subsidence of the Thames basin. The subsidence of Zeeland is continuing at the rate of 22 to 60 centimetres per century, and a similar subsidence is taking part in the Lower Scheldt.

6. *Les pertes allemandes pendant la guerre* 1914-18.

Commandant Jeannest has collected from German official sources a list of German casualties during the war. The German statistics do not go beyond the 31st July, 1918. The total number of men killed, and those who have died of wounds or disease in the army, navy, and colonial forces, amounted to 2,036,897. The statement gives details of the number of prisoners, wounded, and sick, the nature of wounds and of diseases, the proportion of men gassed, etc.

A.S.H.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*June*, 1935.)—*The Development of our Battle-procedure from the Beginning of the Great War up to the Present*, by Major-General Pitreich. This first instalment deals with the principles upon which the fighting methods of the Austro-Hungarian army were based at the outbreak of the Great War, and consists hence mainly of extracts from the *F.S. Regulations* of that time, and comments thereon. In 1914 the Austrians were at a disadvantage compared with their opponents, the Russians and the Serbians, both of whom had experience of modern warfare. It is true that an Austro-Hungarian attaché in the Russo-Japanese war, Colonel Csicserics, had given full warning of the great extensions of the modern battle both in space and time, and of all the consequences to be deduced therefrom, but these teachings were generally disregarded as not applying to Europe. Consequently the Austrians, trained for war in 1914, as the Prussians had been in 1870, on the principle of getting forward at all

costs, had to learn by painful experience what their *F.S. Regulations* had failed to take account of, and what Russians and Serbians alike had learnt at first-hand. The attack was still, as it will be for all time, that which brings about the decision, but the manner of carrying it out had changed. The very encounter-battle, upon which the Austrians' training had been mostly concentrated, did not go according to their rules for after clearing away the enemy's covering troops they invariably found him entrenched.—(*To be continued.*)

On the Use of Artillery and its Methods of Procedure in Mobile Warfare. Major Zuber analyses the new factors in warfare and their probable effect upon the conduct of operations. Taking this as a starting-point he works out how the artillery will attempt in future to carry out its various tasks.

Thoughts on Umpiring. Major-General Materna concludes his article, the object of which was to tackle the solution of the many-sided tasks of umpiring, and to stimulate the extension of a subject which is necessary, and if well applied can be of great value, to the troops in their preparation for war.

Literature of the Great War, additions during 1934. Dr. Frauenholz continues his lists, notices of which have appeared in *The R.E. Journal* from time to time, viz., in December, 1932, March, 1933 and September, 1934. Of the greatest importance among last year's publications are considered Vols. III and IV of Lloyd George's *War Memoirs*, from which one learns how strong on the side of the Entente was the consciousness of the problem of unity of command, and how " the statesmen strove to maintain in their hands the conduct of the war as a political affair." Other memoirs which have appeared are those of the Hungarian statesmen, Count Apponyi, called *Erlebnisse und Ergebnisse* (Keil, Berlin), and Poincaré's *Neuf années de souvenirs* (Plon, Paris).

Amongst articles the *Berliner Monatshefte* have produced " Sir Henry Wilson and his influence on the British pre-war policy," and the Journal of the German Officers' Association has dealt with *Joffre in the Marne battle* and *In Defence of Colonel Hentsch.*

The German and Austrian Official Histories continue to appear, having reached by the end of 1934 Vol. IX (end of 1915) and Vol. V (end of 1916) respectively.

As, without counting regimental histories, over eighty books and articles are mentioned by Dr. Frauenholz it would seem that the flood of war-literature has not yet started to slack.

The End of the War-year 1916. Under this title Major-General Kerchnawe reviews the third double-number of Vol. V of *Austro-Hungary's Last War*, which completes that volume. It contains the conquest of Wallachia, which the reviewer finds its main interest, and also the account of the 7th to 9th Isonzo battles. There is again a rise in the number of maps issued, and a further increase in statistical matter.

What form will the next War take? General Wiesinger reviews at some length Rocco Moretta's book bearing this title (Rowohlt, Berlin ; price R.M. 3·80), and has gone to the pains of constructing a comparative table of the leading authorities, showing in different columns, name, teaching, form of the army of the future proposed, and special remarks, including role of the land-forces.

Moretta treats his subject under three heads :—(1) The new teachings. This is sub-divided into (*a*) The Revolutionaries or Enthusiasts for Material, and (*b*) The Evolutionists. Under (*a*) are grouped : General Douhet, as representative of the idea that the air-forces will be the principal instrument of future war ; the chemical warfare enthusiasts ; and the complete mechanization of General Fuller, the leader of the " Young-English " school.

Under (*b*), the Evolutionists, are considered : the idea of political and military surprise, the latter being carried out by a strong and very mobile peace army, of which idea the exponent is Major Guadagnini : the motorization of land-forces, of which General Cramon and General Allêhaut may be taken as the representatives ; and " total " or " three-dimensional " war, as foreseen by the evolutionary schools and official continental teachings.

The exposition of the new teachings given by Moretta under the six sub-heads mentioned does not exhaust the subject, as there is a notable omission. In Germany there was no doctrine of future warfare as expounded by the Young-Italian and Young-English schools, when General von Seeckt formulated his ideas in 1928 in his *Thoughts of a Soldier* (Verlag für Kulturpolitik, Berlin), which ideas are here accepted as the representative German view. Very shortly, war will continue to be a land and sea affair. On land all indications, material, financial, and the necessity of mobility and power of manœuvre, point to the small specially-equipped and highly-trained professional army, kept in peace-time at concert pitch. This covering or operations-army will have to struggle for the first decision, while behind it a "military mass" provides for home-defence and furnishes reinforcements to the operations-army.

The second head is called "Probability *versus* Dogma," and it is in this portion of the book that the new teachings are criticized. Under the third head is the summing up: the deciding factors of the fight are movement and manœuvre: the source of success is the unchangeable application of the fundamental principles which govern the conduct of war; the nature of war is determined by weapons and means: the ideas of numbers and power of performance are not opposed, but interdependent: the present state of armaments in Europe indicates that there will be a co-operation of land, sea and air forces: the dominating element will be the land force, the sea and air forces being valuable auxiliaries: within the land force man remains the deciding factor, above all the infantry soldier: numbers retain their significance. The war of the future will be a scientific war, a war of all weapons, a war of material, but for every technical means of attack a technical means of defence has always been found. The one thing unconquerable remains the spirit of man.

(*July*, 1935.)—*The Development of Tactics in the Austrian Army from* 1914 *to the Present Day*. In this continuation Major-General von Pitreich deals with (1) the influence of artillery upon methods of attack, and (2) methods of defence and position-warfare. He points out the causes in the Great War which contributed to a complete change in the character of the fight, and shows how the artillery rose to be a chief bearer of the fire-fight. It had on the one side to batter down the defence, and on the other side to prevent this from happening by counter-battery work. The break-through battle of Gorlice is then described in some detail as being the origin of all later battle-procedure, not only in battles of this nature, but also generally in position warfare and in mobile warfare. At Gorlice in May, 1915, it is claimed that for the first time overwhelming artillery fire completely overcame the resistance of the defence, before the attacking infantry started to storm.

In (2) General Pitreich points out that it was not position warfare as such which was responsible for the long duration of the Great War, but the long-enduring equality in strength of the opposing forces. He runs over line defence, infantry and artillery co-operation in defence, the eclipse of the rifle in defence by the machine-gun, and defence by distribution in depth.

General von Linsingen. This officer's career started brilliantly with the Franco-Prussian war, in which, at the age of 20, he won the Iron Cross for capturing two French guns. Almost a lifetime later his great hour struck in the battle of the Marne, when, after Manoury's success against the German right, the German II Corps was disengaged from the British and withdrawn to the Ourcq to guard the German flank and rear with other bodies. Linsingen, to whom the command there was at first entrusted, contributed essentially to the German success at this point of the battle-field. The remainder of this short notice deals with General von Linsingen's activities in the Great War, lasting nearly three years, during which he was either co-operating with or commanding Austro-Hungarian troops on the Russian frontier. In January, 1915, he was appointed to command the German South Army, and with his Chief of the Staff, Ludendorff, was instrumental in inducing Falkenhayn to agree to Conrad's proposal for the employment of the German troops it contained

in the inhospitable terrain of the Carpathians. The Austrians appear to have found him none too easy to get on with in the trying circumstances and forced inactivity of that severe winter in the mountains. The attempt to relieve Przemysl failed, but Mackensen's great effort in May brought about a general advance. In September von Linsingen was promoted to the command of a Group of Armies, and drove the Russians back, but without reaching his objective, Rovno. Brussilow's offensive in the spring of 1916 he managed to survive with the loss only of his Chief of the Staff. His last enterprise was the invasion of the Ukraine in February, 1918, and defeat of the Bolsheviks, when German troops reached the Crimea, and even the Caucasus. In April, 1918, he became Commander-in-Chief in the Marches and Governor of Berlin. When the revolution broke out in the autumn the War Ministry intervened to stop General von Linsingen from using aeroplanes against the insurgents. He promptly resigned as a protest against "this unwarrantable interference with his authority."

British Views on the Fight, by General von Eimannsberger. Under this title the late Inspector of Artillery in the Austrian Army examines and discusses Colonel Macready's lecture at the Royal United Service Institution last November (*vide The R.U.S.I. Journal*, February, 1935) on "The Trend of Organization in the Army," the importance of which is to be judged by the fact that the C.I.G.S. was in the chair. The lecture gained in interest as well as importance because Colonel Macready in stating facts gave the reasons for the various W.O. decisions, thus letting his audience behind the scenes in a happy combination of caution with indiscretion. General von Eimannsberger finds that the War Office has been true to its task of organizing the British Army with regard to imperial needs, the protection of the colonies and trade-routes. Incidentally he is kind enough to say that official views in the British Army gain in importance for foreign readers as emanating from a professional army which shares the responsibility of keeping a world-empire in order, and which in the Great War fulfilled with honour a rôle for which it was never created.

