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Reproduced from a water-colour drawing by Orlando Norie (about 1875), recently acquired for the R.E. Museum.

Reproduced from a water-colour drawing

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THE QUARTERMASTER-GENERAL AND THE ROYAL ENGINEERS IN WAR.

A Lecture delivered at the S.M.E., Chatham, on November 7th, 1929, by LT.-GENERAL SIR HASTINGS ANDERSON, K.C.B., *p.s.c., Q.M.G. to the Forces.*

IF I had taken counsel of my fears on receiving the flattering invitation to lecture to an audience composed of officers of the Corps of Royal Engineers, on a subject of such interest to me personally as well as to them, I should have adopted the new British motto of "Safety First," and prayed to be excused. But Biblical memories of the story of Daniel in the Lions' Den reminded me that that prophet came safely through his ordeal. I do not presume to the eminence of Daniel as a prophet, but I have hopes that your courtesy and self-restraint will equal that of the lions, and that I also shall emerge unscathed from a somewhat terrifying experience.

For some centuries the Royal Engineers served under the Master General of the Ordnance, and it is only since October, 1927, that, both in peace and war, the Corps has been closely connected with the Quartermaster-General.

Properly to understand the gradual development of the Corps of Royal Engineers, and its final connection with the Quartermaster-General, it is necessary to glance back at its history, which is doubtless familiar to you, but which I venture to recall.

We must realize that the ancient title of "Engineer" was originally purely military; it is only in the last century or so that the title has been adopted by the members of a civil profession, now usually known as Civil Engineers. Previously, the name was applied exclusively to the body of officers who had charge of the King's engines of war, and who were employed in the construction of fortifications and in the duties connected with their attack and defence: in fact, fortifications and works—barracks were non-existent.

Until comparatively recent times, fortresses played a predominant part in every campaign, and it was early found necessary to retain the services of engineers in peace as well as in war; so that engineers were kept for the King's service long before the introduction of standing armies. I hope I shall not be accused of undue modernism if I say that Waldivus, the chief engineer of William the Conqueror, may be regarded as the father of the Royal Engineers.

When Edward I. conducted the war in Wales in 1287, there were 2,000 wood-cutters and sappers employed with the army, and these men were of great service in making roads, cutting paths through the forests, and assisting in the sieges of the Welsh strongholds.

At the siege of Calais by Edward III. in 1347, the Chief Engineer had under him a body of 314 men composed of masons, carpenters, smiths, engineers, tentmakers, miners, armourers, gunners and artillerymen. The last two had become necessary owing to the invention of gunpowder, and the Siege of Calais furnishes the first recorded instance of the use of artillery.

When Henry V. invaded France in 1415, his Chief Engineer, Nicholas Maybury (or Merbury), was styled "Master of the King's Works, Guns and Ordnance." He was the first Master of the Ordnance, and as such he heads the list of past M.G.O.s in the War Office. Maybury received honourable mention for his conduct at Agincourt, but the war was to a great extent a campaign of sieges, and the engineers bore the brunt of them. In the 1417 campaign, no fewer than 1,000 masons, carpenters and other labourers were employed.

Gradually, an Office of Ordnance was formed, to take charge, on behalf of the King, of all matters concerning fortifications, sieges, artillery, and stores. This office developed into the Board of Ordnance, which was established in the Tower of London about 1455, and which existed for exactly 400 years, until it was abolished after the Crimea. Its principal officer became the Master General of the Ordnance, and the Chief Engineer was from early times one of the important officers of the Board. At out-stations, under the orders of the Board, were the following officials :—

Engineers, master gunners, firemasters, proofmasters, fireworkers, storekeepers, wagonmasters, tradesmen and artificers.

Sir Richard Lee, a distinguished Chief Engineer in the reigns of Henry VIII., Mary and Elizabeth, was employed as Head of the Boundary Commission for the delimitation of the Franco-English boundary in France in 1545; in the construction of the Castle at Upnor in 1560; and was mentioned in dispatches by the Duke of Norfolk in the Expedition to Scotland of the same year for his excellent reconnaissances of Scottish positions. How constant have been the duties of the Royal Engineers. It reads like a page of some R.E. officers' services in the *Army List*. Sir R. Lee had a good-looking wife, who was a friend of Henry VIII., which may have helped her husband. His looting propensities were, I hope, not so characteristic. He looted the Royal baptismal font and a brass eagle lectern from Holyrood Chapel, which he brought back to St. Albans. The font was given to the Abbey and destroyed in the Cromwellian period. The eagle lectern he gave to St. Stephen's Parish Church. It was buried, and dug up in 1750, and is now used.

It must not be forgotten that when the Board was established in the 15th century, it was the only permanent military office. Commanders, cavalry and infantry, were appointed and raised as required at the beginning of a war, and disbanded at its conclusion. The Board, therefore, as was natural, acquired a very strong position, and when a standing army, comprising infantry and cavalry, was kept up after the Restoration in 1660, and placed directly under the King, or a general deputed by him to command the Forces, there was jealousy between those branches of the army and the officers of the Engineers and Artillery who owed allegiance to the Master General of the Ordnance and his Board, and were independent of the Commander-in-Chief. Is some faint echo of a note of challenge to be detected in the title assigned to me for my lecture this evening? What hast thou to do with us?

Up to the beginning of the 18th century, the Engineer and Artillery Services formed one Corps, detachments from which were placed at the disposal of the Commander-in-Chief in the field at the beginning of each campaign by the Master General of the Ordnance. After Marlborough's wars, the importance of having a permanent body of gunners instead of raising a train for each campaign led to the formation of two permanent Artillery Companies in 1716; and the Engineer Corps, composed of 1 Chief Engineer and 27 other officers, received a separate constitution. The men were still raised as required for each particular campaign, and it was not until 1772 that a permanent force of non-commissioned officers and men was established for service at Gibraltar, while in 1787 a Corps of six companies was founded, known as Royal Military Artificers, and commanded by officers, styled "Royal Engineers." In 1802, the Chief Engineer became the Inspector-General of Fortifications. The Peninsular War saw the name Artificers changed to Royal Sappers and Miners—a title still in use in India; but it was not until the end of the Crimea, in 1856, that the two Corps, Royal Engineers Officers and Sappers and Miners, finally became the Corps of Royal Engineers.

In Russell's letters from the Crimea he remarks on the excellence of the clothing and equipment of the Engineers and Artillery, who were under the Board of Ordnance, as compared with the other fighting arms who were equipped by the Horse Guards under the Commander-in-Chief.

The formation of the Corps of Royal Engineers synchronized with the disappearance of the Board of Ordnance, and the chief officer of the Corps, the Inspector-General of Fortifications and Royal Engineers, was placed directly under the Commander-in-Chief, and remained so until 1904. He became responsible for the construction and maintenance of fortifications, barracks, store buildings and the inspection of ordnance factory buildings, for military railways, telegraphs and balloons, the custody of War Department lands and unoccupied buildings, the design, inspection and custody, and issue of Engineer stores, and—here we get the first connection with the Quartermaster-General—in concert with the Quartermaster-General the preparation of the annual estimates for Engineer services. As Inspector-General of Royal Engineers, he advised as to the general distribution of the Corps, and as to the appointment of officers to, or their removal from, responsible positions in connection with works. He inspected the Corps of Royal Engineers and advised on all questions relating to its technical instruction.

Looking back on the history of the Royal Engineers through the 19th century, certain prominent factors emerge. At the beginning of the century, they were—if we except the officers of the Royal Artillery—the only strictly professional officers of scientific attainments, and they were, as a class, men of higher education than the bulk of the officers of the army. These qualities, and the absence of any sort of peace training for the duties of the Staff, gave to the Royal Engineer officer an outstanding position in war and perhaps especially in India, where the standard of military proficiency among the officers of the Honourable East India Company's Forces was not so high as in the Home army. The Peninsular War provided practical training for Commanders, Regimental Officers and Staff, but the latter was composed almost entirely of men of family, many of them personal friends or family connections of the Commander.

At Sandhurst, after 1812, there was a senior department at which some few officers were trained for the Staff, but their instruction was, for the most part, concentrated on mathematics, astronomy, survey and fortifications; with little bearing on practical war or Staff problems, and sufficient only to give them a smattering of the knowledge already possessed by the Royal Engineer officer. And they were regarded as cranks and were seldom employed on the Staff.

We have only to look at the history of the Crimea, the Mutiny and the Chinese War of 1860, to realize the important place that was occupied by the Royal Engineer in the army. Gordon is only one name. Anyone who knows Delhi and has visited the little concrete blocks which mark the emplacements of the British batteries at the siege in 1857, must have remarked how the descriptive plaques give the name of the Royal Engineer who erected the battery. The batteries were named after him, and no mention is made of the officer or the unit of Artillery holding the emplacement.

The lessons of the Crimea, and the Mutiny, and the military successes of Prussia in the Wars of 1864, 1866 and 1870, led to a realization of the need of a more professional outlook on the part of the officers of the British Army, and of the importance of their professional education. A Staff College was instituted in 1858, promotion by purchase in the cavalry and infantry was abolished in favour of seniority, tempered by selection and by examinations for promotion. Gradually, therefore, and greatly owing to the influence of Lord Wolseley and his associates, a higher standard of professional attainments was secured in the officers of the army. During the same period we can observe the growing power of artillery fire, and of the cult of mobility, so that war was losing much of its dependence on the precise science of the construction, the attack and the defence of permanent fortifications. At the same time the increasing technicality of the science of engineering, and the parallel increasing demands of armies in the field on the works services of the Engineers, enhanced the importance of the Royal Engineers in their technical capacity as Works Officers.

It seems to me, then, that by the end of the 19th century, the army relied less on the Royal Engineers for general professional knowledge and more for technical engineering science as regards works. But certain Royal Engineer officers had been attracted to the Staff College and to a career on the Staff and in command, as distinct from purely Royal Engineer duties. Such names as Lord Nicholson, Sir Richard Harrison, Bindon Blood, Lawson and Hunter-Weston will occur to you at once, not to mention Lord Kitchener, Rundle, Chermside, Aylmer and Hart. The welding of the officers of the Board of Ordnance and of those under the Commander-in-Chief into one composite whole had progressed surely since the Crimea; but the army still thought in terms of peace routine rather than of war preparation.

And just as the Crimean War had brought out the disadvantages, delays and administrative chaos resulting from the dual responsibilities of the Commander-in-Chief and the Board of Ordnance, so the South African War emphasized the dangers of the overloading of the Commander-in-Chief, who dealt direct with seven departments in the War Office, with administrative functions in peace; the absence of systematic preparation for war, and of a military body definitely charged with the duty of advising the Government on military policy.

After the South African War, a Royal Commission under Lord Elgin was appointed to investigate the organization and administration of the army during the war, and a special report upon the organization and equipment of the Engineer arm was submitted to it. Maj.-Gen. Sir Elliott Wood, who went out as Chief Engineer, strongly pressed upon the Commission that Engineer officers should be attached to the Divisional Staffs of Generals.

This view was also that of Sir Charles Warren, who said that:—

"One of the most retrograde steps taken in recent times was to remove the Commanding Royal Engineer of a Division from his position on the Staff of the Divisional General. The result has been chaos in many directions. How is it possible for a general officer to have his arrangements made in advance for crossing rivers, telegraph services, engineer services generally, if his Commanding Royal Engineer is cut off from him and reduced to the position of the officer commanding a battalion ?"

As a result of the Elgin Commission report, a Committee, consisting of Lord Esher, Lord Fisher and Lord Sydenham, was appointed to advise on the reconstitution of the War Office and of the system of command and administration of the army. The principal results of this Committee were the abolition of the office of Commander-in-Chief in peace, and the formation of the Army Council, and of the General Staff, with the separation of command from administration.

Among high offices which disappeared was that of the Inspector-General of Fortifications. His duties were to be combined with those of the Armaments Branch under the 4th Military Member of the Army Council, the Master General of the Ordnance. The entire technical work of the Royal Artillery and Royal Engineers was again brought under one head, thus reverting to the conditions of the Board of Ordnance, but without its responsibility for personnel, which had passed to the Adjutant-General, the 2nd Military Member of the Council. For many years the handling of questions of defence had suffered from dual administration, the R.A. and R.E. not always working together over fortifications and armaments. From 1904, therefore, the Master General of the Ordnance had under him a Director of Artillery and a Director of Fortifications and Works, the latter charged with :—

Design and construction of works of defence ; of all store buildings ; of barrack services not exceeding £2,000 in cost ; and of barrack maintenance generally ; and the administration, but NOT the purchase of, W.D. lands.

Barrack buildings exceeding £2,000 were placed under the Under-Secretary of State, a civil and political Member of the Council.

The functions of the four Military Members of the Army Council may be summarized as follows :—

General Staff Branch.—Policy, Operations, Intelligence, War Organization, Training.

A.G. Branch.—Personnel and Discipline and Mobilization.

Q.M.G. Branch.—Movement, Maintenance, Accommodation.

M.G.O. Branch.—Production, Armament, Works.

In war, the M.G.O. was not directly represented in the field, and the Director of Works came under the Q.M.G., where Lord Esher had wished to place him in peace.

An Engineer-in-Chief was to be appointed to G.H.Q. in war, and his duties would consist of advice to the General Staff, or rather, perhaps, it would be better to say arrangements for the General

Staff, regarding the distribution of engineer units; the allocation of field engineering work; the collection and distribution of engineer intelligence, except that regarding the enemy's engineers, and the preparation of schemes for large scale demolitions. He would arrange through the Q.M.G. Branch for the distribution of the engineer stores produced or held by the Director of Works, and he acted as a buffer between the D.W. and the Staff in balancing demands for stores with the possibilities of supply.

He also acted as Inspector in the Field to ensure that G.H.Q. orders regarding the employment of engineer units were obeyed, and that G.H.Q. schemes for field engineering works were properly executed.

During what we may call the Renaissance period, before and during the Great War the incorporation of officers of the Royal Engineers in the outside activities of the army as Commanders and Staff Officers continued. The names of Generals Kirkpatrick, Gorringe, Fowke, Macdonogh, Ronald Maxwell, Lee, Fraser, Capper, Charles, Swinton, Elles, Twining, Bowman-Manifold, are some of them. The Manchurian War gave warning—for the most part unheeded—of the continued importance of field engineering in modern war.

The Great War has been styled an infantry war, an artillery war, and an engineers' war, and there are good claims to each title, which I need not discuss. Certainly the Royal Engineers can claim that the abolition of their special position under the Board of Ordnance 60 years before had served only to enhance their position in the army, not only in respect of their technical functions as Engineers, but also as Commanders and Staff Officers. They no longer stood detached, but their influence permeated the army.

Consideration of the higher organization of the army during the Great War tended to show that once more the Commander-in-Chief was in danger of being overloaded with detail. As the War progressed, with its extension of technical and scientific functions, too many advisers had crowded G.H.Q., nearly all with the right of access to the C.-in-C. At the same time, the question of the supervision of army ordnance stores, of reserves of ammunition, explosives and other ordnance stores, to be maintained in the theatre of operations, and the requirements of research, design and experiment, in connection with ordnance stores, mechanical transport, engineer and signal equipment, had given rise to a demand for the representation of the M.G.O.'s Branch in the field.

As regards peace distribution of duties at the War Office, there were obvious administrative and economic advantages in concentrating under one head the Q.M.G. services of accommodation and the R.E. works services, which were responsible for the erection and maintenance of that accommodation. The latter, as already mentioned, were under the M.G.O. in peace, and the Q.M.G. in war.

After discussion which covered some years, effect has been given to these considerations by decisions, of which the following directly affect the Royal Engineers :—

(*i*) The Commander-in-Chief in the Field to be assisted by four Principal Staff Officers :—The C.G.S., Deputy A.G., Deputy Q.M.G., Deputy M.G.O.

(*ii*) The Works Service, under the Director of Fortifications and Works (renamed Director of Works), to be transferred from the M.G.O. to the Q.M.G. in peace—it already was there in war.

(*iii*) The appointment of Engineer-in-Chief (amongst others) to be abolished in war.

In accordance with these decisions, the new *Field Service Regulations, Vol. I*, which will shortly be issued, contains important alterations in the Staff at G.H.Q., which deals with Engineer matters. Below G.H.Q., that is, in armies (when formed), corps and divisions, where the work of the C.E. or C.R.E. is executive as well as advisory, no change is made in the existing organization.

In order to secure the limitation of access to the Commander-in-Chief, advice on technical matters will not be given direct to him unless he definitely so desires, but officers of technical arms will form part of, and be attached to, the appropriate branches of the Staff, so that their advice will be rendered through the four principal Staff officers, according to their various functions.

In the rearrangement of Engineer duties consequent on these considerations, the better co-ordination of Engineer work will be ensured by making one senior Engineer officer, named the Director-General of Engineer Services, working under the Q.M.G., responsible for the technical supervision of all Engineer work, and for the supply of all Engineer stores from base to front. It will be remembered that the responsibility of the Engineer-in-Chief did not extend to the lines of communication, and moreover, that though he advised the General Staff on the rationing of Engineer stores, he had no control over the Director of Works, who was responsible for producing these stores.

Let us consider Engineer duties in war as they appertain to the functions of the four principal Staff officers.

General Staff (Policy).

R.E. duties under the General Staff are allotted to a section of the General Staff Branch under the Director of Staff Duties, composed of R.E. Staff officers, headed probably by a Colonel. The section will be charged with the duties of organizing Engineer work in accordance with the general plan of the General Staff, with the forecasting of future needs, with the collection and dissemination of information required by the R.E., and with the training of Royal

Engineers in the field. Although the technical knowledge of the officers composing the section will obviously be at the disposal of the General Staff, the section will not be responsible for technical advice on Engineer matters. This will be a matter for the Director-General of Engineer Services.

Adjutant-General (Personnel).

The requirements of R.E. personnel, as of other arms, will be a responsibility of the Adjutant-General, on whose Staff there will be R.E. Staff officers, corresponding to the A.G.7 Section at the War Office.

Quartermaster-General (Movement and Maintenance).

Under the Quartermaster-General, the remaining functions of the Engineer-in-Chief, with additional duties, will be performed by a senior R.E. officer, styled the Director-General of Engineer Services. He will be a Major-General, and will be the senior Royal Engineer officer at G.H.Q. for technical duties.

In the words of the new *Field Service Regulations*, "he will exercise a general supervision of the technical methods to be employed by Engineers in the Field." He will issue instructions on technical R.E. matters for the guidance of Chief Engineers of armies (when formed), of Corps and C.R.E.s of Divisions. He will have the power of inspection, in order to see that his instructions are carried out, and he will be available at G.H.Q. for technical advice. Strictly speaking, he will not intervene in the affairs for which the Engineer Section of the General Staff are responsible, but it is not possible (at any rate for me) to envisage a situation in which professional jealousy could intervene to prevent the advice of the most experienced and senior Engineer at G.H.Q. being sought by the General Staff Section on all major engineering problems.

These may be called the supervisory and advisory duties of the Director-General of Engineer Services, but in addition, he will be the executive Head of two Directorates. Under him will work: firstly, the Director of Works, responsible for the arrangement of all Engineer works required at the base and on the lines of communication. This will include work for the transportation service, if there are no special construction units available in that service. Secondly, the Director of Engineer Stores, responsible for the provision of all Engineer stores, both "bricks and mortar" for the Works Service, and "sand-bags and barbed wire" for Field Engineers. Some of these stores must come from overseas, while others will be produced in the field. The Director of Engineer Stores will hold and distribute those coming from abroad, and will establish factories, sawmills, quarries, etc., for those which can be produced in the theatre of operations. It will be remembered that formerly the store duties were performed by the Works Services, who were thus called upon to feed both themselves and Field Engineers. Such an arrangement entailed the disadvantage that when, as must very often happen, the Stores available were not equal to all the demands of R.E. in the theatre, either the Works Services or the Field Engineers had to go short, with a general prevailing doubt on the part of the forward areas as to the spirit of self-sacrifice of the Works Service.

The Director of Engineer Stores will be neutral, and the Director-General of Engineer Services will be in a position to survey the whole area of Engineer activity, so as to instruct the Director of Engineer Stores regarding the allotment of stores on a basis best calculated to forward the plans of the Commander-in-Chief. It is easy to raise difficulties that here he may be in conflict with the Engineer Section of the General Staff, whose duty is the policy as regards engineer work and the distribution of Engineer units. No organization can work on a basis of mutual suspicion and departmental opposition. It is obviously no use the General Staff making plans to push forward a road, and sending road construction companies to work on it, if the Director-General of Engineer Services has allotted all his quarrying and road-making plant for the construction of roads at the base. It is possible to multiply such causes of difficulty. They may arise in any organization, and the personal factor must always be of importance in a large organization of the nature of General Headquarters. The importance of close co-ordination of the work of the General Staff and the Quartermaster-General's Branch in war is a truism. That such close co-ordination must exist between the officers of the Royal Engineers serving in Staff and technical capacities must also be axiomatic. It will be the duty, in case of necessity, of the C.G.S. and the Deputy Quartermaster-General to see that the experience of the Director-General in all technical engineering questions is not ignored by the Head of the General Staff R.E. Section, and that the Director-General is doing everything possible to further the plans of the General Staff by ensuring that the most suitable Engineer stores and plant are available when and where required, and that the best and quickest methods are employed by the R.E. in the execution of their work.

All this may appear self-evident. I mention it only because it is on these lines that objections have been raised to the new organization.

The new *Field Service Regulations* has, of intent, refrained from a very exact definition of the respective spheres allotted to the Director-General of Engineer Services and the Engineer Section of the General Staff. It will be necessary, by means of Staff Exercises and Training in peace, to define these more clearly. What stands out is, that the new Director-General of Engineer Services will, in effect, be a Consulting Engineer to G.H.Q. and Inspector of Engineers in the field, Executive Engineer for all works up to railhead, and to some extent beyond, and purveyor of Engineer Stores. A position of great importance has thus been created, and on a firmer basis than that of the former Engineer-in-Chief.

The Fourth Principal Staff Officer (M.G.O.), Research, Experiment and Design.

The requirements of research, experiment and design of Engineer Stores and of mechanical vehicles, will call for the employment of R.E. officers under the Deputy Master-General of the Ordnance.

Let me now take an imaginary situation to illustrate the relationship between the Director-General of Engineer Services, the R.E. Section of the General Staff and Chief Engineers of formations.

The Commander-in-Chief intends to move I and II Corps forward across a wide river, and over 60 miles of roadless, waterless country, leaving III Corps to guard his right flank and L. of C. by establishing a chain of posts.

The General Staff prepare the operation plan for the advance. The R.E. Section of the General Staff appreciate that the Engineer plan will have to include a M.T. road over 10 miles of loose sand, also water development at certain points on the road, one heavy and one medium bridge on each corps front, and a system of defences including extensive obstacles in the III Corps area.

Before making the Engineer plan, the R.E. section of the General Staff would consult the D.G.E.S. on such points as best type of road, having regard to stores, labour, transport, and time available. Whether existing water sources can be exploited, or whether water should be piped from existing sources; whether tube wells could be sunk; how the available pontoon equipment should be allotted between I and II Corps. The D.G.E.S. would also be asked to produce estimates of time, Engineer units, stores, and labour required for the road, with semi-permanent bridging, water development, and defences and communications of the III Corps. R.E.(G.) will then formulate their plan, allotting R.E. units to corps. The plan would include the allotment of store tonnage on the basis of estimates obtained by D.G.E.S. from Chief Engineers, and the arrangements, in conjunction with the Quartermaster-General's Branch, for extra labour and transport required. The dividing line between Director of Works and Chief Engineer, III Corps, will be laid down as regards R.E. work in L. of C. defences.

As a result of above, Engineer instructions, drafted by the R.E. Section of the General Staff, will be issued with operation orders. It will be necessary for D.G.E.S. to issue supplementary instructions to Chief Engineers on technical points of design and construction, dealing with specific types of work.

Once the above is issued, it is for the D.G.E.S. to see that the methods on which his advice and estimates were based are followed by C.E.s. For instance, that the C.E., I Corps, constructs a plank road, and does not use wire mesh or stone, and that the plans and specifications laid down in his technical instructions are followed. The position of the D.G.E.S. towards Chief Engineers will, therefore, approximate to that which exists in peace between the Director of Works at the War Office and Chief Engineers of Commands. It will be his duty to see that there is no confusion, delay, or waste of effort, when work has to be handed over from one corps to another, or from Corps Engineers to the Works Directorate.

In addition to the above, the D.G.E.S. will have to plan and carry out, through his Works Directorate, any work needed in the L. of C. area for the impending operation, such as construction of camps, development of water supply, additional roads, in preparation for troop concentrations. Information regarding these works must come from the General Staff, either from the R.E. Section of the General Staff to the D.G.E.S. direct, or from C.G.S. to Q.M.G. as regards the wider aspects.

The presence of a R.E. Section in the General Staff will ensure that full emphasis is given to the time required for Engineer work, and the consequent need for early information to the Engineers regarding contemplated operations.

Possibly, in the above outline, I may have conveyed the impression that everything is to be done, thought of, and prepared, at G.H.Q., and that the attitude of Chief Engineers of armies and corps and C.R.E.s of divisions may be a purely static one. Nothing could be further from the intention of the *Field Service Regulations*. Engineer Commanders of every grade must help in trying to prepare for eventualities. I can only say from some considerable personal experience as the Senior General Staff Officer of a Division, Corps and Army in France, that the attitude of sitting quiet and waiting for orders from above was never one which characterized Engineer Commanders in the field. Indeed, as a harassed Staff Officer, I have often found myself wishing that it did.

That, gentlemen, concludes my review of the work of the Royal Engineers and the developments of its connection with the Quartermaster-General. Much of what I have said about the past is doubtless familiar to you ; some of what I have said about the future may conflict with your personal views. For myself, I can only say that the preparation of this paper has brought home to me, in a way which nothing else could have done, the gradual development of the Royal Engineers from a small body of somewhat doctrinaire exponents of an exact science to a Corps whose motto, *Ubique*, expresses not only the widespread location of its technical employment, but also the predominant position of its officers in all the varied functions of an army.

THE BRIDGE PROBLEM OF THE BRITISH ARMY.

Winning Essay for the Cooper's Hill War Memorial Prize, 1929, *by*
CAPTAIN C. P. WORSFOLD, M.C., R.E.

WRITING an appreciation is the recognized method of solving a tactical or strategical problem. The bridge problem is alike in its complexity, so that it would seem appropriate to adopt the same method for its solution. This involves, firstly, defining the object to be achieved, then weighing the factors affecting the attainment of the object, and, finally, making a plan.

Definition of the Problem.

The object in this case is to organize, equip, and train, the British Army so that in war the passage of rivers may be effected with ease and speed. The commander of the whole, or any part of it, must not be hampered in his liberty of manœuvre, either by lack of means to cross any bridgable obstacle, or by an excessive train of bridging equipment. Finally, there must be an adequate provision for the maintenance of communications.

PRINCIPAL FACTORS BEARING ON THE PROBLEM.

Limitations of Finance.

In peace, finance is the most important factor in all problems of military organization. There is an ever-present urge for economy, which rules out frequent changes of equipment in large quantities, or additions to peace establishments. Developments in engineering, however, render equipment obsolete. Increased weights of military vehicles make heavier bridges necessary, and heavier equipment needs more men to handle it. The great mobility added by mechanization means that more rivers may have to be crossed in a given space of time and more equipment is, therefore, required.

Methods of meeting the need for economy.—On the other hand, manufacturing processes become ever more rapid, and at the same time, mobilization is a more leisurely affair, so that much equipment may be manufactured on the outbreak of war. Small peace establishments for engineer units can be rapidly expanded with partially-trained men from the engineering trades, organized as in the Supplementary Reserve. Lack of training may be compensated by standardizing and simplifying equipment, though standard designs must be kept up to date by continuous research and experimental work.

If supply, on mobilization, is properly arranged, it may be possible to reduce the equipment held in peace to the amount required for training purposes. Desirable changes of pattern could then be introduced at small expense.

Role of the British Army.

Bridging requirements are affected to a great extent by the conditions under which the British Army may be expected to take the field. It is unfortunately impossible to prepare for all eventualities. All that can be done is to select the most probable and make provision for meeting that, at the same time planning the alterations required under other possible sets of conditions.

Most probable campaign.—From past history, the present international situation, and a study of the frontiers of the Empire, it may be deduced that the most probable employment of the British Army is in an undeveloped territory, against an enemy equipped with modern rifles, machine-guns, and, possibly, a considerable artillery. It is, however, conceivable that it might have to go to the rescue of a Dominion in defence of its territory, or to act as the advanced guard of the nation in arms in a European theatre of war.

If operations are to be conducted in undeveloped country, it follows that transportation facilities will be poor. Therefore, the amount of bridging equipment carried with field formations must be reduced to a minimum, though the fact that it may be more difficult to get equipment forward must be taken into account. The equipment and its transport must be robust, to stand the long distances over rough going, and every part must be easily portable. The effect of climate must be allowed for in determining the materials of which the equipment is made.

The possession of machine-guns and artillery by the probable enemy, renders a certain amount of assault bridging equipment essential, though perhaps not on the scale necessary in a "national" war.

The possible use of the British Army in support of a Dominion points to the desirability of using the same type of equipment throughout the Empire.

Tactical Considerations.

Time.—The most important tactical factor is time. The passage of a river must not delay a force longer than is absolutely necessary. The bridging equipment should, therefore, be devised so that bridges may be ready by the time the troops, or vehicles, which are to cross them, are needed on the other side. This naturally involves a series of different types of bridge to meet the needs of the various arms, and of the stages in the attack.

Location of equipment.—It is obviously essential that the bridging equipment, and the men to use it, should be on the spot when they are needed. Long intervals of time, however, frequently elapse between major bridging operations. It is an unsound policy to burden mobile formations with the impedimenta which they may need for the passage of the one important river in the theatre of war, though it may be many days' march away, if it can be sent forward from the rear when it is wanted. In principle, bridging material should be kept as far back as possible, consistent with its being available at the place and time when it is required.

The distance in rear at which it may be kept is a matter which can be calculated with reasonable accuracy from known data, such as the distance at which aircraft reconnaissance, or other means of intelligence, may be expected to reveal the presence and approximate width of a river, the time which the formation will take to march that distance, and the time required to get equipment forward. A substantial factor of safety must, of course, be allowed in such a calculation.

Maintenance of tactical integrity.—Another important tactical point is, that every commander must be permitted to keep his force intact. A cavalry division must not be compelled to leave its armoured cars behind for lack of bridging or rafting equipment, or an infantry division tanks which may have been allotted to it. Every detached force must be equipped to allow all parts of it to cross any bridgable obstacle that it may meet.

The assault on a river position.—An opposed river-crossing is a most difficult tactical operation. The usual process is, first of all, to get infantry across to form a bridgehead, under cover of darkness, smoke, or violent artillery bombardment; secondly, to follow them up closely with their supporting weapons—mechanized machine-guns, anti-tank guns and close support artillery; thirdly, to move forward part of the field artillery, and, finally, to send over the remainder of the force—reserves, transport and ancillary units.

The conditions imposed on the leading infantry make it necessary that their bridge should be of the simplest description, inconspicuous, very portable, not easily damaged by fire, and, above all, suited to rapid construction by unskilled men. It must be provided on a generous scale, to ensure that the enemy's fire shall be distributed over a large number of bridges. The present Kapok equipment seems to provide a complete solution to this problem for rivers of moderate width and current.

Bridge for infantry-supporting weapons.—The question of a bridge for the infantry-supporting weapons is much more difficult, and it is, perhaps, a little premature to suggest that a design should be attempted, seeing that the method of carriage of these weapons is far from being finally settled.

It is evident that they will have to follow the infantry very closely, and that, in consequence, their bridge may have to be launched under rifle and machine-gun fire. The ideal would be to have an equipment which could be constructed under cover and then towed down to the site by the vehicles to cross it, in the same way that the infantry carry their own Kapok assault bridge. There are many technical difficulties, however, in designing a simple, robust and cheap equipment to this specification. Owing to the steady increase in the weight of the vehicles involved, it is probable that a rafting arrangement will be the compromise, in spite of the time wasted and the inevitable exposure of men to bullets.

Passage of field artillery, etc.—The increased range of field artillery makes it unnecessary to move batteries across a river until the infantry have got some thousands of yards ahead. There should be ample time, therefore, to construct a medium or even a heavy bridge of pontoon equipment before batteries have to cross. This bridge can then be used for the remainder of the force.

Number of pontoon bridges needed by an infantry division.—Tactical considerations always govern the number of assault bridges, and frequently the number of pontoon bridges required for the passage of a river. It is necessary to bear this in mind when settling the scale of equipment. The normal needs of supply, and of the passage of troops and vehicles, can be met by two medium bridges on a divisional front, but tactical necessity frequently demands three or four crossings for medium and, in some cases, heavy loads.

Heavy bridge for an infantry division.—Although medium tanks are not included in the war establishment of an infantry division, it is reasonable to suppose that no advancing infantry division will be without a few of them. At least one heavy bridge is, therefore, likely to be needed by a division under normal circumstances.

Cavalry needs.—The cavalry are often detached to perform tasks in advance, or to the flank, of the main body. It is, therefore, fitting to consider their special requirements with regard to bridges.

One of the main advantages of the retention of the horseman, in these days of mechanization, is that he can swim across a river. There is, accordingly, no need to worry about his bridging needs. But in addition to mounted men, a cavalry division has armoured cars, and mechanized machine-guns, anti-tank guns, artillery and transport.

Armoured cars.—Armoured cars must range far and wide away from the main body of the division. Their tactical advantages are their extreme mobility, and their comparative inconspicuousness. These advantages would be entirely negatived if they had to be accompanied by vehicles carrying bridge equipment. If they cannot get forward with equipment carried on the car itself, they must use their mobility to find a way round. It should be possible to carry on the car itself a pair of light joists for crossing shell holes and trenches. It might be possible to add to them inflatable floats, and so make a rafting arrangement, but that is the most that can be expected.

Need for a light bridge.—The primary role of the mechanized machine-guns is defensive. They occupy positions on which the mounted squadrons can fall back. It is unlikely that the cavalry would be ordered to seize a bridgehead if the further bank were strongly held by enemy machine-gunners. It may, therefore, be supposed that bridging for the mechanized machine-guns, following the mounted squadrons at some distance, would not be exposed to enemy machine-gun fire. Ordinary pontoons might be used, but they are not well adapted to these "light" loads. Their use on the scale required by the tactical situation would involve a great waste of material. A special "light" bridge would be much better.

The opposed crossing of wide rivers.—Crossing wide rivers, in the face of opposition, presents particular problems. During the Great War, there were several instances of attempts to cross wide rivers being defeated with very heavy loss; the Turkish attempt on the Suez Canal; General Maude's attempts to cross the Tigris, etc. These instances demonstrated that the effect of machine-gun fire on men in open boats was devastating. The possibility of attaching armoured protection to pontoons might be worth consideration. Armoured "bellums" were successfully used by Townshend at Amara, and the armoured lighters, called "Beetles," used in the landing at Anzac, saved a lot of casualties. In particular cases it might be possible to adopt the original method employed by the American who escaped from Sing-Sing. He walked under water for several hundred yards, breathing through a tube attached to a float at one end, and at the other end to a face-piece. Such a method would give excellent protection from enemy bullets, and might be feasible if the current were not too strong.

The needs of an armoured force.—Bridging for the armoured force offers a very difficult problem. If the force is employed on an independent mission, it must have means to get across a river. Even if it succeeds in finding an intact bridge on its way out, there is the danger of the bridge being blown up behind it, and its retreat being cut off. Its wide radius of action might necessitate crossing several small rivers, and these rivers must be crossed quickly, if full advantage is to be obtained from its mobility. Rafting, though economical in material, is too slow. There is also the problem of crossing in the face of opposition. It is evident that, with the present equipment, it would be impossible to get a single vehicle across a river if the far bank were held by an enemy armed with machine-guns.

On the other hand, an independent mission is not necessarily the only, or even the normal, employment of an armoured force, according to present ideas. It will usually be employed with normal formations who will be responsible for meeting its bridging requirements. A special type of equipment for the armoured force would be an expensive luxury. The only alternative is to provide it with sufficient pontoon equipment to meet its probable needs, when it is ordered on an independent mission. There still, however, remains the question of getting across a river in the face of opposition. The solution to this may be the floating tank, or, at any rate, a means of rapidly attaching floats to a tank without exposing men to bullets, combined with a gear for crawling up and down the steep banks of streams. Or it may be possible to produce an "assault" bridge for the lightest tanks. It is a problem inviting research.

Technical Factors.

Need for an increased supply of bridging material.—Before the Great War, all the vehicles of a division could cross a lightly-built timber trestle bridge. In consequence, little time was wasted in improvising with materials found locally. The advent of the tank and the mechanization of transport have greatly increased bridge loads, and in consequence, improvisation with local materials has become too slow a process. It is, therefore, necessary, not only that an increased amount of portable equipment should accompany the expeditionary force, but also that there should be a plentiful supply of material for the semi-permanent bridging which replaces the portable equipment.

Design of floating bridge equipment.—It has already been argued that the design of equipment should be as simple as possible, and that it should be standardized. It is also desirable that it should be adaptable to as many different uses as possible. There are, however, definite technical limitations to the design of an equipment to suit greatly varying loads. The floating bridge pier is the chief stumbling-block. If it is sub-divided too much, the fastenings become unduly heavy, and the piers required for the greatest loads become difficult to handle in the water. It is apparent that every equipment can be designed to suit a range of loads of a reasonable degree. The determination of this range demands very careful consideration, both from technical and tactical points of view.

As regards the ranges of present equipment, the Kapok bridge is ideal for infantry in single file, adaptable for infantry in file, possible, though unsatisfactory for pack animals and for rafting light tanks, motor vans, and horsed vehicles. The next range, the pontoon equipment, is designed for medium loads, that is, the maximum loads of the infantry division as it appears in *War Establishments.* It is quite satisfactory as a heavy bridge to take medium tanks, and six-inch guns. It is clumsy and unsatisfactory as the light bridge needed by light tanks, field artillery, mechanized machine and anti-tank guns, cavalry transport, horsed vehicles, marching infantry etc.

A new intermediate floating bridge suggested.—The present equipment is the outcome of experience in the Great War, but great strides in mechanization have been made in the last ten years, and to-day, it seems that some intermediate floating bridge is called for. In its lightest form, it might take pack animals, infantry in file, and vehicles of the nature of the Carden-Loyd machine-gun carrier. In its heaviest form, it might be designed for armoured cars, 30-cwt. six-wheeled lorries, and field artillery drawn by tractors. It might be the normal cavalry divisional equipment, and also be given to the infantry division for the passage of the infantry supporting weapons in the attack. Possibly, it could be adapted to the needs of the armoured force for an assault equipment.

Passage of swift rivers and dry gaps.—The main bridge problem is the passage of the river for which a floating bridge can be used, but there are the subsidiary problems of crossing swiftly-flowing rivers, shallow dry gaps and deep ravines.

The passage of infantry across a swift river under fire is a most difficult operation. Probably the only solution will always be to choose some point of crossing where the current is sufficiently slow to permit the use of Kapok equipment. The light Inglis bridge was developed during the War for crossing distances up to about 120 feet in a clear span, but such an equipment would seem a luxury for the type of campaign which is our primary concern. Bridging for the infantry to assault across a ravine, or other dry gap, will so seldom be necessary that it is evidently not worth while providing a special portable equipment for the purpose.

Clear span bridges.—For vehicles the present trestle equipment has been evolved as the result of years of experiment, and seems entirely suitable for shallow rivers, and shallow dry gaps. For ravines up to 100 feet in width, the box girder, divided up into portable sections, has been devised. For longer spans, the only solution appears to be the suspension bridge, since the weight of girder bridges in proportion to the load they bear increases very rapidly after about 100-foot span.

The chief difficulty about suspension bridges, is in providing a sufficiently good anchorage for the cables in a short space of time. The possible use of rapid-setting cement should not be overlooked in this connection.

Equipment for crossing dry gaps.—As regards the carriage of equipment for dry gaps, there is always the possibility of the enemy cratering a road, blowing up a bridge over a railway, or a culvert, and so creating an unforeseen dry gap. This will usually be made in a place where a détour for vehicles is impracticable.

It is necessary that there should be some trestle and girder equipment well forward to meet this contingency. About thirty yards of medium trestle equipment, with, perhaps, sufficient box girders to take medium loads over a sixty-foot gap, might reasonably be allotted to an infantry division for this purpose. A cavalry division, with its superior mobility, should, as a rule, be able to avoid the necessity of bridging a dry gap. Moreover, it would seldom have the time to spare for the construction of girder bridges. As for trestle equipment, the cavalry will, in any case, need some for the shore bays of its pontoon bridge.

Semi-permanent bridging.—When time is not so pressing, economy comes to the fore. That is why it is necessary to arrange for the replacement of "equipment" bridges by bridges of cheaper and more permanent construction. It is not essential that the parts of these bridges should be very portable. The more they accord with ordinary civil engineering practice, the easier it will be to provide them in war. It is essential that time and labour should not be wasted through trying to improvise with unsuitable materials. Facilities of transportation have greatly increased in recent years, and there is to-day small reason why the engineer should not have an ample supply of stores sent up from the base when he cannot find suitable material locally.

Railway bridges.—There has been no appreciable change in the problem of constructing military railway bridges in the last thirty years. The experience of both the Great War and the South African War is available to determine the amount of stores which may be required, and the best organization of the transportation engineers for carrying out the work. Railway construction itself is not sufficiently fast to warrant the use of portable equipment, as in the case of road bridges. The chief directions in which improvements might be effected are in the use of portable power, and the application of recent new engineer materials, such as rapid-setting cement and alloy steels, to speed up work.