In order to throw further light on the subject the writer then examines it from another, and unofficial, standpoint, viz., that of General Fuller, as expressed in his *The Army*, 1910-1935. He points out how the W.O. is cramped in possible further mechanization along General Fuller's lines by the permanence of the Army's imperial duties. Nevertheless, as might reasonably be expected of the author of *Tank Warfare*, he finds no difficulty in following General Fuller in predicting in England at no very distant date the existence of armoured formations higher than the tank brigade, on the grounds that there are strategic tasks too great for a mobile division, containing a single tank brigade, and which only a tank division could fulfil.

The 1935 German Defence Law, by Field-Marshal Schäfer. On the 21st May the new Defence Law was published and came at once into force. It maintains the existing ministry for the army and the navy, but extends it to include also the air force. At the same time its name is changed from National Defence Ministry to National War Ministry. A general obligation is introduced to serve in the national forces, but for the fleet-personnel of the navy and for the flying-personnel of the air force voluntary long service is retained. In peace this obligation to serve lasts from the age of 18 to the age of 45. "In war every German man and every German woman is obliged to serve the Fatherland." Every spring all men in their 21st year will be called up either for one year's active service or for passing, after probably eight weeks' training, into the Auxiliary Reserve. Up to their 21st year men will not be called up for military service, but only, in accordance with a Law not yet issued, for National Labour service. Those serving their one year in the army may be permitted to volunteer for a second year, and N.C.O's will generally serve 12 years. The one year of actual service applies also to all fortress and harbour personnel of the navy, and to all ground personnel, signals and A.A. artillery of the air force. After their one year of service all men pass into the Reserve, where they remain from 22 to 35. From 36 to 45 they remain in the Landwehr and at 46 they pass into the

Landsturm. Those in the Reserve, *i.e.*, those who have done their year with the colours, those in the Auxiliary Reserve, *i.e.*, those who have served for eight weeks instead of one year, and those in the Landwehr, *i.e.*, those who have finished their time in either of the Reserves, are all classed together as belonging to the Army, but on the Furlough List. The Landsturm are not included.

The writer now attempts to assess how the re-introduction of conscription in Germany will work out as regards the strength of the German Army. The first class to be taken for a full year's training consists of those who were born in 1914. Those who are already 22 are exempt from this, but they and the other classes back to those born in 1910 will do eight weeks' training and be passed into the Auxiliary Reserve.

Assuming that 300,000 recruits are required every year for the army after the needs of the navy and air force have been satisfied, by the end of 1939 Germany will possess over a million fully-trained men, *viz.*, the classes of 1934-5-6-7. It will, however, have at that time no other fully-trained soldiers to call upon except the veterans of the Great War, who will be at least 42 years of age and finishing their time in the Landwehr, while the majority of them have already passed into the Landsturm. In the German field army the fourteen non-conscription years which have passed since the Treaty of Versailles have caused a deficiency in trained soldiers of over four million men. This army of untrained men causes at present a deficiency in the Reserves, which will pass later to the Landwehr. Only when these fourteen untrained classes have disappeared into the Landsturm will the German field army reach its full strength, so as to be comparable in numbers with the armies of the "conqueror" nations. This will happen forty-five years after the last class (the 1909 class) which has just escaped conscription, viz., in 1954, which will therefore be a remarkable year. Thus the effect of the Treaty of Versailles on the strength of the German field army will be felt for the next twenty years, and during that time of development a strong protective air force is indispensable.

The International Political Situation and Armament Question. The first six months of 1935 were so particularly full of events of international importance, and the tempo generally has been so much quickened up, that General Paschek has been constrained to bring out a half-yearly instalment instead of waiting for his annual review in December. The political events of six months thus collected, condensed and collated make thrilling reading. It would be a mistake to judge of the accuracy of compilation by the author's persistent references to Lord Simon, Lord Eden and Lord Baldwin.

(*August*, 1935.)—This number starts with a portrait and an obituary notice of General Baron Arz, Austro-Hungary's last Chief of the General Staff. There are in what is now a part of Rumania, but before 1919 was a part of Hungary, a number of German enclaves or areas in which the population is predominantly of German descent. In one of these, in Hermannstadt, lived the family of the man on whose shoulders was to descend in March, 1917, the mantle of a very great soldier, Conrad von Hötzendorf. In 1876 Arthur Arz, a student of law, decided during his year of military service to become a professional soldier. He joined a rifle battalion, passed the Staff College eleven years later, and was always a brilliant officer. At the War Office he was credited with the faculty of "always being able to put his hand on the right man." In 1908 he became a major-general, and completed his time in command of a division before the war broke out. From the W.O. he volunteered for the front, and was lucky enough to get his own old division, the 15th. Successful as his career had been up to 1914, it was only when he came to command in the field that he showed his greatest powers. He was extraordinarily quick in the uptake, bold, decided, and never got rattled. With his division in Galicia, then with the VIth Corps at Limanova, at Gorlice, at the capture of Brest-Litovsk, and later holding up against Brussilow, everywhere he put up a good show. In August, 1916, he was sent to defend his home, Siebenbürgen, against the Rumanians. This he did against odds of 10 to 1 until the arrival of the 9th German Army permitted the counterstroke. As C.G.S.

General Arz was responsible for the Isonzo offensive which resulted in the great victory of Caporetto. In June, 1918, he had his first failure in the Austrian offensive across the Piave, which had to be called off after six days, but retained his post till the Armistice, the Emperor judging correctly that the army had been tried beyond its strength. It was not among the least of General Arz's qualities that he was always able to get on with his allies. Here in addition to a naturally kind disposition he had two assets, he had been at school in Germany, and his home was in Hungary.

The Development of Tactics in the Austrian Army from 1914 to the Present Day (continued). General Pitreich deals this month with distribution in depth, its effect upon infantry methods in defence and upon the attacking infantry, remarks on artillery and aircraft, and the "material" battle.

An Example of Cavalry Charging Infantry in the Great War. Capt. Scheff describes how in October, 1914, a squadron of the 6th Austrian Dragoons, 90 strong, acting as an advanced guard, charged two Russian companies on the march, heading them off from a bridge they intended to cross, and took 270 prisoners. The squadron had five casualties, and the whole show was over in three minutes from the first view.

The Progress of Mechanization. An authorized free translation of an article by R. Icks which appeared in *Army Ordnance* (May/June, 1934), and deals with each country separately. Good photographs show: French Citroen-Kégresse semi-track m.g. carrier, Russian light tanks, Mark I, II and III, light Lanchester armoured-car for British cavalry, British light tank Mark II A, Carden Loyd light tank Mark VI B, Fiat light tank, and the Japanese medium Osaka tank. There is a side elevation of the Swedish medium Landskrona, and a table of data of the 30 most important tanks now in use.

Tactical Exercise No. 2. Colonel Zellner deals with the preparation of a systematic attack by a strengthened infantry brigade, with attached artillery and tanks, on a fortified position in mobile warfare.

Alternative Weapons for Infantry. Colonel Rendulic intends this article to act as provocative. His argument runs:—Inasmuch as in the attack infantry have chiefly to deal with concealed stationary targets and the destruction of artificial cover and obstacles, while in the defence they have to deal with advancing and unconcealed targets, it is clear that the individual weapons for the two tasks must have different properties. The multiplicity of present-day infantry armament is therefore certainly justified, but for obvious reasons it must be kept down as low as possible. All nations are striving to give their infantry the weapons they need—for the attack, infantry guns, trench-mortars, grenade catapults, automatic pistols; for the defence, anti-tank guns, anti-tank rifles, heavy m.g's. To the question as to whether the infantry to-day are adequately equipped for their tasks we must answer that in defence they will be so as soon as the anti-tank question has been satisfactorily solved, but as regards the attack the answer is "Certainly not." The reason for this is that the infantry's chief weapon up to now, the machine-gun, develops its real strength in the defence. Hence attacking infantry have nothing equally powerful with which to oppose the defenders' most effective weapon. The attack cannot hope to even things out by putting in a superior number of m.g's, because, where a weapon is little suited to a task, increasing its numbers is a very uncertain way of improving matters. On the other hand the trench-mortar and the grenade catapult are most effective in the attack, and are to be regarded as the infantry's attacking weapons *par excellence*. The most radical remedy is to abolish the usual line of cleavage between infantry and artillery and to create units having the weapons of both. As a matter of organization this is not too difficult, but tactically there are grave objections, and also especially from a training point of view. The infantry gun is a special weapon for use against visible targets, and with only small effect against targets under cover. The trench-mortar, on the other hand, can do in the attack almost all, and in many respects considerably more than what we use the infantry gun for, and has

not its disadvantages. Hence, it is not the infantry gun, but the trench-mortar, which should be considered as the coming weapon for the increase of the power of attacking infantry. Moreover, it is of special importance that the T.M., being very simple, can be taught in a very short time to men trained in the heavy machine-gun. The same personnel should be trained in both heavy machine-gun and trench-mortar, and armed with both weapons respectively for defence and attack.

Towards Scientific War-history. Under this title Colonel Heller mentions first the introduction of lectures on military subjects at Vienna University. The real object of these lectures is not the imparting of patriotic and national defence views; they are intended rather to serve science itself, and to bring about better results of historical research and studies than has hitherto been possible, when army officers have too often been lacking in sufficient schooling, while professors have lacked practical knowledge of military matters. Secondly, the writer refers shortly to the contents of two recent books, which should serve the same purpose. They are von Frauenholz's *The Armies of Early Germanic Days, of the Empire of the Franks, and of the Age of Chivalry*, which is Vol. I of *The History of the Development of the German Army*; published by Beck, Munich; price 16 marks; and Ritter's *Politics and the Conduct of War, their Mastery as Exemplified by Prince Eugene*; Junker and Dünnhaupt, Berlin; price 8 marks. In the latter work the author points out the many difficulties of all sorts which Eugene overcame, in order to strengthen his thesis, which is that the peculiar cleft between politics and the conduct of war can be bridged by no arrangement according to scheme, but only by a personality, who is both statesman and general.