Transport.

Effect of motor transport for bridging equipment.—Motor transport can move two or three times the distance that a normal division can move in one day. The use of it for bridging equipment, therefore, makes it possible to keep the equipment with rearward formations, corps, or army, and send it up when it is needed. It is essential that the motor vehicles should be able to travel across country even when fully loaded, so that they may be brought as close as possible to the bridge sites. The recently-developed six-wheeled motor lorry seems to meet requirements in this respect.

Means of economizing in transport.—So much transport is locked up by keeping all the portable bridging equipment on wheels, that the question of whether transport should be provided for the whole of it is worth examination. Sometimes, for weeks or months on end, the equipment is not needed. As a rule, it is then dumped and the transport released for engineer work. This, however, does not justify the provision of more vehicles than are absolutely necessary. There is no doubt that all the pontoon and all the assault equipment might be required simultaneously, but that is only likely to be so when a large-scale attack on a river position is planned. It is probable that such an attack would take several days to prepare, during which the force would be halted. In consequence, a quantity of transport would be released which could be used for bringing up such bridging equipment as did not require special vehicles.

There remains the problem of moving the stores as the formation advances, when no surplus transport is available. In the division, the only solution seems to be to have everything on wheels. Most of the bridging equipment, however, can be located back in corps and army areas, where it should be feasible to keep it in parks near the railway. As the advance progresses, new parks could be established for corps by railing equipment from the base, the army taking over the corps parks, and in turn, handing on its equipment to an advanced base. This method might be applied to all equipment other than that requiring special vehicles. The latter must, of necessity, be entirely on wheels.

Engineer Mechanization.

The mechanization of military engineers is being tried out in two directions, namely, the supply of power in a portable form to speed up engineer operations, and the carriage of engineer personnel and tools in motor transport.

Use of power in a portable form for bridging.—The civil engineer to-day makes a very wide use of portable power tools, such as pneumatic drills, picks, shovels, saws, riveters, hoists, wood borers, etc. Many of these are adaptable to military needs. For bridging, power might be applied to lifting and hauling, pile-driving, timber-cutting and boring, metal-cutting, drilling, riveting, concrete-mixing, etc. Provided, therefore, that experiment leads to the conclusion that these tools can stand the very rough usage, and the unskilled attention which they will inevitably get in the field, it follows that the saving of time justifies their forming part of engineer equipment.

Carriage of engineers in motor transport.—There are many arguments in favour of the carriage of engineers in mechanical transport. From the point of view of bridging, it should have an important influence in speeding up work. The control of the engineers could be centralized, thus giving increased facilities for the co-ordination which is necessary in bridging operations. Concentration of engineers for a particular bridging task would be easier to achieve. It would be possible to leap-frog engineer units, so that when once a unit had been entrusted with the construction of a certain bridge, it would be unnecessary to move it until its task were complete. This would involve the elimination of differences between units for constructional engineering, the field company, and the army troops company, but would lead to a great economy in the use of engineer personnel. If units were leap-frogged it should be possible to manage with less motor vehicles than would be required to carry the entire personnel of all the companies. This would reduce the heavy cost which is the chief obstacle to the adoption of the scheme.

Character of the Terrain.

Need for an engineer study of the theatre of war.—Equipment must, from its nature, be suited to average conditions, since it must be designed long before the commencement of a campaign. The material and plant sent out for semi-permanent bridging should, however, be suited to the conditions in the theatre of war, and the local resources, if any. This demands, in peace, a close study of the available intelligence respecting districts in which operations may take place, both as regards the rivers, and the possible local supplies of timber, steel, stone, cement, etc. It is not sufficient to wait until the expeditionary force has arrived, and then to send out what is demanded. The material will always arrive too late.

Training.

Simplicity in equipment.—The principle of economy of force makes it undesirable to have special units exclusively allotted to bridge building. Bridging must, therefore, have a part in the training of every engineer. Since it is only a part, it follows that the equipment must be made as simple as possible, and training must be confined to essentials.

Principal points in unit training.—The saving of time in bridging is the chief matter from the tactical point of view. Tactical efficiency is more important than technical efficiency, since it is vital to the success of operations. Moreover, technical efficiency can be acquired by practice during the campaign. Training should, therefore, be directed towards the saving of time. This involves paying most attention to drill, watermanship, and the handling of heavy weights. Drill, because it quickens all operations, particularly when it may be necessary to undertake them in the dark. Watermanship, because pontoons demand good handling in the water, and bad handling is a very fruitful cause of delay. Practice with heavy weights speeds up the construction of girder bridges.

Take advantage of India for collective training in bridging.—Collective training in Great Britain offers little opportunity for large-scale bridging operations, owing to the lack of important rivers in training areas. In India, however, there are much better facilities, and the large part of the British Army stationed in that country might be specially exercised in them.

Things to practise during collective training.—Collective training is intended for the purpose of practising things which require the co-operation of the different arms, and of the staffs of formations. From the bridging point of view, this should include the organization of bridging reconnaissance, co-operation of engineers and infantry in the assault on a river position, exercise of the engineer headquarters and the staffs of formations in planning bridging operations, and the organization for ensuring that the bridging equipment is at hand when it is needed.

The Plan.

Having discussed the main factors bearing on the bridge problem, it is now necessary to frame a plan for its solution. It will be convenient to outline the plan under the headings of equipment, organization, training, research, and preparation for war.

Equipment.

Cavalry division equipment.—Taking the various arms in the order in which they may be expected to arrive at the point to be bridged, the first formation to be considered is the cavalry division.

It is reasonable to suppose that, with aircraft available, the commander-in-chief, before dispatching a cavalry division on a detached mission, will be aware of all major rivers (say, over forty yards average width), which it may be called upon to cross. For these major rivers, or if he attaches medium tanks to the cavalry, he can allot additional equipment from army reserves.

It is, therefore, recommended that the permanent provision with the cavalry division should be sufficient for forty yards of a bridge suitable for all its vehicles, and a " tactical " bridge of similar length for its mechanized machine-guns, and anti-tank guns.

Thus the cavalry division bridging equipment would be :—

(1) Present pontoon equipment, including trestles for shore bays : 40 yards medium, 40 yards light.

or preferably the same quantity of :—

A new " intermediate " floating bridge equipment which, in its heaviest arrangement, would take all cavalry divisional loads, and, in its lightest, mechanized machine-guns.

(2) For armoured cars : light joists and possibly inflatable floats which could be carried on the cars.

Infantry division equipment.—The next consideration is the infantry division. This is a slow-moving formation, and there will always be such ample warning of the proximity of the smallest stream, that equipment can be sent up from corps.

For training purposes and emergency use it is necessary to provide the infantry with some assault bridging equipment, both for men on foot and also for the supporting weapons, machine-guns, anti-tank guns, and close-support artillery.

It is suggested that sufficient material for an opposed crossing of a sixty-foot stream on a battalion front would meet the case. An average amount to allow would be eight bridges for infantry and four for the supporting weapons.

From this and previous conclusions, the equipment of the infantry division might therefore be as follows :—

(1) Kapok equipment : 160 yards.

(2) New "intermediate" equipment in light arrangement, as for cavalry : 80 yards.

(3) Present trestle equipment : 30 yards for medium loads.

(4) Box-girder equipment : 60-foot span for medium loads.

Armoured force equipment.—To the armoured force, no permanent allotment of the present pontoon equipment should be made. Some means must be found for getting its lightest tanks across a river under machine-gun and rifle fire, either by adapting the proposed intermediate equipment, if practicable, or by attaching floats, a propeller and crawling-out gear to the tanks themselves.

Corps equipment.—The corps must carry sufficient bridging equipment to meet the needs of its infantry divisions, in the passage of such rivers as may have to be crossed with insufficient notice to send forward equipment from the army. Army aeroplane reconnaissance may, at least, be expected to reveal any river over twenty yards in width, a hundred miles ahead of the leading infantry division. A hundred miles is seven days' march, so that there should be ample time to get bridging equipment from army engineer parks for all rivers over twenty yards wide.

On this basis, it is recommended that the corps should be provided with sufficient assault and pontoon equipment to enable two infantry divisions, accompanied by tanks, to get across a river twenty yards wide. The amounts necessary for this purpose would be as follows :—

(1) Kapok equipment for six battalions : 960 yards.

(2) New "intermediate" equipment in light arrangement : 480 yards.

(3) Present pontoon equipment, sufficient for one heavy and two medium bridges per division (allowing one medium for tactical purposes) : 56 yards heavy, 112 yards medium.

The corps also requires box girders, tube piers, steel cubes, joists, decking and other bridging stores, to enable its engineers to release the portable equipment for further work ahead. These might be provided on the basis of one complete replacement of the pontoon equipment, further replacements being met from army or base reserves.

Transport should be provided for all portable equipment requiring special vehicles, such as pontoons, for fifty per cent. of the assault equipment, and perhaps twenty per cent. of the remainder.

Army equipment.—The army should hold enough bridging equipment to assist corps over all rivers of the normal width to be met with in the theatre of war. Exceptionally wide rivers, which might be taken as those more than a hundred yards wide in the vicinity of the point of passage, are usually well known. The possibility of having to cross them can be foreseen in time to forward bridging material from the base.

The army may also be called upon to supplement the pontoon equipment of a cavalry division, or to provide equipment for an armoured force to enable it to execute an independent role. It must have girders, and other bridging stores for semi-permanent work to release the portable equipment for further use.

On this basis, it is recommended that the army should be equipped as follows :—

(1) Sufficient "Kapok" bridge to supplement the corps equipment for the passage of a river up to 100 yards wide.
(2) New intermediate equipment on a similar scale.
(3) Present pontoon equipment. Sufficient to supplement corps and cavalry divisional equipment for the passage of a river 100 yards wide, and to provide, in addition, at least two heavy rafts for the armoured force.
(4) Box-girder bridges, tube piers, piles, steel cubes, steel joists, decking, cement, fastenings, etc., for one complete replacement of the corps portable equipment.

Transport for army equipment.—As in the case of corps, transport need not be provided for all this equipment. The scale of transport might be :—

(1) All pontoon equipment.
(2) 30 per cent. assault equipment.
(3) 10 per cent. remainder of bridging material.

Base reserves of equipment and stores.—Finally, it is necessary to consider what should be kept at the base. There are three demands which have to be met, viz. :—

(1) The replacement of wastage in portable equipment.
(2) The extra portable equipment required for an exceptionally wide river.
(3) The need for large quantities of semi-permanent bridging material during an advance to free the portable equipment for further work ahead.

The replacement of wastage can be assessed from experience in past campaigns.

The amount allowed for the exceptionally wide river must be settled for the particular theatre of war from intelligence collected in peace. An arbitrary width of a quarter of a mile might be taken as the basis of provision plans in peace, the amount actually dispatched with the expeditionary force being varied as required.

The base reserve of steel bridges and of bridging stores also depends very greatly on the circumstances of the campaign, such as the distance from home, character of the country, local resources, etc. The lack of any determinate basis should not be allowed to result in the dispatch of the expeditionary force without any of these stores. The requirements for the most probable theatre of war should be worked out, and arrangements made in peace for provision to meet them. If some other war should break out, the necessary adjustments to supply could be made on mobilization.

Organization.

Centralizing the control of engineers.—Bridging is to-day the most important function of the military engineer. It is, therefore, reasonable that engineer organization should primarily depend on what is most suitable from the bridging point of view. Efficiency in bridging operations demands close technical control, concentration of engineers, co-ordination in depth by an engineer commander, and an assured supply of stores, transport and labour. Given the mechanization of engineers, these desiderata can best be achieved by centralizing engineer control. This might be done by withdrawing the permanent allotment of engineers to the infantry division, and forming them into a brigade under the chief engineer of the corps. In this way, the services of the engineers could be utilized with maximum efficiency. It does not mean that the leading divisions would be deprived of engineers, and their commanders of engineer advice, any more than that they would not be allotted tanks or heavy artillery if they needed the latter. But it does mean that the chief engineer of the corps would be able to concentrate the whole engineering force of the corps on the execution of important tasks, such as bridging. He would also have full control of the consumption of the stores, which it is his function to provide, and would be in a stronger position to get the transport and labour needed.

It necessarily involves the provision of mechanical transport for the carriage of engineer personnel, though not for more than about half, since work can be organized so that units are leap-frogged forward. This transport will often be available to meet the large demands of engineer work for which little allowance is made in present *War Establishments.*

Reconnaissance and liaison arrangements.—From the bridging aspect, if engineers are concentrated under corps control, it is essential to make special provision in their organization for reconnaissance, for liaison with leading formations, and for engineer advice to the commanders of those formations.

Reconnaissance can best be carried out by small parties of an officer and one or two other ranks, equipped with motor-cycles, or perhaps a small cross-country motor-car. These parties must accompany leading units and have means for the rapid dispatch of information to the rear.

Engineer advice is best given by the engineer commander responsible for carrying out the work. Engineer commanders must, therefore, expect to be normally at headquarters of formations and often detached from their units. Their presence at headquarters also solves the problem of liaison, but it is necessary that recognition should be made of the need for the frequent detachment of the commander, with a small liaison group, when framing establishments.

Transport arrangements for equipment.—If there are no engineers permanently allotted to the division the carriage of the divisional bridge equipment might devolve on the divisional R.A.S.C., a few sappers being attached for maintenance purposes.

Corps and army equipment should, however, be kept under engineer control, so that there may be transport available for other engineer work. Bridging parks might form part of the centralized R.E. organization of those formations. As previously stated, it should be entirely unnecessary to keep the whole of the equipment on wheels, a hundred per cent. transport being provided only for such equipment as requires special vehicles, for instance, pontoons.

Training.

Features of unit training.—It has been deduced that the three principal features of peacetime individual and unit training in bridging should be drill, watermanship and the handling of heavy weights.

Drill in the use of equipment is the first essential, since it will quicken bridging operations at their most critical stage. It must be taught not only to the engineers, in the use of pontoon equipment, but more essentially to the infantry in the use of their assault equipment, since they may be called upon to work under more severe conditions of fire and darkness. Drill in the use of Kapok equipment, and of the proposed intermediate equipment, must, therefore, form a conspicuous part of the training of every infantry unit.

Watermanship is entirely a matter of practice in handling heavy boats and pontoons. It is impossible to make sappers into efficient watermen, unless a great deal of time is devoted to practice. The annual bridging camp is not long enough to provide sufficient time, so that it is necessary to seize every opportunity throughout the year of training sappers in the handling of boats.

Dealing with heavy weights, launching girders, use of derricks, etc., are matters in which engineer officers and N.C.O.s require constant exercise, both in practice and theory. They can be practised at the unit's station all the year round, as well as at the annual bridging camp, since they do not necessitate a wet gap.

Special features for collective training.—The matters to which special attention should be directed in collective training, are as follows :—

(1) The organization of bridging reconnaisance.

(2) The exercise of the staff and the engineer headquarters in planning bridging operations.

(3) Movement forward of bridging equipment from the engineer parks of rearward formations.

(4) Co-operation of the engineers and other arms in forcing a river-crossing.

Full advantage should be taken of the more favourable conditions in India for collective training in bridging operations.

Research.

Problems inviting research.—The principal problems which invite research and experiment at the present time, are :—

(1) The evolution of a new floating bridge equipment to provide :

- (*a*) In its heavy arrangement for the passage of the heaviest cavalry divisional load.
- (*b*) In its light arrangement for pack transport, mechanized machine-guns, anti-tank guns and close-support artillery.
- (*c*) Possibly an assault bridge for the lightest armoured fighting vehicles in the armoured force.

(2) Any alternative means of getting light tanks across a river under machine-gun fire, whether by raft, or by detachable floats, combined with propelling machinery and crawling-out gear.

(3) The provision of light joists to enable armoured cars to cross shell holes, trenches, etc., and possibly inflatable floats, which could be carried on the car and used for the crossing of rivers.

(4) The protection of infantry from machine-gun fire in crossing wide rivers.

(5) The application of power to military bridging. Power might be applied to lifting, hauling, launching pontoons, pile-driving, concrete-mixing, timber-cutting and boring, metal-cutting, drilling, riveting, etc.

(6) The use of rapid-setting cement in military bridging.

Direction of research.—The control of research has been efficiently conducted for a number of years by a board of technical officers, the R.E. Board. If any improvement is possible, it is in the method of initiating research. The direction of research policy is in the hands of the General Staff, but in directing policy, the Staff must be kept informed of technical possibilities. Better liaison might be achieved by making a senior member of the General Staff at the War Office president of the Board, the senior Technical Officer retaining his present co-ordinating duties, and ranking as deputy-president.

Preparation for War.

Arrangements for supply on mobilization.—In order to save expense and to facilitate the adoption of the latest improvements, it is desirable to provide, in peace, only sufficient equipment to admit of peace training, leaving as much as possible to be produced on mobilization. Although mobilization is to-day a leisurely proceeding, there is not sufficient time to improvise supply arrangements. It is essential that these arrangements should be worked out in peace. The preparations might include, first of all, a schedule of articles required to complete the bridging equipment of units of the expeditionary force, and to stock the engineer bridging parks, showing the time by which they will be needed; secondly, a list of the contractors who can supply the stores, with details of their manufacturing capacity and usual stocks; thirdly, the dovetailing of these lists together and the preparation of draft orders on contractors, designs, specifications, and possibly jigs, so that manufacture may be as rapid as possible. The adoption of commercial sizes and designs, wherever possible, without serious detriment to military requirements, would greatly facilitate supply. The responsibility for the preparation of such a mobilization scheme should, of course, rest with the War Office branches responsible for the provision of engineer equipment and stores.

Preparation of an engineer plan in peace.—It has already been suggested that an engineer study of the conditions in the most probable theatre of war, is needed to ensure that adequate and suitable bridging material accompanies the force sent. This study is only part of the larger matter of framing an engineer plan to foresee and provide for all engineer arrangements required during the advance of the expeditionary force from its base until contact is gained with the enemy. The need for such a plan is obvious.

Unfortunately, there is no engineer co-ordinating authority, such as an engineer-in-chief, to whom the framing of this engineer plan could be entrusted. The next best solution would seem to be to give the task to a War Office committee, composed of representatives of the engineer personnel, provision and research authorities, and of the part of the General Staff concerned with operations and intelligence, under the chairmanship of the senior engineer officer.

Besides working out the engineer plan for the most probable war, such a committee might be required to examine the modification necessary for a national war. It might also be made responsible for recommending arrangements for ensuring the Imperial standardization of bridging equipments.

"FORTIFICATIONS IN 1914–18."

"One does not fortify by systems but by good sense and experience."—*Vauban.*

By BT. MAJOR G. I. THOMAS, D.S.O., M.C., *p.s.c.*, R.A.

I. LIÉGE AND VERDUN.

General.

It is convenient to deal generally with Liége and Verdun under the same heading, for, as we shall see later, they both differed materially from the German fortifications at Metz, and both belonged in essentials to the same school. The systems of defence advocated by all writers on the subject during the years subsequent to the Franco-Prussian War of 1870 were, in nearly every case, "guided by the three following considerations: that works should be as little visible as possible; that cement concrete cannot be seriously injured by high-angle fire, either with shells or obus-torpilles; that guns in cupolas will out-last a great deal of hammering, even if they may at last succumb."* The fortifications of the frontiers of Belgium and France were overhauled and reconstructed commencing about 1880–88 in accordance with the theories advocated by General Brialmont,† one of whose forts has been described as follows:—‡

"It is triangular in form, as being easy to adapt to the ground and having the minimum number of sides to be flanked. The ditch had a counter-arched counterscarp, 16 feet high, of a very solid construction to resist obus-torpilles, the arches being 8 feet 6 inches thick in cement concrete. The exterior slope of the parapet at 2/3 forms the escarp. The parapet is about 26 feet thick, arranged for musketry only, except at the angles, where are cupolas for machine-guns.

"In the centre of the fort is a large mass of cement concrete, hollowed out underneath into magazines and stores, illuminated by electric light and artificially ventilated. This concrete mass carries, at its highest point, a look-out place and an electric light.

"In front of this is a large cupola for two 15-cm. (5·9-in.) guns. This has a command of 3 feet 3 inches over the outer parapet. To right and to left of this, at the same level, are two cupolas for one 12-cm. (4·7-in.) gun each, and in front of the guns there are three

* *Text Book of Fortification and Military Engineering*, Pt. II, 1893, p. 164.

† Lieut.-General Henri Alexis Brialmont, 1821–1903, *Fortification du Temps Présent* and other works.

‡ See * *Ibid.*, p. 165.

cupolas each for one 21-cm. (8·24-in.) rifled mortar. These are 3 feet 3 inches below the outer parapet, and, therefore, hidden from the enemy. The gorge,* both escarp and counterscarp, is arranged for casemates for men and stores. The only way for the infantry to get to the outer parapets is by the stairs in rear of the concrete mass."

Forts of this description were usually sited on what were considered in those days to be good artillery positions, and so we find them on the top of hills commanding with direct fire the country in the immediate vicinity. The whole work is flat and does not usually break the contour of the hill when seen from a distance, whilst it was camouflaged from ground observation by growing turf over the white concrete; planting small trees, laurel bushes, etc.

Liége.†

The defences of Liége, commenced in 1888, consisted of twelve detached forts, half large and half small, and equally divided between the two banks of the Meuse. They formed a girdle around the town on a perimeter some 30 miles in extent, at an average distance of about 4 miles. On the east, towards Aix-la-Chapelle, and on the north they were about 2½ miles apart, whilst on the south the interval was bigger and there were three on a front of 7½ miles. All the forts were the recognized Brialmont type, though four of them were in the shape of a quadrangle, with the addition of traditor‡ guns in cupolas for the defence of the glacis to the front and flanks, and in casemates in the counterscarp for firing along the ditch. In 1914, the armament consisted of 15-cm. (5·9-in.) and 12-cm. (4·7-in.) guns, and 21-cm. (8·24-in.) howitzers mounted in cupolas. The guns were in twin turrets (except in the case of the 12-cm. in the small forts), but the howitzers were single cupolas, two in the large and one in the small forts. The traditor guns were 5·7-cm. (2·3-in.), the number varying.

All the cupolas were without exception disappearing, and no doubt their role is well put in the following quotation from the *Encyclopædia Britannica* of that time: § "Before quitting the subject it may be well to offer a few remarks on the employment of cupolas or turrets in land defences. Either of these forms of iron construction may be advantageously employed in advanced positions where it is necessary to retain guns until the very last—such as the salients of ravelins and in the angles of fronts of fortifications; also in points which are commanded from heights in their vicinity. As these constructions are indestructible by the direct fire of siege guns, and are absolutely safe from enfilade or reverse fire, they confer very

* *i.e.*, the ditch on the side farthest from the enemy.

† For much of the detail the author is indebted to *La Bataille de Liége*, by Colonel A. de Schryver.

‡ *i.e.*, quick firing guns for close defence.

§ 1879 edition reprinted 1898.

great advantages upon the defence. They should mount heavier guns than can be brought against them ; . . . ; and, at any period of the attack, they can meet its artillery with heavier metal." In 1909, the Engineer Staft of the Austrian Army only refers to a siege train "including howitzers of at least 10½-in. calibre,"* whilst our own regulations in 1910 only gave details for the construction of a siege platform up to the 9·45-inch B.L. howitzer as "heavier pieces . . . do not yet form part of the service siege equipment."† If the Belgians had had the least idea of the size and weight of the shells with which the Germans were going to bombard them we may be certain that they would have caused "the said bulwark before the said Milk Gate to be made so massy that it be not bateable."‡

Each fort was provided with armoured look-out posts, which, of course, only gave a direct view over the immediate countryside up to 1,000 to 1,500 yards, and also on to the tops of the more distant ridges. But the nature of the country implies a great deal of dead ground which it would be useless to search even with howitzers if there is no proper observation, and the Belgians only possessed a very few. To assist in repelling assaults by night, searchlights were installed in all forts in disappearing armoured cupolas.

The ditch round the forts was not very deep, about 17 feet, so that the entrance to the rear was down a gradual slope and never by a bridge. In some cases an infantry trench was dug on mobilization on the top of the counterscarp, to which it seems very doubtful if there were any underground passages. There were no machine-guns, either in cupolas or mobile. It had originally been the intention to raise one machine-gun company with each of the Fortress Reserve Regiments of Infantry which comprised the actual garrison, but, when it came to the point, this could not be done owing to lack of equipment. The living quarters were quite comfortable and well up to the standard of any continental barrack-room. They were lit by electric light, there seems to have been some form of central heating, whilst ventilation was partly natural and partly artificial with armoured ventilators on the rampart. Passages were narrow, but quite large enough.

What did Liége achieve in 1914?

Liége lies on the banks of the Meuse, at its confluence with the Ourthe, absolutely in a hole, completely surrounded by hills which rise abruptly from the main part of the town itself. It is an important industrial centre. Its population undoubtedly increased to an enormous extent in the 24 odd years before August, 1914. It is

* Para. 9, *Permanent Fortification for the Imperial Mily. Training Ests. and for the instruction of officers of all arms of the Austro-Hungarian Army*, by Major Moritz Ritter von Brunner.

† Para. 27, *Military Engineering*, Pt. II, 1910.

‡ Nichols' *Chronicle of Calais*, 1540, edited for the Camden Society, London, 1846.

difficult to say whether the Commandant ever had any authority over what buildings were or were not allowed to be constructed in the immediate vicinity of the fortified zone. Certain it is that in 1914, as it is at the present day, houses existed everywhere right up to and around the very forts. Clearing a field of fire was attempted, but was from the first a hopeless task. When the Germans attacked, a front of about 4 miles facing Aix-la-Chapelle, between Fort Fleron (then as now the most important) and Fort Barchon, was alone even reasonably clear, whilst in the wooded area to the south of Liége all efforts were given up as useless. In general, the country between and in front of the perimeter of forts is undulating, close and wooded. No doubt partly to overcome the difficulties due to the country, the agglomeration of buildings, and the limited view from the forts themselves, the defence scheme allowed for the manning of O.P.s in church towers, etc., at anything up to 2 miles in front of the perimeter. These were given 1 company of infantry for local protection, but, even so, they were right out in front of the main line of infantry redoubts, which were themselves sited abreast of and actually in the intervals between the forts. These redoubts seem to have been constructed mainly to cover the roads and tracks, but there is such a lot of dead ground that it was impossible in the time available to build sufficient to cover everything or even to make them mutually supporting. Barbed wire entanglements were everywhere very elementary. There was not enough wire, and the necessary transport did not exist to convey pickets, etc., out from the town. The mobile batteries intended to cover the redoubts in the intervals did not get into action in time and took no part in the defence.

The German plan for the capture of Liége was the work of Ludendorff and was bold and simple. It was carried out by General von Emmich with six columns of all arms, assisted by the Cavalry Corps of General von der Marwitz. Briefly, each column was ordered to detach parties to mop up the forward O.P.s, blind the searchlights, and contain the forts, whilst the main bodies forced their way through the intervals and seized the Meuse bridges and the town itself. This, with initial vicissitudes, was accomplished successfully, no doubt largely the result of the withdrawal by the Belgians of their 3rd Division, which they were afraid might be surrounded. Having thus isolated the forts, the Germans proceeded to subject each fort in turn to a violent bombardment, in which 42-cm. (16·8-in.) howitzers took part, directed from the air with aeroplanes and a Zeppelin.

Shortage of money had prevented the Belgians from constructing a permanent work covering the ford at Lixhe, the point at which the Germans crossed the Meuse. Whether economy was also responsible for the poor quality of the concrete used in the forts cannot be said, the fact remains that 22 cupolas out of 56 were put permanently out of action. German cavalry crossed the frontier on 4th August, the town and citadel of Liége was captured on 7th August, the last fort fell on 16th August.

The Belgians have always maintained that their defence of Liége gained three or four days for the Allies. On the other hand, the German "Schlieffen" plan for the invasion of France placed their armies on the line Thionville–Sédan–Mons on the 22nd day of mobilization (*i.e.*, 23rd August), and that is actually just about where they were on that date.* Be this as it may—consider for one instant the plight of the Liége forts. Manned entirely by reservists, isolated by the withdrawal of the 3rd Division from the field works, surrounded where they were never constructed for all-round defence, cut off by the fall of Liége town from all chance of obtaining ammunition or supplies, the armament blinded by the loss of the forward O.P.s and impotent against shell fire of a size and intensity never before dreamt of, with men going mad from the detonations and suffocating from the H.E. fumes—who will cavil at their white flags? In Fort Loncin, to which the Belgian Commandant, General Leman, had retired, the last act of the drama came when a 42-cm. shell penetrated the superstructure and blew up the magazine. This fort is now a museum and a meeting place for a club of the remnants of the defenders in memory of their oath to die together in defence of their country—300 Belgians are buried amongst the debris. A club of the survivors of such an oath may to the cynic sound humorous—let him go and see the place—it must have been a terrific explosion which blew gun turrets into the air to descend upside down, and filled the centre with enormous blocks of concrete refuse across which stumbled the wounded and semi-conscious Commandant.

Verdun.†

Verdun has always been fortified since the days of the Romans, and, in the centuries since, it has frequently been besieged. About 1880, the French started to reconstitute the defences into the form which they now have; for the forts of Verdun on the north, joined to Toul on the south, formed the defended area of "les Côtes de Meuse," which was an integral part of the frontier protection of France as planned a few years previously by General Séré de Rivières. Between that date and 1914, they spent over the whole country about 16 million sterling—Fort Douaumont is said to have cost £240,000. When the war broke out Verdun was protected by a ring of forts, sited in depth, on a circle round the town at a maximum radius of some 8 miles. They were all Brialmont type, but considerably strengthened and improved. The actual trace varied with the site, as at Liége; thus Fort Vaux was quadrangular, the smaller

* See footnote, p. 33 *Official History Milty. Operations, France and Belgium*, 1914.

† For much of the detail the author is indebted to an article on "Fortifications Françaises et Allemandes," by Colonel R. Normand, which appeared in *La Revue Militaire* in May and June, 1925.

forts triangular. Constructed in the first instance of brick, the most important were later rebuilt with concrete, *e.g.*, Vaux and Douaumont; Fort Tavenne and many others were still brick in 1916.

The armament consisted of 155-mm. long guns (6·2-in.) and shortened 75-mm., the latter sited for use as traditor guns and for the defence of the intervals for which, in addition, intermediate works were constructed. All guns were in disappearing cupolas, protected with 30 cm. (12 in.) of armoured plate. The country around Verdun is comparatively open and a far better view is obtained from the forts than is the case at Liége, furthermore the town itself is small and there was, and is, no tendency at all for buildings to spread out into the fortified zone. The gun turrets were placed in the central rampart or on the counterscarp, which in this case had a ditch in the glacis, and were connected to the centre of the fort by underground passages. Complete reliance was not, however, placed in the guns of the forts, which were not very numerous, but the intention was to provide the main artillery defence from mobile batteries, fed by narrow-gauge railways. There were armour plated O.P.s and disappearing twin machine-gun turrets, but no searchlights. The ditch was very deep, and in some cases (as at Tavenne) entrance was effected by a bridge.

Ventilation was natural, and was assisted by the passage in the main works being wide and very high, whilst the barrack rooms themselves were lofty. There was no electric light, even the gun turrets were controlled in action at night by lanterns, and the washing, etc., arrangements for the garrison were very primitive and uncomfortable. All the contrivances for the comfort of the troops, of which traces can still be seen in Douaumont, sleeping bunks, wash-houses, the canteen, operating theatre, electric light operated from a Diesel engine-room, were all installed after its capture by the Germans.

The Verdun Forts during the War.

The plans drawn up by General Séré de Rivières in 1874 had provided France with several lines of forts which covered Paris very effectively towards the north and north-east. In the succeeding years the results of the general trend of policy had been to "declassify" all forts on the northern frontier, *i.e.*, north of the Verdun area—for example, Lille was declared an open town in 1914.

In August, 1915, the French General Staff,* influenced by the rapidity with which the forts of Liége, Namur, Maubeuge, Warsaw, etc., had succumbed, decided that fortifications of such a nature had no further role in modern war, and that their resources in guns

* See p. 220, *Les Armées Françaises dans la Grande Guerre*, Book III, Part 2.

and garrison should be released for use with the field army, from which alone a decision could be expected. The Territorial Divisions which formed the garrisons were therefore sent elsewhere, and the heavy and field guns were removed. For the September, 1915, offensive in Champagne, eighty 75-mm. guns and some 100,000 shells were taken from the Verdun forts alone.

The Germans opened their big offensive against Verdun on 21st February, 1916. Fort Douaumont, which up till then had been in the third trench line, perhaps 3 miles from the front line, and was only held by a small maintenance party, was captured by surprise on 25th February. Fort Vaux, deprived of its 75-mm. guns for flanking fire, could not assist Douaumont, and on the 8th March was powerless to prevent an attack on the Bois de la Cailette by seven German battalions, who assembled under its very nose in a hollow, to command which its now empty casemates had been built.

On 12th March, 1916, General Petain brought the forts once more into the picture. He let it be known that experience showed that forts were not the shell traps they were reputed to be. In fact, they had shown themselves very largely shell-proof, and far better organized for defence than hastily constructed field entrenchments. He ordered that they should be re-armed at once, the turrets put in proper repair, fresh garrisons detailed, and that they should take their place as part of the general defences of Verdun, to which end the demolition charges placed in all the turrets, etc., were to be withdrawn. Thereafter the forts were used consistently and considerably strengthened. Underground M.G. emplacements with tunnels leading to them were built in the glacis—piles of chalk, etc., were placed to thicken the protection over the passages leading to the counterscarp works—underground chambers were constructed at a depth of 60 to 70 feet—long tunnelled galleries, often 200 to 300 yards long, and in which a trench tramway line was laid, provided a safe entrance and exit to the forts—whilst the water supply was assured by wells. Everywhere where it was possible to replace the guns, the turrets remained in action throughout the rest of the War, and the forts themselves proved invaluable as bomb-proof shelters where front line and reserve troops could get rest and hot meals. The effect of the German shells of all calibres is a fine tribute to the work of the French Engineers. Douaumont, where the whole rampart and environs is pock-marked with craters, is the only fort that actually let a shell into the main superstructure. Here one French 400-mm. (16-in.) shell came in through the side and blew up a German grenade dump and many men—and in addition a German 420-mm. (16·8-in.) came in through the roof of the passage at the point where the thickness of the overhead concrete was reduced from 5 yards to 2, and destroyed a barrack room and a company of

French infantry. Some of the weaker observation posts and machine-gun turrets were wrecked, but not one of the disappearing gun turrets was ever put permanently out of action, a statement which is not qualified by the case of the cupola in Fort Vaux which blew up owing to a German shell detonating the demolition charge which had at one time, in common with all the turrets, been placed inside it by the French.

The action at Verdun was of quite a different nature to that at Liége. The circle of forts was never surrounded, the forts were never isolated, only four, *i.e.*, Douaumont, Vaux (both without guns), Souville, Tavennes (both with guns), were ever in or really near the front line. The intervals were elaborately organized with field entrenchments held by the pick of the French Army, supported by a mass of skilfully led mobile artillery fully provided with aeroplane and balloon observation. We do not in any way belittle the extremely gallant defence of Verdun by the French if we remain unconvinced that its success was due to the forts, and reserve for the moment our decision as to whether the design of General Brialmont adequately fulfils all the requirements of permanent fortifications in modern war.

II. Metz.

The Germans started to overhaul the defences of their Western frontier soon after 1891, when von Schlieffen became Chief of the Staff. The system which they adopted, known as "Dispersed points d'appui," was radically different to that employed previously by other nations, and has been well summed up by Major Brunner.* He says :—

"There are still those who say that the modern forts with their active means of defence crowded close together form a very good target for the enemy, in spite of their small dimensions. They contend that the small width of the target lends itself to concentrated fire, and that the various positions, the flanking galleries, close range parapet, gorge buildings and the long range position, lying as they do one behind the other, all come within the danger zone of heavy howitzer and mortar fire.

"Thus, if the fire is directed at the cupolas of the long range position, shots which fall short are likely to damage the flanking galleries, while shots which are over the target may injure the gorge buildings.

"Several proposals to overcome this difficulty have been made. Some advocate the dispersion of all the component parts of the fort, others. . . . The first arrangement may be described as a system of 'Dispersed points d'appui' . . .

* p. 62, *Permanent Fortifications*, by Moritz von Brunner, 1910 (quoted before).

"The advantages of this system are :—

(1) The dispersion of the target.
(2) It is easy to conform to the lie of the ground.
(3) Less dead foreground.

"The disadvantages are :—

(1) The difficulty of obtaining unity of command.
(2) Liability to assault owing to the impossibility of surrounding the whole position with a deep ditch.
(3) Difficulty in choosing the necessary enfilade fire positions.
(4) The communications cannot be fully protected; for the cost of constructing the necessary lengths of bomb-proof passages would be prohibitive.*
(5) The cost is from 50 to 80% more than that of the ordinary modern fortress.*

"When considering the advisability of using this system we must remember the increased effect of artillery fire. Some of the disadvantages might, of course, be overcome by employing a picked garrison."

At Metz, the construction of these "points d'appui," or "Feste," as the Germans christened them, was inaugurated personally by the Kaiser in 1899. The best known is perhaps the Feste de Mercy (la Marne),† which was completed in 1911 at a cost of approx. £900,000, or nearly four times the price of Douaumont, and was sited as a defence against attack from the direction between Nancy and Pont à Mousson. This *feste*, which is about 5 miles from the centre of the town, consisted of three infantry works, arranged in a triangle, and two armoured batteries. The whole of the works cover a ground surface area of 14 acres and are all jointly interconnected by some 3,000 yards of concrete passages, often 150 feet underground. The centre work was the most important. Here, on the first storey, were the barrack rooms, bathrooms, etc., for the garrison, which consisted of 500 men exclusive of the artillery; on the second, lower, storey were all the installations, *e.g.*, bakery, cook-houses, boilers for central heating, engine-room, oil storage, water tanks, etc. Everywhere was electric light, and electrically operated artificial ventilation, with a manual system superimposed in case of accident. The telephone exchange (one *feste* had 300 lines) was alongside the Commandant's Office, and he himself was provided with an electric lift to take him up to his armoured O.P. The works were surrounded by barbed wire, a steel palisade, and a concrete-faced ditch, relying for close defence upon machine-guns and pom-poms, some of which fired along the ditch itself. The batteries, each usually of 2 or 3 turrets, consisted of 105-mm. (4·2-in.) or 150-mm. (6-in.) guns under cupolas

* This did not deter the Germans.

† Described p. 154, Normand, in *Revue Militaire*, May, 1915, already quoted.

8 in. thick, which were not of the disappearing type. The mountings were fixed and the muzzles projected several feet out of the cupola. Each battery had its own control O.P. The surrounding countryside is very similar to Salisbury Plain, yet these *festes* were remarkably inconspicuous, for everything was below ground level, and the batteries were only visible from the air.

In the years immediately before 1914 the Germans spent everywhere on fortifications more than twice as much as the French. The works at Metz were sited in depth and represented the last word in concealment, dispersion of the target presented to the enemy, mutual support, and concentrated local fire power, " wherein we may say that nothing hath been forgotten, either in wealth, diligence, invention or plenty of stuff."*

The main artillery defence was, as at Verdun, intended to be provided by mobile batteries.

Metz during the War.

Profiting by their experience on all fronts the Germans, in the course of the War, considerably strengthened the Metz defences. They installed 77-mm. guns in double cupolas to flank the intervals between the *festes*, and on the twelve-mile front between Arry (on the Moselle) and Sorbey, a line 8 miles south of Metz, they scattered over a depth of a mile more than 1,900 concrete pillboxes.

A few American shells falling in a suburb was the nearest Metz got to actual war. At the risk of appearing critical, it is curious that the vulnerability of protruding gun muzzles had not occurred to the Germans, and spare pieces were no cure. Furthermore, the lot of the garrison, hidden in the concreted bowels of the earth, would have been anything but enviable when the electric ventilating apparatus commenced to suck down air contaminated by gas shells. Whether the turrets would have stood up to shell fire as well as the Verdun ones did is problematic. The French have stated that the German concrete was not as well laid as theirs, and the armour plate over the cupolas was certainly four inches thinner.

III. Epilogue.

Liége fell because the field defences were sited in the intervals between the forts instead of well out in front of them—because the essential observation posts were to all intents and purposes indefensible and their loss made the forts blind and their armament useless—because it was deprived of the assistance of the field troops and the forts were accordingly isolated. Verdun was successfully defended as a result of the extreme gallantry of a very large field army, fighting

* La Noue, a Huguenot, in *Political and Military Discourses*, 1587, when referring to the citadel of Antwerp.

in entrenchments elaborated during fourteen months of trench warfare; this system was, on the greater part of the front, thousands of yards in front of the perimeter of forts—the majority of the actual forts were only subjected to long range bombardment, which they withstood remarkably well, whilst their armament formed a very small percentage of the guns available—as concrete bomb-proofs these forts proved an invaluable asylum for the defending infantry, for which role they were not constructed—as *points d'appui* they showed themselves capable of prolonged defence, and the most sanguinary underground fighting occurred before they changed hands. Metz was never subjected to the acid test of war, but, if it had been, the very immunity which its garrison obtained by burrowing so deep might well, with gas shell, have proved its undoing.

Prophecy is dangerous, but it seems that there are certain deductions to be drawn which will enable us to frame some suggestions as to the design that the permanent fortifications of the future may take.