River-crossings in the Great War. General Knaus reviews *Flussübergänge im Weltkriege*, by the late Major von Bose, being No. 7 of the series *Tactical Experiences*, 1914-18, published by Mittler and Son, Berlin; price 4 marks 50; and praises the book highly, especially the author's fanatical desire for truth, which keeps him from benevolent silence and from beautifying. Strictly the title is misleading, since the work deals not with river-crossings in the Great War in general, but with two crossings in particular. They are the crossing of the Save near Belgrade by the German XXII Reserve Corps early in October, 1915, in which Major Bose took part, and the famous crossing of the Danube by Germans, Austro-Hungarians, Bulgars and Turks at Svistov in November, 1916, which turned the Rumanian left. General Knaus recommends the book most heartily for the instruction it contains.

(*September*, 1935).—An *In Memoriam* to Conrad von Hötzendorf on the tenth anniversary of his death, 25th August, 1925, places him not only amongst the greatest generals of the war, which will be readily admitted, but first of them all. The latter claim would certainly not be admitted by Germans, let alone by Frenchmen. And yet over and above his great qualities as a leader, and what he did, there are two things which distinguish Conrad from the rest. No other leader had so constantly to struggle against odds and misfortune "with nerve unshaken and undismayed." No one could have inspired more confidence than he did, or been more successful in keeping up the home morale, even in disaster.

Twenty Years Ago, a Strategic Study of the War against Serbia, 1914-5. The popular idea in Austria during the war, and even after it, of the Austro-Hungarian offensive against Serbia in 1914 was that it was a failure; and three hardly contestable facts were adduced in support of that belief: (1) that the campaign, after initial disappointments, promised a great success, but ended in an annihilating defeat, (2) that the Austro-Hungarian losses, especially in prisoners, far exceeded those of the Serbs, and (3) that, on account of the foregoing, the prestige of the monarchy, its army and leadership, suffered heavy loss.

Colonel von Wittich points out that twenty years later we have got a better perspective and understanding, and he pursues the thesis he has already presented elsewhere (*Oesterreichische Wehrzeitung*, 24th and 31st January, 1930) and produces in support of it fresh evidence to show (1) that the campaign of 1914 was a Pyrrhic

victory for the Serbians, inasmuch as (2) the victorious second campaign against Serbia in 1915 was based upon the results of the first, and was really the harvest of the seed sown thereby, and (3) that General Potiorek's leadership is not to be judged from the catastrophe of December, 1914, alone, and that the majority of the Austro-Hungarian troops, like many of the Serbs, put up quite splendid performances.

Tank Troops in the Framework of an Operation by an Army. Lieut. Field-Marshal Schäfer welcomes a series of articles entitled *Emploi des Chars Renault T.F., étude d'un cas concret*, by Lieut.-Colonel Michoux in the *Revue d'Infanterie*, April, 1935, as presenting to Austrian readers, who possess no tanks and want to know about them, a chance of getting an insight into French ideas on their use. The object of the original series was to give infantry officers a picture of the whole problem, too seldom studied, of the incorporation, distribution and action of tanks on a large scale.

The tank in question appears from Heigl's *Pocket-book* to be the Renault M.17.F.T. It is full track, male or female, carries two men, weighs 6·7 tons, and travels 5 m.p.h. Tanks being General Reserve troops in France, they have to be allotted to Armies. In this exercise the allotment to the 10th Army, consisting of 3 Corps of 4 Divisions each, is 4 Tank Bde. H.Q., 8 battalions of tanks, each consisting of Staff, H.Q. Coy. and 3 tank coys. of 15 tanks each; 2 transport coys., comprising 120 tank-transport lorries and 40 light lorries; and 1 Tank Park. The tanks will travel generally by night. Their nightly performance (the exercise starts on June 1st) will be taken as 45 km. on transport, 15 to 20 km. self-propelled.—(*To be continued.*)

The Development of Tactics in the Austrian Army from 1914 to the Present Day. Major-General Pitreich deals this month with the possibilities of avoiding position warfare, with post-war development of aircraft, with tanks—including a short account of Cambrai—and with gas. The whole furnishes an outline of post-war tendencies in the conduct of war and of the fight.—(*To be concluded.*)

The Design and Proving of New Guns. Major-General Rieder lays down: For the design of a new gun generally, 6 to 8 weeks; for checking the same (unless much alteration is required), 6 to 8 weeks; for detailing the project, 2 to 3 months; for the construction of one or more trial guns, and of the ammunition, 2 to 3 months; for tests and trials (under favourable circumstances, *i.e.*, if the season is suitable, and nothing goes wrong), 1 year; for preparation for and trial by the troops, 6 months. Total minimum time, 2 years. Whenever this minimum time could not be allowed, as happened with certain guns owing to the pressing demands of war, the same has generally had to be paid for by faults and drawbacks, which have become evident later, and which have had then either to be put up with, or with great difficulty remedied. For comparison with his figures the writer then gives some times of actual guns from inception to issue: the 7·5 cm. mountain-gun M 15, 9 years; the 10 cm. and 15 cm. field howitzers, 7 years; and the 10·4 cm. gun, 12 years. These are all Austrian guns, but other countries can corroborate.

The best conditions would occur if the authorities who formulated military demands were so far informed of the existing state of gun-technics, and also of its probable future development, as to put forward demands neither too modest nor unreasonably high and incapable of solution, and if the technical experts had at their disposal sufficiently wide military understanding to enter into the army's needs, necessities and limitations. The greatest failures have to be recorded under this head. Although the United States possessed a highly developed industry it could not produce the guns for its army in Europe. Although the Westerveldt Commission toured the victor-states after the war, to collect experience to guide design and manufacture, the American gun-makers have been unable to conform with many of their specifications. Although Hauszner had in 1891 applied the hydraulic brake to barrel-recoil so as to keep the carriage of a field-gun steady, the whole of the German field artillery was re-armed with a new gun in 1896 on the old principle.

The remaining articles in this number are:—The continuation of Colonel Zellner's Tactical Exercise No. 2; the prize essay on "The Training of those who have matricu-

lated to become Section-commanders," *i.e.*, referring to a peculiarity of certain countries having conscription, that only a single year of service is required of university students, and others who have passed matriculation as a sort of school leaving certificate; *Publications by and Concerning Marshal Pilsudski*, in which Colonel Wittich recommends, as giving the best picture of that interesting, and by no means popularly understood, figure, "the creator of modern Poland," Dr. Loessner's "Josef Pilsudski," and Koitz's "Gesetz und Ehre," both of which quote Pilsudski himself freely, and, of quite another sort, a pamphlet "Biography of Pilsudski," by von Oertzen; *The Commencement of the War-Year* 1917, a review of the first double number of Vol. VI of "Austro-Hungary's Last War"; and *The Character of the next War according to Soviet Russia*, the *résumé* of an article in the Russian magazine *War and Revolution*, October, 1934, from which it appears that there are Russians who expect a war against the capitalistic nations, and that in that war the latter will be hampered by revolutions at home. To encourage these revolutions Soviet Russia must strike early and powerful blows (by aeroplane and tank-raid), comforted by the thought that *no* foreign power can operate against Russia's political and economic centres so effectively as the other way about.

F.A.I.

WEHRTECHNISCHE MONATSHEFTE (formerly *Wehr und Waffen*).

(*July*, 1935.)—*The Disaster by accidental Explosion at Reinsdorf, and its Lessons*, by Lieut.-Colonel Justrow. The chief lesson of the recent disaster at Reinsdorf seems to be, as in very many cases of accidental explosion, that there can be no certainty as to its cause. When there is nothing left at the point of origin but an enormous crater—and the writer mentions a similar explosion, during the war, at the I.G. Farben Works at Oppau, near Ludwigshafen, as having made a crater over 100 yards across and 16 feet deep—there is likely to be a lack of evidence on the subject. It is then that people begin to talk of sabotage. The possibility of sabotage cannot be always ruled out, but generally the cause lies in some fault, or quite small mistake, in the working procedure, process of manufacture, supervision, or in the fire-fighting arrangements, and "last, not least," owing to workmen through familiarity growing careless, in negligence and under-estimation of the greatness of the danger, and in heedlessness in working with tools and fire. Too great an importance must not be attributed to lightning and other electrical effects, since they are, at any rate in Germany, most efficiently guarded against.

From the characteristic of an explosive, its instability as a chemical compound, arises the first precaution against accidental explosion, viz., the avoidance of everything that may set it off, a slight blow, a small amount of friction, a slight rise of temperature, a tiny flame. The second great precaution deals with localization. It arises from the characteristic of an explosion. When an explosive detonates, two waves of shock are produced, one in the air and one in the earth. The latter, according to the nature of the ground, travels a great deal faster than the air-wave, but the intensity of the air-wave, and hence its destructive effect on buildings, and above all on neighbouring explosives, is much more powerful than that of the earth-wave. The second precaution is, therefore, to control the quantity of explosive which can be detonated at the same time. This control is dual. The amount of explosive produced, in use for filling, etc., or stored, at one spot must be limited; and the distance apart of all explosives must be such that the explosion of one cannot detonate the next. This, then, is a matter for legislation. Many of the formulæ which have been suggested after investigation of the behaviour of detonation-waves, the magnitude of their pressure, and its rate of fall, cannot be regarded as sufficiently reliable, as they to a certain extent contain contradictions. From numerous practical trials a safe distance to guard against detonation purely by air-shock, and apart from all question of flying splinters, may be calculated best by using Lheur's formula,

$$R = k\sqrt{M}$$

where R is the minimum distance in metres, M is the weight of explosive in kilos, and k is a coefficient determined by circumstances. For quantities of explosive, *e.g.*, in manufacture, or loosely stored, or worked up into charges for ammunition, bombs, mines, etc., the value $k = \cdot 5$ will guard against simultaneous detonation by air-shock. The same formula may be used with different values of k to determine degrees of safety of persons and property, apart from the detonation of other explosives. Thus, putting $k = 2 \cdot 5$ will give a formula for determining the nearest distance of storing or handling explosive from a public street. The corresponding distance for a dwelling-house is given by $k = 5$. To guard against slight damage, *e.g.*, the loss of tiles, or the bursting in of a door, put $k = 10$: while $k = 20$ is said to provide safety against flying splinters.