1. Fortifications will be sited in depth over an area in preference to the former linear perimeter. These areas will shield rather than surround the centre they are required to protect. The flanks will rest on natural obstacles or frontiers. Their full power will only be produced by the presence of first line field troops. They will act as bastions which will facilitate manœuvre by the main army, and by their potential strength they will form strategic obstacles to an enemy. They will probably not be in the immediate vicinity of the frontier. The area may be large, perhaps 50 to 100 miles, but then the cost of the works to be erected in peace will not be very great.
2. Isolated forts, *qua* forts of the old type, will not be built. In their place will be constructed:—

    (*a*) "Points d'appui" with great powers of local defence—a very modified type of *feste*.

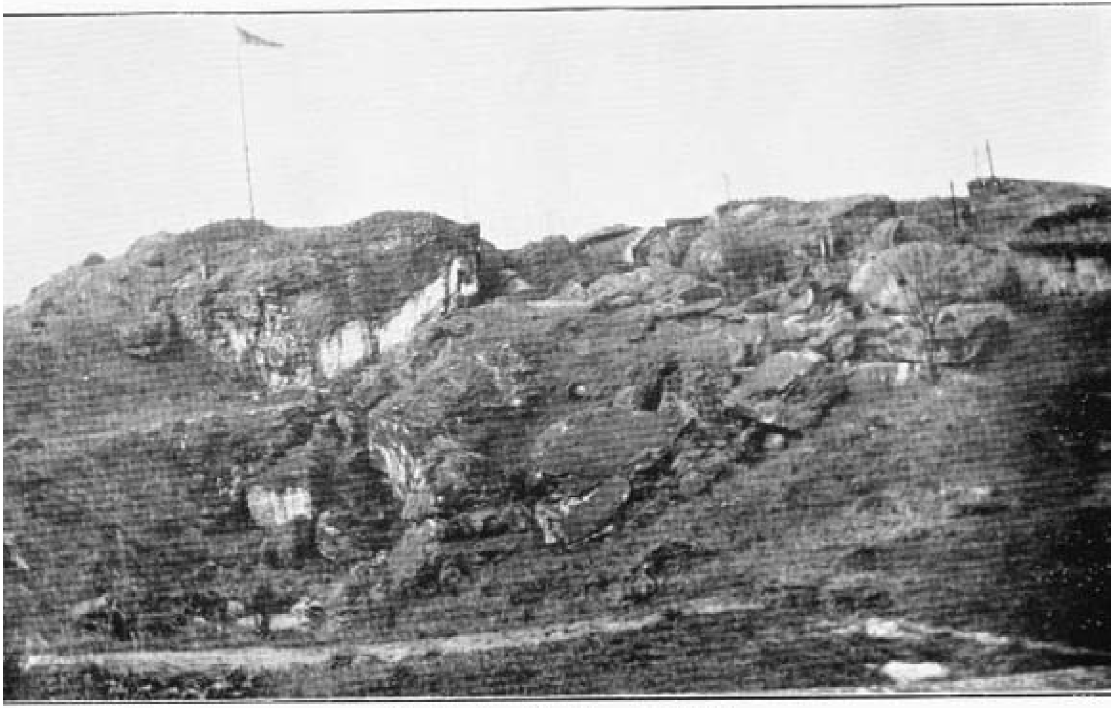
    (*b*) Bomb-proof underground shelters.

    Both (*a*) and (*b*) will provide cover and strong points around which the mobile defence will be organized.

    (*c*) Armoured observation posts with an extensive system of telephone communications laid in pipes well underground. (W/T and R/T may avoid the necessity for the latter.)

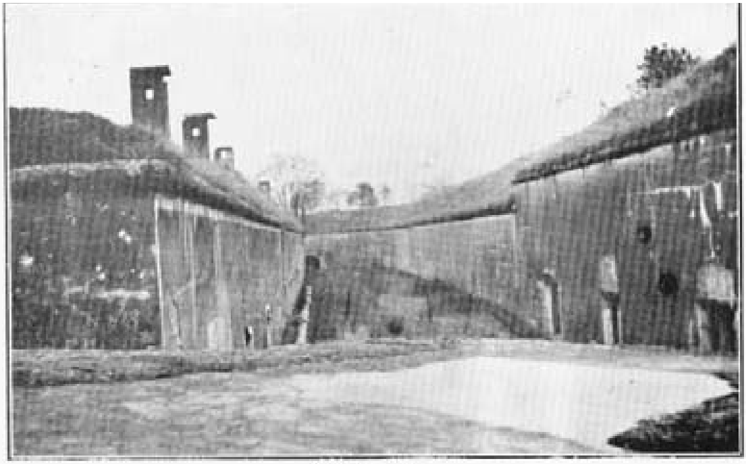
    (*d*) A limited number of skilfully sited casemates for flanking fire, armed with machine-guns or quick-firing guns.

    With all of the above, depth will be the essence of the lay-out.



The interior of Fort Loncin in 1928.

The interior of Fort Loncin in 1928



Fort Loncin.
Looking along the Gorge.

Fort Loncin
The southern part of the main rampart, showing a howitzer turret upside down.

Fort Loncin

3. Now that the heaviest gun can be mounted on a travelling carriage, none of the artillery of the defence will be placed into permanent works (other than traditor guns mentioned at para. 2 (*d*)).

   The power of the counter-battery organization is such that any battery in an immovable concrete position is ultimately certain to be located, and even if it cannot be destroyed it will inevitably be neutralized. All the artillery will therefore be mobile; in peace, it will be cantoned near or in the defended area; in war, it will occupy previously selected positions where a careful plan of cultivation will provide natural concealment, and where a short line will connect the battery to the permanent telephone system and so to the existing armoured O.P.s. This policy would be an economy and an immense improvement on the old practice, for should the course of the war justify it, all the defended area artillery could be withdrawn for use with the field army.
4. All permanent buildings in the area must have gas-proof chambers, and some installation whereby the supply of pure air can be guaranteed.
5. Tactical tank obstacles, on the principle of tactical wire, must be prepared so that they are immediately available, for an "attaque brusquée" by an armoured mobile force is most to be feared.

The influence which fortifications can exercise in the realm of grand strategy is rarely alluded to. In the case of the German plan for the invasion of France, Von Schlieffen certainly considered them. He knew the line of the Meuse and Moselle from Verdun to Epinal bristled with forts. He was aware that the French had neglected to keep up-to-date the fortifications facing the frontier north of Verdun. He correctly appreciated the powers of resistance of Liége. He rightly assessed that Alsace-Lorraine would attract a French offensive like a magnet. He foresaw that if he attempted an ambitious enveloping movement then his right wing could never be too strong. He therefore strongly fortified his southern flank, only leaving a gap of difficult wood and lake country, and when these works were approaching completion the "Schlieffen" plan was adopted. In 1912, von Moltke stated that the violation of Belgian neutrality "presents more chances than a frontal attack against the fortified screen in eastern France, which would result in the operations degenerating into a war of fortresses, occupying many months, and tending to deprive the army of the *élan* and initiative which are its greatest assets."* General von Kuhl in *Der*

* Ludendorff, *Documents du G.Q.G. Allemand*, quoted by Normand, p. 150.

Marnefeldzug wrote that "only the existence of the line Verdun–Toul–Epinal–Belfort compelled us to undertake the invasion *via* Belgium."*

The French plan has been severely criticized by many writers. Their III Army observed Metz, whilst they launched their I and II Armies, to be weakened as the offensive progressed, into the difficult terrain in the gap between the Metz defences and the Vosges. The effect which the "declassified" fortifications on their northern frontier might have seems to have been overlooked, and it was anticipated that the Germans would make the same mistakes as themselves and attempt to manœuvre large forces through the openings in their fortified line, *i.e., via* Stenay, north of Verdun and *via* Charmes, between Toul and Epinal—the one 18, the other 30 miles wide. In *Les Bases du plan XVII*, the French General Staff forecasted to within two Divisions the numbers which Germany would deploy against them, but they miscalculated by twelve Divisions the strength of the force which could be rapidly detrained and concentrated north of Trèves, and hence failed to appreciate the true danger of the outflanking movement through Belgium which they suspected might develop. Furthermore, "it was estimated that an important role would be played by the group of armies which would concentrate behind the Metz–Thionville position, and it was always believed that, for reasons of policy and morale, the Lorraine plateau would prove an attraction to the Germans."† In 1876, when he planned the northern defences of France, General Séré de Rivières laid it down that "the role of these places is no longer to ensure the possession of great cities or centres of communications, but to cover mobilization, to protect concentration, either to allow operations against the flank of an invader to be staged in complete security, or to serve as pivots of manœuvre, *or finally to ensure protection against turning movements which have become such a danger in an age when the improvement in firearms has deprived a frontal attack of any chance of success.*"‡ The italics are mine. The shade of this able soldier must have been a very perturbed spectator at the Council on 18th April, 1913, when Plan XVII was adopted.

* Quoted by Normand, p. 151. Von Kuhl was Chief of Staff to Von Kluck.
† See p. 40, *Les Armées Françaises dans la Grande Guerre*, Book I, Vol. 1.
‡ p. 146, Normand, *Revue Militaire*.

L.O.X.

(The Modern High Explosive.)

By Col. R. E. M. Russell, c.b.e., d.s.o., *Military Attaché, Chile.*

1. A visit recently paid to the great Chuquicamata copper mine, in Northern Chile, gave the writer an insight into the use as a high explosive of carbon soaked in liquid oxygen (familiarly known in this context as "L.O.X."), which may be of some interest to his brother officers and to the Service generally.

Nothing is to be learned on the subject from Service, or other easily accessible, textbooks, and the writer has only once previously come across an instance of its practical use, namely, in 1926 and 1927, for the blasting of rock in the construction of the canals and power house of the Shannon hydro-electric plant between Limerick and Killaloe.

There may even be others who share the writer's previous ignorance of the fact that the saturation with liquid oxygen of a mixture of finely-divided carbon and soot, without any further ingredients or process of any kind, produces immediately an explosive whose rate of detonation is 40 per cent. higher, and whose locally destructive effect is 20 per cent. greater than those of commercial 65 per cent. ammonia dynamite, and which is reasonably safe to handle in bulk, though easily detonated by cordeau without the use of any primer or other detonator. And, further, that this explosive, after the lapse of a few hours, becomes, by the evaporation of the oxygen, again completely inert. The sole product of the chemical action which causes the mixture to detonate is the inert but non-poisonous carbon dioxide gas.

The only raw materials required for its manufacture are charcoal, soot and air; and the only plant necessary consists of air filters and compressors (driven by any available source of power), expansion vessels, pumps, and vacuum insulated containers.

2. The scale on which the Chuquicamata mine works will be apparent from the description that follows and will enable an appreciation to be formed of the value of the experience which is there gained.

The bulk of the ore is of low grade, averaging 1·6 per cent. of metallic copper, but the deposit constitutes the largest single copper ore body in the world. It occurs close to the surface, necessitating the removal of an overlaying sterile stratum of only a few metres in thickness, in order to expose an ore bed, covering an area of 2½ kilometres by 1¾ kilometres to a great depth, there being sufficient ore in sight to enable mining to be carried on by surface methods at the present rate for some eighty years.

The issued capital is approximately £30,000,000, held almost entirely in the United States, and the mine is potentially the greatest producer of copper in the world, being fully equipped for dealing with 50,000 tons of ore per diem, though it is at present being held back by market considerations to the third place amongst producers with an input of 32,000 tons of ore per diem. This enormous quantity is put through the mill day in and day out, with mathematical precision, the variations between one day's supply and another being extraordinarily small.

The whole of it, and also the corresponding waste covering, is quarried by the use of explosives of various natures, according to the nature and situation of the rock or soil to be moved. Some six million pounds weight (2,700 tons) of explosives are consumed each year, making this mine probably the largest user of explosives in the world.

Individual blasts at Chuquicamata are large, black powder shots which dislodge masses of rock averaging 250,000 tons each, and high explosive shots which dislodge masses averaging 80,000 tons each.

The largest single shot yet fired involved the use of 788,000 lb. of dynamite and 76,000 lb. of black powder—altogether 385 tons of explosive (L.O.X. had not then been introduced)—in 8-in. bore holes, averaging 52 feet deep. Twenty miles of cordeau fuse were required to ignite it.

Before the introduction of L.O.X., an ammonia dynamite of about 65 per cent. strength was being exclusively used in the hard underlying ore body, where a strong disruptive as well as a displacement effect is required for breaking the rock. Part of this dynamite was manufactured in a neighbouring factory, and the remainder, under the trade name of "Sikrit," imported from Norway.

It was desired to attempt to effect economies by replacing this relatively high-priced explosive in the smaller blasts, but it has not been considered economical to replace the black powder which is manufactured by the mining company itself on the spot, at very low cost.

L.O.X. was accordingly introduced on a considerable scale in 1927, and as a result of a year's experience, it has been decided to triplicate the present plant, which is capable of producing 126,000 lb. of liquid oxygen per month.

The cost comparison is very favourable to L.O.X., which works out (including full provision for overhead charges, manufacturing losses, etc.) at 8½ cents (U.S.A.), or about 4¼ pence per pound, as compared with 16 cents or about 8¼ pence per pound of dynamite, while the "duty" factor, for blasting in bore holes on existing faces, has been found to be 3·78 tons of rock broken per pound of L.O.X., against 2·9 tons for dynamite.

3. The proposition appears an extremely attractive one for military purposes, but there is at present one grave disadvantage, namely, that the technique up till now employed necessitates the preparation of the explosive immediately before use, while the transport of the saturated carbon, or of the liquid oxygen alone, for any considerable distance or time, involves a high rate of wastage by evaporation even when carried in bulky and delicate vacuum insulated containers. The extent of this loss may be appreciated from the fact that it has been established that in a bore hole charge fired 1¼ hours after commencing to soak the cartridges, only 58 per cent. of the oxygen used originally in soaking them is usefully employed, and within three hours after laying the charge is completely inert. The industrial purposes to which the explosive is at present confined are not insurmountably inconvenienced by this characteristic, but further research and experiment are necessary before L.O.X. can be made available for anything approaching general military use.

Trouble has been experienced in attempting to use L.O.X. in small diameter holes in underground workings. A large mine in Peru, working under these conditions, and using 2-in. and 1½-in. drill holes, has abandoned its use after several accidents thought to be caused by the abnormally high rate of oxygen evaporation from the relatively large surface of the small bore cartridges.

4. Before entering into details and technicalities, a short general description of the method here used of preparing and using L.O.X. may enable the process to be more readily understood.

(*a*) 8-in. bore holes in the mine face are drilled and cordeau laid from the bottom to about 9 in. above the top (but not connected to the firing mains).

(*b*) Liquid oxygen is manufactured by compressing, cooling and expanding clean atmospheric air, and is stored in 1,000-gallon vacuum insulated containers in a building alongside the railway track.

(*c*) Cylindrical "cartridges," consisting of a mixture of two grades of finely-divided carbon, one as fine as soot and the other slightly coarser, loosely contained in canvas bags, 7 in. in diameter by 20 in. long (weight, 8 lb.), or 5¼ in. by 12 in. (weight, 3½ lb.), are packed in heavily-insulated wood soaking boxes, carried on shaded railway cars alongside the oxygen house.

(*d*) The liquid oxygen is run through flexible hoses into the soaking boxes in sufficient quantity to enable each cartridge to absorb a pre-determined weight of the liquid, and the cars are run out to the site of the blast.

(e) The "wet" cartridges, now weighing about 31 lb. (or 14 lb. each), and "steaming" freely, are off-loaded on to hand-barrows and placed alongside the bore holes, where they are dropped by gravity to the bottom (average depth 45 feet), and tamping sand shovelled in. The cordeau leads are then jointed up to the cordeau firing mains. Total time from oxygen factory to time of firing about 70 minutes for a train of about 1,000 31-lb. cartridges, which necessitates extremely smart work, everyone moving at the run.

5. BLASTING PRACTICE.

(a) *Drilling.* All charges are fired in 8-in. bore holes, whose depth is regulated by that of the working face, and averages about 45 feet. These holes are drilled by "jumper" (locally called "churn") drills, operated electrically. The pattern which has been standardized is the Saunderson "Cyclone" portable mine rig, type 14 S.R., driven by a motor using 23 amperes at 500 volts, manufactured at Oreville, Ohio, U.S.A.

Eighty-seven of these rigs are in constant use, 24 hours per day in 3 shifts, and drill about 36,000 feet per month, at an average cost of 5s. 1d. per foot run, including full provision for overhead and maintenance expenses. Many of the holes have to be lined for 10 or 15 feet with light steel tubing, owing to the disintegration of the ground caused by previous explosions.

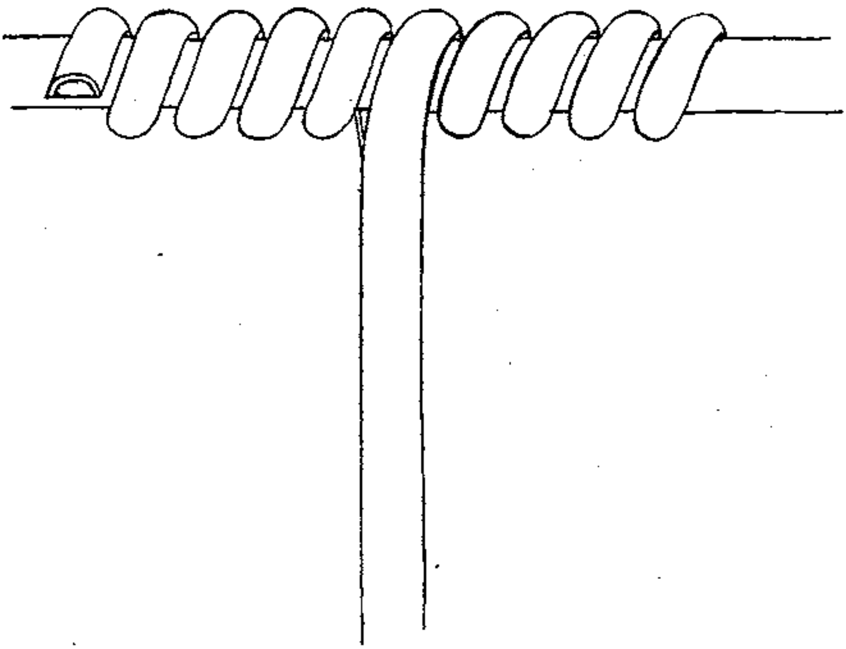
(b) *Charging.* Each hole is individually sited by a mine engineer, and its position recorded on a map. As drilling progresses, an accurate record of the material passed through is kept by the foreman, and with these data shot plans are made up in the mine engineering office, and a "prescription" issued for each hole. Certain holes are chambered or "sprung" at the bottom by the explosion of small charges, in order to enable main charges of as much as 2½ tons to be concentrated. Some holes are given multiple charges, varying weights of different explosives being laid at different levels in the hole and separated by sand tamping.

The use of a free running explosive is desirable for charging the chambers, and some difficulty was expected when L.O.X. was substituted for Sikrit, which is a dry granular substance, pouring and packing freely, owing to considerable loss in the density of the charge. It was found, however, that the increased speed of detonation (5,200 metres per second) more than compensated for the loss of density.

All holes are inspected with a mirror before charging, and no attempt is made to force the bulky L.O.X. cartridges down ragged or crooked holes. The only accident which has yet taken place with L.O.X. was the result of an endeavour to do so. (No one was seriously injured.) The cartridges drop freely by gravity without danger. (See Photos Nos. 1 and 2.)

Accidents of any kind are rare, and confined almost entirely to failure to detect " blind " dynamite charges until the power shovel has got to work.

Remarkably little surface effect is produced even by the explosion of shots of 170 tons of high explosive, such as the writer witnessed, owing to the scientific application of the material, the ideal being to leave the rock as far as possible in situ, broken up sufficiently small to be dealt with by the shovels, but otherwise undisturbed. (See Photo No. 3.)



Joint of Cordeau branch to main.

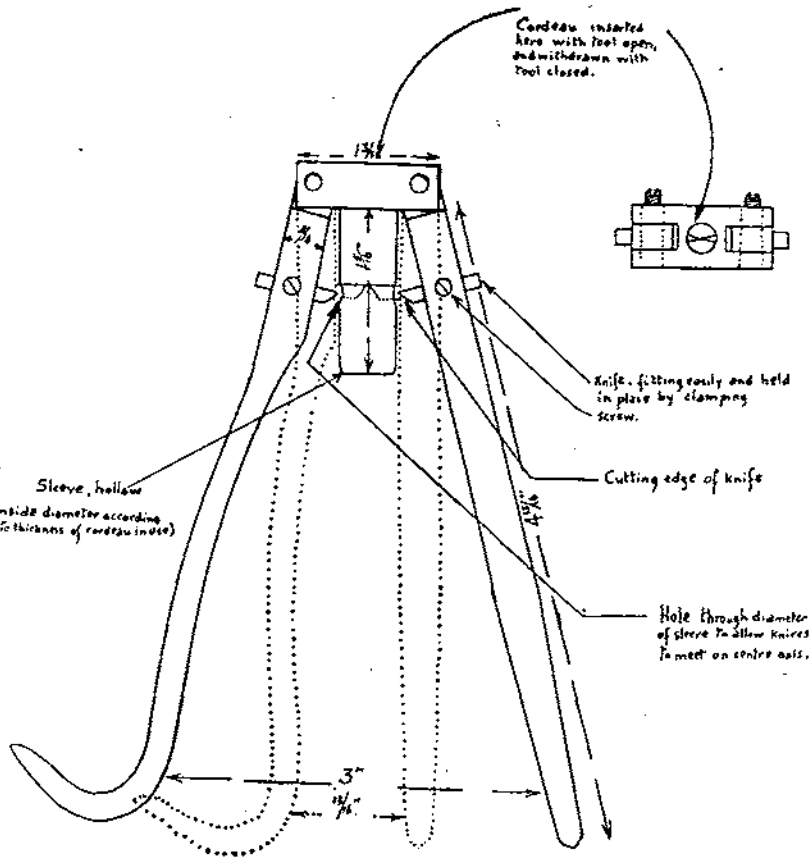
Many of the lining tubes can be partially used again, the most damaged parts being cut off.

(c) *Ignition.* Ignition is done entirely by cordeau fuse, without the use of any sort of primer or other detonator.

Two patterns of cordeau are used, that which is inserted in the bore holes having the lead tube protected by wire braiding, while the connecting mains are of the ordinary bare lead service type. The jointing is interesting, as being much more simple and economical than Service practice, and so successful that I was informed that no failure of a joint had ever been experienced.

Two lengths are joined end to end by simply butting the ends, freshly square cut, together in a thin copper sleeve which is pinched over them by a special pliers.

A branch is jointed to a main by splitting the end with a special tool (see Sketch " A "), for about four inches, and tightly wrapping the split portions in opposite directions round the outer surface of the main. The tool resembles a pair of nut-crackers, with a sharp cutting edge of sufficient length to reach the centre of the cordeau inserted in the centre of each jaw, and a sleeve of sufficient diameter to admit



Sketch "A."—Special Tool for Splitting Cordeau.

Full lines show tool open ready to insert cordeau.
Dotted lines show tool closed.

the cordeau through the axis between the handles. The cordeau is inserted through the sleeve, the cutting edges pressed home through the lead tube, and the cordeau then drawn out by hand, keeping the instrument closed. The cordeau is thus neatly sectioned, leaving two clean strips of explosive exposed.

As rain is almost unknown in Chuquicamata and all charges are fired within a few minutes of connecting up, the question of protecting joints against weather does not arise.

In the lay-out of a large shot, cordeau mains are run out along the lines of holes by unreeling from large drums. These mains are cross connected every hundred yards or so and the ends of the braided cordeau which protrudes from the charge holes are rapidly split and wrapped to the mains, but not before everything is reported as otherwise ready.

The main system is then detonated in one point by a commercial pattern electric detonator, the joint being made in a special copper ferrule, into one end of which the cordeau is nipped by a special pliers, and in the other end of which the detonator, with its point in contact with the cordeau, is held by the natural spring of the copper ferrule, which is split. (See Sketch " B " page 50.)

Detonators are tested for resistance and continuity in test boxes immediately before use, and not more than one is ever used for firing even the largest groups, sometimes consisting of several hundred holes.

By means of these blasts, the hillsides are worked into tiers of " benches " or gigantic steps, the average vertical rise of each step being about 45 feet, and the horizontal width equal to 2½ times the height, plus 15 metres, so as to give room for a double line of railway, a line of power shovels and the drilling rig preparing the next face for blasting.

The rock is disintegrated to a depth of about five feet below the working level of the bench, so as to facilitate track laying and shifting, which is done mechanically by a heavy electric locomotive provided with a steel beam projecting horizontally athwart the track at sleeper level. This beam smooths the shattered rock sufficiently to form a bed for the track, which is then unfished and slewed in lengths of sixty feet or more, into its new alignment by an electrically operated tackle, working from the end of the beam. Scarcely any manual labour is required, and the finished track is good enough to take with safety the 100-ton (gross) ore trucks used.

Over twelve miles of bench are at present being worked.

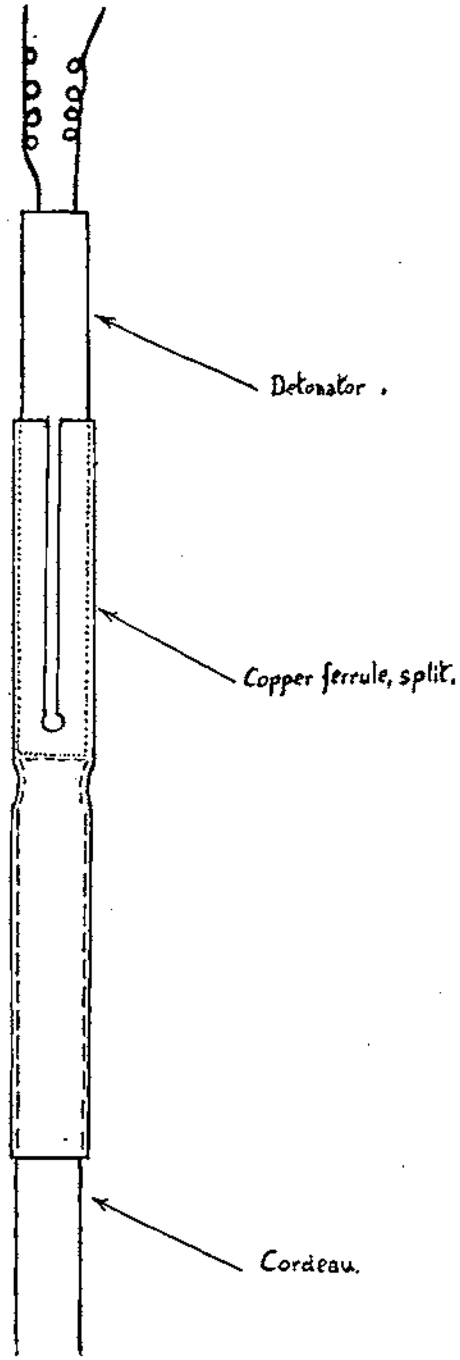
6. Manufacture and Storage of the Liquid Oxygen.

Air inspired through a dust-excluding inlet is first compressed to 853 lb. per square inch in a three-stage Ingersoll-Rand compressor, driven by a 175 h.p. electric motor.

This compressed air is then circulated through oil extractors, cylinders containing caustic soda (to remove CO_2) and quick-lime (to remove moisture), to a heat exchanger in which it is partially cooled.

A portion of the compressed air is then used to drive an expansion engine, causing further cooling of the portion of the air which expands and the compression of the remainder to 2,845 lb. per square inch.

At this pressure, the oxygen content of the air liquefies at a temperature of −182°C., while the nitrogen remains gaseous until −194°C. is reached.



Sketch "B."

The temperature of $-182°C.$ is attained in a liquefaction apparatus (Claude system by L'Aire Liquide, Paris), without mechanical aid by a simple process of partial expansion and heat exchange, and the effluent is practically pure liquid oxygen which gravitates directly to the storage containers through ⅝-in. copper pipes, insulated by passing through 3-in. steel pipes, which are lined with a thick layer of hair felt, and contain a counter flow of cold oxygen gas from the liquefaction apparatus.

The liquid oxygen, when drawn off in a mug, resembles water, but has a slight steely colour and is in constant ebullition, with the appearance of "steam," caused by the freezing of moisture in the surrounding air as the intensely cold gas comes in contact with it. Mercury poured into the mug freezes instantaneously, and a rubber tube becomes as brittle as thin glass.

The whole of the above apparatus, with the exception of the expansion engine, is perfectly simple, everyday plant, and occupies but little space, owing to the purifying of the air being done after the reduction in its volume by the first stage of compression. A hut of about 40 feet by 20 feet houses the whole, with plenty of room for additions.

The expansion engine, with the second-stage compressor, is more delicate and requires careful adjusting of valves and packings.

The plant seen in operation was designed to produce 75 litres (about 16½ gallons, or 150 lb.) of liquid oxygen per hour, and in practice gives 73 litres at an all-in cost of seven cents, U.S.A. (or about 3½d.) per litre, or 1½d. per lb. It is worked 168 hours per week, whenever possible, to avoid starting losses, but even then, some 28 per cent. of the liquid is lost during the week's operation.

The liquid oxygen is stored in three vacuum jacketed containers, having a total capacity of 10,000 litres (*i.e.*, about 750 gallons each).

The jacket is maintained by Goede Mercury diffusion pumps and Cenco-Hyvac oil pumps at a vacuum of between 0·0001 and 0·00007 millimetres of mercury. Both inside and outside walls are of ⅝-in. steel boiler plate, covered internally with smooth sheet copper, which immediately before assembly is polished to mirror brightness in order to insulate against heat radiation. They are, in fact, "thermos" flasks on a large scale.

The heavy plating is necessary to withstand the pressure due to the vacuum on large surfaces which cannot be stayed on account of the loss of insulation which any support would cause. The reduced strength of the steel at the low temperature has also to be taken into account.

The containers seen were designed by the Purox Co. of Denver, U.S.A., and manufactured by the American Welding Company.

No material difference is being made in the new plant now on order, which will have three times the capacity of the original plant.

7. MANUFACTURE OF CARTRIDGES.

Cylindrical bags of the required size, namely, 7 in. in diameter by 20 in. long, for 8-lb. loads, and 5¼ in. diameter by 12 in. long, for 3½-lb. loads, are machine-made from No. 8 cotton duck.

The carbon mixture in use consists of 65 per cent. "Bugbird," a proprietary coarse-grained carbon produced by burning woodpulp, and 35 per cent. "Huber" gas black (a very fine soot). The power of absorption of oxygen, rate of detonation, sensitiveness, and mechanical strength of the cartridge are all materially affected by the natures and proportions of the carbons used.

They are intimately mixed in an overhead hopper by plant similar to a wheat-flour mixer, and the mixture descends through a pipe over the lower end of which the empty cartridge bag is placed. When full, the end of the bag is closed by a brass clip. About 350 bags per eight-hour shift can be filled by one man. It is a dirty job.

8. SOAKING OF CARTRIDGES.

Cartridges prepared as above will absorb up to 3·4 times their weight of liquid oxygen, and gain progressively in explosive strength with the amount they absorb. To attain this maximum, however, it is necessary to keep them wholly immersed for forty minutes, with consequent large expenditure of oxygen and waste by evaporation, and unusable dirty residue. The most economical result has been found in practice to be attained when the cartridges are only partially covered, and allowed to soak for twenty minutes. Under these conditions they absorb 2·9 times their dry weight of oxygen.

The dry cartridges are packed in layers into stout waterproof-covered wooden boxes, 72 in. by 36 in. by 22 in. (holding 50 large or 125 small cartridges), insulated on all six faces by 4 in. of "balsa" wood, and carried permanently on shaded railway trucks. (See Photo No. 4.)

Immediately before being required for use, about 800 litres of liquid oxygen are run into each box from the vacuum-jacketed storage containers, through canvas-covered flexible metal hoses. The twenty minutes average time taken to run the trucks to the vicinity of the bore holes is sufficient to enable the requisite amount of liquid to be absorbed and the cartridges are unloaded and laid as above described immediately on arrival.

Waste liquid remaining in the boxes is recovered in portable "thermos" bottles and used (after filtration) in connection with the cooling portion of the plant.

From the moment when soaking commences, the cartridges have to be treated with the precautions customary in the case of all high explosives, i.e., rough handling has to be avoided and great care taken to avoid contact with sparks.

Soft-soled shoes should be worn and steel fittings dispensed with.

9. Statistics.

It is estimated that, at the moment of firing an average charge, normally within 1¼ hours after having commenced to soak the cartridges, the oxygen-carbon ratio which was originally 2·9 has been lowered to 1·88.

Only 30 per cent. of the liquid oxygen originally manufactured is usefully employed, the remainder being accounted for as under:

Pipe losses between plant and reservoir	5%
Storage losses (one week)	23%
Soakage losses	16%
Evaporation after soakage	17%
Recovered from soaking boxes in thermos bottles	2%
Not recovered from soaking boxes	7%
Total	70%

It is necessary to manufacture 5·9 lb. of liquid oxygen for every lb. of dry cartridge.

The rapid loss of weight by evaporation makes statistics difficult to compute, and introduces an indeterminate factor for which a mean value based on experiment has to be assumed.

The following tables of costs* are obtained from figures kept during one month of 1927, in which were manufactured:

6,579 cartridges weighing (dry) 23,027 lb., and
126,000 lb. of liquid oxygen.

TABLE "A."—CARTRIDGES.

	Total Cost.	*Cost per lb. of cartridge.*
14,968 lbs. Bugbird carbon black	$1600·08	$0·069
8,059 lbs. Huber gas black	$1195·15	$0·051
2,192 yds. 36 in. No. 8 canvas duck	$544·08	$0·024
Brass clips and thread	$85·54	$0·004
Labour	$83·98	$0·004
Supervision and overhead charges	$69·08	$0·003
Power and maintenance	$20·85	$0·001
	$3598·76	$0·156

TABLE "B."—LIQUID OXYGEN.

	Total cost.	*Cost per lb. of liquid.*
105,526 kw. horse-power at $0·00868 ...	$915·97	$0·007
Labour, 10 men	$543·60	$0·004
Supervision	$370·00	$0·003
Maintenance	$240·00	$0·002
Chemicals	$94·14	$0·001
Water, lubricants and miscellaneous	$47·13	$0·001
Interest and amort. on capital at 10½% per annum	$1290·00	$0·010
	$3500·84	$0·028 or $0·0716 per litre.

* Dollars (U.S.A.) at $4·86=£1. ($1=4s. 1½d.)

TABLE "C."—L.O.X.

Cost of 1 lb. of dry cartridge (Table "A")	\$0·156
Cost of 1·88 lb. of liquid oxygen actually exploded (equivalent to 5·9 lb. of liquid manufactured), at \$0·028 per lb. (Table "B")	\$0·165
Cost of 2·88 or, say, 3 lb. of cartridge (sum of above) ...	\$0·321
Cost of cartridge weighing 1 lb. at time of explosion ...	\$0·107

TABLE "D."—SUMMARY OF STATISTICS DURING FIVE MONTHS OF 1927.

Rock broken			937,195 tons
L.O.X. used	Liquid oxygen manufactured	494295 lb.	
	Liquid oxygen wasted ...	330565 lb.	
	Liquid oxygen actually exploded ...	163730 lb.	
	Dry cartridges exploded ...	83830 lb.	
	L.O.X. actually exploded		247, 560 lb.
Weight of rock broken per lb. L.O.X.			3·78 tons.
Dynamite required to break above amount of rock			312000 lb.
Cost of 247,560 lb. of L.O.X., at 0·107 (Table "C")			\$26488·92
Cost of 312,000 lb. dynamite, at 0·16			\$49920·00
Saving effected by use of L.O.X.			\$23431·08 or 47%

Cost of L.O.X. replacing 1 lb. of dynamite at 0·16 (8d.)

$$= \frac{247560}{312000} \times 0\cdot107 = \$0\cdot085\ (4\tfrac{1}{4}d.).$$

10. GENERAL.

(*a*) A few general particulars of this mine and of the process used may be of interest.

Owned by the Chile Exploration Company, it is situated in latitude 22° S., longitude 9′ W., about 10 miles north of the Calama Station of the Antofagasta-Bolivia Railway, in hilly country, entirely without previous population, water, fuel, fauna or flora, and about 9,500 feet above sea level. Not the least remarkable feature of the organization is the way in which these inherent difficulties have been overcome.

The principal "township" has a normal population of 15,000 souls, and is laid out as "garden city" of excellent reinforced concrete houses of pleasing appearance, provided with water supply and water-borne drainage, and many with small gardens or enclosures. The workmen, all Chileans who have never before seen such luxury, bring their families, for whose education, health, amusement and general welfare the most complete arrangements are made. For instance, the main hospital has a staff of five doctors and forty trained nurses, with such equipment and apparatus as is rarely seen; a special maternity hospital is provided on the same scale; there are several schools, clubs, two theatres, fine recreation grounds, swimming baths, and many retail shops in which all commodities are sold at 10 per cent. *under* cost price. And last, but not least, a retired serjeant of the Royal Artillery has charge of the sports and gymnasia.

The expense, of course, has been enormous, but it is interesting to note that those concerned consider that full value has already been derived therefrom. The best class of workman is obtainable without difficulty and there has never been a trade dispute, even in times of most acute industrial tension. It is typical of these large New World organizations that they consider it bad policy to pay a man and give him expensive plant and machinery to handle unless he is kept in the best mental and physical state to obtain the maximum advantage from it.

Labour is paid, as far as possible, by piece work or by small contracts, in which the Company provides plant and appliances. Every man can earn, and most do earn, very considerably more than the standard time rates of the country. It is rare to see a man working with his unaided hands.

Water is piped from two sources in the Andes, distant 80 and 65 miles, and is supplied in unlimited amount.

All power is electric, 158,710 kilowatts being generated on the Pacific Coast, 85 miles distant, by oil-fired steam and Diesel engines, and transmitted by overhead line at 110,000 volts, at an all-in cost of $0·00868 (about 0·4d.) per unit at the mine.

Inexpensive and entirely practical motor routes are made through the soft desert by building concrete wheel tracks. Some were seen which have withstood years of traffic by heavy vehicles, and the cost is infinitesimal in comparison with that of a road which would give equal service.

Section of Concrete Wheel Tracks.

The ore comprises a complexity of copper compounds, of which sulphates, sub-sulphates and chlorides are at present chiefly worked. Proportions are adjusted so as to give a milling assay of about 1·6 per cent. of metallic copper, though as low as 1·4 per cent. has been profitably dealt with. A plant for dealing with copper sulphides will be erected when required.

The process consists of the following steps:

1. Quarrying.
2. Crushing.
3. "Leaching," *i.e.*, extraction of the copper from the ore by soaking in acid solutions.
4. De-chloriding.
5. Electrolysis.
6. Smelting.

(*b*) *Quarrying.* The quarrying process has already been described. The resultant shattered rock is loaded into ore trucks (average tare 68 tons) by electrically-driven "Bucyrus" power shovels, of from $\frac{3}{4}$ cubic yard to 8 cubic yard capacity, the standard being the 4 cubic yard shovel, some of which run on rail track, some on caterpillar tracks. The 8 cubic yard caterpillar shovel weighs 230 tons, and the 4 cubic yard shovel 160 tons.

Haulage to the mill is by electric locomotive, those on the working face being accumulator or petrol-electric drive, those on the permanent line taking the current at 500 volts from a third rail.

Cost of loading and hauling from mine face to mill $0·177 (about 0·08d.) per ton of ore, as against $0·682 (about 0·32d.) per ton by the steam shovels and locomotives which were formerly used.

(*c*) *Crushing.* The ore trucks (each about 100 tons gross) are pushed by an electric "mule," two at a time, into a cylindrical tip, which empties them into an ore hopper by rotating them through an angle of about 160°.

When empty they are pushed out of the tip by the next incoming pair of trucks, and run by gravity to a sorting siding. Time, 40 seconds for discharging each pair of trucks containing about 136 tons of ore.

The ore is then reduced from rocks of several tons weight to a gravel of $\frac{3}{8}$-in. mesh by a succession of crushers of different types, in the largest of which the oscillating core weighs 86 tons, the dust, which contains 4 per cent. of copper, being carefully collected by aspirator fans.

(*d*) *Leaching.* The "gravel" is conveyed by 52-in. belt conveyors, about a kilometre long (cost, £3 per foot run), to belt distributors feeding over large mobile cantilever bridges a series of concrete tanks, each about 300 ft. x 150 ft. x 20 ft. Dilute acid liquor, containing 5 per cent. sulphuric acid, is run in from the bottom and converts 96 per cent. of the copper into copper sulphate in solution. A second washing is given with more dilute acid and a third with water.

(*e*) *De-chloriding.* The object of this process is to remove all traces of chlorides (mostly those of sodium, potassium and magnesium) before electrolysis, where they would, if present, be decomposed into chlorine gas and render work impossible.

The liquor from the leaching tanks is mixed in concrete vats with very finely divided copper (known as "cement" or "amorphous" copper), suspended in water. This combines with the chlorides, forming cuprous chloride, which is then brought in contact with scrap iron (of which about 40 tons per diem are expended), in rotating bronze drums, and combines with it to form ferrous chloride (which is wasted), and a larger amount of amorphous copper than was originally used. Sufficient is retained to continue the process and the remainder is smelted in a special small furnace.

L.O.X.

Photo No. 1.—Dropping 30 lb. L.O.X. cartridge down bore hole.

Photo No. 2.—Charging bore holes with L.O.X.

Photos no 1 & 2 LOX

Photo No. 3.—Explosion of 170 tons of L.O.X. and Dynamite.