If insufficient attention has hitherto been paid to these matters the editor assures us that in future it will be otherwise, now that there is in Germany "a strong government which subordinates respect for the individual to the good of the whole, and is prepared to undertake thorough measures to that end."

A Comparison of the Chief Methods of Communicating Artillery Information. Major Schneider here discusses the application of field-survey results to gunnery, which is rendered nowadays the more necessary owing to the increased range of modern artillery, and owing to the necessity for surprise concentrations of fire which registration will not permit. Flattering reference is made to an article in the *Schweizer Artillerist* of 15th June, 1935, on the Artillery Intelligence Service.

Experimental and Research Establishments for the Development of National Economic Requirements. Capt. Wesemann, formerly of the F.A. Gunnery School, Jüterbogk, makes out a strong case for governmental experimental and research establishments. In the bad old days research was left to the private industries. Great manufacturing firms, armament and otherwise, found that it paid them to run establishments for many kinds of research, in the interests of future development. As it was a case of all against all, there was much overlapping in research and no co-ordination. Government research establishments will remedy all this. They are the more necessary now that the World War has destroyed the world-trade, and consequently every nation is striving to make itself independent in economics and in manufactures. In all departments new possibilities of raw materials are being opened up in order to provide bread and labour for the unemployed, and to decrease imports. The old liberal idea of buying cheaply abroad is being replaced by the national-socialistic creation of employment at home, which will educate the unemployed instead of ruining them both morally and as craftsmen by giving them the dole.

Two thousand five hundred such establishments have already been created in Germany and are costing yearly in millions of marks (about £80,000):—

for medical research ...	36	for natural science	8·1
for agriculture and forestry	11·8	for psychology	6·6
for technical research ...	5·7.		

The writer pleads for more money for technical research, since it is precisely this branch which is of special importance for the nation's economic future. He would also extend its sphere to include all war material. He considers that the nation's potential to war, apart from military leadership and the armed forces themselves can best be raised by:—

1. The moral education given by military discipline.
2. Weapons of the greatest efficiency.
3. Rapid manufacture through methods of labour of very high technical standard.
4. Preferential use of home raw materials.
5. The development by engineers of new inventions.

Factors 2 to 5 in this list are to be fostered in the government research establishments, the first task of which is, however, to be, to reawaken in engineer circles and

amongst the people their almost completely lost sense of army and armament questions. Capt. Wesemann pleads for a Minister for Technical Research.

Gas-pressure Curves in Rifles as recorded by Oscillatory Measurers. A differential excursion by Messrs. Kutterer and Schwarcz, in which the rifle has been chosen because its rise and fall in pressure is particularly short, viz., from o to over ½ a ton to the square inch in less than 1/160th of a second, and down to ⅛th of a ton to the square inch in the next 1/160th of a second. As all modern measurers of gas-pressure in the barrel are on the oscillating principle, the ballistician will desire to know with what degree of accuracy such apparatus will measure gas-pressure and record its changes, since frequently the result of his investigations has to be taken as decisive for one theory or another.

The joint authors show that if the motion of such an apparatus be represented by

$$m\frac{d^2x}{dt^2} + p\frac{dx}{dt} + Dx = o$$

and its natural period of oscillation and decrement are known, the record of the pressure in the barrel can be arrived at with the greatest accuracy, providing that the natural frequency of the measurer is suitable, *i.e.*, not too small, a diagram showing that a frequency of 1,600 per second, as compared with a frequency of 8,000 per second, can throw out the record of gas-pressure as much as 12½%.

The remaining articles in this number are *The Limits of Photographic Reconnaissance*, the second instalment of *The History of Fire as a Weapon*, *Lloyd George and War-Technics*, *The Numbers of Patents granted Yearly from 1925 to 1934 in the Department of Weapons, Projectiles, and Fortification*, and *Technics in the Service of the People*, under which slogan a very successful exhibition was held at Breslau in June to celebrate the 25th anniversary of the founding of the Technical High School at that place, and which was arranged to fall together with the 73rd General Meeting of the Union of German Engineers.

(*August*, 1935.)—*The Principles of War Economics*, by Dr. Jahn. War economics is a special case of national economics, or, rather it is an intensified case of national economics, when it includes not only the whole economic production of a State, but also the co-operation of all for the satisfaction of the needs of all.

War economics falls clearly under three heads:—

(1) The peace-time national economic preparation for war.
(2) The changing-over from peace to war economics; in other words, the economic mobilization.
(3) National economics during war, or war economics proper.

Considering these, with reference to Germany and the Great War, there is no doubt that the lack of (1) and the planless and extemporized nature of (3) contributed largely to the war's fateful course and its unhappy end. Planning and direction are therefore necessary in future, not only to the fullest extent in war economics, but also, to a great extent, in the peace economics upon which the planning and planned leadership of war economics have to rest. For it is one of the peculiarities of war economics that it is the more effective the less the changes that are necessary to bring it about. The unavoidable rearrangements are in any case large and difficult enough. Since this peace-time planning and control of national economics must be undertaken it might at first appear that the Bolshevik State, which owns and controls all industry within the nation, would be the best for putting it into effect. Practically, however, the best foundation for war economics is the national economic scheme of the National-Socialist State, because its thorough scientific penetration permits it to comprehend and control production without throttling healthy competition, and because it recognizes that an exclusively authoritative control is incapable under modern conditions of maintaining the standard of performance. No degree of State supervision can replace the attention of the private industrialist, responsible to himself and bent on success.

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Dr. Jahn makes out a strong case against war loans, and insists that the nation at war must pay its extra expenses by means of taxation.

The High-Speed Diesel Engine in the British Army. The writer discusses Capt. Blagden's article in *The R.E. Journal*, December, 1934, and finds that the case made out by that officer for the high-speed Diesel for stationary purposes holds good for Germany also, only more so, since they have already got in Germany Diesels running at over 2,000 r.p.m. with perfect reliability on pure coal-tar oil.

Galileo and War-Technics. Dr. Wolff has extracted from Galileo's writings, and other documents, many interesting facts about his activity as a teacher of mathematics, fortification, etc., in the private military academy, which he conducted at Pisa from 1589 to 1592, and later at Padua, and which was attended by young officers and noblemen from foreign countries.

A Fire-Worker's Manual of 1445. General Marx describes amusingly what he thinks must be the oldest artillery regulations in existence, a hand-written volume bound in pigskin, and with an iron lock, containing much information to gun-masters (say, battery-commanders), especially concerning the manufacture of ammunition, which they were called upon themselves to provide!

The History of Fire as a Weapon. In this final instalment Major Reddeman, who at the end of 1914 raised the first flame-throwing detachment in the German Army, deals with flame-throwing in the Great War. The first attack at Malancourt near Verdun on 26.2.15 was a complete success. The German plan was to choose a place where the enemy's front-line trench was only 30 to 40 yards distant, and to play upon it with the fire-hose before the infantry stormed. The effect upon the enemy, moral and material, was very great. There was also a heartening effect upon their own infantry. One division reported, "Our infantry has gained the confidence that, working with the Flame-throwing Pioneers, no task is too difficult."

National Defence and Railways, consists mainly of extracts from *L'Armée Moderne*, by A. Marchand, which appeared in the *Bulletin Belge des Sciences Militaires*. The burden is that so far from the vast increase in M.T. and aircraft having diminished the importance of railways for war, the opposite is the case. Only the railways must be adapted in time to the strategic and tactical requirements of modern warfare. This is a matter for peace-time organization, and not for improvisation. This number contains also an article on *The Italian Artillery*, which it sums up in three phrases—strong in numbers—very mobile—suited to mountain-warfare. Further it calls attention to Major Fowle's *The R.E Problem of the Tank Brigade*, and to Capt. Blagden's proposed use of A.F.V's for raids on power-stations, etc., behind the enemy's front, and his suggested means of wrecking: for which *vide R.E. Journal*, June, 1935.

(September, 1935.)—The History of Signalling from the Fire-beacon as Transmitter to the Valve. The connection between signalling by means of fire-beacons, which Colonel von Dufais traces through history from the siege of Troy onwards, and the wireless telegraphy of to-day is more real than apparent. The writer does not labour the point. He states simply that sending messages by means of light signals, the bearer of which is the ether, differs fundamentally from the wireless telegraphy of to-day only in the wave-lengths of the waves travelling: and he leaves it at that. In fact he rather takes it for granted that his readers will say, not that we see an object because it is visible to our eyes, but that we see it because it receives ether-waves of different wave-lengths from an extraneous source, absorbs some and reflects others, according to its outline, nature, colour, contrasts and detail, to a sense-organ which appreciates their differences.

With a glance at semaphores, which, arranged in lines over the hill-tops, did Napoleon good service, *e.g.*, Paris-Metz-Strasburg in 1794, and by 1813 connected Paris with Milan, Turin, Venice, Geneva, Mainz, Brussels, Rotterdam, Amsterdam and Calais; and with another glance at the heliograph and the "lamp, daylight, signalling," Colonel von Dufais arrives at wireless telegraphy, which he calls the

"sister" of visual signalling. Telegraphy on wires is not dealt with, being from the standpoint of this article no nearer than a distant cousin.