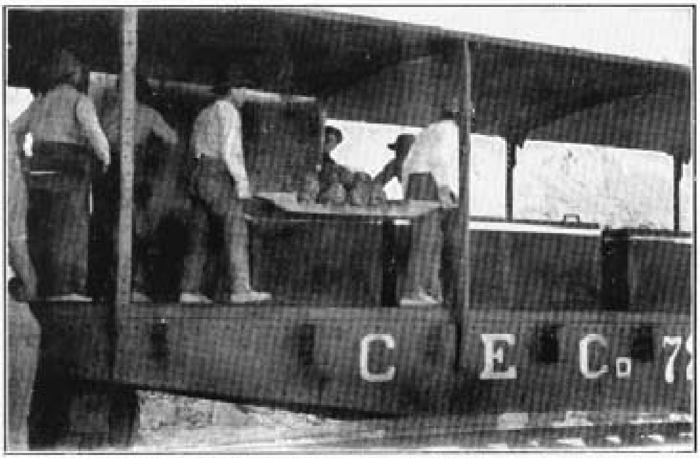


Photo No. 4.—Unloading of L.O.X cartridges from the soaking boxes at the site of the blast.

Photos no 3 & 4 LOX

(*f*) *Electrolytic Process.*

(*i*) The *electrolyte* contains nitric, sulphuric and hydrochloric acids in addition to the copper sulphate in solution.

(*ii*) The *anode*, made of a copper-iron silicate, evolved and manufactured at Chuquicamata, is cast in the form of a grid, about 6 ft. x 4 ft., with copper rod reinforcement, from the material formed by fusing with scrap copper in an electric furnace the silicon-iron alloy imported from Norway. The resulting compound contains about 60 per cent. copper and 20 per cent. silicon, with iron and impurities. Is electrically a good conductor and almost indestructible.

(*iii*) The *cathode* is made by depositing copper electrically for about 24 hours on an oiled copper matrix, about 6 ft. x 4 ft., when thin copper "starting sheets," weighing 13 lb., and easily separable from the matrix, are formed. These are removed and used as separate cathodes for 7 to 10 days, during which they are built up to a thickness of ⅜ in., and a weight of 160 lb. of copper, about 99 per cent. pure. The impurities comprise traces of gold and silver, a little iron, some sulphur and other chemical and mechanical substances, which have to be further reduced by smelting.

(*iv*) The electric current is used at the rate of 17 amperes per square foot, at very widely-varying voltages, the maximum being about 60. 60,000 k.w.h. are used in the shop and the field near the vats is so intense that the individual keys of a bunch held in the hand, while walking in the alleyways, are visibly affected, and it is, of course, at once destructive to a watch.

(*v*) The liquor after the copper is all deposited consists largely of dilute sulphuric acid, with nitric and hydrochloric acids as impurities. Some of it is required for the leaching process but there is a large excess and some 3,000 tons of sulphuric acid are run to waste every month, as the distance of any possible market precludes the expense of purifying it.

(*g*) *Smelting.* The electrically deposited sheets are smelted to reduce them to a more marketable form and get rid of the impurities, raising the percentage of pure copper to 99·95, most of the remainder being gold, which would not repay the cost of extraction.

The melting is done in reverberatory oil-fired furnaces, which require seven hours to melt the charge. Most of the impurities pass off as gas, and the remainder form a slag. The copper oxide produced on the surface is reduced by the insertion of charcoal and by periodical stirring (mechanically effected) with poplar poles.

The molten copper is run off through pneumatically-controlled doors, into moulds carried on continuously rotating tables, whence they automatically upset, depositing the ingots on a conveyor where they are quenched by water jets and carefully inspected, cinders and surface blowholes being cut out with pneumatic chisels.

"Wire bars" and wedge-shaped ingots, weighing 220 lb., are the most usual form.

(*h*) *Tailing Disposal.* The tailings, in the form of clean gravel, of about $\frac{3}{8}$-in. mesh, are transferred from the leaching tanks to railway cars, by rapidly operated grabs worked from two immense movable bridges, in which are incorporated hoppers with pneumatically-controlled chutes.

A train of 32 tip-cars (each 20 tons tare and 20 tons load) is filled from the hoppers in $12\frac{1}{2}$ minutes, motion being almost continuous, and pushed to the tip (186 feet high at present) by an electric locomotive. Tipping takes $2\frac{1}{2}$ minutes, the train being in motion all the time and only 4 men being required, one to drive the train, 3 to knock the pins out of the tip-trucks (which right themselves automatically when empty). The locomotive takes current from a third rail until near the site of the tipping, where it changes to an overhead wire.

The gigantic scale of the whole plant cannot be appreciated without seeing it, but some idea can be obtained when it is recollected that it is designed to deal with 50,000 tons of ore per diem, and that the leaching and electrolysis are slow processes taking many days.

At every stage, there are to be seen examples of organization and every branch of engineering on the largest scale. Graphs showing all material figures are kept and circulated daily to every department, and the whole concern works like a well-run army headquarters in war, with a well-organized chain of command, everyone with plenty to do and no one unduly busy, the "G.O.C." having more spare time than anyone.

It is to the more-than-efficient "G.O.C." or (as he has it) to the "General Manager," Mr. Burr-Wheeler, that I am particularly indebted for devoting a whole day of his valuable time to showing me round in person, and to him and his assistant, Mr. Woodhul, and to Mr. Bellinger, a vice-president of the Company, not only for most kindly hospitality, but also for providing me with the general information which I have endeavoured to record above.

For the particular information on the subject of L.O.X., I am very grateful to Mr. Dunbar, who was in charge of that department at the time of my visit, and to Messrs. Schultz and Hunter, who recently contributed a valuable paper on the subject to the American Institute of Mining and Metallurgical Engineers, and have allowed me to use some of their data.

AN ATLANTIC LINER FROM INSIDE.

By Lieuts. F. M. Hill and H. E. M. Cotton, R.E.

The following Notice was circulated to students at Cambridge :—

"The directors of the Cunard Steam Ship Co., and the directors of the White Star Line, are again kindly offering facilities to a certain number of Cambridge engineering students to gain engine-room experience, on round voyages to America or Canada, between June and September next, each voyage extending over a period of approximately three weeks.

These voyages are intended for second-year students only, and the first choice will be given to those who are reading for honours.

Individuals selected will become temporary members of the engineers' mess. They will be under the authority of the Chief Engineer, and will have definite duties to perform. To avoid passport difficulties, they will be signed on as members of the engineering staff, and receive pay at the rate of one shilling per month. On the other hand, they will be given free board and lodging during the voyage, and can live on the ship while it is in port.

I shall be glad if gentlemen who wish to avail themselves of this opportunity of combining engineering experience with a voyage to America or Canada, will apply to the office at Scroope House for an application form, fill this up and send it in to Mr. A. H. Chapman, Room 11, Scroope House, as soon as possible. No applications can be considered after May 4th.

Dates of sailings will be posted later.".

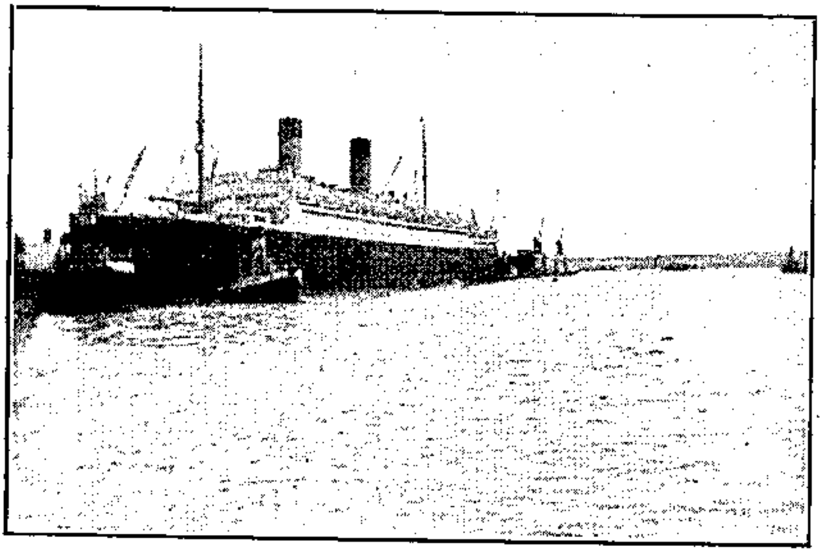
For several summers, the Cunard Co. has been offering free trips on liners, as " Probationer Engineers," to students taking the mechanical sciences tripos at Cambridge, the object of these trips being to encourage people to take up marine engineering.

This year, the White Star Line followed the example of the Cunard Line, and two Sappers, who had just finished their Cambridge course, were lucky enough to obtain a trip to New York and back on the S.S. *Homeric.*

A complete article might be written on the lay-out of Southampton Docks, and the shore organization that is required to keep a big liner in commission, but the Southern Railway issue an exceedingly interesting illustrated book on the docks, setting out their history, capabilities, and facilities for trade, and outlining the proposed future extensions of the wharf and warehouse areas.

The "Homeric."—The *Homeric* is a twin-screw boat of 34,350 tons, built at Hamburg in 1914. She was laid up at Dantzig throughout the War, was handed over by Germany under the reparations clauses of the Peace Treaty, and was then given to the White Star Co. in compensation for tonnage lost in the War.

Compared to the *Majestic's* 56,600 tons, she is small, and compared



THE "HOMERIC," SOUTHAMPTON DOCKS.

to the *Bremen's* record, her seven days' trip is slow, yet she averages about 19 knots, and from on board seems gigantic.

Deck Plan.—Her size may be gauged from her decks. First, there is the sun deck, which is used for games, and is on a level with the upper bridge. Next comes the boat deck, equal in height to two ordinary decks, and housing the library, the lounge, the tea-room, the smoking-room, and the gymnasium. Below this is the promenade deck, with a wide, closed-in walking space right round the ship. "A" deck is filled by passenger suites and the top of the saloon. "B" deck, the saloon deck, also contains the kitchens and pantries. "C" deck is the last deck above the water-tight bulkheads, and is divided longitudinally by a working alleyway, which runs from stem to stern. Finally, "D" deck is on a level with the tops of the engine cylinders, which stand about thirty feet above the double bottom.

Engine-Rooms.

Engineer Officers.—The ship carries 35 engineer officers, who keep the watches, and also have to carry out all repair work, since, unlike the navy, the company does not carry engine-room artificers. In addition to the Engineer-in-Charge, there are nine junior engineers on each watch. These are distributed, two in the stokehold, three in the engine-room, the electrician and refrigerating engineers in the auxiliaries room, and the " gang " of two workshop engineers, who are continually kept busy with small running repairs and replacements.

Working Kit.—All wear overalls and boots with wooden pegs in the soles, since it is suicidal to wear rubber on the oily plates in the neighbourhood of the engines.

Engine-Rooms Lay-out.—The engine-rooms lay-out is essentially simple in principle, but is complicated in practice by the extremely limited space.

The boilers are divided into four sections or ranges, two under each funnel, and the main and settling fuel tanks are placed round and between the boiler-rooms. The engine-room is immediately aft of the boiler-rooms and extends right up to the topmost deck level, to allow of easy access for overhauls. Aft of the engine-room the auxiliaries are housed in a low room, which also contains the thrust blocks, and whence the two shafts run down separate tunnels to the stern glands.

Oil Fuel System.—As far as possible, fuelling is carried out at New York, because of the cheaper cost of the oil. Tank barges are brought alongside and their pumps are supplied with steam from the ship's boilers. The oil is pumped through filling stations in the ship's side to a duplicate filling main, which connects through valves to the various fuel tanks. From the top of each tank, an overflow pipe is carried into a duplicate overflow main, a 12-in. pipe, which slopes aft to a sump and through which air is forced by a fan, to prevent accumulation of explosive gases on the tops of the fuel tanks.

Firing System.—For firing, the oil is pumped from the storage tanks to settling tanks, where any water is drained off and where it may be given a preliminary heating before filtering. The oil feed pumps draw the oil from these tanks through a coarse filter, send it through steam heaters, which bring it up to its flash-point temperature, and then deliver it through a fine filter to the burners.

Boilers.—Each of the four boiler sections is in a water-tight compartment, and each section is formed by six boilers, placed back to back, the outer boilers having four burners and the inner boilers three. These boilers were put in before the ship was converted to oil fuel, and are of the ordinary forced-draught Scotch type, with the fire doors adapted to take burners. The superheaters in the smoke tubes, which were originally fitted for coal firing, have now been discarded.

Fire Precautions.—Each boiler has an emergency cut-off valve on the oil supply in case of fire, and there are also " Foamite " hand and hose sets to deal with small outbreaks, while larger outbreaks can be quenched by a system of overhead " Foamite " pipes, controlled from outside the stokeholds.

Steam Mains.—From each boiler-room, a separate steam main runs to the engine-room, so that if any stokehold is flooded, the other three may carry on independently.

Boiler Feed.—The main feed from the engine-room is led to each boiler and, in addition, each section has its own auxiliary feed pump for closer control of the boiler water-level.

Engine Control.—Each of the two propeller shafts is driven by a 15,000 H.P. triple-expansion reciprocating engine. The steam lines from the four boiler sections enter the engine-room *via* a cross-connecting main, whence the steam is led through two steam traps to the throttle valves. These throttle valves are moved by a hand lever, connected to a simple steam following gear, or may, in emergency, be moved by a hand-and-worm gearing.

Engine Details.—There are four cylinders on each engine, since the L.P. stages are divided between two similar cylinders, to avoid excessive bulk. The H.P. cylinder has an effective area of 2045·5 sq. in., with a stroke of five feet, has no tail rod, but, in compensation, has an extra thick piston. It is supplied with steam at 205 lb., through a piston valve, which is worked by an ordinary Stephenson link motion, with adjustable cut-off. The I.P. cylinder has an area of 5361·6 sq. in., and the piston has a tail rod and is fitted with special L-section rings, held by springs against the cylinder walls. The exhaust steam from the H.P. passes into the I.P., through a Stephenson link-operated piston valve, at a pressure of 60 lb. The two L.P. cylinders have each an area of 7313·8 sq. in., the pistons have tail rods and have ordinary steel piston rings. The steam enters the cylinders at 19 lb., through " D " slide valves, which are balanced on their seating by exhaust pressure on the back of the valve, and are balanced vertically by equalizing pressure on the under-surface of the valve and exhaust pressure on the top surface.

Reversing.—Reversing is carried out by shifting the link motions of all the cylinders by an armed shaft, that runs along the back of the engine. This shaft is normally operated by a steam following engine, rather similar to a small steering engine, or, if this breaks down, by another small three-cylinder steam engine, which works through the hand-and-worm gear that is provided for emergencies. Full ahead to full astern, with the steam gear, would take about three minutes, or a mile in distance, but with the hand-reversing gear and hand throttle, might take up to ten minutes, and, if there is room, it is quicker for a liner to turn in a complete circle than attempt to stop.

Condensers.—The exhaust steam from the L.P. cylinders is led into the condensers through two baffle cylinders, to prevent the hot steam from hitting the condenser tubes in sudden gusts. These condensers are of tube type, through which sea water is circulated by large centrifugal pumps. There is a cross-connection between the two condensers, which can be opened in case of a breakdown. The make-up water is fed into the bottom of the condensers, and about 100 tons a day is used. Air pumps lift the water from the condensers to a tank, from which it falls by gravity through filters to the hot-well. It is then raised to 240°F. by feed heaters, which are fed with the exhaust steam from the auxiliaries, and passes along the feed line to the boilers. There is also a spare line to each boiler section for use in case of emergency.

Propeller Shaft.—The 130 feet of hollow 30-inch propeller shaft is supported by oil-ring bearings every 12 feet. The thrust blocks are of very simple type, consisting of collars on the shaft, which revolve in an oil-and-water slurry against adjustable collars on the blocks. These blocks and the condensers are the two weak points in the German design, both being rather too small for the ship.

Stern Glands.—The ship was originally fitted with German-metal stern glands, but these have now been replaced by lignum-vitæ glands. Each shaft is split up into 30-foot lengths, and may be withdrawn very simply and hoisted through the hatchway of the after-hold.

Lubrication.—Lubrication of nearly all the moving parts is by gravity feed from oil wick reservoirs, which are kept full by the engine-room greasers. Each cylinder is lubricated by a small pump, which forces oil through the cylinder wall at two points. The piston rod is periodically greased by hand, with a brush. The big ends dip into an oil trough, and the main bearings have oil rings. In addition, a sea-water pipe line is led to all important points for emergency cooling purposes.

Engine Duty.—One engineer is always on duty, within reaching distance of the main steam controls and the engine-room telegraphs, which latter are in duplicate and are tested daily. A hit-and-miss type governor is fitted to each engine, but in a heavy sea, it is found better to have an engineer standing by each throttle valve and to dispense with the governors. In fog, there are always extra engineers on watch at the throttles and reversing levers.

Auxiliaries.—The auxiliary room contains the electrical and refrigerating plant, fresh and salt bath-water heating boilers, run off exhaust steam, and an emergency salt-water evaporator.

Electrical System.—The electrical equipment consists of six 140 kw. D.C. generators, 12-pole compound-wound machines, driven by double-expansion steam engines at 180 r.p.m. Of these, four are always kept running, since the load, being chiefly ventilation fans, does not alter appreciably by day or night. The switchboard and wiring system is German, pre-war and obsolescent, there being an unnecessary amount of cable throughout the ship.

Refrigerating System.—The refrigerating plant consists of two single-expansion CO_2 compressors, only one of which is used at any time, each of which has its own evaporator. There are three cooling systems. A direct CO_2 expansion line, which is only used for the ice-room. A high-pressure brine line (96 lb. per sq. in.), which is circulated throughout the ship, and which supplies the cold larders, the refrigerated cargo, and the water coolers—of which there are 16 distributed through the passenger accommodation. A low-pressure brine line, which serves the cold-storage rooms.

Pumps.—The pumps in the *Homeric* are worthy of especial mention, as they are nearly all of what might be termed a "general purpose" type; thus one duplex steam pump in the engine-room may, by a system of valves, be made to draw from either the sea, the bilges, the fresh water tanks, or the hot-well, and, similarly, to deliver to the fire system, overboard, fresh water lines, or the boiler feed lines. By these means, almost any pump may be withdrawn from service for repair work without interrupting essential services.

DECK MACHINERY.

Steering Gear.—The steering gear is by far the most interesting part of the deck machinery. The movements of the wheel on the bridge, or the after bridge, are transmitted by a glycerine-and-water hydraulic system, to the steam following gear, situated in the rudder-house. To the top of the rudder post is bolted a horizontal platform, on which is mounted a double-expansion steam engine. The crank-shaft and connecting-rods of this engine are totally enclosed in an oil bath, together with a screw gearing, which drives a pinion wheel, engaging with a fixed toothed arc. This engine runs very silently, but there is unavoidably some play between the pinion and the arc, which gives rise to a continual banging as the water jerks the rudder. For emergency, there is a second engine, which is stationary, and drives the rudder by a large chain, which is fastened to the rudder platform. As a final resort, the rudder could, with a little ingenuity, be worked from two winches, situated one on each side of the rudder-house. An electrical indicator gear shows the rudder position on a dial, situated in the wheel-house, so that the quartermaster can see if the ship is taking weather or lee helm.

Anchors and Winches.—The two bow anchors each weigh seven tons, and each link of the cable weighs more than a hundredweight; the method of anchoring is, therefore, to allow the anchor to drop, and the requisite amount of cable to run out and then to snub the cable. The anchor capstan embodies a metal plate clutch, and is driven through screw gearing on the deck below, by a double-expansion vertical engine, which can also be used to drive a cable capstan. Cargo winches and derricks are mounted round each mast, and there are also a few winches on the boat deck to assist in the handling of boats.

Boats.—The boats are mounted in a double tier on roller davits, and are always kept swung inboard. There are also four motor-boats, which are useful when the ship is making its annual Mediterranean cruise.

Wheel-house.—The centre portion of the bridge is roofed over to form the wheel-house, which contains, besides the wheel operating the hydraulic steering telemotor, a wheel connected direct to the steam valve of the steering engine. Here also are the indicator-boards of the watertight doors, and the thermostatic fire-warning system. These indicators consist of plans of the ship, mounted with little electric bulbs, which light up when the doors are closed or the temperature rises above a certain point.

Compasses.—The standard compass is on the upper bridge ; there is a stand-by one in the wheel-house, but the quartermaster normally steers from the gyro compass, by a repeater that is mounted in front of him. The gyro compass itself is in a special room on " C " deck, and was made by Sperry. At one time the *Homeric* was fitted with an " Iron Mike," or mechanical steersman, worked from the gyro compass, but it was found that, in all but the smoothest sea, a quartermaster was better, since the machine could not anticipate large waves, and in any case needed a man constantly on watch over it.

Bridge Apparatus.—A gyro repeater, fitted with sights, is placed on each wing of the bridge for taking bearings, where also are situated the engine-room telegraphs and fore and aft mooring telegraphs communicating with the mooring stations.

Chart-Room.—The chart-room opens out of the wheel-house, and contains the ship's chronometers and duplicate electric master clocks, which work electric repeater clocks throughout the ship.

Trim Indicator.—On a passage wall, near the chart-room, is placed a tank diagram and a trim indicator. This is a large level, placed longitudinally and graduated, to show whether the ship is down by the bows or stern. The engine-room is responsible for keeping the tank chart up-to-date, and the bridge, by looking at the trim indicator and the chart, can ask the engine-room to transfer oil or water ballast and so trim the ship.

Wireless.—The wireless-room is near the bridge and has a short-range and a long-range transmitter, worked from power from the engine-room, with a secondary battery for use in emergency. A double loop direction-finding aerial is mounted on the upper bridge.

but this is still in an experimental stage. The ship is poorly equipped with telephones, there being only the essential communication loud-speaking telephones, and none in the staterooms or passenger accommodation.

Whistles.—The ship's whistles are operated by shuttle valves, worked electrically from the bridge. In foggy weather, there is a clock arrangement whereby the whistle may blow automatically at set intervals.

Ozonizing Plant.—The ship is fitted with an ozonizing plant on the sun deck, and pipe lines lead to all lavatories and bathrooms, but this has been found to be unnecessary and is not used.

Fans.—A deck electrician is always on duty, in charge of the fans. These are nearly all on the sun deck, some exhaust the foul air and others pass fresh air through heaters and down through pipe lines to all parts of the ship. These fans constitute the main electric load.

Deep Sea Lead.—A Kelvin deep-sea sounding machine is mounted on the stern ; this consists of an electrically-driven drum, from which a fine-stranded steel wire lowers a 36-lb. lead. To the lead is attached a long thin tube, sealed at one end and coated internally with a red chemical, which changes colour on contact with water. The pressure forces water up the tube, according to the depth, which may be read by placing the tube alongside a graduated scale. By Board of Trade regulations, soundings have to be taken on approaching the coast.

PASSENGER ACCOMMODATION.

Printing.—A small flat-bed printing machine produces a newspaper, and all menus, daily. It is also used to print any special notices, such as the log extract, but cannot cope with very large work.

Cinemas.—There is a full-size cinematograph screen with two projectors in the saloon, and other smaller ones in the second and tourist classes. The projectors are electrically-driven, with a magnetic change-over device to ensure continuity of projection.

Lifts.—British Waygood lifts with the motors at the bottom of the shaft were installed by the Germans, and serve the 1st and 2nd class passengers. The automatic luggage lifts are a German make with the motors up above.

Cold Rooms.—The food cold rooms are divided up to take the different types of food, at the different storage temperatures required. The coldest room is used for the storage of ice-cream, which is not made *en route*, but is shipped before each voyage. Fresh milk is stored in small urns at a slightly higher temperature, and usually remains fresh for the seven days of the crossing. Poultry, game, meat and vegetables, each occupy other rooms, and a lift is provided to take the food from the cold rooms to the galley.

Galleys.—Food brought up from the cold rooms is gradually thawed in cold larders, and is then prepared for cooking by electric potato-peelers, vegetable-washers, mincing machines, dough-kneaders etc. The galley ranges and ovens are all heated by electricity, and electric hot-plates keep the food warm at the serving hatches. All plate-washing is done in electric machines of a spray type, which are found to be more economical in water than the immersion type.

Provisioning.—Under the chief steward are stewards responsible for accounting for, and forecasting, the provisions used, and required, on each trip; the quantity of linen needed, and the stock of liquor. These requirements have to be completed a day before the ship docks, and are indented for in advance by wireless, so that they may be ready and save delay on arrival.

Summary of Trip.—From the personal point of view, the trip was great fun, as an unusual experience. After two years of theory at Cambridge, contact with practical engineers, and their difficulties and methods, was very refreshing. A ship's engine-room is like a giant power station, which must be kept going at all costs, and the organization and supervision needed to ensure this smooth running is very instructive.

The description of the vessel that has been given is an incomplete picture of the trip, since the most interesting parts of the voyage were experiences which cannot easily be reproduced on paper.

Thus, for example, at the S.M.E. workshops, and at Cambridge, one was always told that the first remark to make on meeting a boiler was: "What weight of steam does it evaporate per hour?" This question was tried, timidly enough, on the junior sixth engineer. The shock which was received, when he answered that he had not the least idea, helped to temper the successive shocks when neither the senior third, nor the second, nor even the chief engineer himself, could answer the question.

Similarly, the dryness fraction of the steam entering the H.P. cylinder was unknown. All that mattered was that the engines should run smoothly, and that there should not be too much priming in a head sea.

The engineers are all very good fellows, knowing nothing of entropy or internal energy, but able to tell the condition of a bearing by an applied thumb, or the exact health of an engine by ear, and physically fit to stand eight hours' work every day, Sundays included, in a temperature that averages 108°F., and in some jobs over the boilers, may reach 160°F. In foggy weather, anyone may have to stand an extra four-hour watch, besides his own two watches, and in case of breakdown, or when entering and leaving harbour, everyone has to be in the engine-room.

The lighter side is presented by the trick of crawling under the auxiliary room plates, and rattling a hammer against them in time with the beats of one of the high-speed dynamo engines, with the result that the electrician on duty is nearly driven crazy in trying to find out whereabouts in the room the odd noise is, and what it is that has gone wrong.

A rap with a metal bar on the gong of the engine-room telegraph also produces astonishing results, if the back of the engineer on duty at the controls is turned.

A fast and furious game of football in the small engineers' changing-room gives relief after a four-hour watch, while everybody occasionally gets ducked, fully-dressed, in the bath, starting usually with the senior engineer of the watch.

The tales of the engineers are impossible to reproduce, since they need to be told while sitting on a thrust block, transmitting some 15,000 H.P., or standing in the draught of the ventilator between the two engines, and they must be constantly interrupted by short pauses, to verify gauges or to thumb the bearing of a big-end weighing five tons.

Practical experience gained on the trip varied from a method of making ordinary cement into quick-setting cement for small jobs by adding soda, to a working knowledge of the ineffectiveness of prohibition in America.

One of the greatest inducements for making the trip was the prospect of seeing New York, and the unusually short stay of only twenty-five hours had to be very crowded. A letter, written by the author, will give the best idea of the visit.

" . . . I went to a midnight cinema show on arrival, travelling up-town by express and local subway, exactly as described by General Parsons, in his lecture at Cambridge, last term. The cinema was cool, well-ventilated, and the 'talkie' reproduction was 50 per cent. better than in London. An added touch of care for the patrons' comfort was the free presentation of a morning paper as one left the cinema.

" I slept at a hotel, and the next morning went over the New York Stock Exchange with a friend, the youngest member on the floor. It is very well worth a visit, and I now know the true meaning of the word 'babel.'

" I then went up the Woolworth Building, 57 floors, and the lift does not stop till the 36th. The view is magnificent, but the surrounding architecture is atrocious, since the true massive plain style for skyscrapers is only just starting, and the older buildings vary in styles from the Egyptian to a florid Gothic.

" I lunched in a City club (cocktails were ordered before the meal, just as simply as in any club in London), and then went up-town by elevated to shop. Then on to the residential quarter on East side, to friends, where I saw the interior of a typical New York private house, cool and comfortable.

" These friends took me out by car over the Long Island suspension bridge (four lines of cars in one direction, two in the other, all crawling across at about 10 m.p.h., in a traffic block a mile long), by main roads, which at their best were perfection, and at their worst had tramlines sticking up four inches above the surface. We went to a country club, complete with tennis courts, a golf course and a swimming pool, that lay immediately in front of the broad, shady verandah. Here we dined, and after dinner, I returned by train (complete with headlight, cow-catcher and conductor) and caught the ship.

"The Americans are essentially a practical nation; where we put up a notice 'Wet Paint,' they simply put up 'Paint'; if you feel hot in the subway, you take off your coat and hang it on a peg, if you still feel hot, nobody will object if you add your collar and tie. Every store and hotel lobby is fitted with a water cooler, whence you may obtain iced water in a paper cup.

"They are a gregarious nation, and seem incapable of entertaining themselves, but have to be in a crowd. Finally, that they are a persistent nation, is shown by the fact that the statue of Liberty was pointed out to me as the statue of Liberty no less than forty-five times, as we sailed up the harbour."

Hints for the Trip.—A few hints for others making the trip. Make firm friends of the pursers and the chief electrician; the pursers can move one into a comfortable cabin and the chief electrician can supply a fan. Whatever may be said to the contrary in the instructions, it is advisable to take a dinner-jacket, since all the first-class passengers change for dinner. Finally, cool clothes should be taken, as New York in the summer is very hot.

The trip as an experience was invaluable as, in an army career, it probably provides the only chance of visiting America.

View from the Woolworth Sky Scraper.

View from the Woolworth skyscraper

THE PERMANENT DEFENCES OF SHANGHAI.

By LT.-COLONEL L. E. BARNES, O.B.E., R.E.

WHEN the Defence Force first arrived in Shanghai, at the beginning of 1927, their problem was to keep outside the International Settlement the warring Chinese factions, namely, the Northern and Southern Armies. To this end, barbed wire entanglements were erected, across fields, along creeks, in streets, up alleyways—in fact, all along the Settlement boundary and round the residential area to the west of it; it was even necessary to continue these barriers between the International Settlement and the French Concession (*vide* Plate I), as it was doubtful at that time whether the French preparations were adequate to prevent the ingress of Chinese troops. In all, 16½ miles of wire were erected, and, in addition, some houses were fortified and many breastworks, little blockhouses of concrete slabs, sandbag emplacements for machine-guns, etc., were constructed, all of which formed strong points along the perimeter. The principal danger was anticipated from the open country to the west, as the Cantonese forces were approaching Shanghai from that direction.

As time went on, the theatre of civil war moved northwards, the French defensive arrangements on their south and west boundaries were improved, and the situation generally became less tense. By degrees, the temporary defences on those parts of the perimeter which lie in open country were removed, or, in places where the removal was not worth the cost of materials, left for the local Chinese to take away.

The passing of the Southern, or Cantonese, Army, however, left a virulent form of Communism in its trail. As is well known, the Cantonese forces had been enrolled and instructed in Communistic principles, and they had Russian Bolshevik officers on the staff. It would have been hard to find a more receptive outlet for their nefarious energies than was provided by the thousands of illiterate Chinese coolies and mill-workers of Shanghai, already somewhat tainted with Bolshevik teaching; the Communist leaders were not slow to grasp the opportunity thus offered to them, and they fanned the fires of discontent and disorder with great advantage from their own point of view.

Thus the danger to Shanghai was no longer to be anticipated externally from organized Chinese forces, but internally from dis-

Photo (c).—The modern blockhouse and steel gate which have replaced the defences shown in Photos (a) and (b).

Photo (d).—Blockhouse "E," just beyond the cross-roads of two narrow streets. It is raised on a framework of reinforced concrete, and the caponier gives facilities for firing up and down the street at right angles to the one in the photo.

Chapei is in the background, and a steel gate can be distinguished under the centre of the blockhouse.

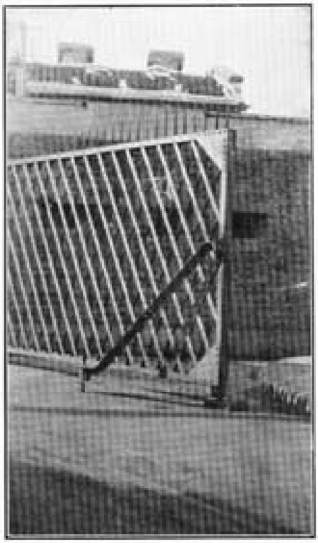


Photo (e).—The moveable end of a steel gate, showing the drop-bolt and the bracket which puts it out of reach of the mob.

Permanent defences of Shanghai

THE PERMANENT DEFENCES OF SHANGHAI.

PHOTO (a).—Some original defences at "B" on Plate II. from the Settlement side.

PHOTO (b).—As Photo (a), but from the Chinese side. The sentry shown is a Cantonese.

These two show a concrete slab blockhouse, a gate made of barbed wire on a wood frame, and a sloping screen of expanded metal to catch bombs.

Permanent defences of Shanghai

organized mobs, and the probable scene had shifted from the open country to the narrow streets of the Chinese part of the town.

In order to follow the development of the situation, it is necessary to bear in mind the broad outline of the geography of the place. In Shanghai, as a whole, there are two densely-populated districts outside foreign control, namely, Chapei and Paoshan to the north, and the Chinese City and Nantao to the south, and these two are the potential centres from which Communistic danger threatens the foreign settlements. The southernmost of these need not be further considered here, as the French Concession, with efficient defences, police and troops, lies between it and the International Settlement.

Now the International Settlement has a population of 857,000, of whom 824,000—about 96 per cent.—are Chinese. It also has an armed and well-trained police force of some 3,800, of whom 450 are British, 100 Japanese, 800 Sikh, and the remaining 2,450 Chinese, principally from the North; this force, well served by an excellent C.I.D., is fully able to quell, in the early stages, any mob which might try to collect within Settlement limits. But the police cannot deal with a mob collecting outside the Settlement, until it attacks or comes within the boundary, by which time it will have attained alarming proportions, and thus it comes about that the Chinese-controlled district of Chapei and Paoshan is the serious danger-spot for the Settlement.

Till the end of 1928, the original barbed wire entanglements and concrete blockhouses still existed along this part of the perimeter. They greatly impeded traffic in the narrow streets, and caused much inconvenience and loss to the small shopkeepers, whose shops were thereby cut off from the streets and whose trade was consequently impaired; many applications and petitions for removal of these obstacles were made to the Shanghai Municipal Council. From the military point of view, these temporary defences required replacement by something more permanent; the wooden posts for the wire entanglement—no screw pickets were available when they were erected—were unsatisfactory, being liable to rot, and the concrete blockhouses were very elementary in construction, being neither bullet-proof, weather-proof, nor equipped with drainage or any conveniences for fighting or for comfort.

Headquarters, North China Command, therefore represented to the Shanghai Municipal Council that permanent defences should be provided without delay, so that the reduction or entire withdrawal of the garrison might not leave Shanghai as unprepared as it was in 1927. A committee was accordingly formed, with the Commandant, Shanghai Volunteer Corps,* as President, the Commissioner of Police,

* The S.V.C. is under the direct control of the Shanghai Municipal Council, the ruling body of the International Settlement. The Commandant is a Regular Officer, of the rank of full Colonel, lent by the War Office and changed every 3 to 5 years: he is, *ipso facto*, the expert adviser of the Council on all military matters.

and a representative of the Public Works Department of the S.M.C., as members, and the C.R.E., North China Command, as technical adviser. This committee put forward recommendations for a total provision of eight blockhouses, thirty steel gates and a few lengths of permanent barbed wire fencing on steel uprights, all of which are shown on the attached plan. The Council approved of this, allotted the necessary funds, and the work has recently been completed.

Briefly, the principle which guided the committee was that mobs are not dangerous unless they can move unimpeded down streets or wide alleyways: any obstacle, such as a creek, or a narrow alleyway leading to only a few houses, though not insurmountable, will suffice to break up a mob, and will, therefore, rob it of the power to do serious damage. Based on this principle, the scheme submitted by the committee put a steel gate at every bridge, road and large alleyway leading from Chapei and Paoshan into the Settlement, and, to support this defensive line, sited blockhouses where tactical considerations showed them to be necessary—always bearing in mind the experiences of 1927. Where possible, the gates were located on the Chapei side of those roads which run parallel to the boundary, but, in places where the boundary actually runs along the road itself, it was necessary to put the gates across the Settlement roads leading therefrom. The detail is shown on Plate II.

Naturally, this defensive line was made strongest in the centre, but it extends far enough to the east to cover all the main roads leading into Shanghai from the north, beyond the limit of the disturbances of 1927, and far enough to the west to cut off, from the residential part, the mill area along the Soochow Creek, where Communist troubles have been known in the past and are quite likely to occur in the future. The second line, giving depth to the defence, is provided by the Police Stations themselves: this is a convenient arrangement, as the police will close the gates and occupy the blockhouses in the first instance, and will only be relieved by the Volunteers if the situation becomes so serious as to demand that measure.

Some details of the blockhouses and gates are shown on Plates III and IV, reproduced by the courtesy of Mr. C. Harpur, Commissioner of the Public Works Department of the S.M.C., and the photographs serve to illustrate the mode in which the work has been carried out.

The blockhouses are, generally, of brick with walls 20 in. thick, provided with loopholes and platforms for machine-gun and rifle fire: each loophole has a ¾-in. steel plate to close it, and the sliding door is of similar material and design. They are provided with arm-racks, shelves and pegs, furniture and latrine arrangements; water and electric light are laid on, and an observation post, in which one

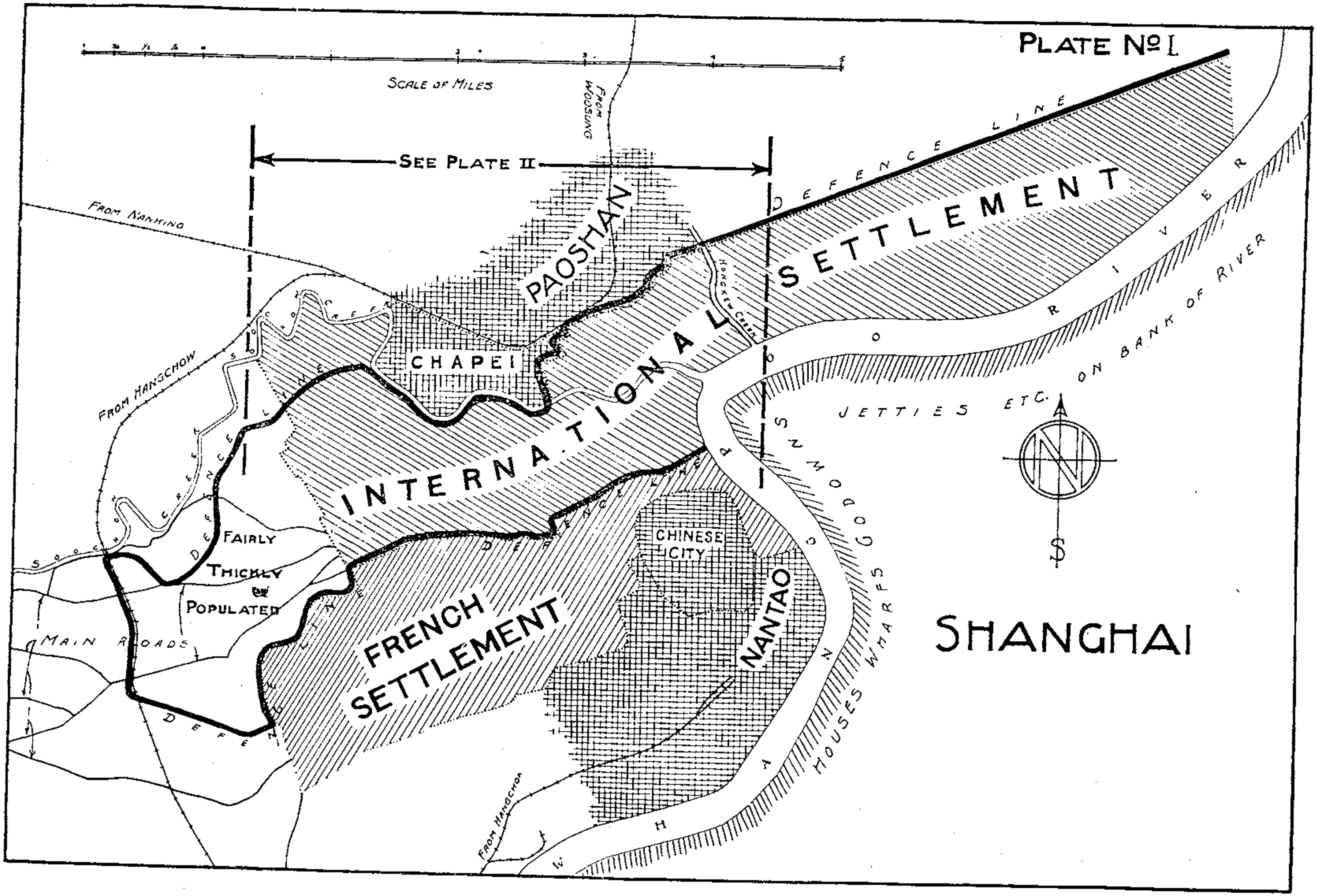


PLATE No I
SCALE OF MILES
SEE PLATE II
FROM WOOSUNG
FROM NANKING
FROM HANGCHOW
FROM HANGCHOW
DEFENCE LINE
INTERNATIONAL SETTLEMENT
PAOSHAN
CHAPEI
HONGKEW CREEK
SOOCHOW CREEK
FAIRLY THICKLY POPULATED
MAIN ROADS
FRENCH SETTLEMENT
CHINESE CITY
NANTAO
WHANGPOO RIVER
JETTIES ETC. ON BANK OF RIVER
HOUSES WHARFS GODOWNS
N
S
SHANGHAI

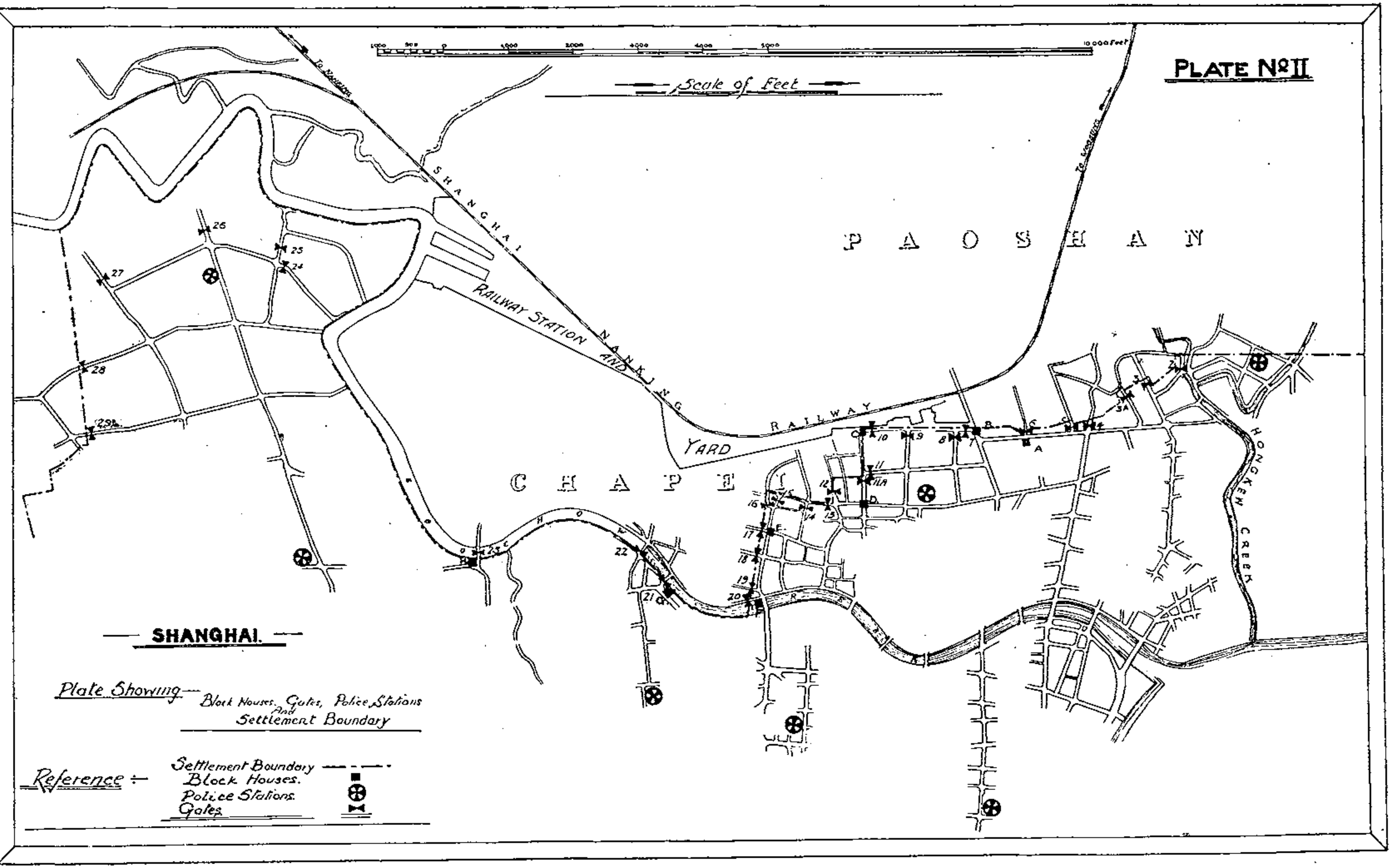
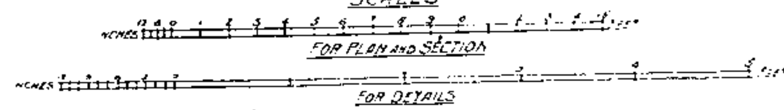
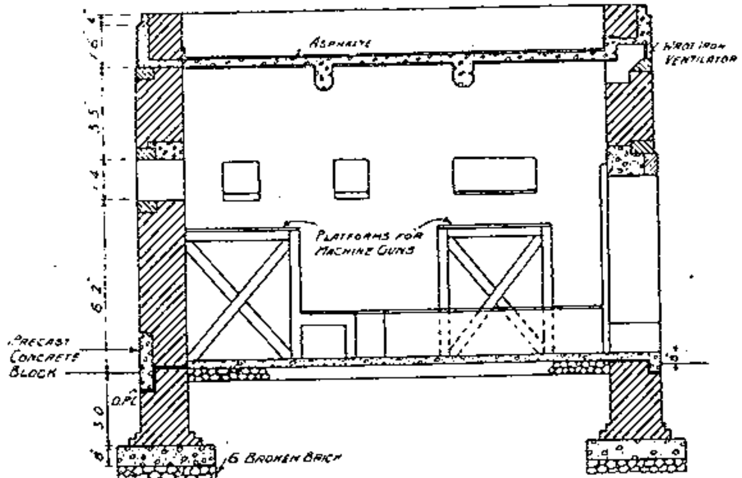


PLATE Nº II
Scale of Feet
SHANGHAI
Plate Showing Block Houses, Gates, Police Stations And Settlement Boundary
Reference :-
Settlement Boundary
Block Houses.
Police Stations.
Gates
PAOSHAN
CHAPEI
SHANGHAI NANKING RAILWAY STATION AND YARD
RAILWAY
HONGKEW CREEK
To Woosung

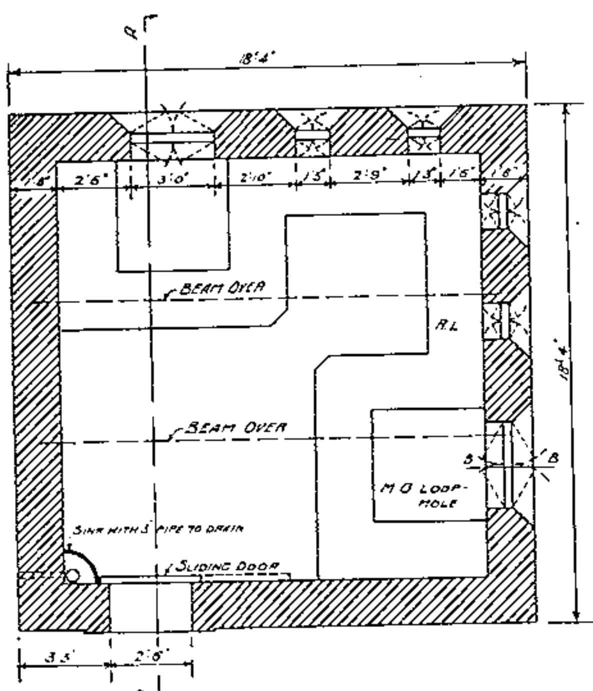
SHANGHAI DEFENCES
BLOCK HOUSE
ONE STOREY TYPE

SCALES

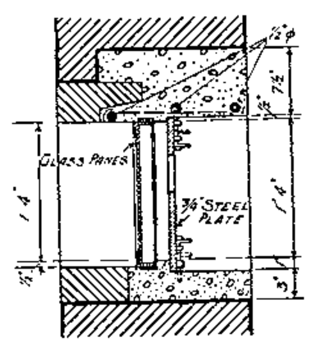




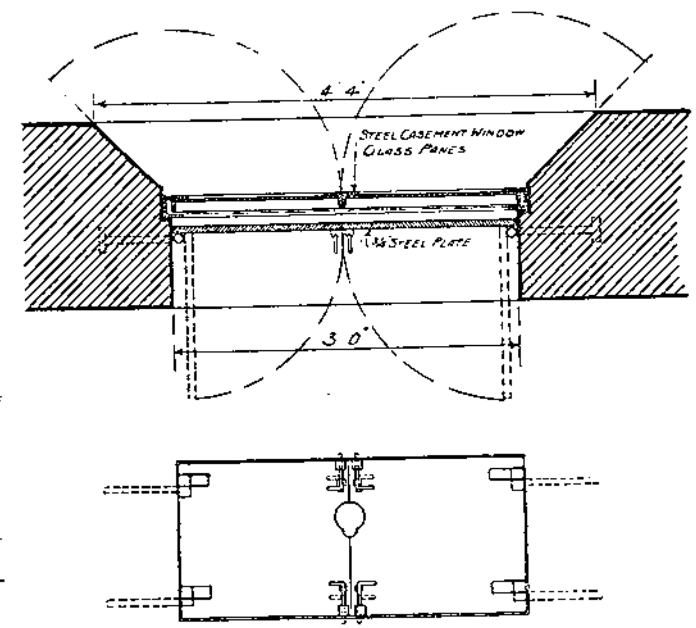
SECTION A.A



PLAN



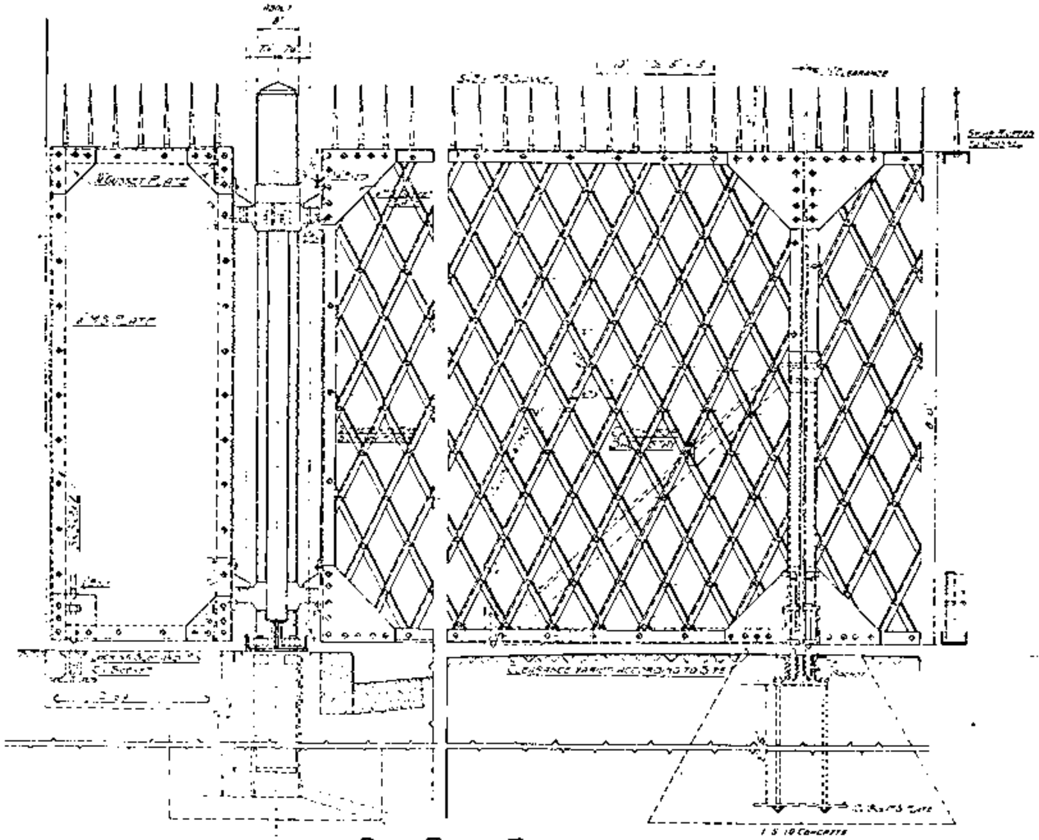
SECTION B.B



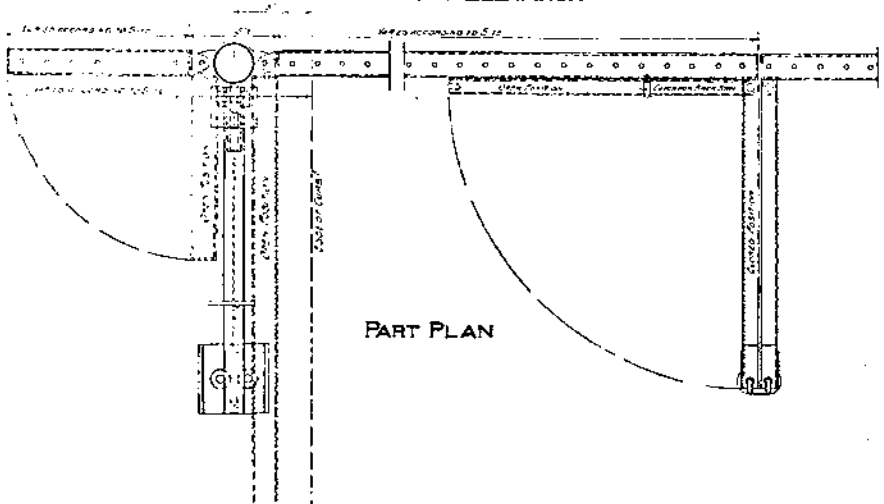
M.G. LOOPHOLE

SHANGHAI DEFENCES STEEL BARRIER GATE.

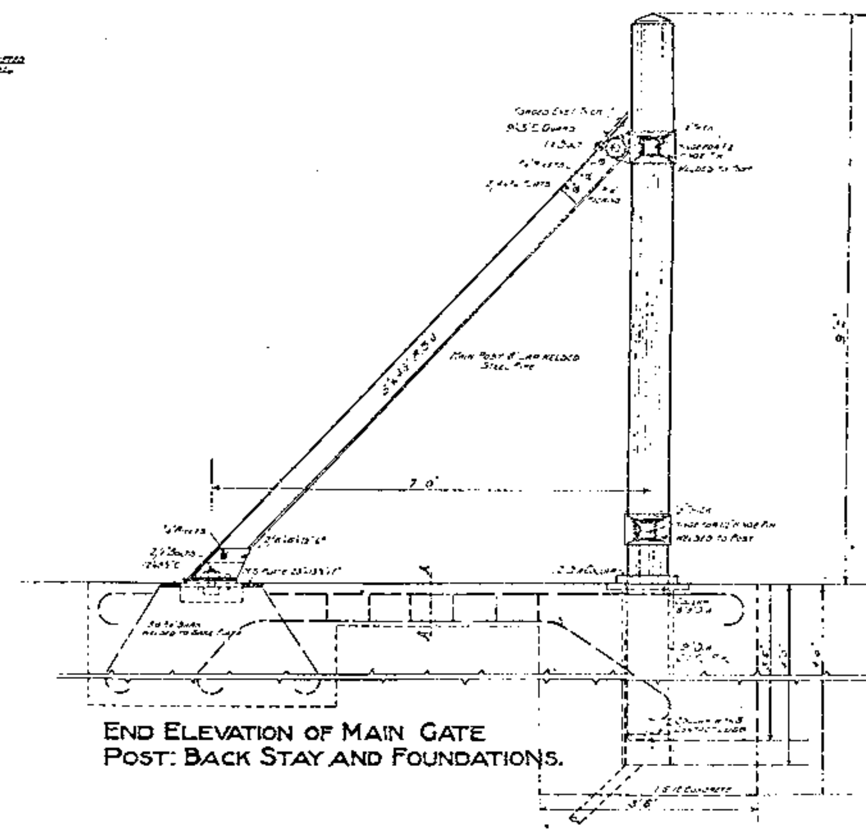
PLATE No IV



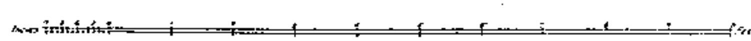
PART FRONT ELEVATION



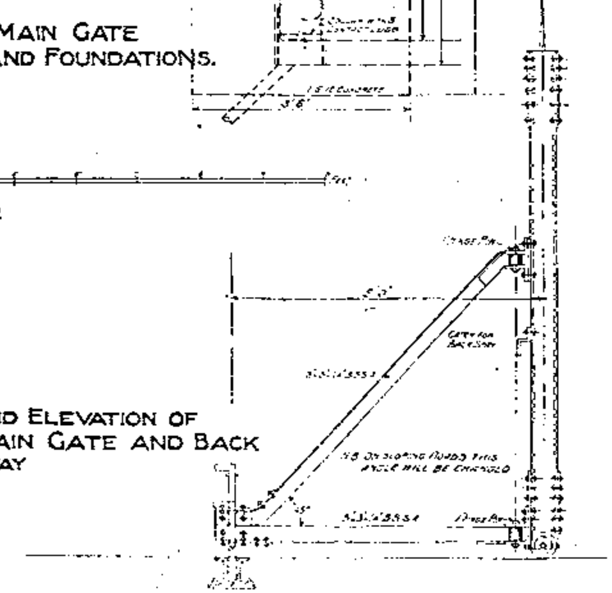
PART PLAN



END ELEVATION OF MAIN GATE POST: BACK STAY AND FOUNDATIONS.



SCALE



END ELEVATION OF MAIN GATE AND BACK STAY man can keep a look-out over all avenues of approach, has been added recently: further, each blockhouse has direct telephonic communication with the Central Police Station, and this can be switched over to the Headquarters, Shanghai Volunteer Corps, if and when the defences are handed over to them.

Some blockhouses are single-storied, and some are double-storied, whilst one is at such a narrow cross-roads that it has been necessary to raise it on pillars so that all traffic can pass underneath: two others are of "mushroom" design, being steel cylinders raised on a single central pillar above the traffic. The cost averages taels 1,500 (£200 approx.) per blockhouse.

The gates are 9 ft. 6 in. high, of ½-in. channel steel, laced together by ¼-in. angles in a lattice-work design. They can be shut by one man, and a neat arrangement of brackets ensures that the drop-bolts, which keep the closed gate in position, are out of reach of the mob on the far side. Bullet-proof gates of steel plates were found to be too heavy. The cost of these gates averages taels 700 (£100 approx.) each.

Thus the Settlement is now well defended in the centre of her boundary, but has nothing whatever on either side. If armies advance on Shanghai again special measures will once more be required in these open parts of the perimeter, with mobile forces and field defences as necessary; but it is to be hoped that this is a very remote contingency. The ever-present danger is to be found in the Communist efforts, and the permanent defences described above should greatly reduce this menace to the safety of Shanghai. In fact, it is by no means unlikely that the very existence of these defences will nullify the best efforts of Bolshevik orators to send others on the dangerous mission of doing violence in the Settlement. If this proves to be the case, then the outlay on this visible and tangible form of insurance is an expenditure which the Shanghai Municipal Council will never have cause to regret.

A TWENTIETH-CENTURY SPORT.

By Captain C. A. de Linde, R.E.

It is only fit that the Journal of a Corps so diverse as ours should have reflected the catholicity of its readers in publishing, within the last few years, articles on the great sports of hunting, sailing, mountaineering and travelling. This century has seen the coming of age of another sport ; a sport that can vie with fox-hunting itself in bringing out the military virtues and in giving its followers the most pointed pleasures of the open air. A belief that, in these respects, it need not shrink from comparison with any other sport whatsoever must be my excuse for writing about ski-ing in this place.

Ski-ing, which to-day we are apt to think of as a mountain sport, was born in the rolling country of the Lapps as a most utilitarian means of locomotion. For a thousand years it was nothing more and nothing less, till about 1880 the Norwegians began developing it as a sport ; later, it was introduced to the more precipitous Alps of Central Europe ; to-day, the sport has spread over almost the whole mountainous world. It is natural to ask how this sudden and ever-increasing popularity of ski-ing has come about. Thomas Cook, The Swiss Hotel Proprietors' Association, the Southern Railway, may, singly and collectively, have had something to do with it. The crowds, fumes and noises of an ill-adjusted civilization have undoubtedly made twentieth-century man—and woman—turn more and more to open air holidays. But above all it is the innate merit of a holiday in the snows that has made ski-ing so popular. First, there is no healthier holiday ; one spends the whole day in air that Margate itself cannot rival for purity and bite. Not only is there this bracing air but, possibly even more provocative of health, there are the unabated rays of the Alpine sun. To go to the mountains in winter is one of the few practical methods open to twentieth-century man of getting away from the sound of a motor-horn and the stench of exhaust gases. Then there is the matter of scenery ; there may be those who prefer the wild waste of waters, the peace of Suffolk's "lilied lowland waters," or the quiet greens and browns of the Shires, but no one will deny the noonday majesty of the Jungfrau, the magic of sunrise against the Wilde Kaiser or the ethereal loveliness of a larchwood under the tracery of snow. So much for outward circumstance. For the running itself, it is not just a matter of sliding and falling down a slippery slope; there is the zest of speed, the thrill of succeeding, at the tenth time perhaps, in doing a turn just a little faster than you have ever done it before; the effort, a painful joy, of bracing yourself to take a slope straight which dull caution would have you traverse; the excitement of the start down to the road which you see four thousand feet below you; the thought of the hot rum that you will order at the Schwarzer Adler further down that same road; the satisfied fatigue of the hours between dusk and bedtime.

Ever since the Peninsular War, it has been a tradition in most branches of the Service for commanding officers to give every encouragement to officers desirous of hunting the fox. Even in a mechanical age, excellent reasons can be found for continuing the tradition. In the same way, there is much to be said for encouraging officers to go ski-ing. I believe I am right in saying that this is a definite policy in the Royal Air Force. Leaving aside these amiable generalizations, we can now consider what are the attributes of this sport that make it one particularly suitable for our martial selves. First of all, it inculcates the hotch-potch of virtues which we call "dash," sound judgment combined with quick decision, boldness held in light restraint by caution. In a single day's run, you will be called upon a dozen times to make decisions; the quicker you make them the less likely you will be to get into trouble. Unless you are quite mad, you will never ski alone, and the presence of companions will always stimulate you to take the bold course without taking the foolhardy one which may involve their *carrying* you down, painfully and slowly. To make a good decision it will be necessary to take in the country at a glance. There is much to take in: snow conditions (there are at least half a dozen varieties of snow, most of which you may meet within the space of half an hour), rocks and boulders, cornices and avalanche slopes, fences and gates, trees and half-hidden bushes, ditches and sunken roads, and, as troublesome as any, every change of gradient. Your eye for country is being constantly exercised. This is not only the case while you are running down, but also while you are climbing; few things are more exasperating than a leader laying a bad track. To no one is the contour less of an abstraction than to the skier on his ascent. It is scarcely necessary to point out how essential in war is an eye for country. A small fold in the ground that has been seen and noted may turn failure into success; no one is more likely to note it than the ski-running man. Again, weather is often a factor in military appreciations; to notice weather conditions becomes second nature with the mountaineer and ski-runner. His life, like that of the soldier, may come to depend on weather wisdom.

It will not be inapt to quote here the following from the *British Ski Year Book*, 1927: "On December 12th, 1916, snow began to fall and fell continuously for a fortnight [on the Austro-Italian front]. Colonel Bilgeri had drawn the attention of the Authorities to the precarious situation of various Alpine Barracks, but his warnings were disregarded. During this fortnight, no less than 3,000 of the 80,000 men in the Higher Alpine Stations were killed by avalanches. The Italians suffered even greater losses." Comment is superfluous, the moral obvious.

Map reading is one of the minor military arts. There is not much to choose between the difficulty of reading a map in a devastated forward area and that of reading it in a desolation of mountain peaks shrouded in mist. Both tasks may be impossible; but if you can do one you can do the other. A map and a compass are as essential for serious ski-ing as for real war. Lastly, to digress from the particular to the general. In any sort of cross-country ski-ing, there must be a leader, and on the capabilities and character of the leader depends often the enjoyment and success of the expedition. So, in this particular form of sport, there lies an excellent way of practising the art of leadership, to a soldier the most essential of all arts.

To get the best value out of ski-ing, one should never stick to one centre or even one country. An idea is prevalent in England that ski-ing means Switzerland. It most emphatically does not. The more an officer knows of foreign nations the better. If he goes to the more obvious places at the more obvious times, the Oberland, in January, for instance, he can no more claim to be seeing a foreign nation than the man who winters at Cannes can claim to being a traveller in France. The Alps take their rise in France, however unfashionably, and at Grenoble and Briançon, you will be able to see the Frenchman at home and, if you go about things the right way, you may even be able to go ski-ing with those fine mountaineers, the Chasseurs Alpins. Then south of Switzerland, the Alps spill over into Italy, and the Italian enthusiasts will be met in great numbers at Cortina, amongst other places. East, the Alps run almost to the gates of Vienna. In the Silvretta group, ski-ing is practicable as late as June. Colonel Bilgeri, the great Austrian expert, organizes week or ten-day tours every year in various parts of the Alps, and is always very good in taking English people who have provided themselves with an introduction to him. Germany can boast ski-able mountains in Bavaria. Then the Carpathians run through three countries, Czecho-Slovakia, Hungary and Poland. Only last year the Czech military authorities issued a special invitation to British officers to attend their ski school. Lastly (I write here only of Europe), there are the two countries of Norway and Sweden, for the wise runner who looks for fresh snows and mountains new. It is safe to say, without having visited all these lands, that the man who visits them armed with ski will come to know more of them and their peoples than ever would the mere tourist, however much his pockets bulged with Cook's coupons and circular tickets. There can be no denying that an enthusiasm shared is an introduction that will open the most reserved heart; the natural freemasonry that has always existed between horse-lovers is only equalled by that between mountain-lovers.

It is too commonly thought that ski-ing is an expensive sport. It certainly can be, but it equally certainly need not be. It is not necessary to stay in the Grand Babylon Hotel; nor to buy your kit in Savile Row; nor to lounge expensively over the bar. It is possible and not unamusing to drink the beer of the country; to use up your old uniform—dyed blue for preference; to take a room in the village—in the home of a guide, if it may be; to travel less expeditiously, but perhaps as serenely, in a train equipped with second-class accommodation. To take an example, a month at a place like Briançon need cost you no more than £20 to £25 when once you have attained to some wisdom in foreign travel. Even an agency will quote prices which work out as low as £5 10s. per week (to this must be added equipment, club, lessons or guides and incidentals included in the first figure).

It is a platitude, but nevertheless true, to say that the British Army may be called upon to fight anywhere, and at any time. In the last war, British troops were to be found in the Trentino Alps, in North Russia, and on the snow-covered plains of Siberia. It would have been fantastic in 1910 to think of British troops advancing up the Struma Valley, of a British General receiving the keys of Jerusalem, of a British rest camp at Faenza, in the heart of Italy. Is it so fantastic to think to-day of a campaign among, say, some of the mountains that radiate from the Pamirs? France has her school of mountain warfare at Briançon; the Norwegian, Swedish, Czecho-Slovakian, Polish, Japanese, Italian, German, Austrian and Finnish armies, all have units specially trained to winter and mountain warfare. Our defence problems are different and we obviously could not afford any specialized unit, even in India; but it might be profitable for authority to look in future on ski-ing with the same benevolent eye that it has in the past turned on the sport of fox-hunting.

*THE FORCING OF THE SAVE AT SCHABAZ BY THE AUSTRO-HUNGARIAN ARMY, AUGUST 12th–24th, 1914.**

By LIEUT.-COL. DR. OSKAR REGELE, *of the Austrian Army.*

THE subject of forcing rivers is steadily increasing in importance, since, through the development of technical science, obstacles on lines of communication are being gradually eliminated, and mountains and rivers will soon be the only effective obstacles. This has already been fully illustrated in the course of the Great War. The crossing at Schabaz, in Serbia, in 1914, is amongst the most instructive and important forced passages effected by the Austro-Hungarian Army.

Schabaz, a town which, at that date, had a population of 14,000, stands on the right bank of the Save, on the southern border of the Matschwa plain, and is an important point of communication. On the northern bank a railway runs to the Save, and several roads, as well as a railway line, connect Schabaz, which is also a river port, with the interior of Serbia. Considered as a crossing-point, the town presents several disadvantages. It is situated on a sharp bend of the river and therefore presents great tactical disadvantages for the site of a bridgehead on the southern bank. These are intensified by the fact that the hills situated to the S.E. of the town, near Mischar, command the crossing-point, whereas there was no favourable spot in the immediate vicinity of the town, owing to the thick undergrowth. But the occupation of the hills above-mentioned for the protection of the bridgehead would have entailed a dissipation of effort, and was, therefore, almost out of the question. The breadth of the river is about 650 m., and at the normal level the depth is 2 to 2½ m. Its current is 1 to 1½ m. per second. The banks are of moderate height, of a soft soil, of which the river-bed is also formed.

The plan of the Austro-Hungarian H.Q. Staff was a march by the 5th and 6th Armies from Bosnia, across the Drina, to Serbia. In order to support this difficult operation, the 2nd Army, which had advanced to the Save and the Danube, was to hold up Serbian forces by local attacks across the Save at Mitrowiz and Schabaz, while feint crossings were to be made east of the latter. The outline of

* (1) *Oesterreich—Ungarnsletzter Krieg* 1914-1918. Vol. 1, Vienna, 1929.
(2) *Schabaz* by Feldmarschall-Leutnant T. Schön, Reichenberg, 1929.
(3) *Les Victoires Serbes* by Desmazes and Laumowitsch, Paris, 1928.
(4) *Tagebücher des Verfassers.*

this plan clearly shows the strategic importance of Schabaz, and the importance of the successful crossing planned for this point. From the first, however, this scheme was doomed to disappointment, since it was known that the 2nd Army could serve on the Serbian front for a short time only, as it was to be transferred to the Russian front. The 2nd Army could not, therefore, undertake any operation on a large scale, which decidedly hampered the decisions of the commanders. For this reason, the operations at Schabaz were an extremely doubtful proposition, and made the heaviest possible demands upon both officers and men. It was, undoubtedly, a very difficult problem to cross a broad river, within view of the enemy, and to hold up strong enemy forces, whilst at the same time guaranteeing the possibility of an immediate withdrawal of our own troops to the northern bank at any moment.

Whereas six battalions of the 29th Infantry Division crossed to the southern bank at Mitrowiz and Jarek, on August 12th, without special difficulties, engagements took place on the same day at Klenak, where a "demonstration with Infantry only, unaccompanied by horses," took place; which was the prelude to a thirteen days' battle around Schabaz. The following units took part in the first crossing: the 62nd Brigade, under Maj.-Gen. von Dani; the 44th Infantry Regt.; and the 5th Pioneer Battalion, with 18 bridging columns. After a march of 32 km., on August 11th, the Pioneers reached Hill 81, north of Klenak, after sending forward mounted reconnaissance officers to the Save. Between 5 and 7 p.m., artillery fire was directed upon Schabaz, in order to warn the enemy of the commander's intention, since this was of the nature of a demonstration. The first crossing was so organized that, during the night of August 12th, the 1st, 2nd, 3rd and 5th Companies of the 5th Pioneer Battalion, with three bridging columns each, marched over the concrete bridge (3) to the bank, where they prepared pontoons for the attack. The bridging wagons moved off across the military bridge (2), constructed during the night, back to Hill 81. The pontoon groups were separated by two sunken vessels (10), so that on the right flank, the 1st and 2nd Companies—and south of these, the 3rd and 5th Companies—occupied their positions in observation. Each company had 18 pontoons, which were to be sent in three successive bounds of 6 pontoons each. Each company in each bound included 160 infantrymen. The night of August 12th was moonlight; preparations were not disturbed by the enemy, and only a few stray shots were fired. The 44th Regt. were brought to the wooden bridge (4) by Pioneer commanders, and by 3 a.m. had embarked in the pontoons. At 3.10 a.m. came the order for the attack, and the first bound of all four Pioneer Companies left the bank immediately. Silently they rowed out into the river, and reached the middle unopposed. There, they were suddenly attacked by the fire of the Serbian forces on the bank, and fell into disorder. In the confusion of the engagement, the various pontoons were left entirely to their own resources. Many mistook the direction, and began to drift; others could not complete the crossing, and turned back. The 2nd Pioneer Company alone, with units of the 1st Company, succeeded in landing their infantry—in accordance with orders—on the enemy bank, and in returning to their own post with few casualties, in spite of hostile fire. Here it was already assumed that the first crossing had failed, but the empty pontoons of the 1st and 2nd Companies dissipated the fears. General transportation was at once continued, and at daybreak, 5.15 a.m., the whole of the 44th Regt.—four battalions—had reached the southern bank. There was some friction due to the fact that the infantry did not come up quickly enough, and so checked the transport arrangements. The heaviest casualties occurred amongst the troops and the teams of the bridging columns assembled on the northern bank, whereas the troops ferried across quickly reached the dead ground of the southern bank, and were therefore soon under cover. The ferrying was continued, a battalion of the 32nd Regt. followed, and towards noon, a battery of the 10th Field Artillery Regt. transported in sections. At 3 p.m., Gen. von Dani took Schabaz from the north, with these troops. The Pioneers started for Schabaz at 4 p.m., with their entire equipment, and immediately constructed two landing-stages on each bank (11 and 12). Half of the 1st, 2nd and 4th Pioneer Companies remained during the night—as ferry reserve—on the south bank, and maintained communication with the Infantry. At the bridgehead, fairly frequent fire was maintained against the enemy, who were endeavouring to gain contact, and the embarkation position was also under fire.

On the Serbian side, there were, on August 12th—on the bank at Schabaz—two Infantry Companies, with two guns, as well as customs and gendarmerie detachments. One company was at Mischar, and in the immediate vicinity of Schabaz there were also four battalions and one squadron. In spite of this garrison—sufficient for the defence of a large river—the Serbian Reserves did not intervene in the engagement, but withdrew in the direction of Mischar, in consequence of the effects of artillery fire from Tursko Groblje. Owing to this action, the first and the best opportunity of driving back the landing parties into the water was lost, and the attacking party gained an important initial success.

On August 13th, ten ferry units of the 5th Pioneer Battalion, assembled on the previous day for transport, were taken across on simple pontoons—the crossings continuing up to 8 p.m. In addition to the horses and trains of the fighting units already in Schabaz, three composite battalions (third line), artillery and Pioneer columns, with entrenching tools, reached the south bank. Since no motor-boats were available, parties of Pioneers were obliged to row across the broad river. On the return trips, the wounded were brought back. During the day the first steam ferries arrived, which decidedly accelerated the passage (13). At first, it was composed of one steamer with two, and another with four, towed boats. The two monitors, *Marosch* and *Leitha*, afforded great protection at the crossing-point; built in 1871, they had been in action together in 1878, at Brod, on the Save, co-operating with the 5th Pioneer Battalion. They were indeed obsolete (310 tons, 50 m. in length, 8 m. in breadth; armament: one 12-cm. gun, two 47-mm. Hotchkiss m.g's., one 8-mm. m.g., armour-plate, sixteen 50 mm.; two screws; draught, 1·2 m.), but did excellent service in the battle of Schabaz. In order to establish continuous communication with Schabaz, and in the absence of special means of communication (aeroplanes, wireless, river-cable), 20 pontoons were anchored, on August 13th, straight across the river above the crossing-point, and a telephone line laid over them.

Gen. von Dani occupied the outskirts of the town, and repelled the first Serbian attacks from Mischar. The Serbian 3rd Army gave orders for the recapture of Schabaz, on August 14th, and dispatched the Schumadia 1st Division for this purpose. Since the Austro-Hungarian troops in Schabaz were forced to take the offensive, Gen. von Hortstein—who was now in command in Schabaz—formed an attacking force, composed of the 29th Division, and various units of the 7th Division, which was to assemble in Schabaz. The small demonstration carried out by the 44th Regt. at Klenak had now already developed into an important action. During the night of August 14th, the 1st, 2nd and 5th Pioneer Companies—the latter making use of the steam ferry—remained on the south bank, where, by raids, they maintained communication with the Infantry, and at 11 p.m., also took an active part at the steamer quay in repelling Serbian attacks. The demonstration of the 29th Division at Mitrowiz and Jarek was ineffective. At Belgrade, the Zigeuner Island was occupied.

The first important attack of the Serbians upon Schabaz opened on August 14th. Transport had been continued during the entire forenoon, the 5th Pioneer Battalion received orders—towards noon—to prepare in Schabaz to launch a military bridge, since ferrying alone was inadequate, and the troops on the southern bank were steadily increasing in numbers, and needed a safer means of communication between the banks. Preparations had just begun on both banks, and the bridging columns were about to unload the equipment on the north shore, when the enemy opened heavy artillery fire, surprising the bridging column, and forcing it to retreat and take cover. Shortly afterwards, the Pioneer Companies on the right bank received orders to prepare without delay to intervene in the battle behind the bridgehead on the left flank, where the 52nd composite battalion was hard pressed by the enemy, and, in any case, to keep in touch with the retreating Infantry, until reinforcements arrived. Meanwhile, the 53rd composite battalion was ferried to Schabaz under artillery fire. After this battalion reached the fighting line, the Pioneer Companies were withdrawn from the engagement and assembled on the left bank of the Save, to launch a bridge which was to be completed by 5 a.m., August 15th. But continuous artillery fire from Mischar, as well as infantry fire, interfered with the bridging work, which was, therefore, postponed to the following day. The Serbian attack had opened at 10 a.m., with ten battalions and four half-squadrons, with the object of capturing Schabaz from south and east. The Serbians reached the outskirts of the town, but were repulsed by the eight battalions of the defence, all reserves being brought into action; artillery also co-operated from the north bank, and very effective support was received from both monitors. By the later intervention of a force, under Gen. Letovski, which had marched through the Matschwa, and appeared before Schabaz at 1 p.m., the Serbians were forced to withdraw across the Dobrawa. A panic which occurred amongst the men of the train, together with numerous casualties, once more made great demands upon the Pioneers (especially at the steam ferry), since parties of the train had to be taken back to the north bank. Gen. Letovski took over the command in the town, from Gen. von Dani, who was wounded. The Schumadia Division I, which was moving up by forced marches, could only bring two of its sixteen battalions into action; this enabled the defence at the bridgehead to gain a fine success. The attempt to recapture the town had failed. The Serbian forces, now including 26 battalions and 7½ squadrons, were concentrated at Varna, during the night of August 15th, for a renewed attack upon Schabaz, by order of the Serbian H.Q. Staff, issued at 7 p.m. On the other hand, the 2nd Austro-Hungarian Army received definite orders to hold Schabaz. Hitherto, this Army had succeeded in holding up three Serbian divisions on the northern front. During the night of the 15th, Landsturm units were ferried to Schabaz, to reinforce the bridgehead garrison.

The ferrying of the 29th Division began at dawn, on August 15th. Fresh units reached the south bank continuously. The launching of the bridge (14) also began very early, the General's order including the following words: "*The decision of to-day's action depends upon the Pioneers.*"

The bridge was completed by the 1st, 2nd, 3rd and 4th Companies of the 5th, and the 1st Company of the 9th Pioneer Battalion, between 7.30 a.m. and 2.30 p.m. (without previous preparation). The work was not interrupted by the enemy, and was excellently carried out by the Pioneers, whose only experience had been training in peacetime. The Schabaz bridge is the longest bridge constructed during the Great War, and, in respect of the use made of it, should constitute a record. The sketch gives detailed data. The bridge was launched with pontoons, from the left bank. Since it was necessary to construct approximately ten extra bays—beyond the original estimate—in order to complete the bridge, two companies voluntarily undertook this task. Owing to a storm, with a strong wind, which made the insertion of the last pontoons very difficult, the work of completion was much hampered. At 5 p.m. traffic across the bridge began, amidst a thunderstorm and the opening of an artillery duel; a squadron of the 2nd Landwehr-Uhlan Regt. crossed first, and, with a few unimportant pauses, traffic continued uninterruptedly—in both directions alternately—for over 200 hours. Four Pioneer Companies were required for service on the military bridge, and two companies on the steam ferry. Moreover, the Pioneers were also responsible for tactical protection in the immediate vicinity, and for technical protection on the water, as well as for cover for guns, and various duties at the bridgehead. On August 15th, a military bridge was also constructed at Jarak. By the evening of August 15th, there were in Schabaz 34½ battalions (7th and 29th Divisions), which were not, however, ready to go into action on that day; the Serbians, also, let this day pass without any important action. At 3 p.m. orders were issued by their H.Q. Staff, for the recapture of Schabaz on August 16th; the enemy at the bridgehead must, at least, be cut off. The night preceding the 16th was comparatively quiet.

Important engagements again took place on the 16th. Gen. von Hortstein decided to make an attack from Schabaz, with the forces now concentrated there, in order to pin down the enemy. Meanwhile, the Schumadia Division began an advance on the town, but turned westwards, under the impression that their left flank was threatened. Therefore, the main body of the Austro-Hungarian forces did not gain contact with this Division, on the S.E. of the town; the 29th Division alone was heavily engaged at Dobritsch, which led to their withdrawal to the concentration point, whither the other troops also retreated in the evening. Towards midnight, large sections of the train were forced back from Schabaz to the north bank. Traffic on the bridge was very heavy during the whole day, and also at night.