The history of W/T is traced from Hertz's proof in 1888 that the electric waves he produced by means of his oscillator, as regards reflection, refraction, polarization and speed of travel behaved like rays of light. Feddersen had found earlier that the discharge from a Leyden jar was under certain conditions oscillatory, and Hertz suggested that the effect of each spark upon the ether might be something similar to what occurs to the water when a stone is thrown into a pond, as evidenced by the ripples travelling outwards in widening circles from the centre of disturbance. He invented his "resonator" to detect these waves. An improved detector, Branly's coherer, in 1890, and an improved oscillator by Righi in 1893 were at first of small effect as regards the future progress of W/T, but in 1895 Popoff invented the aerial for reception purposes in his experiments with lightning. To Marconi in 1896 came the *genial* idea of using the antenna also at the transmission end. Colonel von Dufais then explains the principles of the early Marconi spark-sets, and mentions the trials with Preece and the G.P.O., which led to the formation of the Marconi Company; efforts to overcome damping; the Slaby-Arco transportable wireless stations on the German Army manœuvres, 1900; the formation of the Telefunken Company with Siemens and Halske; Slaby and Braun's invention of the coupled closed circuit, which owing to the reduction of power for range first made army portable wireless feasible; and Wien's invention in 1905 for quenching the spark.—(*To be concluded.*)

Explosions carried out by the Engineers with the Advice of Geologists, by Major Kranz. Among the military uses of geology are quarrying for stone, for concrete, road-making and building, the siting of military roads, etc., and indicating in subterranean warfare, such as has taken place often in sieges, and between stabilized fronts in the Great War, the best spots for sinking shafts, and the position, depth and extent of the best strata in which to run galleries. The author follows the section on "Blasting" in the excellent *Pioneer's Primer* by Lieut. Zahn (published by *Offene Worte*, Berlin W35; price 1 mark), especially the sub-head "Blasting in masonry, concrete, earth and rock." He divides mines into supercharged, normal, and camouflets, according as the sphere of their effect intersects, touches, or does not reach as far as, the surface of the ground. To arrive at the amount of explosive required he uses the formula

$$W = r^3 \times c \times c^1$$

where W = weight of explosives in kilos, r = radius of effect in metres, c is a coefficient of resistance depending upon the material, and also a function of r, and c^1 is a coefficient dependent upon the efficiency of the tamping. In using this formula the engineer can select for himself a value of c out of the tables as long as it is a question of masonry or something homogeneous. When, however, the matter is more complicated only the geologist can pick the value of c, depending upon whether rocks are igneous or sedimentary, in thick layers or in thin layers, whether strata are horizontal or inclined, uniformly dry or alternately wet, hard and soft, or cracked. An example in quarrying is given to illustrate this, and also specimens of reports such as the engineers might expect to receive if they consulted a geologist before undertaking a task of demolition, *e.g.*, of a railway-tunnel, or of a mountain-road. As regards the latter Major Kranz points out that in modern Italian mountain-roads mining chambers are provided, as is the case with bridges and tunnels of strategic value.

The Rôle of Inundations at Nieuport. Professor Oehler has searched the history of Nieuport, and finds that in addition to its successful defence by inundations in the Great War, it was successfully defended by the same means on five separate occasions between 1488 and 1677, on one occasion against Louis XIV, holding out for five years. In 1745, however, it was captured by Louis XV, owing to the French being able to drive their parallels forward on the S.E. face, which was not inundated. Fifty years later the same thing happened again, affording a good example of a neglected lesson.

Professor Oehler says that before judging of flooding possibilities the engineer in addition to modern contoured maps should study carefully old plans of inundations. From the former he will get the present possibilities, but from the latter he will learn what to expect when more recently constructed canals and dams have been damaged by artillery fire, or by extra high tides.

Brown Coal or Pit Coal for Gas Making? Dr. Pothmann takes exception to conclusions arrived at by Dr. Dresden in an article with the same title which appeared in the *Schlesische Zeitung* of May 5th, viz., that brown coal could only be used for gas-making in Germany on the large scale if its production in time of stress were as reliable as that of pit coal, and that inasmuch as brown coal is got out by daylight working its extraction is in a much greater degree exposed to interruption by air raid, than that of pit coal. Dr. Pothmann says that this is all beside the point, because it ignores two great facts. First, that pit coal is found in great quantities in a few large coal-fields, which are without exception close to the frontiers of Germany, and hence are comparatively exposed to enemy action from the air; while brown coal is found all over Germany, and especially in Central Germany. The second fact is still more important, and that is, that coal mines are connected with the outer world only by the shaft, which is easily recognizable, in fact a landmark, together with its entourage of machinery, pumps, ventilators, compressors, etc. A mine can therefore be easily put out of action by an air-raid, which attacks its life-centre; and it may be out of action for months. Against brown coal workings on the surface an air-raid can at most knock dredgers out, and a single dredger can be replaced. Even if all dredgers could be put out of action, resort could be made to hand-working instead. Thus hostile attacks from the air against brown coal workings are both harder to execute and less dangerous in their effects.

A rolling Headquarters. An account compiled out of Trotzki's *My Life*, published by Fischer, Berlin, relates Trotzki's doings from March, 1918, when he became People's War Commissary and President of the Supreme War Council, and as such was entrusted with the task of conquering the White Armies. He decided to make his headquarters in a special train, so as to be able to travel always to threatened points, to see everything for himself, and to be wherever he thought he was most needed. His train contained offices, a printer's shop and newspaper office, a garage with several cars, a telegraph office, a wireless station, electricity supply station, petrol tank, technical stores, clothing and boot stores, library, baths, etc. It had two locomotives, of which one acted as courier when the train was at rest. In this train Trotzki lived for two and a half years, and travelled a distance equal to five and a half times round the world. He says, "Hundreds of times the train played the part of that shovelful of coal which at the last moment just keeps the fire from going out." The Soviet commanders said that the arrival of the train was "as good as reinforcement by a division."

The remaining articles in this number are *Principles of Artillery Fire*, by Major Schneider, and *Tasks and Possibilities of Heavy and of the Heaviest Artillery*, by Lieut.-Colonel Justrow.

F.A.I.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*August*, 1935).—This quarterly continues to improve, its latest innovation being full-page maps in three colours, brown, green and blue, upon which military information, fronts, sectors, lines of operation, etc., stand out clearly in black. The frontispiece is a photograph of Field-marshal Mackensen, in his uniform as Colonel of the 17th (or "Death's Head") Hussars, a Hanoverian regiment, who wear the skull and crossbones on the busby, and have among their battle-honours "Peninsula" and "Waterloo." The message to the Engineers from this distinguished soldier, the conqueror of three vast tracts of Europe, Galicia, Serbia and Rumania, runs:—"The

World War showed again and proved increasingly the importance of the Engineers for operations, as also for the fight. As a result of the ceaselessly advancing conquests of technics the importance of the Engineers will further increase. Their spirit and their training will also in future overcome all obstacles."

Orders for the "Alberich" Block. This second instalment of Major Bessell's article continues the account of the orders issued by the 2nd Army and subordinate formations for the laying waste of the area to be given up to the enemy by retirement to the "Hindenburg" line, *i.e.*, the area, one boundary of which was the German front line between Villers-Carbonnel and Chaulnes and the other 20 miles back, behind the Somme at St. Quentin. Relying on the exhaustive orders of the Army Group and of Army H.Q., as also on the weeks of preliminary work for executing the blocks, the actual order for blocking issued by the 2nd Army was laconic, emphasizing only that the most important factor in the smooth carrying out of the whole operation was the unconditional maintenance of the front line as then existing. This had perforce to be left to the infantry and the artillery, the pioneers (and hence the trench-mortar personnel) having to be drawn out first, so as to get ahead with the demolitions, etc. The orders of the XXIII Reserve Corps and of the 25th Division are reproduced as models. As regards all this wealth of orders, rendered possible only by the peculiar circumstances of a voluntary retirement in position warfare, the author says, "Nowadays we should say 'In order to reach the Siegfried-position undisturbed it will be necessary to make numerous blocks, so as to delay the enemy as long as possible, especially ——,'" and leave it at that; and he thinks that with a better understanding of the Engineers' capabilities the same might have sufficed even then.

Finally as to the effect of the blocking. On the 28th March, twelve days after the retirement began, the XXIII Reserve Corps reported the presence of three to four British divisions between Roisel and Beauvois, and of eight to nine French divisions between Beauvois and La Fère. The greatest depth of the enemy's advance in these twelve days, entirely unopposed, was 25 kilometres.

The Pioneers of the 7th Army in the Offensive Across the Marne on the 15th July, 1918, by Major-General Kuntze. The origin of this offensive was the desire to seize the initiative and to prevent the French from attacking. The weak spot selected was the front from Château-Thierry to Rheins and east of Rheins, and the task was entrusted to the Crown Prince's Group of Armies, 7th, 1st and 3rd. The operation is treated in this article most fully from the Engineers' point of view under the headings: strategic task; terrain; information of the enemy; strengths of pioneers and bridging columns; plan of attack and general orders; orders for the pioneers, viz., those of the Army, its three Corps and of certain of the Divisions; the course of events and progress of ferrying and bridging treated separately for each of the seven divisions taking part; and, finally, a criticism which includes a list of fifteen lessons to be learnt, some of which apply to that particular crossing of the Marne, but most of which are of general application. The first of these runs:—An opposed river-crossing belongs to the most difficult of operations. A *sine qua non* for its success is absolute secrecy.

Mining Warfare and Military Geology in the Wytschaete Salient, by Major Kranz. The author, who is a government geologist in Würtemberg, appears to have been employed in 1915 in the sector south of Messines. From the German records and various authorities, notably Major-General Harvey (*vide The R.E. Journal*, December, 1929, and *The Military Engineer*, Washington, 1931, No. 132), W. B. R. King's "Geological Work on the Western Front" (*The Geographical Journal*, 1919, No. 4), Misson's "La guerre de mines sur le front anglais" (*Bulletin Belge des Sciences Militaires*, June, 1935) and others, Major Kranz has compiled a most readable article, well illustrated with sketch-maps and sections, in which the mining on both sides is objectively depicted.

The British mines fired at St. Eloi in March, 1916, had the effect of causing the Germans to take more interest in mining than hitherto, and to increase the strength

of their tunnellers, but they were never able to catch up the six months' start that the British tunnelling had gained. In May, 1916, a geologist was appointed to the German 4th Army H.Q., followed by two more a few months later, and German mining began in consequence to be done on a more scientific basis.

The story of Messines is then told shortly, followed by separate accounts of the preparation of the principal mines fired on the 7th June, 1917—at Hill 60, St. Eloi, Maedelstede Farm, Peckham, Spanbroekmolen, Kruisstraat and Ontario Farm, which are told in detail. General lessons to be learnt from the Messines mining adventure follow. The German Higher Command had often been warned, and in plenty of time, about the danger their foremost positions were in, owing to British mining, but the correct conclusion had not been drawn from these warnings. Either sufficient labour and material for effective countermining from more favourable positions approved by the geological experts should have been provided, or an evacuation should have been carried out of all the threatened points, and a retirement of 200 to 300 metres. The latter course is what General von Kuhl says Sir Douglas Haig feared would happen before the mines were fired.

Major Kranz finds that mining had not been sufficiently taught in the German army before the war. The British were at first certainly no better prepared, but they began considerably earlier than the Germans to get together mining personnel trained in civil life, to mine with mechanical tools, and to work, with geological advice, upon an operation on the grand scale. The valuable services to British G.H.Q. of the geologists, Edgeworth David and King are mentioned. On the opposite side of the line almost the whole mining strength of the Germans was expended in warding off minor attacks nearer the surface. Possibly the British desired by means of such attacks to divert attention from their main work deep down. The latter was, however, betrayed more than once by the Germans noticing the appearance in the parapet of sandbags of a different colour, viz., those filled with the blue Ypres clay which occurred over sixty feet from the surface. The Germans failed in sinking inclined shafts into water-bearing strata which became waterlogged, whereas the British sunk vertical shafts into the dry clay. Both sides failed in providing main laterals parallel to the front, connecting up the galleries, and invaluable for listening-posts. To the defence they are essential, and should be in two storeys. Major Kranz says there would have been a different tale to tell from that of the disaster of Messines if the Germans had only realized earlier the vast amount of labour and materials necessary for successful countermining, and the necessity of its direction by expert geological advice.

Experiences in the Training of Infantry and Cavalry Pioneers. Capt. Meltzer has written some notes as a result of his experience in training large classes of infantry and cavalry to become regimental pioneers. His conclusion is that a few pioneers distributed amongst the companies will do little good. An infantry pioneer section must be a unit welded together from the very start under a leader responsible for its training and spirit, and not something that meets occasionally.

A River-crossing in the Thirty Years' War, by Colonel Jesse. The reproduction of an old engraving of forces in battle on both sides of a winding river, under the title, *Prœlium ad Licum commissum inter regem Succorum & comitem Thillyum*, gives the writer the opportunity of pointing out that a battle fought 300 years ago may contain teachings for to-day. In the spring of 1632 when Gustavus Adolphus, strong in artillery and with an army of 40,000 Swedes, was advancing to the Danube, the unfortunate Tilly, outnumbered and already heavily beaten, was ordered to Ingolstadt to prevent the Protestant army from entering Bavaria. Gustavus, however, turned aside and crossed the Danube higher up at Donauwörth, which he took by siege in two days. This move had the disadvantage of putting between him and Bavaria a tributary of the Danube called the Lech, over which all bridges had been destroyed. Instead of crossing the Lech where he pleased, by evading Tilly, who could not guard the whole river-front, and against the advice of his Council of

War, Gustavus chose to fight his way across the river exactly where the League troops were in an entrenched camp outside Rain. A reconnaissance he had made personally had shown the King that his bank of the river was the higher, and that owing to a bend in the river his batteries would be able to concentrate on the enemy's guns from three directions. The Swedes found the river swollen by melting snow and too swift for the use of pontoons. Under cover of their artillery-fire they put 500 men across to form bridgehead, and started building a trestle-bridge under the fire of the Imperialist guns, but covered by the smoke of large fires which they made of green wood and damp straw. All this the picture shows very clearly. It also shows Finnish cavalry crossing the river by a ford farther up, but nearly 40,000 must have crossed by the trestle-bridge. The Swedes were gallantly counter-attacked, but they pressed on. Count Tilly received his death-wound, while carrying forward the standard of a regiment that was wavering, but the day was lost, and the Imperialists streamed away to Rain. This the picture manages to show also.

F.A.I.

THE INDIAN FORESTER.

(*June*, 1935.)—A description of the people and forests of Peint, a small district in the Western Ghats, occupies a prominent place in this number. Situated barely 100 miles from Bombay, the locality is almost inaccessible by road, and the inhabitants are consequently delightfully untouched by civilization. As in many other out-of-the-way parts of India, the Forest Officer is invested with the control of Revenue and Excise, no sinecure in a district of 240 scattered villages. The Forest Staff have in addition the maintenance of 120 miles of metalled and unmetalled roads.

The marketing of timber at Doraha is a somewhat technical article, but one of great interest to those of us who have had to buy timber in Northern India. Logs felled in the Punjab Himalayas are floated down the five rivers and their accompanying canals, and hauled to land at the places, of which Doraha on the Sirhind Canal is one, where the N.W. Railway crosses them.

The Forest College at Dehra Dun, closed for two years owing to financial stress, has been re-opened, and in his inaugural address, Mr. Trevor, the Principal, refers in eulogistic terms to the first director, Lt.-Col. F. Bailey, R.E., who, Colonel Sandes informs us, was the only Sapper officer to serve in the Indian Forest Service.

In the editorial notes we are told that the inception of the shelter belt of forest in the U.S.A. was due to a brain wave of Mr. Roosevelt, who was compelled by a railway breakdown to spend three hours in terrific heat on the plains of Montana. 3,500,000,000 trees will be required, 200,000 miles of fencing are wanted, and 75,000,000 dollars will be spent on the project. The area forming the belt, not all of which however is to be planted, is said to be three times that of England. The main object of the belt is to prevent the further denudation of the soil of the prairie states by wind and rain.

The necessity for such a belt is emphasized by another note, which deduces from measurements made in the U.S.A. that bare land is eroded by weather 4,300 times as fast as forested land.

Mention must be made of a broadcast talk on the important timbers of Bengal. India very often imports timber when equally good or better stuff is obtainable from her own forests.

(*July*, 1935.)—In the July number, we read that yew wood for the bows of the Royal Company of Archers has on occasion been supplied from the forests of Chamba State, in the Lower Himalayas lying to the north of the Punjab.

Mr. Osmaston, of the Indian Forest Service, in the July and August numbers, relates the story of a hike into the East Central Himalayas, with his cousin, J. H. Osmaston, of the Corps. The party just failed to reach an elevation of 20,000 feet above sea-level. Many who have spent years in India often fail to realize the glorious opportunities that the Himalayas afford for trekking, amid the most wonderful

mountain scenery in the world. The article is very good reading, though we regret the absence of a map.

Mr. Sundravarada Chariar, Range Officer of Mettupalayam, Madras Presidency, relates the adventures of a python in a most amusing way. The brute, eleven feet long and eighteen inches in girth, was despatched, after a long struggle, by the author and his party, armed only with bill-hooks. "Some of them hurled big stones to crush its head. The further movement of this poor creature having been effectively arrested, the Irulars inflicted series of injuries and after all succeeded in despatching him to the other world."

(*August*, 1935.)—A letter in the August number from a Forest Officer expatiates from personal experience on the value of beer as a prophylactic against malaria; the author expresses the pious hope that Government will sanction the free issue of beer for the purpose.

F.C.M.

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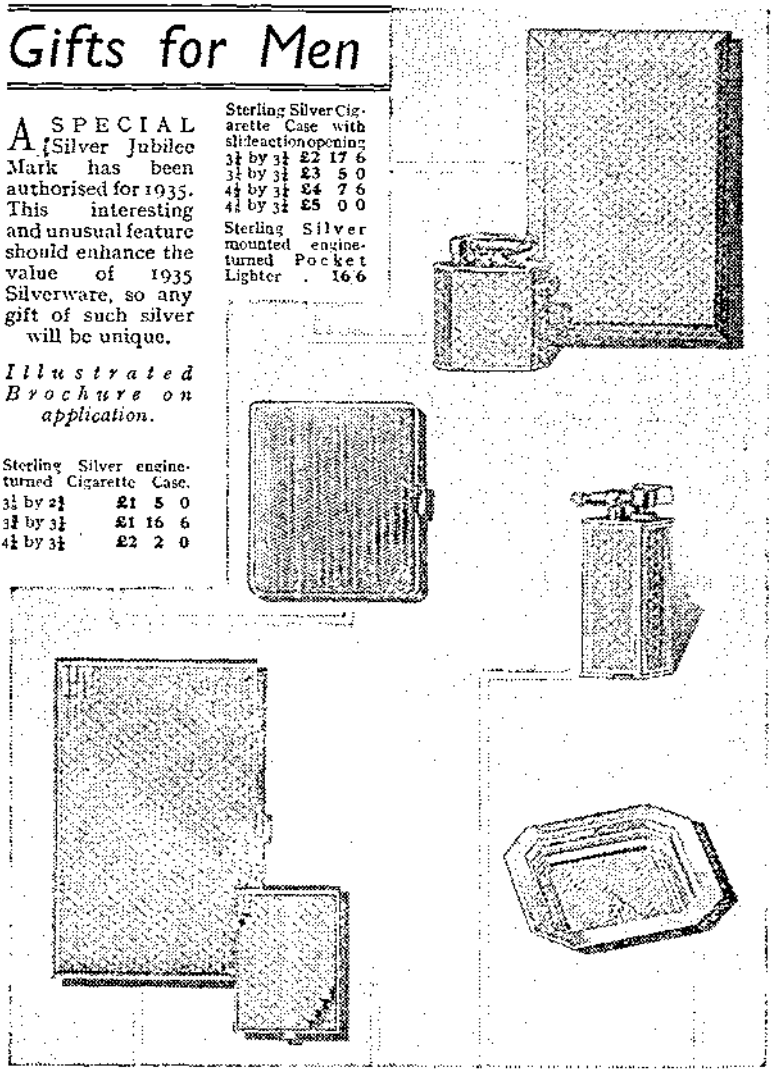