On August 17th, the Serbians opened another strong attack upon Schabaz, which developed intensively; whereas the bombardment of the military bridge by the batteries at Mischar had hitherto been ineffective, the Serbians succeeded—at 1 p.m.—in destroying part of the bridge by several direct hits. Fortunately, few casualties occurred, since it happened that the general direction of traffic had altered, therefore, one part of the bridge—which would otherwise have been crowded—was clear. The situation was nevertheless critical owing to the interruption of traffic, whilst a reverse at the bridgehead might now lead to a catastrophe. Whilst the action in Schabaz was at its height, ammunition wagons suddenly appeared at the southern end of the bridge, on an urgent demand for ammunition from the hard-pressed batteries. For some time it was impossible to send a supply of ammunition across the bridge, since the part which had been hit could only be repaired under cover of darkness. But there was no ammunition on the spot which could have been taken across immediately. The units which had been cut off on the north bank, consisted of part of the 4th Hussar Regt., belonging to the IV Corps, which were to cross the military bridge on August 18th, and come into action on the south bank. Owing to continuous artillery fire, these units were forced to deploy over the ground, whilst in Schabaz itself part of the train had been cut up by fire. In order to provide ammunition, certain Pioneer officers rode off in the direction of Klenak. The first one succeeded in finding an ammunition column, and led it to the bank. The 2nd Pioneer Company at once began to load the ammunition cases on to pontoons. Officers and men vied with each other in carrying the cases, which were taken across the Save, the surface of which was constantly tossed by the falling artillery shell. On reaching the south bank, the ammunition wagons and limbers were loaded, and driven off at a gallop separately to their respective battery positions. Other Pioneer Companies were soon assisting in the transportation of ammunition, and the crisis on the south bank was over. The Serbians observed the interruption of traffic on the bridge, and the transportations, and interpreted the latter as a retreat of the Austro-Hungarian forces. They therefore opened a renewed surprise attack, which they were soon forced to suspend, since it was shattered by the return fire of the defence, on whose side the monitors did excellent service. The Serbians retreated to the heights south of the town. Although their attack had failed, yet the bombardment of the bridge had delayed transport of the cavalry of the IV Corps for seven to eight hours; it was, therefore, impossible for them to carry out a reconnaissance on August 17th, the lack of which was felt during the action on the 18th. The commander of the IV Corps—Gen. Tersztyánszky (Cavalry)—now took over the command in Schabaz. When darkness fell, the four sections of the bridge which had been destroyed were repaired by a detachment composed of picked pioneers—an operation which, however, occupied some hours. The transport of the IV Corps—which also used the steam ferry—began after midnight on August 18th.

Upon the arrival of the IV Corps in Schabaz, the forces within the town now numbered 35 battalions, with 26 batteries—in addition to 10½ Landsturm, and composite battalions. These troops opened the attack at 8 a.m. on August 18th, and during the day forced back the Serbians across the Dumatsche. Owing to the great fatigue of the troops—the IV Corps having just completed very lengthy marches—and to a severe storm, which broke at 6.30 p.m., the exploitation of success was impossible. The bridge was once more under fire the whole day.

On August 19th, the attack was continued, and the Serbian troops were forced back still further—in fact, across the Dobrawa. At mid-day, however, the trains of the IV Corps and some artillery units, were sent to the north bank: firstly, because very large numbers of troops and trains could not be concentrated in Schabaz—which was subjected to continuous bombardment; and also because the IV Corps received orders—at about midnight—to evacuate Schabaz, in consideration of the retreat of the 5th Army, across the Drina. In the midst of this movement of troops, *a heavy ammunition wagon broke one of the trestles on the left side of the bridge*. The quick intervention of the bridging party prevented any long delay.

At 5 a.m., on August 20th, the crossing of the IV Corps to the north bank was, however, suddenly suspended, since attacks from Schabaz were about to reopen. But, at 9.30 a.m., the IV Corps definitely retreated, and used the bridge, and the steam ferry throughout the day. The Serbians observed the clouds of dust raised by the return march of the IV Corps, and concluded that they were due to the approach of fresh troops to Schabaz. They could not, therefore, decide upon a definite pursuit of the IV Corps. The troops, remaining in Schabaz, received—in the afternoon—definite orders to hold Schabaz. The intention appeared to be to retain Schabaz for some time, as a bridgehead; during these days, therefore, the reinforcement of the military bridge by a temporary one was considered.

The passage of the last of the IV Corps continued uninterruptedly for the whole day, the Corps being followed by the Letovski group; from the afternoon of August 21st, therefore, the 29th Division only —with 13 battalions—remained in the town. The bridge was now under fire daily, but it was the first time that an interval of several hours' duration in transport occurred, and, at length, the Pioneers found an opportunity of effecting urgent repairs in the bridge, *the structure of which had suffered severely from continuous use, day and night, since August 15th*. The maintenance of the bridge in a workable condition involved, moreover, heavy labour and great care. Although the river level fortunately varied but little during the days of the battle, yet it was frequently necessary to readjust the anchorlines, refasten the lashings, correct the direction at every opportunity, repair slight damages, manage restive horses, and, in particular, to avert traffic congestion due to bombardment. Traffic management across the bridge was entirely in the hands of Pioneer officers. *The repeated opening of the cutbays for the monitors* also involved much work, since these vessels were sometimes in action below the bridge, and then again returned upstream. The bridge was the constant object of anxiety to all commanders, since the fate of all troops in Schabaz depended upon it. The certainty of uninterrupted traffic in both directions was the necessary hypothesis for all operations on the south bank. A serious interruption on the bridge might, at any time, lead to a catastrophe. This fact also explains the repeated Serbian attacks upon the bridgehead, against which—on the afternoon of August 21st—34 Serbian battalions and 6 squadrons once again attempted an attack. The position was, however, valiantly defended by the 29th Division, under Maj.-Gen. Zanantoni, and the enemy was even forced to withdraw to Varna. The 29th Division which, on the same day, also came into action in support of the sappers engaged in the construction of fortifications (seven technical companies being at the bridgehead), withdrew in the evening to the concentration point and was undisturbed at night. At Schabaz, it often happened that, after an engagement, the enemy forces separated. This may be explained by the assumption that the Austro-Hungarian troops did not always realize the retreat of the enemy, *since it was extremely difficult to effect a reconnaissance over country which could not be surveyed.*

On August 22nd, the 29th Division again occupied the inshore bridgehead, and on this occasion, a serious engagement took place, with the enemy, who was once more advancing upon Schabaz. Towards 4 p.m., fighting increased in intensity, yet the Serbians were again repulsed (rain fell on the 22nd). The situation was, however, more unfavourable to the 29th Division, since the Serbians had now surrounded Schabaz on all sides, and their forces were steadily increasing in number. Orders were, therefore, issued for all eventualities, with regard to a withdrawal to the north bank, which would, in any case, become necessary. The most vulnerable point was now the bridge, which was daily subject to bombardment and, on account of its length, its dismantling would take some time. In case of a reverse, very little time would probably be available. Therefore, orders were issued that, should a serious reverse occur, should the enemy make an attack, the bridge should be partly sunk, and partly destroyed by our own fire. The necessary preparations for this purpose were made, but the Pioneers were quite determined not to leave their bridge, any more than a gunner would abandon his gun in action. The 5th Pioneer Battalion remained at the bridge, and the other Pioneers—including the 15th Battalion recently arrived—with the steam ferry, and the various means of transport. Whilst these preparations were in progress, came the news that the IV Corps—which had already begun the march for entrainment to the Russian front—had been engaged on the south bank and, at 10 p.m., transport began by bridge and steam ferry, and the Corps moved for the third time to the opposite bank. The result of the engagement of the Corps was to repel the enemy—who were preparing for a decisive attack upon Schabaz—so that the latter could more easily be evacuated, according to plan as decided by the H.Q. Staff of the Austro-Hungarian forces in the Balkans.

On August 23rd, the lengthy columns of the IV Corps crossed the bridge, under heavy fire. At 2 p.m., the IV Corps and the 29th Division opened the attack, which forestalled the intended Serbian thrust against the military bridge which, by cutting off the garrison of the bridge, was to precipitate a catastrophe. The Serbian scheme was soon frustrated, and the advance checked. This result induced Gen. von Tersztyánszky, Cavalry Commander, at 7 p.m. to order the evacuation of Schabaz, by all troops, and the movement began immediately, with the retirement of the trains. *In addition to the military bridge, the steam ferry and a pontoon group, much reduced by fire,* were in action. For the protection of the direct crossing-point, the Pioneers dispatched their own signal patrols to the flanks of the bridgehead. The night was quieter, since the evacuation had completely escaped the observation of the Serbians, who were occupied in bringing fresh guns into position, for the continuation of their attack on August 24th.

The 29th Division was to hold the bridgehead until the IV Corps had left the south bank, and was then to cross the bridge, with the exception of a rear-guard battalion. No new orders were issued in reference to the bridge; it was, of course, the duty of the Pioneers to bring over the last of their comrades from the south bank, and, as far as possible, to save Pioneer equipment. At daybreak, artillery fire opened on the bridge, with greater intensity than before. A direct hit upon the close columns would inevitably have been disastrous. In order to facilitate the salvage of the bridge, the Pioneers began—even during transit—to remove the lashings, and take out some of its components. Behind the last wagon, the shore bay was taken up, shortly before 9 a.m., and the left portion of the bridge dismantled into whole and half sections, as used for exercises. All lower anchor ropes were cut through, since it was impossible to consider the raising of an anchor absolutely choked with mud. The remaining right portion—more than half the bridge—was so much damaged, that independent Pioneer groups embarked in pontoons, and released entire sections (three pontoons with two bays). Finally, the 3rd Company fetched pontoons numbers 95–97, and the 2nd Company brought up the remaining part of the bridge, on which many stragglers were transported. When, shortly afterwards, more stragglers appeared on the bank, the 2nd Company took two more pontoons to the Serbian bank, and brought the men into safety.

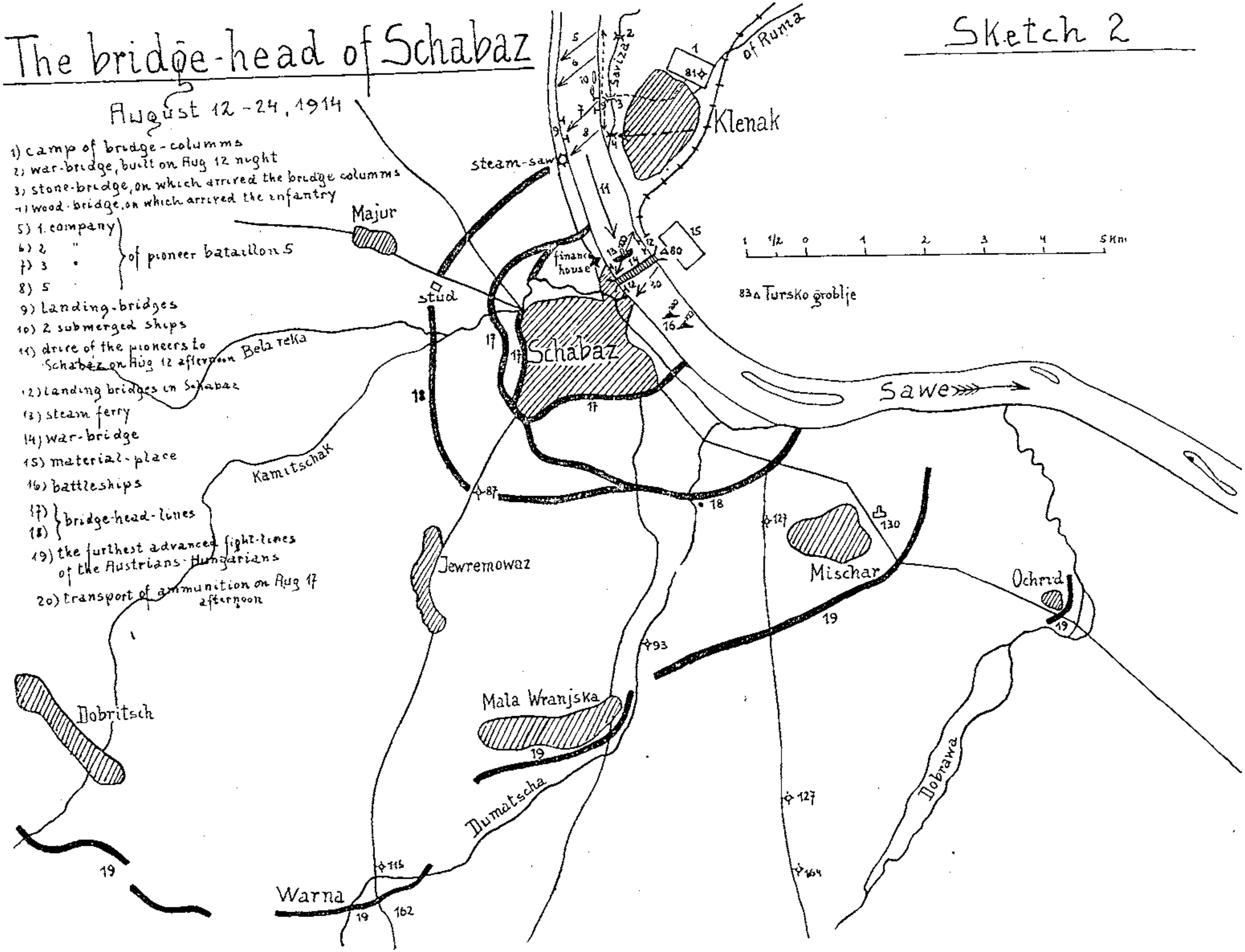
The bridge was saved, and there remained on the Serbian bank nothing but pontoons riddled with shot, and a few stakes driven into the ground. All bridging material was left temporarily on the left bank, since Serbian artillery fire made it impossible to continue work there.

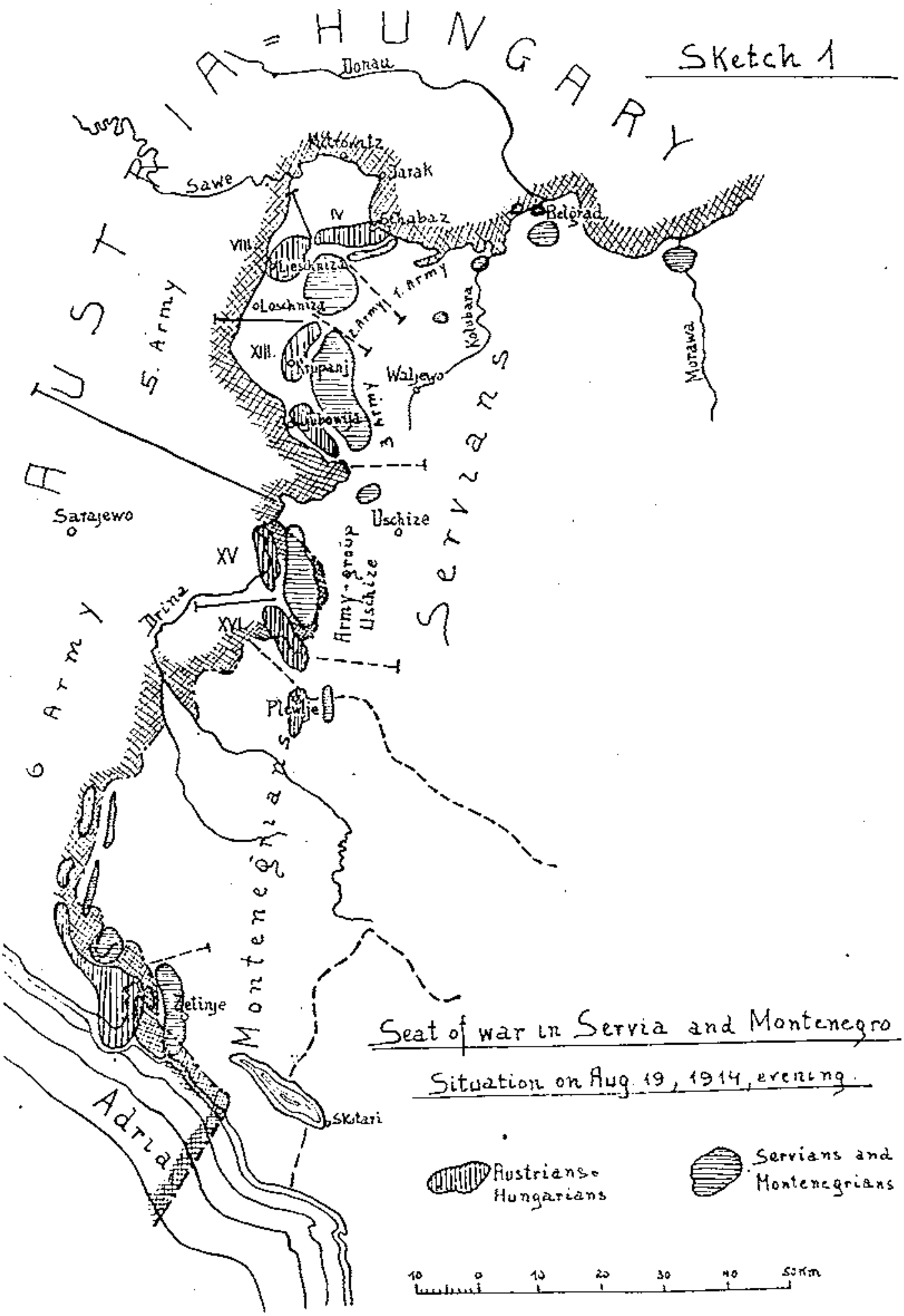
At an early hour, the Serbians once more advanced against the bridgehead, and at 9 a.m. their patrols reached the main square of the town—just when the bridge was dismantled. At 10.15 a.m., cavalry appeared in Schabaz, and at noon, the first body of infantry appeared on the bank. A violent artillery duel went on all through the day. After the nights of the 25th and 26th of August, the Pioneers were busily occupied in getting bridging material out of the water, loading and transporting it, and were meanwhile constantly harassed by artillery fire. This brought the battle of Schabaz to an end.

During this battle, the bridge was utilized by a total of 360,000 men, 2,500 cavalry, 260 guns, 20,000 vehicles and 100 motor vehicles. It was almost continuously under artillery fire, which, however, only at one place developed as effective demolition fire. The Serbians did not fire shrapnel upon the bridge, although it would have been very effective against troops who were crossing. Three serious accidents only occurred during transport across the bridge: the destruction of one trestle by an ammunition wagon; injury to one man, who was caught between a trestle of the bridge and a wagon; and the fall of a horse from the bridge into a pontoon. Losses of bridging material—due to enemy action—amounted to about one bridging column and a half, out of the 18 in use. To this must be added the 45 anchors, which could not be raised. In comparison with later river crossings during the Great War, these losses, and even the serious casualties amongst the Pioneers, must be considered light, as compared with, *e.g.*, 50 to 70 per cent. in the battle on the Piave, in June, 1918. Modern war equipment was still very deficient at Schabaz; there were no motor-boats, no river-cables, gas, aeroplanes, or balloons, and also no wireless and, needless to say, no tanks. Means of communication between the two banks was also very primitive; electric wire across the anchored pontoons, and also across the military bridge, which was, of course, interrupted at every opening of the cut-bay, visual signalling stations, and rowing-boats. At that period, fighting methods were still comparatively simple. The troops were, however, under a terrible strain, owing to the continuous calls upon them for 13 days—15 in the case of the Pioneers—without any actual interval of rest; the contradictions in the issue of orders, in consequence of the changing situation of the 2nd Army, and, in particular, of the IV Corps; there were many forced marches, and difficult fighting in a part of Serbia, where there was but little open country; moreover the Serbians had the advantage of fighting

The bridge-head of Schabaz

Sketch 2




Sketch 1
AUSTRIA=HUNGARY
Donau
Sawe
Mitrowitz
Jarak
Schabaz
Belgrad
IV
VIII
Ljeschnitza
Loschnitza
1. Army
2. Army
XIII
Krupanj
5. Army
Waljewo
Kolubara
Morawa
Ljubowija
3. Army
Sarajewo
Uschize
XV
XVI
Drina
Army-group Uschize
Servians
6. Army
Plewlje
Montenegrians
Zetinje
Skutari
Adria
Seat of war in Servia and Montenegro
Situation on Aug. 19, 1914, evening.
Austrians-Hungarians
Servians and Montenegrians
10 0 10 20 30 40 50 Km

THE WAR-BRIDGE IN SCHABAZ.

TYPE "BIRAGO."

Sketch 3

in their own country which they knew, whereas our forces were in enemy country.

In conclusion, we may ask to what extent the duties required were fulfilled on either side.

The mission of the Austro-Hungarian troops at Schabaz was to engage as large a force as possible of the enemy army, in order to enable the 5th Army to advance across the Drina, and return by the same route. The only method by which this could be effected was the maintenance of a sustained attack. In spite of temporary superiority of numbers (during the presence of the IV Corps), it was impossible to force a decision upon the Serbian troops, since the IV Corps and at first also the 29th Division were under orders at any moment to entrain for the Russian front, and these forces, therefore, could not be effectively employed. In any case, the evacuation of Schabaz without heavy casualties was a fine achievement—as was also the salvage of the great military bridge under critical conditions. It is scarcely possible to find in the history of war a similar example of a successful retreat, under enemy fire, across a great river.

The Serbians certainly have to their credit the final reoccupation of Schabaz. During the whole period of the battle, they did not, however, succeed in accomplishing what was several times within their power, *i.e.*, annihilating the enemy after landing, or inflicting upon him serious losses on the river. They did not take full advantage of the great opportunities of river defence. (Compare Saschinizi, 1914, and Rjahowo, 1916!) Probably, however, they had an effective protective screen against the further advance of the enemy. They possessed the advantage of greater military experience, and unity of command, since they were not obliged to conduct operations simultaneously on two fronts.

In the battle of Schabaz, the opposing forces of Austro-Hungary and Serbia were well matched and showed marching power and courage in action.

In conclusion, we may say that both sides did their utmost under exacting conditions, but neither succeeded in gaining a decisive advantage.

[NOTE :—*The sketches with wording and figures, are reproduced as received from the author of the article.*]

SUGGESTIONS ON PREPARATION FOR PROMOTION EXAMINATION—SUBJECT (f).

By LIEUT. F. C. C. BRADSHAW, R.E.

INTRODUCTION.

THE object in producing these notes is two-fold. Firstly, officers, from time to time, have asked the writer what work he did in preparation for Subject (f), and he hopes (in spite of an excellent pamphlet on the subject, published in January, 1929, by the Field Works and Bridging School, S.M.E., Chatham) that a few ideas, stated from the point of view of a recent candidate as opposed to those of the "official" examiners, may prove of some help.

Secondly, there appears to exist the idea among some officers that preparation for this examination is a well-nigh impossible task, and moreover is unlikely to be of any practical value on the fateful day itself.

Their point of view seems to be this. Whereas preparation for (a) and (b) is fairly straightforward, as the syllabus is clearly defined, and there are plenty of past papers and many good text-books to help one, (f) is a very different proposition. Here the syllabus is so wide, that whatever problems may be studied beforehand, the project set is more than likely to be one not touched upon in such preliminary preparation. Again, it is argued, "why bother to do a number of practice schemes, when by taking the examination, one may be lucky and pass first time, thus avoiding any preparation? Or, in the event of failure, why not treat it as a practice scheme, benefit by the examiner's criticism, and try one's luck again in three months' time?"

The writer believes that it is possible to do sound constructive preparation and puts forward these views in opposition to those stated above.

Since (f) is not so easy to work for as (a) or (b), or, in other words, since (f) is generally considered a more difficult examination, it requires for that very reason all the more preparation.

Although the problems that could be set within the syllabus as laid down in *K.R.* are legion, one can safely remember that one's examiners were young officers once themselves, and are unlikely to set abnormally difficult projects. This means that the likely projects can be narrowed down to some half-dozen main types. Also, although it is quite impossible to anticipate what is going to be asked, preparation which enables you to solve one field engineering problem will assist you in solving any other field engineering problem. The preparation required is not so much the acquisition of a number of particular facts, as to get one's mind accustomed to thinking in the right way, so as to be able to weigh up certain factors presented to one and come to a decision quickly and accurately.

The last argument of "chancing one's arm," and perhaps passing first time, appears at first sight to be attractive. The writer personally thinks that it takes either a more than usually gifted officer or a more than usually lucky one to do this, not because the average officer is incapable of doing the normal project, but because the time limitation will probably defeat him. In the event of failure the first time, reading of the criticism of the examination with no further preparation is unlikely to help the candidate very much in the next attempt three months later.

Finally, the matter might perhaps be looked at from a wider standpoint than that of merely passing an examination. An examination is set not so much to see if an officer can do the particular test, as to try and make him study a subject with which it is necessary for him to be familiar, but with which he may not in the ordinary course of his day's work come into contact. As we are all human, the incentive to do this work is provided by the setting of a test. If work is carried out in a logical manner, the preparation for (f) should achieve the required result of making a sapper officer know his job a little more thoroughly.

To sum up, the second reason for writing these notes, is to try and show that it is possible and advantageous to do some work for (f).

MAIN OBJECT OF PREPARATION.

The writer fully realizes that no two people start working for an examination in the same way, and he merely gives his own methods of tackling the problem, which he hopes combine the merits of cutting out unnecessary work and being fairly logical. Every prospective candidate must, of course, work out his own salvation.

The first thing to do is to discover what Subject (f) entails. *K.R. Appendix X* gives the syllabus, and should be carefully read. "Notes on Preparation for Promotion Examination (Subject (f))," should be obtained from F.W. and Bridging School, Chatham, and thoroughly studied. As far as possible, remarks made in this pamphlet will not be repeated in these notes, and it is hoped that both will be read in conjunction.

The chief difficulty in doing an (f) project is to know how much of the whole solution to the scheme is expected in Part I, what to include and what to exclude, remembering the restricted time available. Part II consists of "tidying up" the ragged portions of Part I, and giving all necessary further information required for a comprehensive and satisfactory solution. This should relatively be fairly simple. It is, therefore, considered that the main object of preparation should be to enable the candidate to produce a good Part I.

This Part falls naturally into two portions, more or less distinct. The first portion should contain all information showing what work is to be done, labour, tools, materials and transport required in the initial stages, *i.e.*, until more work can be provided by further elaboration of the scheme in Part II. This should be in pretty fair detail. The second portion involves a *rough* estimate of labour, time, transport, required for completion of the work, and a list of further stores required in the near future. This can, of course, only be approximate. It should be realized, however, that this second portion is of great importance and should not be neglected. It is better to cut down time spent on the first portion, in order that obvious requirements may be known to higher authority to help in furthering the work. Part II will enable one to justify unexplained means adopted in Part I.

It seems desirable for the candidate to work out *for himself* a sequence of work to be followed out in Part I.

The following sequence would appear to meet the case:—

1st Portion.

(1) Reading of the scheme, and thoroughly "getting into the picture."

(2) Reconnaissance of site or sites, and decision as to what one is going to do.

(3) Preparation of a list of all the various items of work that will have to be done arranged in order of necessary performance.

(4) Preliminary estimate of how much of (3) can be carried out in the initial stages (say, for first 6–8 hours).

(5) Necessary calculations for design of work to be done in initial stages.

(6) Diagrams of essential construction in initial stage (based on (4) and (5)).

(7) List of tools and stores required in initial stages, very often helped by inspection of diagrams in (6).

(8) Weights of essential stores and tools obtained in (7), other than those on the site, or in tool-carts, etc.

(9) Estimate of transport required for essential stores, based on (8).

(10) Estimate of number of men required for initial work, including men for fetching and unloading stores. At this stage, modification may be necessary as to what work can actually

be carried out in initial stage. Stores may not be able to arrive at site as quickly as originally thought, and other work not necessitating stores may have to be put in hand, or alternatively, in order to quicken up delivery of stores, original work contemplated may have to be cut out.

(11) Final estimate of preliminary work to be done in form of work table (or working party table, as may be required).

2nd Portion.

(12) Rough estimate of labour and time required to complete the work. Allowance must be made for collection of stores and unforeseen contingencies.

(13) Rough estimate of transport required to complete the work.

(14) List of further stores required as far as time permits.

(The above three headings are dependent one upon the others.)

(15) Rendering of above in a neat, clear and concise report. Much of the report can be written out fair in the first place, but certain portions will require re-writing and others will not be included in report shown up at all.

Steps in Preparation.

It is assumed that the main object of preparation is to enable oneself to carry out the sequence of work in Part I as detailed above for any given scheme.

First Step—Preliminary Reading.

All necessary books, such as *M.E.* volumes, *Manual of Field Works*, *F.S.P.B.*, *War Establishments*, recent F.W. and Bridging School publications, and all recent amendments, etc., should be procured. These books should be carefully read, all important facts and suggestions can be underlined, and an index for quick reference in the cover of the book may prove useful. The object of this preliminary reading is to enable one to know what information is in the books, and to be able to turn up what is required quickly.

Second Step—Analysis of some Types of Likely Project.

Likely subjects are heavy bridging, involving a junction of spans, pile bridge, pontoon bridge, suspension bridge, landing pier, entraining and detraining troops, water supply, demolitions, field fortification.

To " analyse " a problem in each of these mentioned would take considerable time, and it is suggested that attention be confined to four or five. Others can be worked in as modifications, *e.g.*, box girder bridge can first be taken, and modifications necessary if a piled trestle bridge were used in place of it can be thought out, and so on. Consideration should be given to all main types of projects, but detailed analyses can probably be restricted to those types about which the candidate is least knowledgable. It should be realized, however, that each successive analysis becomes easier and takes less time. It is now proposed to take a simple example and show what is meant by " analysis."

Problem.—A heavy bridge to take loads class B is to be constructed on the alignment of a demolished bridge. Gap is 100 feet. Labour available is 2 sections of a field company, at present 2 miles from site. Infantry working parties can also be obtained for work, commencing at 1000 hours to-day. One 80-ft. 4-girder box girder bridge is available, also 30 ft. x 15 in. x 6 in. R.S.J.s, in store 5 miles distant from site at X. Three 3-ton lorries at X are available. This information is given out at 0800 hours to section officer of field company, who has to do the work. Required usual solution as laid down in *K.R.* App. X.

(*Note.*—It may be found in setting oneself a problem, that it turns out to be rather impracticable by reason of insufficient or bad data, but this will generally become self-evident as the scheme is worked out, and necessary alterations can be made. Setting oneself schemes in itself helps to make one appreciate the various factors affecting their solution. The above problem has not sufficient data for a real project, but should suffice for the work in hand.)

It is suggested that this problem be considered under each of the items in the sequence of work given on page 92. Looking at these, (1) and (2) do not require much consideration in an indoor scheme. It is obvious that the bridge will be a junction of two spans—80-ft. 4-girder box girder bridge and a 30-ft. built up R.S.J. bridge.

The prospective candidate must consider *for himself* what are the various items of work to be carried out as per item (3) of sequence.

The following is given as a suggestion :—

x (1) Reconnaissance of site.
x (2) Setting out.
x (3) Removing debris.
x (4) Loading and unloading stores and tools (carried out at intervals as other work proceeds).
x (5) Excavation for bank seats of bridge and mudsills of trestle pier.
x (6) Construction and placing of above.
(7) Construction of trestles.
(8) Erection of trestle pier.
(9) Preparation and erection of R.S.J. span.
(10) Erection of launching gear for box girders.
(11) Erecting girders.

(12) Launching girders.
(13) Laying decking and completing bridge.
(14) Dismantling launching gear, clearing up, notice boards, etc.
x(15) Work on approaches (carried on as other work proceeds).

The next item is the preliminary estimate of work which can be carried out in initial stages, say, the first six hours. The accuracy of this estimate depends on the officer's previous experience and imagination. The headings marked " x " in the previous paragraph are suggested.

Next come the necessary calculations. Considering work to be carried out in initial stages, the designs of bank seats and mudsills are required. To calculate bank seats, weight of both bridges is required. That of box girder bridge can be found from tables in *M.E.*, Vol. III, that of R.S.J. bridge cannot be found until bridge or main portion of it is designed. The mudsills cannot be calculated until the rest of the trestle pier has been designed. Apparently, then, most of the total calculations are required in Part I.

At this stage, it is suggested that the full calculations for R.S.J. bridge and trestle pier be worked out for several reasons. It will ensure that the candidate can do the required calculations readily; the length of time required for such calculations will be discovered; it will help candidate to find out what calculations are required, *e.g.*, when shear need or need not be considered, and it will give him a notion of size and quantities, *e.g.*, likely sizes of timber required for heavy trestles and so on.

As a result, it will probably be realized that it is quite impossible to carry out all the calculations in time allowed for Part I. The problem appears to be in the nature of a vicious circle, thus: " I have not got time to calculate much, therefore the work to be done must be in the nature of marking out, excavation, fetching stores, so my calculations can wait. But how can the men collect any stores, or how can I discover what transport is needed, or even how many men to cope with their collection, until I have worked out the designs, thus arriving at what stores are wanted. Even to work out designs of the work that I want to start on first seems to necessitate my doing nearly the full calculations."

There is, of course, a compromise, and the discovery of how to compromise intelligently is the whole essence of preparation. *Exactly how much calculation is required must be decided upon by the candidate himself.* The full calculations have now been worked out. The candidate can form an idea of how quickly he can calculate, bearing in mind that practice increases speed, and a little consideration should enable him to discover what is essential. There is no golden rule or simple formula, but at all events this preliminary thought on the matter can be done far better now than under the stress of examination conditions. The writer puts forward the following as a solution regarding calculations required in this case :—

(1) Calculation for R.S.J. bridge (not a very large order).
(2) Calculation for bank seats (or, if preferred, suitable design can probably be found from intelligent consideration of plates in *M.E.*, Vol. III).
(3) Calculate height of trestle legs. Approximate design of trestle pier, assuming normal type of trestle for heavy bridge, 12 in. x 12 in. timber, 3 legs and 2 rakers, can then be made. (Full calculation can be done later in Part II.)

The next item is "diagrams of essential construction." The following are suggested :—

(1) Site plan.
(2) Elevation and plan of proposed reconstruction in position.
(3) Sectional elevation of R.S.J. bridge (to simplify the estimate of stores required for it).
(4) Sectional elevation of trestle pier. This can be copied from similar design in *M.E.*, Vol. III (also to simplify the estimate of stores).

As regards stores required in initial stages, a list of stores required for bank seat, trestle pier, R.S.J. bridge, can be made out in tabular form quite easily from previous work, and weight of such stores ascertained roughly in lorry loads can be given in a column of the table.

This completes items (7), (8) and (9) of sequence of work. Item (10), which is, of course, the most difficult one now presents itself. This can be done by deciding or calculating :—

(1) Number of men and time required to complete initial work requiring no tools or stores other than those carried in tool carts, *i.e.*, reconnaissance, setting out, removing debris, excavation for bank seats and mudsills.
(2) Strength of infantry parties required for loading and unloading three lorries in an economical manner.
(3) Length of time a lorry will take to be loaded, travel to site, be unloaded and return to store dump.
(4) From (3). Total number of lorry loads of stores that can be carried during six hours, and thence what stores can be got to site in that time.
(5) Time taken before first consignment of stores arrive at site, and thus when field sections can commence work on bank seats and mudsills, and how much of this work can be done in first six hours.

In this way, the work that can be done in first six hours can be reasonably ascertained. A certain amount of readjustment may be necessary, but it must be borne in mind that too accurate forecasting is not essential as all kinds of unforeseen events may occur. What is required is merely to show a reasonable forethought on the part of the candidate to ensure that men are well employed on useful work as soon as possible.

Item (11) of the sequence then follows naturally from previous work.

The second portion of Part I now remains.

The work left to be done is naturally all that could not be carried out in the first six hours.

Further stores required are all those already worked out in first portion of project not yet collected, if any, and these can be supplemented by noting down as many obvious requirements as possible, *e.g.*, box girder sections and launching gear, etc. The stores can be roughly sorted into lorry loads to gain an idea of likely transport required. Time and labour for remaining work can be roughly estimated in man-hours, and a percentage added to allow for wastage, as labour cannot always be economically employed. Consideration must also be given for unforeseen contingencies and night-working. A definite time and date for completion of work is required, so consideration of number of shifts is generally necessary.

To complete work required for Part I, it is a useful exercise to write out a specimen report in pencil in A.B. 153. Special consideration should be given to constructing suitable tables for work table, stores lists, transport indents, etc., in A.B. 153, as space is restricted. All information, whenever reasonably possible, should be given in tabular form.

As regards preparation for Part II of the scheme, it is probably enough to consider what remains to be done, and write down in order how it would be carried out. It is a matter of personal opinion as to whether the whole of Part II should be carried out in detail. The writer considers that probably certain portions about which the candidate is uncertain would suffice.

Having carried out this "analysis," the candidate should then think out the effect of alterations in data, *i.e.*, how problem might be affected for a skew span, unusually restricted site, water gap, less or more labour, and so on. The more angles the problem is studied from, the better, and any attempt to form too stereotyped a notion of any likely type of project must be rigorously checked.

Third Step—Practice Schemes.

When the candidate has done a few analyses, then a senior officer should be asked to set a few practice schemes. Many officers may ask why practice schemes should not be entered upon at once, and let all this "analysis" be done on these schemes. The answer to this is that the value of practice schemes as a *test* is thereby wasted, as an analysis cannot be done under a time limit. For this reason, the writer is of the opinion that analysis and all preliminary work should be done by the candidate by himself. Let him enlist the aid of a senior officer when he has found some difficulties to be solved. A senior officer may, and probably will, give excellent advice on how to solve a problem or avoid difficulties, but this is of no value until one has discovered the problem and difficulties for oneself which become therefore realities to one.

The scheme should be done, as far as possible, under examination conditions, and certainly within a time limit. Criticism and "counter-criticism" of the scheme should be of the utmost value, and everything learnt should be rationalized with previous preparation.

THE EXAMINATION ITSELF.

The only points the writer wishes to accentuate here are :—

(1) Careful reading of the scheme on presentation.

(2) A second reading of scheme on arrival at the site before commencing work.

(3) "Time spent in *sensible* reconnaissance" will not be wasted. Writing should not be commenced in a hurry through fear of wasting time. Also, the reconnaissance should be thorough. The site cannot be revisited.

(4) It is worth while remembering that a good Part I probably means success, and a poor Part I is difficult to bolster up in Part II.

(5) Reports should be briefly indexed and paragraphed. As much information as possible should be tabulated or indicated on sketches, and, above all, the report should be written so that it is quite clear what is wanted to anyone else reading it. How often one thinks what a fool a man is who writes and asks for something without giving enough particulars, and how often one does it oneself!

(6) Careful re-reading of Part I, when handed back before starting work on Part II.

(7) Time should not be wasted in vain repetition in ink in Part II of what has already been stated in pencil in Part I.

(8) The candidate should always put himself in the position of the man who has to do the job, and so ensure that all information necessary for its execution will be included.

AIRSHIPS AND THE EMPIRE.

By Bt. Major G. MacLeod Ross, M.C., M.ENG., A.M.INST.C.E., R.E.

The dramatic circumstances so intimately connected with all trans-Atlantic flights by aeroplane have built up a popular impression that the aeroplane in its ultimate stage of development will be the vehicle whereby long-distance, non-stop flight may be commercially achieved, and as an offset to this belief it is not inappropriate to recall that Lindbergh was but the hundredth man to cross the Atlantic by air.

For a variety of reasons the development of the aeroplane has been kept in the forefront of public vision, and the means whereby the mental attitude previously mentioned has been built up are not hard to discover. In the first place, it has been estimated* that one hundred times more money has been expended on the development of the aeroplane than upon the airship. This is largely due to the fact that useful experimenting can be carried out on the aeroplane on a comparatively small scale and at a low outlay per unit, subsequent operation, maintenance and replacement being correspondingly cheap. Aeroplane development has also benefited by the attention it received during the War, whilst interest has been quickened of later years by peacetime raids on London, and by some spectacular writing, at a time when economy was the watchword, purporting to expose the inherent unsoundness of the airship.

Airship development, on the other hand, has suffered and will continue to suffer, from that weighty handicap, that the smallest useful experiment entails expenditure on construction on a scale not only vastly greater than that of the aeroplane but beyond the means of the private firm, and this scale of expenditure is continued when operation and maintenance costs are considered. This factor has also helped to present an unreal magnitude to the constructional failures which airship development has suffered in the past. It is for this reason that the airship has attracted to itself in this country an additional handicap, in the form of development solely by the State, a handicap from which the aeroplane has kept comparatively clear. In consequence, progressive action on airship experiment has often become a political issue, and progress has been staccato, whilst the high degree of vulnerability of the airship precluded it from serious consideration during the War period from which so many mechanical and electrical devices benefited.

* Adm. Moffatt, Chief U.S. Bureau of Aeronautics, Navy Dept.

As a preliminary, then, to a consideration of the characteristics of the airship, it will be useful to underline some limitations of the aeroplane in the sphere of long-range non-stop flight.

LIMITATIONS OF THE AEROPLANE.

The aeroplane is sustained in flight by dynamic forces, and its gross lift is controlled by its aerofoil surface and its speed, and in consequence it follows that the paying load per horse-power, which is the only satisfactory commercial criterion of any form of transportation, remains practically constant whatever its size up to a point where, in the case of very large aeroplanes, a decrease in paying load per horse-power occurs.

Practically speaking, it is no exaggeration to say that trans-Atlantic non-stop aeroplane flights have been purely examples of human endurance. Commercially, they have been stunts, and it can be shown that, with the materials known at present, the commercially paying range of non-stop flight for the aeroplane is around 500 miles, and that, judged by this standard, the size to which an aeroplane may be usefully developed is definitely limited. Capt. Richardson, of the U.S. Navy,* has calculated that the commercial efficiency of an aeroplane commences to diminish when its size exceeds 22·3 tons, a size which is four times that of the largest plane which has yet crossed the Atlantic. Using well-tried standards of performance, it is possible to show that an aeroplane of this size would have a maximum range of 3,460 miles, which would enable it to fly non-stop from New York to London, but it would have no capacity available for a commercial load as all the spare lift would be utilized by fuel. Added to this, there would be no safety factor in the way of power reserve such as is considered essential in all other forms of transport, and which in the case of the largest trans-Atlantic liners, is present, over and above normal operating requirements, to the extent of 35% of the total installed power, and in the case of an express locomotive to the extent of 62%, whilst a passenger aeroplane service works with a 50% reserve of power. The deduction to be made from all this is that the aeroplane, large or small, has a comparatively short commercially effective non-stop range, and it is unsuitable physically for flights over water.

In fairness to the aeroplane, it should be pointed out that recent research into the question of refuelling whilst in flight, and a recent survey of the ocean bottom between New York and Bermuda, where an area was discovered, four miles square, and raised 3,600 feet above the surrounding ocean bed, such as would be suitable for the anchorage of a sea aerodrome (Fig. 1), may go some way to minimize the present limitations.

* Figures in this and the two following sections are based on a lecture by C. B. Fritsche, Esq., Vice-President, Aircraft Development Corporation, June, 1928.

Notice should also be taken of the Ciervo Auto-gyro (Fig. 2), and the attempt to combine the wings of the plane with lift derived from the gas in an envelope, both of which are attempts to increase the commercial efficiency of the plane over long distances.

Finally,* a new gyroscopic compass, an extremely sensitive altimeter, an "artificial horizon," and a short range (15 to 20 miles) radio beacon, provided by the Guggenheim Fund for the Promotion of Aeronautics, afford hopes that the dangers of aeroplane flights in fog and by night may be materially lessened.

The Flying-Boat.

It is when the flying-boat of the Short "Calcutta" (Figs. 3 and 4), or Dornier type, is considered that the limitations of commercial efficiency due to size begin to disappear. This superior characteristic of the flying-boat is held to be due to the substitution of a hull for the landing gear required on an aeroplane, which in the case of an aeroplane, equivalent to the 40-ton flying-boat, Dornier DoX (Fig. 5), would mean wheels probably six feet in diameter.

It is mainly on account of the weighty landing gear necessary that the landing speed of the aeroplane has to be kept to lower limits than are practicable in the case of the flying-boat, and this reacts to necessitate a lower flying speed in the case of the aeroplane.

The accompanying curve (Fig. 6) plots the gross weight of five increasingly large Dornier flying-boats against their useful load (to be distinguished against paying load) per h.p., from which it can be seen how a useful load of 2·19 lb./h.p. for a half-ton boat, rises to 9·47 lb./h.p. for a 50-ton boat. By way of comparison, the corresponding figures for the new Fokker F.32 aeroplane, weighing 11 tons, are also shown. This is the largest aeroplane built in the United States up to the end of September, 1929, though it has since been destroyed by fire.

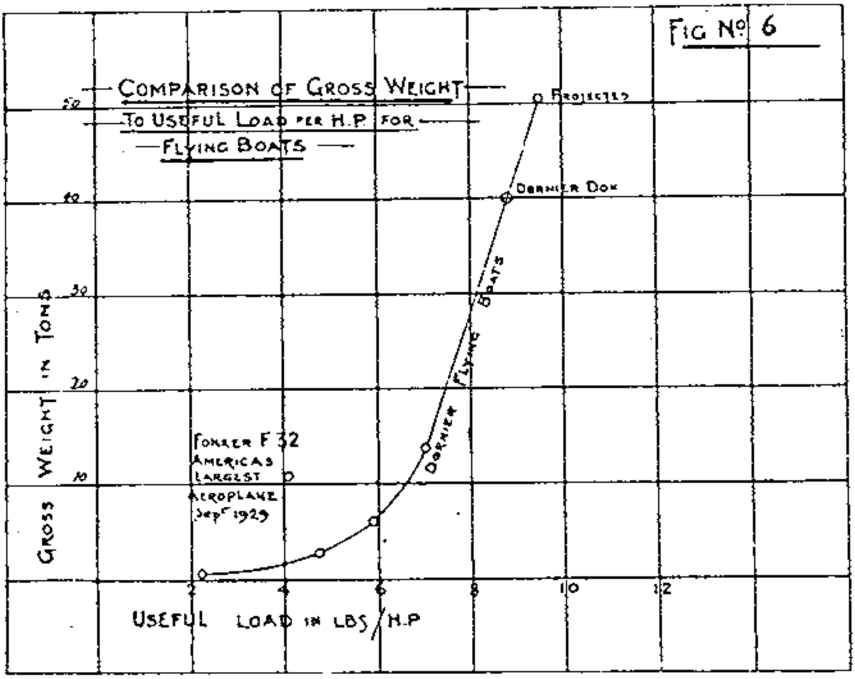
It is found in the case of the flying-boat that the weight of the hull per cubic foot displaced drops as the size increases. The weight of the wings per square foot increases with the size, but this is offset by the gross lift per pound of structure increasing with size. The weight of the fuel and oil tanks also decreases with increase in size per gallon carried.

However, even with the 40-ton Dornier boat, a maximum range of only 2,635 miles non-stop is possible, and such a boat is consequently useless on the northern trans-Atlantic service, though it will probably operate on the New York–Bermuda–Azores route, the longest leg of which is 2,000 miles. But even here its calculated paying load would only amount to 1·23 lb. per h.p., which is poor compared with the 5 lb. per h.p. attained by aeroplane mail services over the

* See *The Times*, September 26th, 1929.

500-mile hops which constitute their commercially effective non-stop range.

The position of the flying-boat is that, provided suitable refuelling points are available, the large flying-boat has possibilities for longer range commercial over-water flights than the aeroplane. It will, however, be shown later that it can never compete successfully with the airship for economy, comfort or safety.



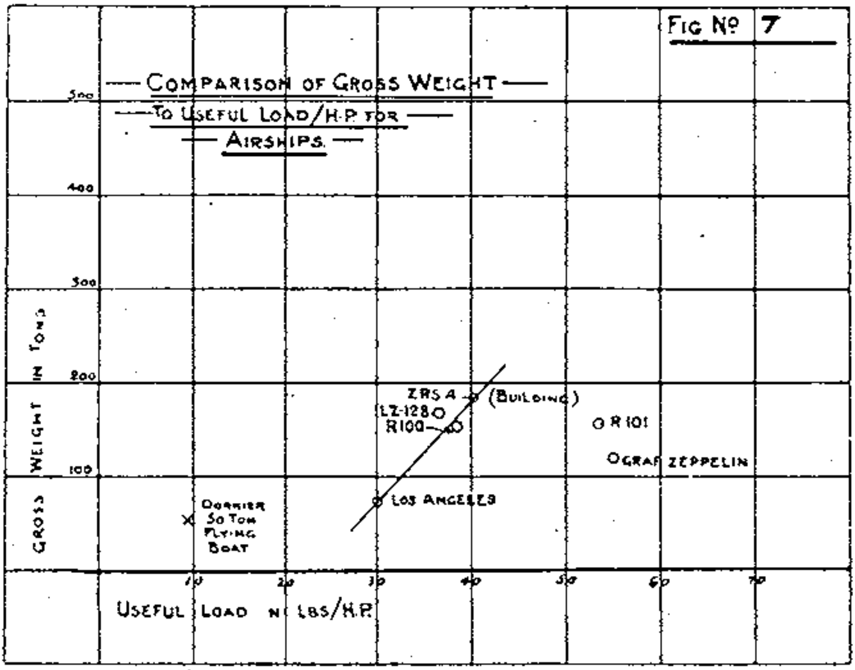
THE CHARACTERISTICS OF THE AIRSHIP.

The airship is sustained in flight by static forces, and its gross lift is directly dependent upon its volume and independent of its power plant, from which it is clear that increased lift is more easily obtainable in the case of the airship than in the aeroplane or flying-boat, since it is simpler to increase volume than to increase area.

In practice, the useful load carried by an airship increases very rapidly with the volume. Reference to Fig. 7 shows the gross weight plotted against the useful load in lbs. per h.p. for the airships at present in existence. The enhanced scale of this graph compared with that for the flying boat (Fig. 6) demonstrates the marked superiority of the commercial performance of the airship over its nearest competitor—the flying-boat.

The following comparative table of two aircraft of the same horsepower but showing the airship capable of transporting 13 times more paying load than the flying-boat, makes clear the former's unchallenged position as *the* long-range, non-stop aircraft.

The flying-boat, it will be noted, has to make three refuelling stops, and flies *via* the Bermuda–Azores route to London. The airship flies with the crow from New York to London.



PERFORMANCE OF AIRSHIP COMPARED TO FLYING-BOAT, NEW YORK TO LONDON.

	Airship.	Flying-Boat.
Units of Comparison.		
Gross weight, tons	250*	50
Useful load, tons	140	25
Paying load, tons	65	5
Horse-power	6,000	6,000
Paying load per h.p./lb.	21·67	1·67
Route Comparison.		
Distance, miles	3,200	4,400
Time required (still air) hours ..	43	43
Landing, including intermediate stops	1	3

* An airship of 250 tons has yet to be built but it is well within the realms of practicability.

It can, therefore, be definitely asserted that the large rigid airship is the vessel of the future for long-distance, heavy cargo transport over sea or land.

Before passing to a discussion of the technical and operational aspects of the airship, it may be interesting to note the gross weight of vehicle required per passenger in various forms of transport :—In a 200-passenger airship, 2,500 lb. per passenger would be required. In the steamship *Leviathan*, 26,000 lb. per passenger, and in the railway express train, the *20th Century Limited*, 9,000 lb. are required. The repercussion of this fact on questions of economy in material, capital, maintenance and replacement is very considerable.

SOME TECHNICAL CONSIDERATIONS.

Of the 149 rigid airships built by the nations of the world to date, 133 have been built by Germany, and 14 by Great Britain.

Of the grand total, the R.38, the *Shenandoah* certainly, and the *Dixmude* probably, failed as a result of structural weakness, and it has been suggested* that, in spite of this long experience in rigid airship construction, Count Zeppelin probably lacked a full theoretical knowledge of the problem with which he wrestled, and it has remained for the whole theory of airship construction and operation to be investigated by British brains on a broad and scientific basis during the years 1921 to 1928.

The R.100 and the R.101 (Fig. 8) are the material outcome of these investigations and research.

A rough specification of the R.101 is as under :—

Capacity	5 million cubic feet.
Length	732 feet.†
Diameter	130 feet.
Displacement	150 tons.†
Engine power	3,000 h.p.† 5 Beardmore "Tornado" Diesel Oil Engines.
Fuel oil carried	30 ton.
Maximum speed	80 m.p.h.‡
Range at cruising speed (71·5 m.p.h.)..	3,500 miles.‡
Carrying capacity	100 passengers and mails,‡ or a useful load of 30 tons.†
Ratio of length to girth ..	5½ to 1.†
Goldbeater skins in the 16 gas-bags	1½ million.
Area of cotton in gasbags ..	10 acres.

* See "*Airship R.100*," published by the A.G.C.Ltd.

† All these figures will be altered as a result of an additional section now being added to the R.101.

‡ Subject to confirmation on tests.

Area of outer covering	..	5 acres.
Propellers	..	16 feet diameter.
Push exerted by each propeller	..	1 ton.
Framework contains	..	27 miles of tube.
One quarter total weight is stainless steel.		
Height of each rudder	..	45 feet.
Total area of the 4 fins	..	9,000 square feet.

Comfort to a degree unknown in an aeroplane is provided in the shape of an electric kitchen, two- and four-berth cabins, a promenade large enough for a dance, proper washing and lavatory accommodation, whilst noise has been almost entirely eliminated. The upper deck has an area of no less than 5,500 square feet.

The salient point to remember in connection with the R.100 and R.101 airships (Figs. 9, 10, and 11) is that they are of the smallest size practicable, not only as a basis for future development, but as a test of the research already referred to. The R.100 is designed only for temperate climates, but she is calculated to excite commercial interest sufficiently to place the further development of the airship in commercial hands without any State intervention. Success on her tests, and those of the R.101, which is designed for Eastern routes, will alone achieve the realization of this last hope.

It is now proposed to consider some constructional details of airships in general, and of the new British ships in particular.

Frame.

The R.100 and R.101 have been designed to withstand an enforced rate of rise of 4,000 feet per minute, as compared with 1,000 feet per minute for the older British ships.

Mere wind velocity puts no force upon an airship in flight, danger arising chiefly from vertical currents of air. The *Shenandoah* hit a sudden vertical current of air having an upward velocity of 15 m.p.h. The R.100 would be safe in an upward current of 50 m.p.h., and is equal in strength against air disturbances to the standard of the present day passenger-carrying aeroplane.

The new ships have been designed to stand a breaking load of 30 tons in any direction at the bow, whereas R.33 broke away from her mooring under a lateral load of less than 4½ tons.

In general, it may be said that the ships R.100 and R.101 have been deliberately built too strong in order that they may be tried out in really bad weather.

Gas.

British airships use hydrogen as their "lifting" medium and since hydrogen, in combination with petrol vapour, produces an appreciable fire risk, the discovery of helium, an inert gas, was hailed as indispensable in the interests of safety. Helium is at present found only in the United States, and has not become universally available, although it is reported to have been found in Canada. The present cost of helium is 1¾d. per cubic foot, which is very high, but since its use may be extended, apart from airship requirements, to various medical and scientific uses, as, for example, in radio tubes, housings of high-speed gyros and in toy balloons, the cost may soon be down to a penny per cubic foot. The supply available in one field alone in the United States is estimated at 20 million cubic feet per annum for 50 years, without touching the State Helium Reserve in Utah.

Apart from the price, another disadvantage is that the range of a helium-filled ship is 30 to 40 per cent. less than that of a similar ship filled with hydrogen, since helium has not got the low specific gravity of hydrogen, and, therefore, before deciding whether this loss of performance is commensurable with the safety obtained, it is as well to investigate exactly the degree of risk constituted by the use, in combination, of hydrogen and petrol as is done in the R.100.

The danger arises from a combination of hydrogen and petrol vapour. Now the hydrogen which fills the several gasbags is in the upper portion of the ship, and is, of course, lighter than air and tends to rise on escaping. The petrol being in the bottom, the vapour can be satisfactorily prevented from accumulating by well-designed ventilating arrangements. With such precautions, it is doubtful whether the disadvantages of helium do not outweigh its advantages which will tend to diminish still more with the development and use of the heavy oil engine burning non-volatile fuel, such as has been provided in the R.101 and which is requisite for operation in the East.

Engines.

From a popular point of view, the main interest, as far as the engine is concerned, lies in the nature of the fuel burned. The disadvantages of petrol have been mentioned, but engines, such as the Beardmore "Tornado," used in the R.101 (Fig. 12), burning heavy fuel oil, secure both safety and increased economy. The risk of fire is minimized, a low priced fuel is employed, and consumption is reduced so that on a voyage to Egypt four tons saving in weight in bulk of fuel carried will be realized. A third alternative is the use of "Blau" gas, as employed in the *Graf Zeppelin*. This gas has an explosibility range one-sixth that of hydrogen, and a density approximating to that of air. Its use as a fuel, in conjunction with petrol, may result in an increased endurance of 40 per cent. Its use also means simplification of operation, since as the gas is burnt, the equilibrium of the ship is unaffected, and there is no need either to "valve" hydrogen or to resort to water-recovery.

Airship Operation.

Numerous as are the difficulties to be overcome in the design of an airship, the operational obstacles connected with a vessel which would nearly fill Northumberland Avenue, and stands as high as the Nelson Column, are not to be overlooked. The airship requires certain terminal facilities, and of these, the mooring mast (Fig. 11), which has been evolved and has now been erected at Cardington, Ismailia, Karachi, Montreal and Durban, is the equivalent of the landing-stage so essential to the ocean-going liner. With the assistance of only 14 men an airship can be moored at such a mast in a wind of 30 m.p.h., and can ride out a storm of 60 m.p.h. The cost of these masts is £50,000 apiece. But with present standards of construction, shelter is on occasion required for an airship and a hangar must be provided in the same way that a liner requires the services of a dry dock. Although these hangars (Fig. 13) may cost £150,000 to £500,000, as the size of the craft increases, the terminal requirements are small compared with the requirements of ocean-going ships. Just as a steamship is often prevented from entering a dock by tide and wind, so an airship cannot enter a hangar in a wind exceeding 15 m.p.h., and must ride at her mast until the weather abates. Again, as a steamer requires the assistance of tugs and winches to dock her, so it at present takes 400 to 700 men to handle an airship into a hangar and the expense of keeping such a large gang available is a question which will doubtless soon be solved in a more economical manner. The Germans are experimenting with revolving hangars, which will rotate into a position in line with the direction of the wind, and are attempting to evolve a rail truck to which the ship may be attached and drawn down. But, up to date, the handling of a gigantic feather having a mass of 150 tons, but no weight, is most safely undertaken by man-power. Once the airship becomes commercially attractive, its size will increase by leaps and bounds and each ship constructed will require a new series of hangars along its route. The Americans talk of erecting artificial lakes of diameter the length of the hangar on which it will float, and they have also experimented successfully with mooring masts on sea-going aircraft carriers.

The satisfactory solution of the docking problem is essential for the commercial realization of the airship.

Meteorology and Wireless.

It has been said that with airships, navigation and meteorology are inseparable, and efficient operation is impossible without a first-rate weather service.

Attempts have been made to discredit airship evolution on the strength of the statement that an airship, owing to its low relative speed, would be unable to make headway against unfavourable winds and would be unable to avoid storm areas.

The chief dangers to be faced by an airship are vertical air currents and the necessity to valve hydrogen gas in a thunderstorm. Given an accurate weather chart, an airship can avoid both dangerous and unfavourable conditions with the speeds obtainable to-day, which are already twice that of the rate of travel of the average storm area. Dr. Eckener, on the completion of his world cruise, asked what changes he would wish in the *Graf Zeppelin*, decided first upon increased volume, thereby attaining greater efficiency and range, and next, for more speed, the greatest attribute for safety an airship can possess.

The dawn of the commercial airship lends added point to the Polar exploration now being carried on by Wilkins and Byrd, and their endeavours will do much to make the operation of airships safe.

The map (Fig. 14), showing the observation and broadcast stations which assisted the *Graf Zeppelin* on her recent 26,000-mile cruise, gives a good idea of how the world's weather service is progressing. But this meteorological service can only be made use of by reason of wireless intercommunication and the scale of the airship, compared with a plane, enables the former to instal much more effective apparatus. The wireless set on the R.101 can operate over a 2,000-mile range, which means that it can anticipate the weather conditions over an area of 12½ million square miles, equal to almost one-quarter of the land surface of the earth. We therefore have our operational safety chain dependent first, on meteorological observation, next on wireless, and finally, on the speed of the airship to utilize the information so afforded. At present, airship speeds range about 80 m.p.h. maximum, but these will improve rapidly as sizes increase and speeds of 100 m.p.h. are not far removed.

IMPERIAL AIRSHIP ROUTES.

It must be again reiterated that the R.100 and R.101 are experimental, and that on their satisfactory performances will primarily depend the establishment of commercially attractive Imperial airship routes.

The best conditions under which to operate the aeroplane commercially are those which provide a series of concentrations of population at 500-mile stages apart. Such conditions exist in the U.S.A., and are being exploited to great effect. The arrangement of the British Empire, however, is such that the average commercially useful stage is 1,000 to 1,500 miles, and whilst the aeroplane is vitally important for feeding to terminals, it is the airship which is peculiarly suited as the modern form of transport for the development of Imperial routes.

The long, non-stop range of the airship immediately places it ahead of the limited paying range of the aeroplane when we consider a flight to the East from England. The nearest British possession is Gibraltar, 1,000 miles distant. A stop here necessitates not only a long détour but as a first stage it is most uneconomic for an aeroplane, and so it may be said at once that an "All Red" route to the East by aeroplane is impossible.

With the airship, the first stage to the East will be to Ismailia in Egypt, which will be reached by R.101 in two days. The next stage will be to Karachi, India, in a total time of 4½ days; continuing to Australia, it would appear that the best route would be *via* Singapore to North Australia, but it so happens that this would lead into a thunderstorm belt which is continuous to the North of Australia, whilst the heat experienced in this region is to be avoided, since the air is more unstable and the airship will deteriorate more rapidly.

It follows that an airship base in South Australia will be most satisfactory.

But there is another interesting fact to recall. Empire colonization was guided very largely by the routes taken by the sailing ships of old, which made use of the prevailing winds, and so in the new era of the airship, advantage will once again be taken of these winds, and we shall find that on the trip from Capetown to Perth (Australia), the "roaring forties" will be utilized, whilst in the reverse direction, the S.E. Trade winds will assist the airships on a more northerly course to Capetown.

So much for the effect of natural climatic conditions on the selection of airship routes.

There is another factor to be weighed. The class of load transported by airship is likely to be, first, even if not ultimately, of a first-class nature: passengers, mails, specie and valuable light freight generally.

The two great streams of first-class traffic in the world, flow from North America to North Europe, and from South America to South Europe respectively. Of these the former is the larger, whilst the latter could never be described as Imperial.

The former, which may be called the Canadian route, and which will also tap the United States, will require for commercial operation a larger type of airship than either the R.100 or R.101, owing to the prevailing weather conditions, but it should be noted as the Imperial route which offers the best chances for the early establishment of an unsubsidized service.

With the establishment of this route in operation, it will be possible to leave London on Saturday night, have a full day in New York on Tuesday, and be back in London on Thursday afternoon. Such a possibility means an immense saving of time, half that required by steam or motor-ship, and assuming fares to be equal, it has been estimated that such a service will attract some 20 per cent. of the normal first-class steamship passengers, and with such a volume the service will be commercially established.

Letters, cables, telephony, wireless, all assist in keeping people in touch, but none of these can equal personal contact in effectiveness. Consider then the possibilities offered by a form of transportation which, even at present speeds, can bring India within 4½ days, Australia within 11 days, Canada within 2 days, South Africa within 5 days, and New Zealand within 14 days, of London.

In the realm of Imperial relations, it will bring the Dominions to the Mother Country at a week's notice when far-reaching decisions affecting the Empire must be taken. Imperial conferences can be held every year, and the highest authorities can be heard personally, instead of by proxy. Better relations and speedier decisions will be the outcome.

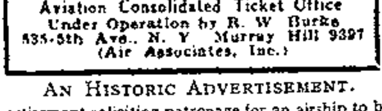
Commercially, the possibilities are obvious, whilst, in the domestic sphere, it may be noted that children will be able to spend their holidays with their parents serving abroad.

Finally, when it comes to the question of the ownership of these commercial airship lines, let us hope that the shipping companies of Great Britain will have profited by the experience of the railways in regard to motor transport, and of the cable companies in regard to wireless. For the preordained operating agents for Imperial airship routes are undoubtedly the shipping companies with their world-wide ground organization already established. If they grasp the gage, they will not be ruined like the railways by losing all their "first-class" traffic, but they will reap the benefits of a speedier vehicle, and be able to continue to operate their steamships at speeds and for loads which are commercially sound in the face of the new conditions imposed on world transport by the airship.

It is interesting to remark that Lloyd's Register of Shipping has now undertaken the specification and survey of privately-owned aircraft and the expression "A1 at Lloyd's" will, in future, apply to aircraft.

Finally, on October 14th, after the successful mooring of R.101 at her mast on the 12th, congratulatory telegrams were received from the Chairman of the Orient Steamship Line, amongst others.

Let us hope that these are straws in the wind, and that, as a result of their tests, the two "R" class airships will between them lay the foundations not only of the commercial development of the airship, but also of the commercial airship routes of the Empire.



AN HISTORIC ADVERTISEMENT.

The first advertisement soliciting patronage for an airship to be published.
A cutting from the *New York Times* published before the *Graf Zeppelin* sailed on her world flight.

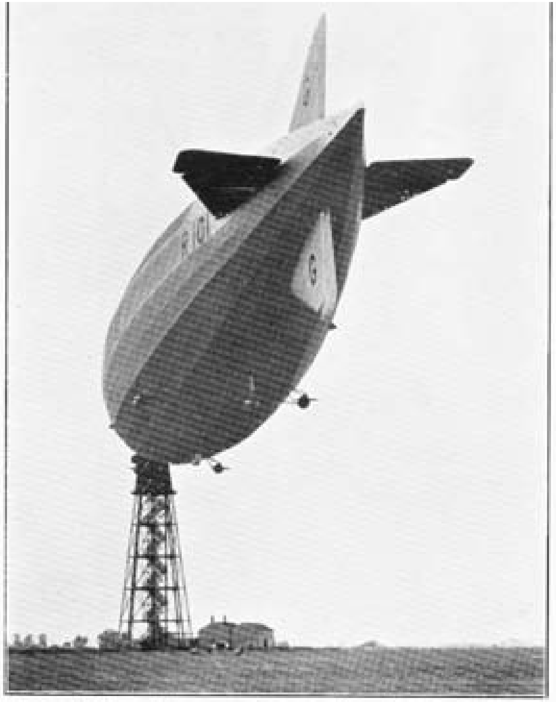


FIG. 10.—A STERN VIEW OF THE R 101.—Note the fins and rudder and elevating planes. Also the "Power Eggs" and the control cabin. Each portion of the rudder is 45 feet high.

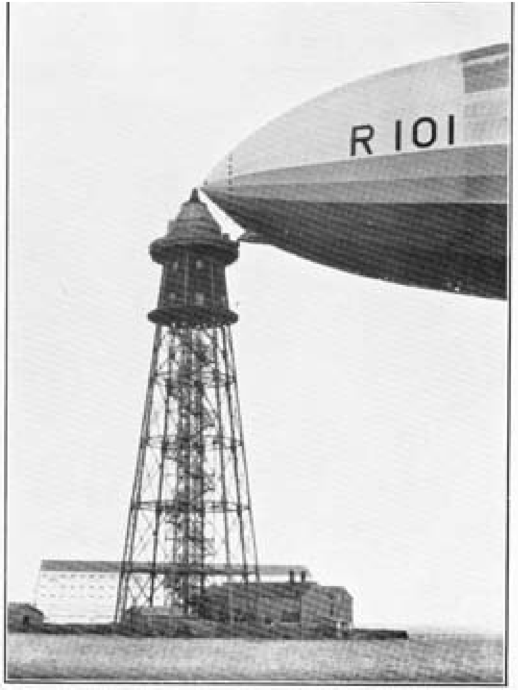
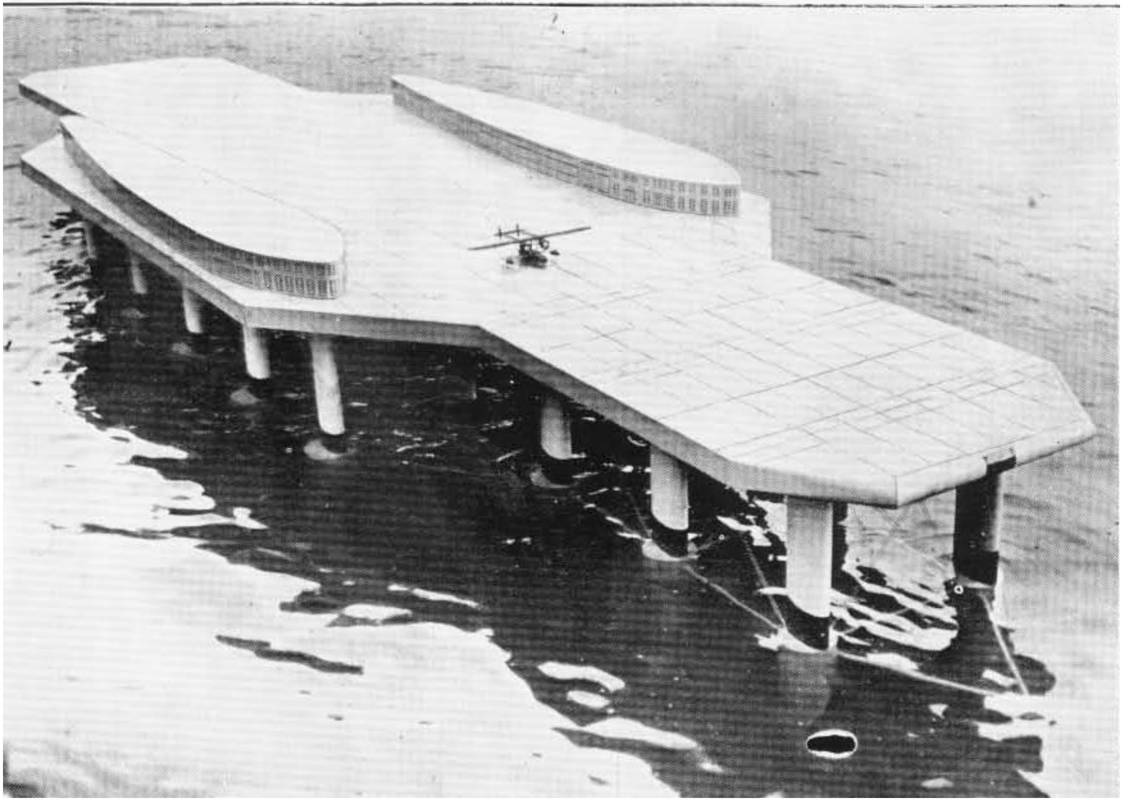


FIG. 11.—CARDINGTON.—The mooring mast, 200 feet high, with R 101 secured. Note the passenger gangway from ship to tower. A lift runs up the centre of the tower, at the top of which are installed the winches for dealing with the mooring cable

Floating Aerodrome

AIRSHIPS AND THE EMPIRE.



Floating Aerodrome

FIG. 2.—THE CIERVO "AUTOGIRO."

By kind permission of the Royal United Service Institution.

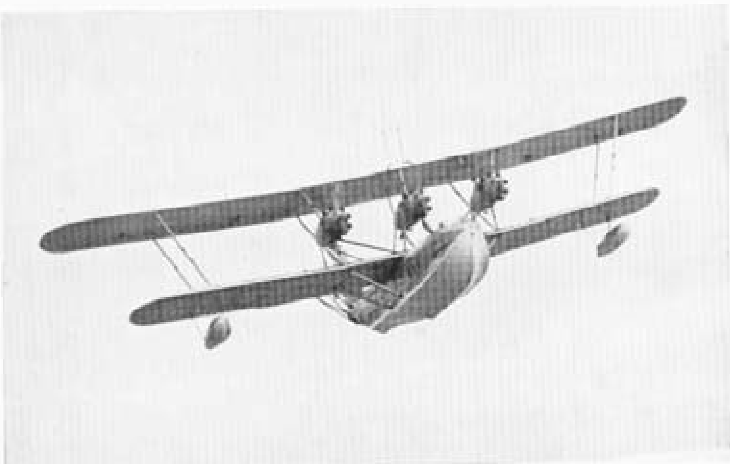


FIG. 3.—THE SHORT "CALCUTTA" FLYING BOAT.
Total weight eight tons. Pay load plus crew, 4,800 lbs.; 14 passengers. Maximum speed, 123 m.p.h. Range, 6·5 hours at 100 m.p.h. 1,390 horse-power.

Autogyro and Calcutta

FIG. 4.—THE SHORT "CALCUTTA" FLYING BOAT ON THE WATER.

FIG. 5.—THE DORNIER DoX FLYING BOAT.

Calcutta & Dornier DoX

Fig. 8.—" In Custody."

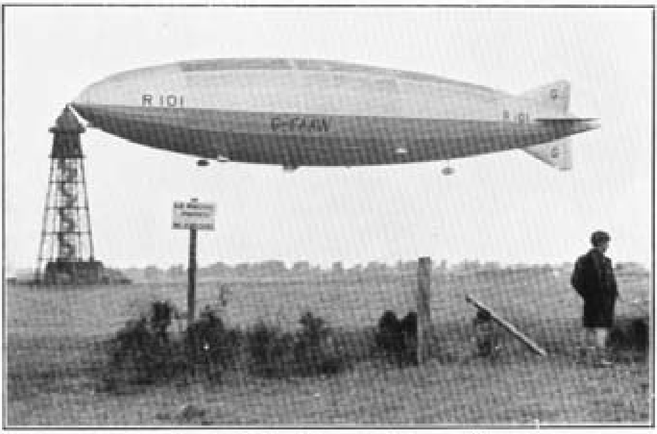


Fig. 9.—" Air Ministry Property."

In Custody & Air Ministry Property

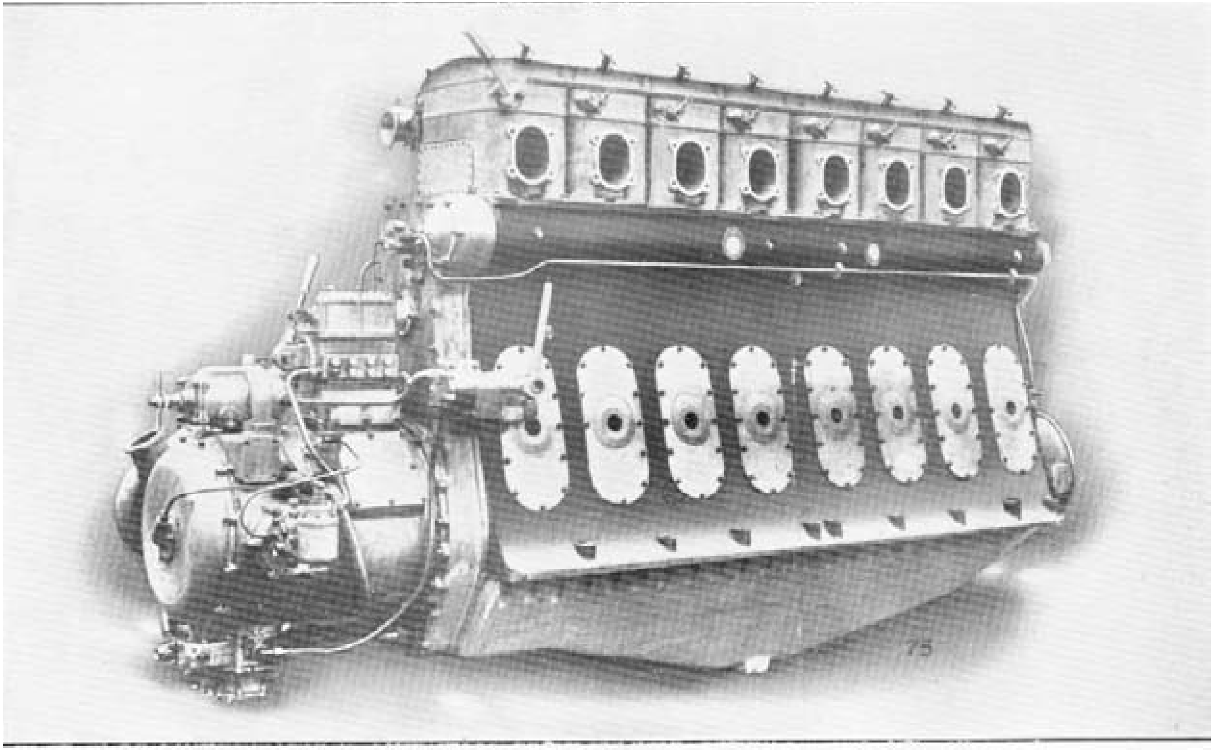
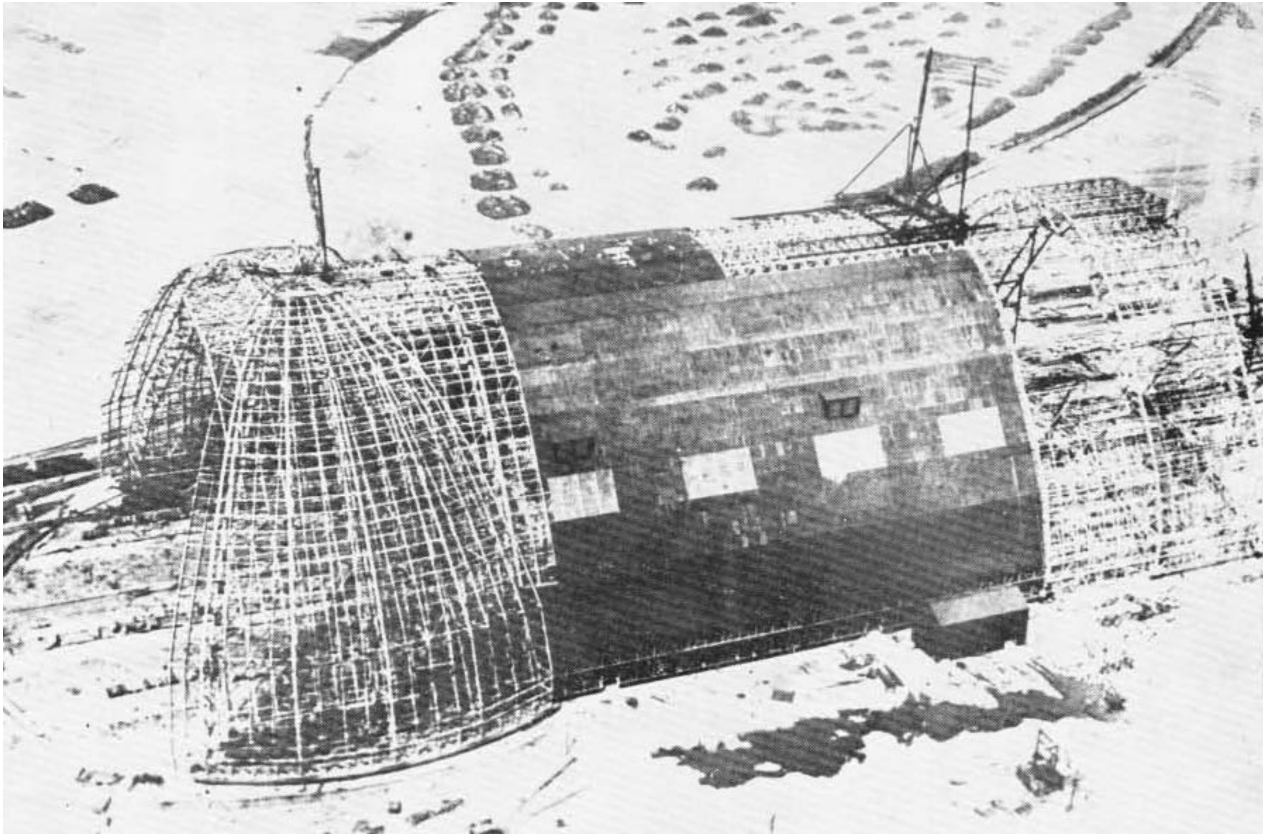
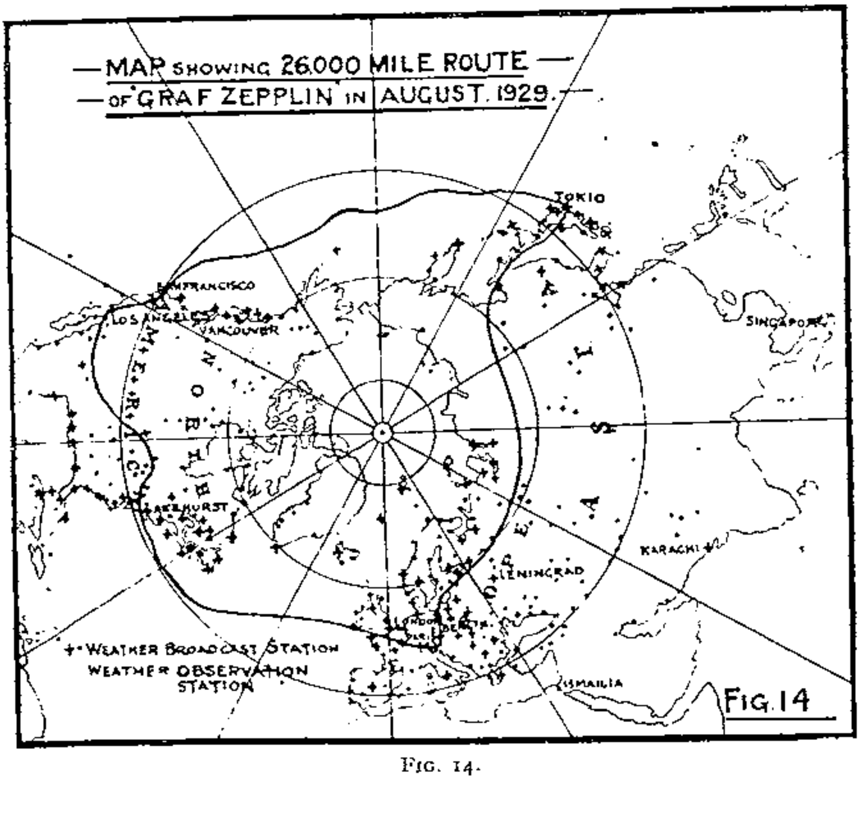


FIG. 12.—THE BEARDMORE "TORNADO" CRUDE OIL ENGINE—five of which are fitted on R. 101. 600 h.p. each.

Beardmore Tornado Engine



Goodyear Zeppelin shed



— MAP SHOWING 26,000 MILE ROUTE —
— OF GRAF ZEPPLIN IN AUGUST. 1929. —
TOKIO
SAN FRANCISCO
LOS ANGELES
VANCOUVER
LAKEHURST
SINGAPORE
KARACHI
LENINGRAD
LONDON
BERLIN
ISMAILIA
NORTH AMERICA
ASIA
+ WEATHER BROADCAST STATION
· WEATHER OBSERVATION STATION
FIG. 14

FIG. 14.

THE WORLD'S RIGID DIRIGIBLES.