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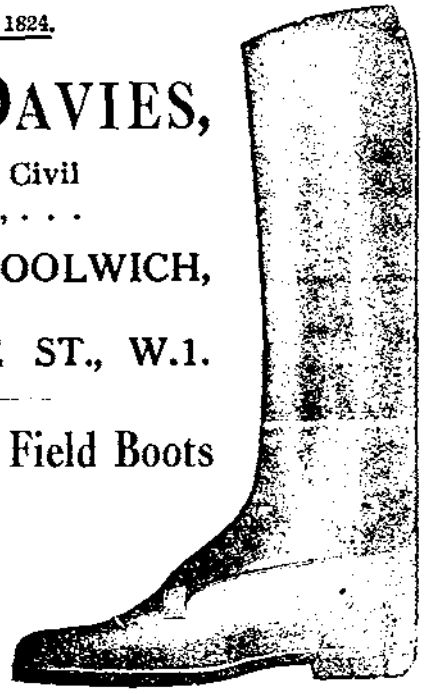

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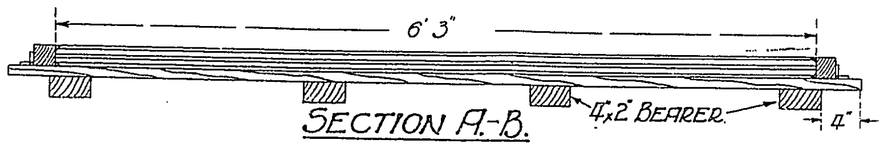

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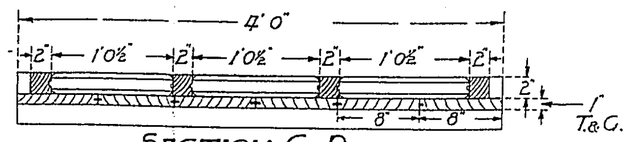
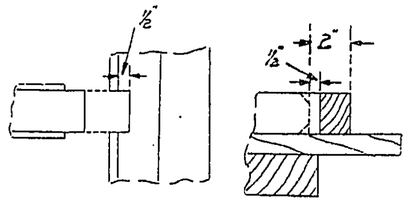
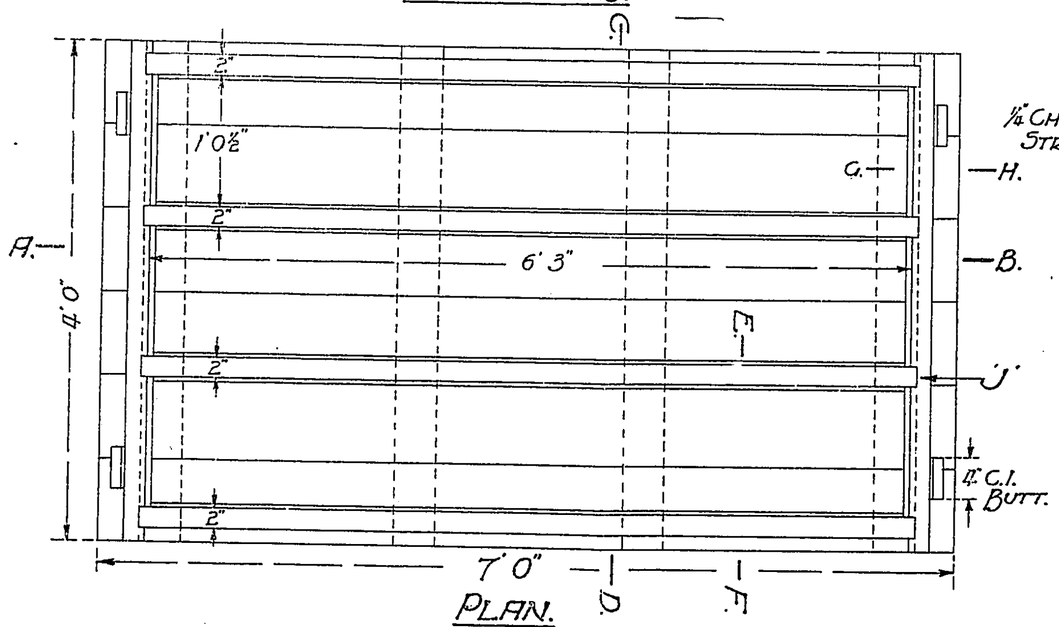


SECTION C.-D.

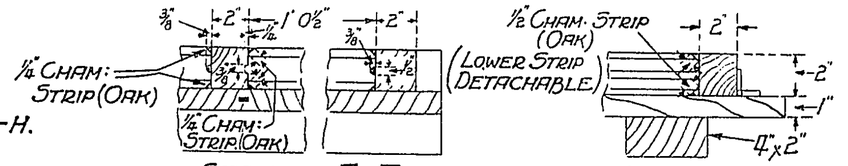
DETAIL AT J'



PLAN. SECTION.

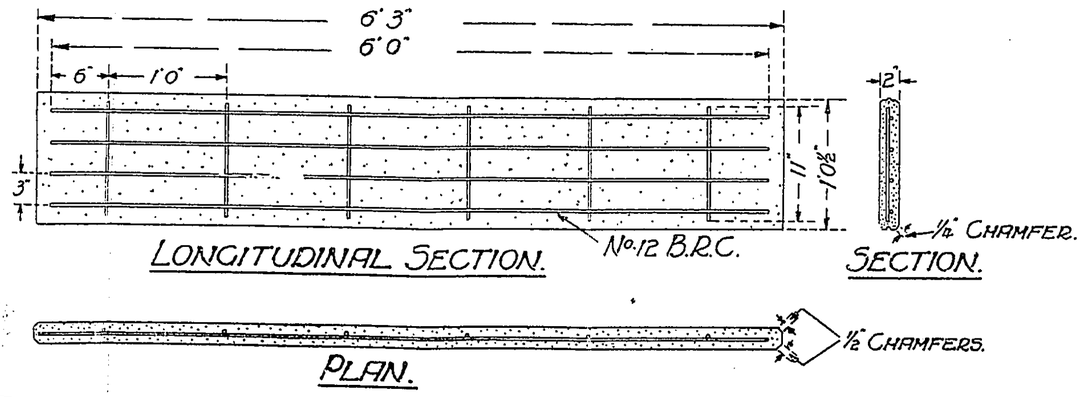


PLAN.



SECTION E.-F.

SECTION G.-H.

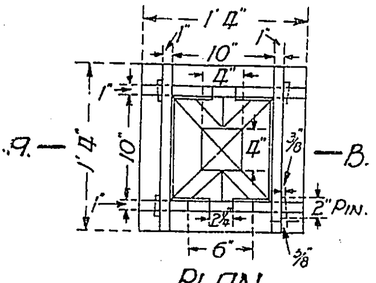


LONGITUDINAL SECTION. SECTION.

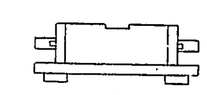
PLAN.

DETAILS OF SLAB.

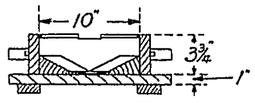
DETAILS OF CASING FOR COPING OVER POST.



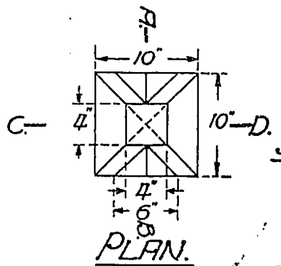
PLAN.



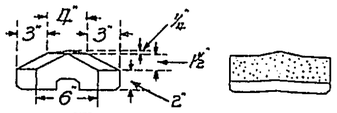
SIDE ELEVN.



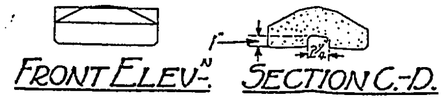
SECTION A.-B.



PLAN.

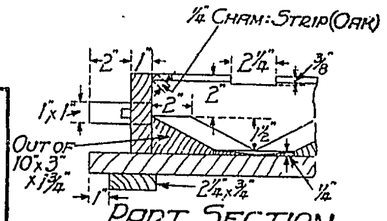


SIDE ELEVN. SECTION A.-B.

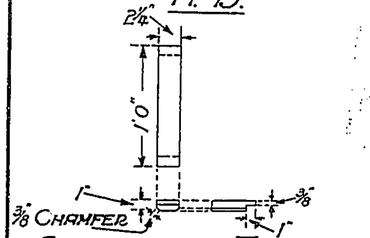


FRONT ELEVN. SECTION C.-D.

DETAILS OF COPING OVER POST.

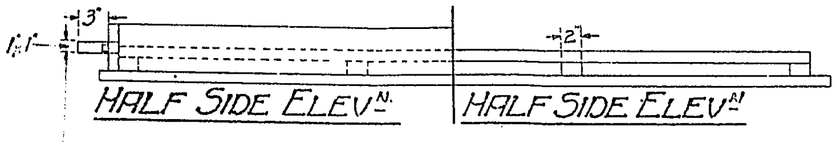


PART SECTION A.-B.

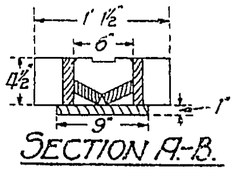


CASING FOR FORMING GROOVE.

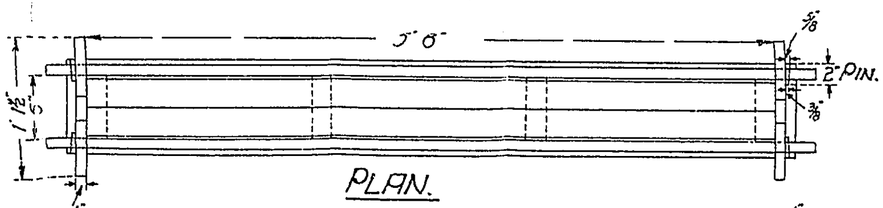
DETAILS OF CASING FOR COPING OVER SLAB.



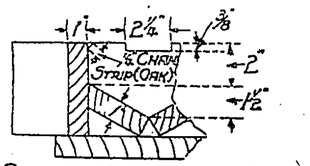
HALF SIDE ELEVN. HALF SIDE ELEVN



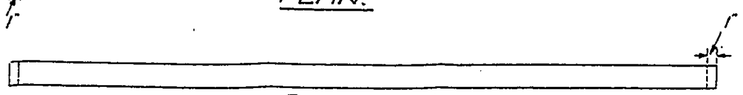
SECTION A.-B.



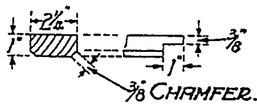
PLAN.



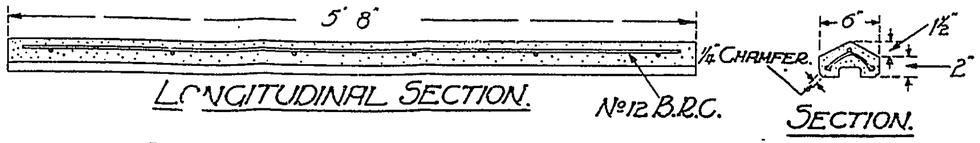
PART SECTION A.-B.



PLAN.



CASING FOR FORMING GROOVE.



LONGITUDINAL SECTION. SECTION.

DETAILS OF COPING OVER SLAB.

SCALE. ⅛ FULL SIZE.

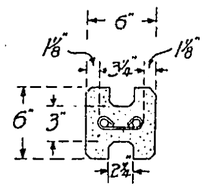
INCHES. 12. 0. 1. 2. 3. 4. 5. 6. 7. 8. FEET

PLATE I

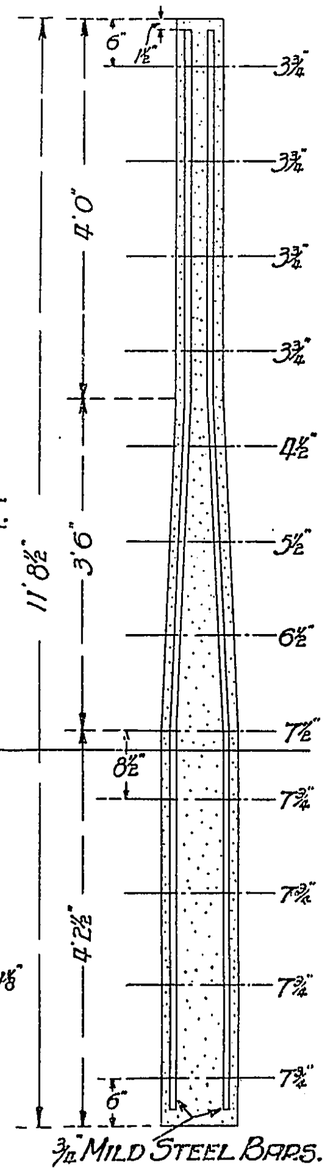
REINFORCED CONCRETE FENCE FOR SHORNCLIFFE STADIUM.

DETAILS OF POST.

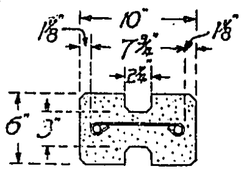
CROSS SECTION. (UPPER.)



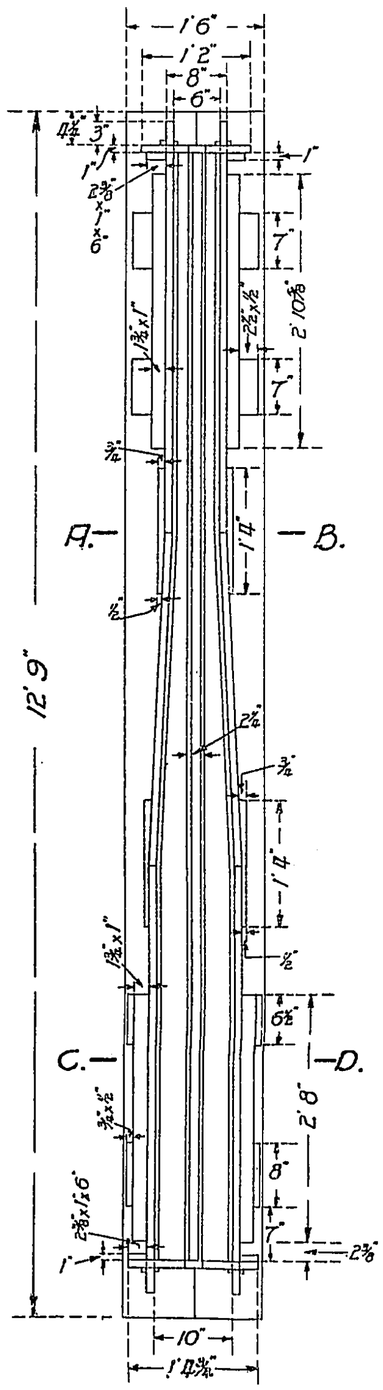
SECTIONAL ELEV.N OF POST.



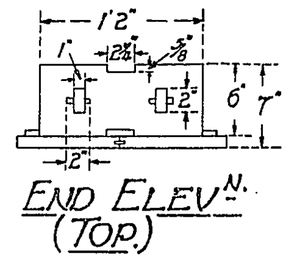
CROSS SECTION. (LOWER)



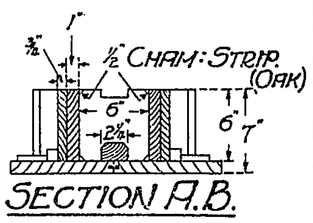
DETAILS OF CASING FOR POST.



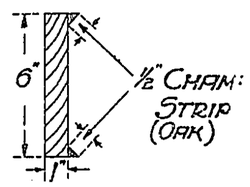
PLAN.



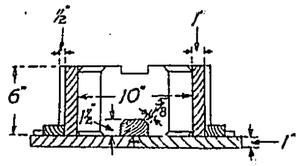
END ELEV.N. (TOP.)



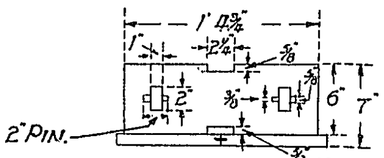
SECTION A.B.



SECTION THRO' SIDE.

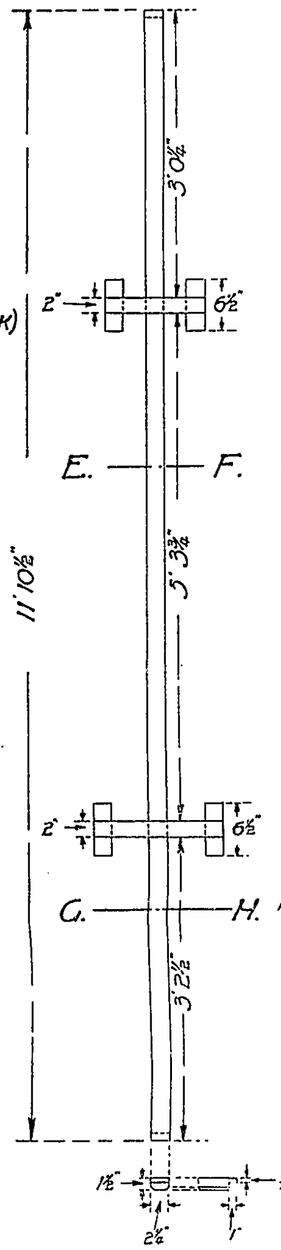


SECTION C.D.

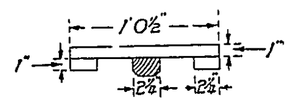


END ELEV.N. (BOTTOM)

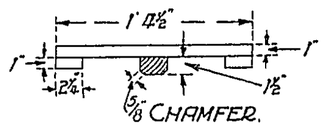
CASING FOR FORMING UPPER GROOVE.



PLAN.



SECTION E.F.



SECTION G.H.

REFERENCE.

STIRRUPS TO BE AT 12" CENTRES AND OF 3/16" M.S. ROUND.
C/L.S. OF STIRRUPS _____ SHEWN THUS:- ——·——·——
DISTANCE APART OF THE OUTSIDES OF THE ¾" BARS, TO BE, AS SHEWN AGAINST THE C/L.S. OF THE STIRRUPS.
ALL CHAMFERS TO BE ½" ALONG THEIR SHORT SIDE, EXCEPT WHERE OTHERWISE SHEWN.
POST MAY BE SHORTENED BY INSERTING BLOCKING PIECE AT LOWER END OF CASING.

SCALE.

1 FOOT TO 1 INCH AND ⅛ FULL SIZE