Name and Designation.	*Los Angeles.*	*Graf Zeppelin.*	*R.*100.†	*R.*101.†ϕ	*ZR S*–4.*	*LZ*–128.‡
Nationality	U.S.A.	German	British	British	U.S.A.	German
Gas volume, cubic feet	2,470,000	3,708,000	5,000,000		6,500,000	5,250,000
Length overall, feet	658·3	776·2	695	732	785	777
Maximum diameter, feet	90·7	100·1	130	130	132·9	124
Height overall, feet	104·4	110·6	141	139	146·5	—
Kind of gas	Helium	Hydrogen & blau gas	Hydrogen	Hydrogen	Helium	Hydrogen & blau gas
Gross lift, lb.	153,000	262,000	343,000	340,000	403,000	370,000†
Useful lift, lb.	60,000	140,000	160,000	154,000†	182,000†	200,000†
Total horse-power	2,000	2,550	4,200	3,000	4,480	5,500
Kind of fuel	Petrol	Blau gas & Petrol	Petrol	Oil	Petrol	Blau gas & Petrol
Maximum speed	73	79	80	70	84†	100†
Cruising speed	—	—	—	63	—	80
Range at 58 m.p.h., miles	4,000	10,000	7,000	6,900	10,500†	—

* Two airships of this size at present building by the Goodyear Zeppelin Company, Inc., at Akron, Ohio
† Subject to confirmation on test.
‡ Construction expected to commence December, 1929.
ϕ Structural alterations now in hand will increase dimensions, lift, etc.

"ILEX" IN THE FIRST PLYMOUTH-SANTANDER RACE, AUGUST, 1929.

By CAPTAIN W. G. FRYER, R.E.

ILEX had managed to finish second in the Fastnet Race, and was spending a few days rolling moodily at her buoy in Plymouth Harbour, while her crew roistered ashore. She grumbled rather, on hearing that she had only got third prize. But when, one afternoon, we hauled up her sails and turned her bowsprit to the east, she got underway with little protest. We heard a deal of mumbling coming from her forefoot, but this, we felt, was merely *Ilex* getting ready her excuses for retail to the fleet at Gillingham anchorage. "Such a shame, *Altair*, dear. We had a breeze fit to blow my side boards under, and that rough fellow, Fryer, pinched me terribly all day."

Ilex rather imagines herself the heroine of the anchorage nowadays. She always returns there with very tall stories of her travels.

In former years, the finish of the Fastnet Race has released *Ilex* from the necessity of doing any serious cruising. So that when we made for Brixham Harbour, after rounding the Start, she imagined that we were merely putting in for a good night's rest. In fact, we intended to do a little trawler racing until the Santander crew joined. This lasted for two dashing days, while *Ilex* sat on her anchor, looking very gay with all her flags fluttering about her.

Then we tried to get her back to Plymouth, to prepare for the great race. It was a passage of under forty miles, and we insulted *Ilex* by allowing her as many hours to do it in. In addition, a friendly tow was following us. But *Ilex* is an extremely capricious vessel. Just as long as we were still pointing towards Chatham and home, she continued to heel over and bowl merrily along. But, as soon as she noticed us edging her back towards the Start, she began to take charge. At first, it was only a few impatient shakes of her mainsail, to call attention to the mistake; but when we persisted in our error, she forgot all her manners and calmly, all too calmly, refused to go ahead at all. Her brisk gaiety was cast aside, her gurgling bow wave vanished, and like a spoilt child, she sat sullenly at sea off the Start.

She did worse. For five hours, we did quite a depressing number of miles backwards. Even when the tide changed, *Ilex* approached

Plymouth at little more than an athletic snail's pace. No friendly tows were to be seen, and we became slightly concerned about our arrival. "Surely a breeze will spring up on the change of tide?" "Could we get a tow to Salcombe?" The paid hand, our ancient mariner, spotted a large number of blue jellyfish which, he stated, were a sure sign of wind.

But we were pessimistic, and put our "well-known helmsman" ashore to rout out some kind of tow as soon as he could. He is rather large, our Wilks, and the yacht he boarded went aground almost immediately. However, she made strenuous use of her tin topsail, and managed to push through. We had given up reasoning with *Ilex* by now, and did a little spirited fishing until change of tide. This is a game at which two can play. And the rocky bottom off Bolt Head played it so joyously that, when the R.E.Y.C. Treasurer, in a carefree manner, was dangling a lead overboard, it was suddenly seized in an iron grip. With a sharp yelp of dismay, he was pulled right across the ship and very nearly overboard. Bolt Head, indeed, still owes the R.E.Y.C. a very good lead and some two fathoms of line.

Night and the fog now fell upon us. The tide began to flow against us, and we dropped a hook. *Ilex* smiled smugly to herself as she tugged gently at it, because there was now little hope of reaching Plymouth in time for the race on the following morning. No doubt, she had regarded the desertion of the well-known helmsman as the act of one exasperated by her tantrums. Perhaps the fog would soon reduce the rest of us to a similar mental condition.

But we still hoped for a tow, and at intervals, we sent out odd messages through the mournful medium of the foghorn. Foghorn morse is disturbing stuff. We could make out a small yacht in the gloom beside us, which appeared to be drifting backwards with the tide. Every message we sent out with our foghorn produced a perplexed wail of "What's the matter?" from its owner. He, it seemed, from the sound of scuffling, rushed on deck at every first hoot with a heart thumping hard, through fear of an approaching steamer. Our final conversation, as he drifted slowly by, ran:

Black Blur: "What's the matter?"

Ilex: "Waiting for a tow." (It seems that he never caught this message.)

Black Blur: "I'm on a light hook out here."

Ilex: "Yes, so are we . . ."

(Pause.)

Black Blur (now reconsidering things and feeling not quite so much on a hook as he had imagined): "I'm drifting back to Salcombe."

Ilex (very heartily): "Yes . . ."

(Pause.)

More foghorn morse, followed by sounds of panic on board *Black Blur*. Then again:

Black Blur: "What's the matter?"

Ilex: "Hullo" (as being non-committal).

(Pause. Fog very dense.)

Then faintly in the distance, our ancient mariner heard a motor horn—very active foghorn morse from *Ilex*—more panic from *Black Blur*, with enquiry as to matter—more motor horn and finally, a dim shape appeared. We now gave a further burst of morse from our foghorn and heard a further plaintive shout from *Black Blur*, who had now drifted far astern. We gave him a final cheerful "Hullo." In reply came a shout of "*Ilex*" from an approaching *Dim Shape*. We all replied together in a positively skull-bursting shout. Whereat *Dim Shape* became panicstricken, mistaking our side view with sails up for the bows of a terrific yacht about to run it down, and turned away.

Amid the enthusiastic poppings coming from *Dim Shape*, we heard the cheering voice of Armstrong, one time lord of I.C. at the S.M.E. workshops. Indeed, it was probably his crude accompaniment which first made us recognize him. The motor-boat continued its coy circling; we encouraged it with cries and finally it came to rest alongside. It *was* Armstrong, and we raised a great cheer, helped out with energetic pumping of the foghorn. He was on *Fulmar*, when she blew out her mainsail on the Heligoland cruise, and one has come to expect wild weather and exciting sailing when he comes aboard.

We now pulled furiously at the anchor and passed a warp to the motor-boat. "Ready?"—"All ready." Chug, chug, chug.

For the next nine hours we were towed over the local ocean at high speed. Blank, grey curtains hung around us. From somewhere ahead came the steady chugging of the motor-boat, but the fog was too dense to make it out. We kept a hand forward on the bows to shout directions to the helmsman. Towards midnight the fog overhead grew thinner and the moon gave out an eerie, pallid light upon the grey twenty-yard circle that was our visible world. One lost all sense of horizon and earth contact. As one sat at the tiller, *Ilex* seemed to be gliding dreamily down an unending hill of eternal greyness. Throughout the night, there was no breath of wind to disturb the perfect flatness of the still sea.

In the early hours of the morning, we recognized the black shape of Rame Head. It loomed up from the mist and gulls screamed an anxious warning at us. With the sun rising over Plymouth, we made fast our buoy and paid off the motor-boat.

It was 7.30 a.m., and we felt as if we had been steering for a whole age instead of one foggy night. The race to Santander was due to start in four hours. We had to provision and water ship, collect our crew, and get *Ilex* under way and in ocean-going trim. We considered this for a little and fell asleep with the cold fog rime still on our hair and faces.

Much stamping on deck brought us back to the urgent matters of the day. We worked in a crescendo of activity. While our rivals were cruising around with little to do except adjust the set of the burgee, *Ilex* did her final furious stow. Wilks, our "well-known helmsman," came aboard with the dinghy only ten minutes before the starting gun. And so we made a bad start. We crossed the line eighth, with most of the crew rushing madly around the vessel, still trying to cure a lunatic form of jackyarder disease. The other starters were :—

Jolie Brise.
La Joyeuse.
Maria del Carmen. (Another and bigger yacht of this name raced in, and won, the larger class.)
Guerveur.
Grey Fox.
Ettsi IV.
Neptune.
Avocet.
Magnet.

We looked upon *Jolie Brise* as the favourite—she has won the American Ocean Race once and the Fastnet Race twice—and she got away at great speed. The small *Maria del Carmen* and *Neptune* appeared to be the fastest yachts in our class, and they went off with *Jolie Brise* rather to the west of our course.

We now had a little breathing space in which to count the crew. Two watches were picked. D. Hunt, who was doing skipper and navigator, decided to form a watch with M. T. L. Wilkinson, and Rupert Brown. Hunt, therefore, had rather a heavy task during the race. We had not been able to collect a larger crew, owing to the delay in the fog. In the other watch were Major S. J. Armstrong, W. G. Fryer and G. D. McK. Sutherland. Carter, our ancient mariner, cooked.

Ilex had now forgotten her bad temper and evidently intended to make the best of things, when she saw so many old friends heading on the same course. But our bad start was quite noticeably depressing the skipper, even though we had already much improved our position. Fortunately, the topsail sheet suddenly cast itself off at this point. And the excitement of climbing out to the end of the gaff and re-reeving it *in situ* with a merry breeze blowing quite restored his good spirits. Energetic skippers, like Hunt, must always be given some such trial as this, or they imagine that yachting has degenerated into a girlish pastime.

The crew is working out a scheme for next season's race. It is to work like this. . . .

Pale and anxious face rushes up from below. "She's leaking like hell! Carter says the keel bolts need tightening from below." And so we feverishly collect an immense spanner, a long rope, and rush up to the skipper with them. He beams with gratitude, makes himself fast, takes a deep breath, and is lowered down from the bows with a rush. And while he sweeps under the vessel, he does the job. This, we feel, would amuse him for the rest of the race, and the idle hands will be able to work out D.R. (dead reckoning) in peace.

Throughout the day, we sailed with the wind just comfortably free on the port bow. Both jackyarder and yankee jib were set and did great work. We logged six knots for most of the day, and the sun made it very pleasant sail.

Working out D.R. became the euphemism on *Ilex* this year for any kind of idling—especially idling of the cat-nap kind. It arose from the curious habits of Wilks, our 7.65 knot man and well-known helmsman.

Wilks seldom takes any real interest in the navigation proper. His chief concern is to see that all the big mileages are done during his watch or his hour at the helm. He refers to himself grandly as the 7.65 man, in memory of the day in this year's Fastnet Race, when nobody else could make *Ilex* do more than seven knots. (Some of us have grave doubts about the correctness of that log reading, but Wilks has been a prouder man ever since.) After a siesta below, Wilks comes on deck with an apparently authoritative statement as to *Ilex's* position. This is usually very much to everyone's surprise, as we know that he has not been to the chart nor seen the log readings. But Wilks always thinks it necessary to give some position, just to show that, although he was lying down with his eyes closed so peacefully, yet that busy brain was working at high pressure on affairs of the greatest importance.

At nightfall, we sighted Ushant white light on the port bow. There were no yachts at all near us now, and we spent the night about ten miles off Ushant making little headway. We had no long anchor line, and did not go in closer lest the tide should carry us too far from our course. Many of the leading yachts were caught in a calm nearer Ushant next morning.

Dawn is always an exacting time in an ocean race. This dawn broke fine and clear, with a variable light southerly wind, and it showed us *Avocet* astern, *La Joyeuse* abeam to leeward and *Guerveur* just ahead. This was fairly good going as *Ilex* was the smallest yacht in the race. We raised a cheer and brought the gramophone on deck. Then we changed the yankee jib for the small jib topsail. Then we changed them again once more. As a result, we passed *Guerveur* and dropped the others out of sight behind.

Maria del Carmen, a fine-looking staysail schooner and the largest yacht in our class, now came out from the north-west like a race-horse. She crossed our bows on the other tack and went ahead at great pace. This startled us somewhat, for when we saw her at the start of the race, she had shot ahead of us in exactly the same way. Somebody suggested that perhaps she was on her second round. It almost looked like it. *Grey Fox* also appeared from the same direction and remained in sight for the rest of the race.

When the skipper had taken his midday sight, *Ilex* picked up a better wind, and sailed full and bye on her course to Santander. The sun was hot, the sea and sky a wonderful blue. Costumes were principally by Adam ; beards were of moderate length. The gramophone managed to play us sea shanties without being greatly affected by the ship's motion.

That night (Tuesday), we met the pirate ship. Even now we do not know what she was. Most probably, she was an inquisitive trawler or a pilot vessel. It was a jet-black night and we first spotted her as a white light on the bow. The wind was getting rather more free, and so we got ready the balloon staysail. *Ilex* was now doing about 6½ knots with her sheets eased. The white light came nearer and nearer, until we could make out a huge black hull beneath it. There was no doubt that it was steering directly for us. We looked at all our navigation lights and waved a torch. Still she kept on. At last, we were forced to bear away. She altered course to meet us ! We then bore away hard and just passed across her bows with great relief. She altered course after us, but we went away at speed. Perhaps she was a well-known bore of these seas and was looking for a victim. For the Bay is a lonely spot.

The deck chatter during this little struggle was horrifying stuff for the watch below to listen to, and they quite lost their keenness for working out D.R. It was an unpleasantly close shave on such a black night and at such a spanking pace.

For the rest of the cruise, our watch regarded any approaching white light with extreme suspicion. So that when, on the return cruise, we spotted a similar white light on the horizon, we watched it carefully. "Yes, here it comes! Getting higher and brighter every moment. Just the same black night. We'll fairly shake it up with the Verey pistol this time, tho'!" And it was not until Sutherland's furious search for the pistol had brought the watch below to the exciting stage of hanging on the bunk side ready for the bump, that the light was recognized as Venus, rising rather more superbly than usual. We handed the watch below a few towels to wipe the sweat from their brows.

Throughout Tuesday night, *Ilex* rushed ahead into the blackness, with all sail set. Shortly after the pirate ship scare, the moon rose grand and clear. By then we were so suspicious of white lights, that the helmsman was only just in time prevented from luffing up to avoid it.

When the next watch came on, *Ilex* was heeling well over under her jackyarder and newly-set balloon staysail. But immediately the 7.65 man came up, he began in melancholy manner to put the yankee jib into stops. And shortly, wild cries, borne down to our bunks below, warned us that somebody had fallen overboard, or else that *Ilex* was adding still more frills to her toilet. We went on with our D.R.

At daybreak, we made out *Grey Fox* still astern. No other yachts were to be seen, and *Ilex* gave us a wonderful sailing day in her anxious search for more company. The sun shone brilliantly upon the warm, blue waters of the Bay, and we decided that we might forgive *Ilex* for her tantrums off Bolt Head. It was now Wednesday—the third day of the race—and we expected to see the Spanish submarines which were patrolling this part of the course. To-day we met our first tunnyman. She was painted green with dark-yellow sails, and was a very pleasing sight as she bowled along with her 70-foot fishing rods out on each side.

Towards evening a glassy grey calm took the place of our gay sailing breeze, and we saw a submarine, C.3, making for us. We decided to check our G.M.T. as the wireless sets had refused, with loud and continuous howls, to give any help in this important matter.

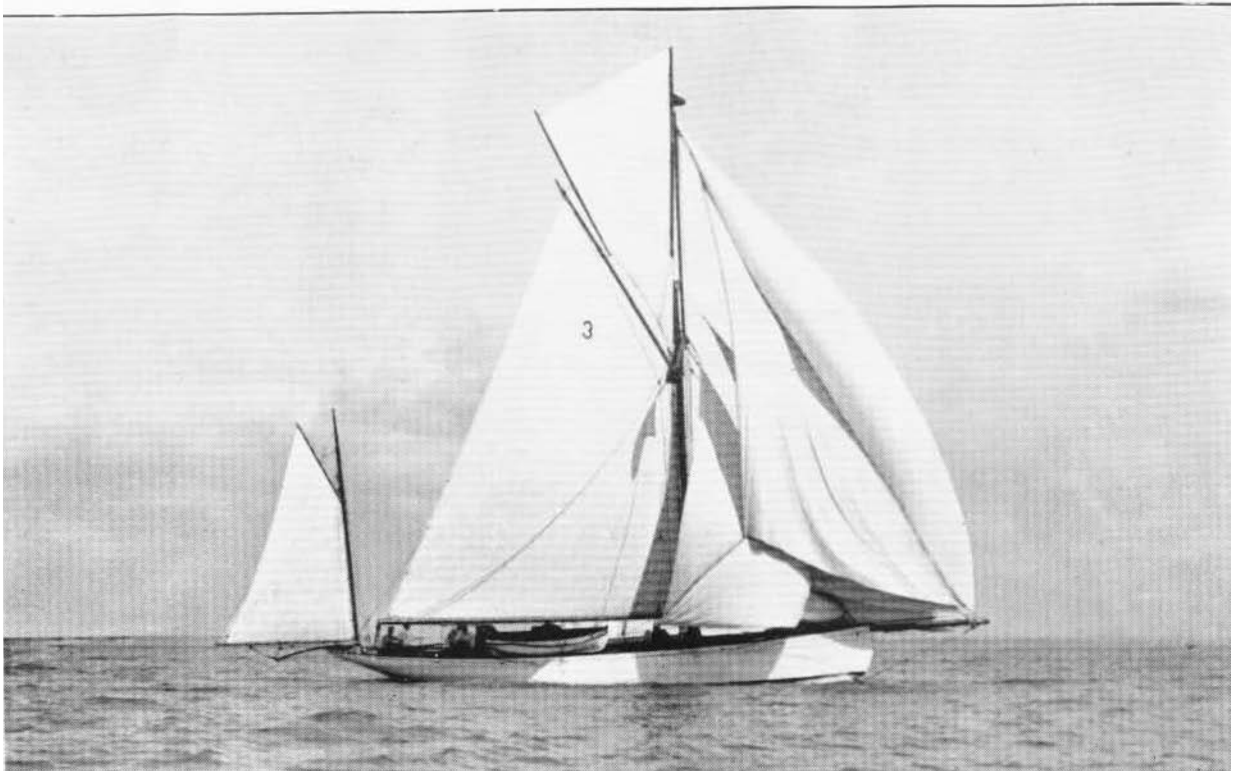
And so some of us staggered on deck with the code book and the signal flags, while the rest lay back and prepared to give advice. C.3 played up superbly. She even developed the precocious habit of answering our signals before we had finished hoisting them up. She came closer, and finally, some crude French and a megaphone produced the required check. We had doubted our chronometer without reason.

Wednesday night was completely calm. There was just enough swell to keep the boom banging about in an irritating manner. The patent log became quite despondent about it and the line hung vertically downwards in a long, phosphorescent blaze.

The yankee jib, our lightest sail, seemed willing to draw at times, but the continual rolling shook the wind out of it. And so the skipper decided to hoist the spinnaker in place of the mainsail and jackyarder. This was done, and *Ilex* seemed to shake very much less. The long line showed activity on several occasions after this change, but we really moved very little throughout the night. For some time, *Ilex* insisted on pointing back towards Plymouth, but this was only in the worst of the calm.

It was an admirable opportunity for some work by our navigation night school. All the stars were readily recognizable. Even those

"ILEX" IN THE FIRST PLYMOUTH-SANTANDER RACE, AUGUST, 1929.



Ilex of Spithead

Spanish Ocean-Racing Kit.

A Fair Wind.

Spanish ocean racing kit and a fair wind

of the most meagre brilliancy ran quite a considerable risk of having their Christian names bandied about the vessel. By dawn the skipper had the ship's position fixed by quite a comforting number of sights on them.

The rising sun brought a gentle wind from just forrard of the port beam. It was time to replace our odd Bermudian rig. Down came our spinnaker-mainsail and up went the main and jackyarder once again.

Long rollers were coming up from the north-west, and *Ilex* went along quite fast on the calm sea. There seemed to be about 100 yards between wave crests, and they rolled ponderously past us like a shoal of enormous sea serpents. After breakfast, our good friend, C.3, very fussy with her terrific klaxon horn, came to see us once more. We decorated *Ilex* with a garrulous array of signal flags. Back came the reply: "*Jolie Brise* and *Neptune* ahead of you." We knew that *Neptune* allowed us an appreciable amount of time, but there seemed little hope of beating *Jolie Brise*. Still, there was a great chance for second prize, and we brought the gramophone on deck once more. It did stout work throughout the day. Most of us can now hit off the chorus of "Wake up, chillun" at the first shot. Our conversation became brighter every moment. We all said several times how wonderfully blue the sea was.

Throughout the day, we kept up a good speed. After tea, we saw that *Grey Fox* astern seemed to be pointing up to the eastward. The skipper speedily took about ten shots at the sun, and these seemed to show that we should keep straight on. We did so, and strained our eyes in the search for "snow-clad mountains, often visible 70 miles out at sea."

Our ancient mariner suddenly saw land out towards the west. This might have depressed any navigator, who was unacquainted with his lively imagination. However, he failed to identify the Statue of Liberty, and found land both ahead and to the east instead.

And then Brown spotted a twinkling light just under the bowsprit. Land ho! Hunt timed it from the masthead. It could only be Cape Mayor light—on the Santander headland. It was 6 p.m. and gin time. We felt that this was superb navigation, and drank bad luck to all navigators who insist on making landfalls in the early hours of the morning.

Night fell, but still *Ilex* rushed amiably at the light. A voice spoke, "I expect *Jolie Brise* is in by now." Immediately the easterly wind died away and we had to hold the boom still once again. We said many horrid things about leader's luck. Actually, we should not have made up our time on *Jolie Brise* even if the wind had held throughout the evening. C.3 once more came up in the dark and we made our name to her with the help of a small pocket torch.

Progress was slow. At midnight, it began to get thick. In the early hours of Friday morning, we could only just make out Cape Mayor light, and the lights on a large ship anchored in the harbour entrance. At 1.30 a.m., a light westerly breeze sprang up and we crossed the finishing line at 2.42 a.m. For the previous hour we had been burning flares and firing Verey lights. No one replied, although a number of lights were visible from *Ilex*.

Having crossed the line, we reduced sail in the fog, and then sailed back to the lighted ship, to discuss the matter of a tow to some suitable berth. Our first venture into the harbour had brought us the sound of breakers ahead in the fog. With a torch, we signalled questions in Spanish, French and Latin to the markship. Finally, she made out our torch light and suddenly replied in English, a language which we had not thought worth trying, "What do you want?"

It then took about ten minutes' wild flashing to make it appear that we were talking to H.M.S. *Royal Oak*. This seemed idiotic, so we gave up the matter and sounded our way in the gloom towards the breakers on the nearby beach. There we anchored for the night, rolling deplorably in the swell.

The fog remained thick until the day was well advanced. A submarine anchored beside us and gave out melancholy fog signals at short intervals. The swell made sleep difficult in any case; one had to retain sufficient consciousness to wedge oneself up against one side of the bunk.

At 8 a.m., we gave up the struggle and went on deck. We made out a large town, a wonderful beach, a ridge of nasty-looking rocks, and a dead shark with a baleful look in its eye. All of them seemed to be unpleasantly close—particularly the rocks. Anchored astern was *Grey Fox*, a British battleship and *Neptune*, with sails still up. Evidently *Neptune* had come in after us, as otherwise we should have seen her while sounding up to our anchorage. "Perhaps *Jolie Brise* had come in with her?"

There was much excitement at the possibility. We bathed, and one of us even washed and shaved himself in readiness for the shore. A pinnace from H.M.S. *Royal Oak*—for our yeoman of signals had been right, though not even he had believed it—very kindly helped in the matter and the Real Yacht Club house was discovered.

On landing at the Club steps, the first people to be recognized there were the crew of the *Jolie Brise*, looking as smart as if they had finished the race at least a couple of days ago. They had come in at 8 p.m. the previous evening, just before the wind dropped, having sailed an excellent race.

H.M. The King of Spain is one of the most enthusiastic yachtsmen at Santander. He showed great interest in our general fortune in the race. He had given the first prize for the larger class, which had finished before ours, and had been won by the immense ex-*Meteor*, now renamed *Maria del Carmen*. *Ilex* had, however, managed to beat one of the larger class, though not a very speedy one. It soon appeared that *Ilex* had very probably won second prize.

The fog had made finishing times very difficult to take. But it was soon clear that the small *Maria del Carmen* had crossed the line about half an hour before us. This meant that *Ilex* finished third and got second prize by a considerable margin.

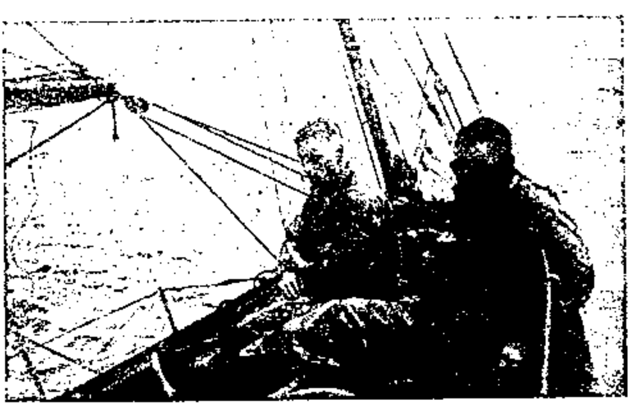
The prize-winners in the smaller class were :—

1. *Jolie Brise* (H.M. The Queen of Spain's Cup).
2. *Ilex.*
3. *Grey Fox.*
4. *Guerveur.*

The prizes were extremely good. H.M. The Queen of Spain presented them in person at the Real Yacht Club. The gold cup which *Ilex* obtained for second prize is so large, that it had to be stowed in a sail locker. It now decorates the H.Q. Mess. Inside the cup we found notes for 3,000 pesetas, with which the Treasurer promptly disappeared.

Spanish hospitality is superb. We spent some wonderful days at Santander, waiting for the prize-giving and official dinner. The members of the Real Club Maritimo Santander entertained us wonderfully well the whole time.

And now we are all discussing next year's race. Hunt, we hope, will still be available. We may not win such a large prize, but we are certain of a most amusing time. Who is for sailing south to Spain next August ?



THE ELIZABETHAN CHRONICLE PLAY AS WAR PROPAGANDA.

By COLONEL B. R. WARD, C.M.G., Hon. Secretary, The Shakespeare Fellowship.

THE history of the rise and decline of the chronicle play in the sixteenth century has been treated up to the present as a literary question pure and simple.

Clemence Dane, in the last act of her play, *Will Shakespeare*, illustrates this by a fine soliloquy she puts into the mouth of Shakespeare as he sits down in the Palace just after Marlowe's murder in 1593 to write *As You Like It* under the Queen's orders. A page enters with lights and announces himself thus :

The Queen, sir,
Has sent you candles, now the sun is down,
That you may see to work.
SHAKESPEARE. I thank the Queen.
Tell her the work goes well !
He sits down at the table.
Act one, scene one,
Oliver's house. It *shall* go well. I have
A strength that comes I know not whence. It *shall*
Go well. And then I'll give the Roman tale
I heard at school—a tale of men, not women :
That easies all. But Antony goes on
To Egypt and a gipsy : leaves his pale wife
At home to scald her eyes out. Mary—Mary—
Will you not let me be ? It *shall* go well.
And after Antony some Twelfth Night trick
To please our gods and give my pregnancy
Its needed peace. How many months for Denmark ?
And then ? A whole man laughs, and so will I.
Oh, Smile behind the thunder, teach me laughter
And save my soul !
The knock-about fat man, try him again !
He'll take a month or less—candles are cheap,
Cheaper than sleep these dreaming nights. That done
I'll sink another shaft in Holinshed . . .

Shakespeare is here thinking of all the plays he intends to write. He has already written *Romeo and Juliet* and the *First Part of*

Henry VI., and with *Richard II.*, *Richard III.*, or perhaps *Henry V.* in his mind's eye, he suggests to himself the sinking of another shaft in the rich mine of Holinshed's *Chronicles*.

Will Shakespeare is described by Clemence Dane on the title page as *An Invention in Four Acts*, and a fine piece of inventive work it is, that thoroughly deserves its popularity both on the stage and as a fantasy to read with one's feet in the fender. But invention is not history, and since the play was first acted in London on 17th November, 1921, historical research has thrown a flood of light on the origin and development of the Elizabethan Chronicle play. The details of this research are recorded for the most part in literary and other journals in the form of notes and articles that have not yet been woven into a coherent and continuous narrative. In the following pages an attempt will be made to trace the history of the sixteenth century chronicle play, and to show the place it occupies in the general history of the time.

In early mediæval times the miracle play was the only form of dramatic entertainment. These plays were performed by trading-companies in the various towns, Chester having set the example by a series of plays acted at Whitsuntide at the close of the thirteenth century. The religious drama was particularly at home in East Anglia; Wymondham, Norwich, Sleaford, and Lincoln being famous for such representations.

Miracle plays represented incidents from the Old and New Testament, and were performed under ecclesiastical authority. They gradually gave way to allegorical plays known as "Moralities."

> "The transition from the morality to the regular drama in England," writes Professor A. W. Ward in his article on "Drama" in the *Encyclopædia Britannica*, "was effected, on the one hand, by the intermixture of historical personages with abstractions—as in Bishop Bale's *Kyng Johan* (c. 1548)—which easily led over to the *Chronicle History*; on the other, by the introduction of types of real life by the side of abstract figures."

The next advance in the evolution of the morality was made by John Heywood, whose "Interludes," or short farces in the French manner, were the direct precursors of what we now call "Chronicle Plays," but which continued to be known as "Interludes" throughout Elizabeth's reign.

The first real chronicle play was *The Famous Victories of Henry V.*, first printed in 1598, but as recent research has shown, first acted before the Queen at Hampton Court during the Christmas entertainments of 1574. The moving spirit at the back of this interlude or chronicle play which ushered in the famous series of Elizabethan historical plays was a young nobleman in his twenty-fifth year, Edward de Vere, Earl of Oxford.

In later years, Oxford's great friend, Lord Lumley, when discussing the drama in *The Arte of English Poesie* (1589), wrote : " For Tragedy, Lord Buckhurst and Master Edward Ferrys do deserve the highest price : the Earl of Oxford and Master Edwards of Her Majesty's Chapel, for Comedy and Interlude." It is not unlikely that Lord Lumley was here thinking of that stirring and at the same time amusing interlude, *The Famous Victories of Henry V.*, which had been acted in its earliest form fifteen years previously.*

The Earl of Oxford, who had married Lord Burghley's daughter in 1571, soon began to tire of Court routine, and what must have seemed a humdrum home life under the somewhat ponderous influence of his father-in-law. In October, 1572, writing from his country house at Wivenhoe in Essex, he acknowledges a letter from Lord Burghley, " the first I have received of your Lordship's good opinion conceived towards me," and goes on to hope " with your Lordship's indifferent judgment to be more plausible unto you than heretofore, through my careful deeds to please you, which hardly, either through my youth, or rather my misfortune, hitherto I have done."

A month before this, he had been applying to his father-in-law to use his influence on his behalf to allow of his volunteering for service at sea. " If there be any setting forth to sea, to which service I bear most affection, I shall desire your Lordship to give me and get me that favour and credit that I might make one. Which, if there be no such intention, then I shall be most willing to be employed on the sea coasts to be in a readiness with my countrymen against any invasion."

For the next two years Oxford was kicking his heels at home, and was obliged to content himself with literary work. It is not unlikely that the Queen had something to do with the want of success of his volunteering efforts, for as young Gilbert Talbot wrote to his father, the Earl of Shrewsbury, on 11th May, 1572 : " My Lord of Oxford is lately grown into great credit, for the Queen's Majesty delighteth more in his personage and his dancing and valiantness than any other."

However that may be, he stuck it out for a couple of years ; but at last—in June, 1574—being unable to obtain naval or military employment, and permission to travel abroad being also persistently refused, he took the law into his own hands and ran away to the Low Countries, where he visited the Spanish entrenchments before Bommel, before the burghers raised the siege by cutting the dykes. This schoolboy escapade ended ignominiously. A Queen's messenger was hastily dispatched to bring back the defaulting courtier, who hurried to Gloucester early in August to make his peace with the Queen, who was then on a Progress in the West Country.

* The circumstances of its original production were first brought to light in an article contributed to the *Review of English Studies* in July last year.

The Queen seems to have borne no resentment against her young favourite, who spent the autumn with his Countess at Hampton Court, where no doubt he continued to delight Her Majesty "with his dancing and valiantness."

The Christmas entertainments at Court required considerable preparation beforehand, and it is probable that, very soon after the interview with the Queen at Gloucester, the idea must have entered Oxford's mind that he could not do better than set to work to gain the Queen's approval to his application to travel abroad by means of a topical interlude.

Although we do not possess a complete record of the Christmas entertainments at Hampton Court in 1574, there can be very little doubt that the *pièce de résistance* on that occasion was an interlude written by Lord Oxford on the subject of the youthful escapades of Prince Hal, followed by his heroic action as King Henry V., the victor of Agincourt. The 11th Earl of Oxford comes into the picture as King Henry's Earl Marshal, and is given a much more prominent role than the chroniclers ever assigned to him. There can be little doubt that the part of Prince Hal was taken by Oxford himself, who had a magnificent opportunity to display that "valiantness" of his in which the Queen so much delighted.

The success of the play and the pleasure which it must have given to the Queen may be confidently assumed from the fact that Oxford's licence to travel abroad received the Royal sanction early in the New Year, and that on 7th January, 1575, he started on his long continental tour, with Paris as his first destination. The Queen had been unable to resist the application, driven home as it was by the comparison between Oxford and Prince Hal.

After spending sixteen months abroad, Oxford returned to Court life and Court dramatic entertainments. In 1583, a company of twelve actors was selected and named the Queen's Players, the element of professionalism thus introduced marking the increased importance attached by the Queen to Court dramatic entertainments. It is also possible—for Queen Elizabeth was a very far-sighted person—that she foresaw the importance of the role that the public stage might fulfil when the long-expected rupture with Spain should take place. At any rate, we know that *The Famous Victories of Henry V.* was one of the plays performed in public by the Queen's players in the late 'eighties.

In 1585, the long-expected war was declared, and the Earl of Oxford was sent to the Low Countries in August at the head of an Expeditionary Force of 4,000 men to assist the Dutch against the Spaniards. Within six weeks, Oxford was mysteriously recalled, and the Earl of Leicester was appointed Lieutenant-General of the English Forces in the Low Countries.

It seems probable that Oxford was recalled by the Queen in order to take charge of a Secret Service Department of State, for, from June, 1586, to his death in 1604, he was in receipt of a grant of £1,000 a year from the Exchequer. No account was to be called for as to how this money was expended. It was a grant for Secret Service purposes.*

The Anglo-Spanish War lasted for twenty years, the peace negotiations being in progress at the time of Oxford's death in 1604. Only once in the whole period did the expenditure on the Army and the Navy drop below 50% of the revenue. In the Armada year the figure was 101%, the average annual expenditure during the whole period of twenty years being 72%. During this time, taxation increased four-fold, food prices were trebled, and there was a threat of famine in 1596 and again in 1597. It is interesting that practically identical statistics recurred during our war with Napoleon, and again in 1914–1918.

It is, therefore, practically certain that Oxford's £1,000 a year, which exactly covered the war period, was granted for war purposes, the special purpose being almost certainly the dissemination of propaganda by means of literature and the stage.

It was during this period that the Chronicle play attained its greatest popularity. After the peace with Spain it was hardly ever revived. The earliest chronicle play was, as we have seen, *The Famous Victories of Henry V.*, acted in the 'eighties by the Queen's Players. This play was afterwards expanded into three exceedingly popular plays—*Henry IV. Part I*, *Henry IV. Part II*, and *Henry V.* The last-named play, which was first printed in 1600 towards the end of the Anglo-Spanish War, is the last of the great chronicle plays. It is interesting to trace its history back to the Earl of Oxford's Court interlude of 1574. Did he, as Director of War Propaganda, feel in 1600 a twinge of satisfaction at the thought of the great literary result that had been achieved by his early comedy? In 1574, his idea was to influence the Queen in favour of his application to travel on the Continent. Since then, his witty interlude had been developed into a great national series of dramas which had had no inconsiderable share during the strenuous war years in the work of influencing the people of England in the direction of loyalty, patriotism, and the will to conquer.

* See *R.E. Journal*, December, 1928, page 658, "Shakespeare and Elizabethan War Propaganda."

A VISIT TO ORAKAU BATTLEFIELD.

By LIEUT.-COL. J. E. DUIGAN, *New Zealand Staff Corps.*

ON 25th August, 1929, a meeting of officers, doing a Senior Officers' Course, in Cambridge, was organized, to meet the two remaining veterans of the Battle of Orakau, fought during the Maori War. This battle was fought in 1864, between some 300 Maoris, who occupied a strongly entrenched position, and a British force of 1,800 men, composed of the 18th Royal Irish, 40th Foot, 65th Regt. Royal Artillery, Waikato Militia, Forest Rangers, and Colonial Defence Force Cavalry, under Brig. Carey. The battle lasted three days. There were two unsuccessful assaults on the Maori position on the first day, after which a sap was carried towards the *pah*. On the third day, Maj.-Gen. Sir Duncan Cameron arrived and took command. During the afternoon, before the final assault, the Maoris were called upon to surrender and gave the famous reply: " We will fight you for ever, and for ever, and for ever," which has become the motto of the present Waikato Regt.

The Maoris were led by Rewi Maniapoto, and came from tribes located near Kihikihi, the King Country, Taupo, and Urewers districts.

After the British terms had been refused, the Maoris were called upon to send their women out of the *pah*. The women's reply was: " If the men are to die, we will die, too."

The following is a brief outline of the description of the battle as told by Te Huia Raureti, the other veteran not being able to come owing to sickness. In order to get certain information, the following questions were put to Te Huia through the interpreter:—

1. When did he come to the *pah*?

Te Huia said he first came to the *pah*, in Orakau, in the days when his people congregated there.

2. How old was he?

When war broke out, he was a married man with children. He says he is now over 100 years of age.

3. How was he dressed and armed?

In those days, he said he was dressed in the ordinary shirt, and was with a double-barrelled gun. Te Huia remarked that he had left his trousers behind, which caused some laughter.

4. How did he carry his ammunition?

He had two belts on, each with 10 cartridges in one portion and 10 in the other, making a total of 40 cartridges in all. It was a proper cartridge belt with leather flaps.

5. Did he help to dig the trenches ?

Yes. He said the trenches were dug with ordinary spades, but they had only very few. They dug the first day and part of the night.

6. Where was he posted in the *pah* ?

He was posted near the south-east corner.

7. When did he first see the soldiers ?

The first of the Pakeha soldiers appeared early in the morning, when it was just breaking day. There were only a few at first, but after a while more and more appeared, and the Maoris wondered where they were all coming from. They appeared in all directions.

8. Describe the soldiers' attack.

The Maoris opened fire on them at first and then let them come as close as desired, but, unfortunately, an old peach grove obscured their view, as the soldiers kept well behind it. Te Huia said the soldiers were very brave and fearless.

9. Did any fall close to the *pah* ?

Yes. One of them, who was very high up in rank, was killed there.

10. Were they carried off ?

The soldiers tried hard to rescue him but, as fast as they approached him, fire was opened upon them, and they had to go back. Eventually, however, some of them made a rush and tied a rope round the dead man's leg and then dragged him in that way.

11. Were any Maoris hit close to him ?

Yes. One Maori, who was standing in the corner of the *pah* near Te Huia and his father, was looking over the parapet to try if he could see anything, when he was shot in the mouth and killed.

12. What did they do with their dead and wounded ?

Te Huia replied that they just covered them with a little earth, as they had no time to dig graves. One Maori was a great hero. He used to walk round the top of the parapet all day and tell the others what was going on until, at last, one night, he was wounded very severely. They made him comfortable in a dug-out, but he did not linger long.

13. How were they fed ?

The Maoris had no time to make proper provision for food and just had to steal out at night and gather potatoes from a pit, which had been left outside the *pah*. They were also able to get *kumikums*, a species of marrow. Unfortunately, they had no water, but used to quench their thirst on the juice which they got from the pith of the *kumikums*.

14. Could he see the sap ?

Yes. Te Huia said there was a small outwork outside the big *pah*.

and they were able to see the sap quite well. The soldiers were very wise and dug a trench from where they were obscured by the peach grove.

15. Did he see the interpreter, Capt. Mair ?

Yes. One of the soldiers asked the Maoris to surrender, so that they could save their women, but he had hardly finished speaking when Te Huia noticed an old man getting ready to shoot him. Te Huia said, by the time he got to this old man and told him not to shoot, the man had fired but missed. The Maoris said that if the *Pakeha* went home, they would leave, too.

16. How was the message to retire given ?

Te Huia said he really could not say. When the soldiers commenced bombing the outwork, the Maoris there came rushing over the parapet into the main *pah*. They seemed to scatter all of a sudden. There was a gateway in the south-east corner of the *pah*.

17. Were there women in the *pah*, and how many ?

Te Huia, after naming them to himself on his fingers, said there were about twelve women there, including two lovely girls, and his old eyes twinkled. One of them was a half-caste and one a Maori.

18. What were their duties ?

They had to do the cooking and carry provisions of food. They acted as drays.

19. How did the Maoris treat bullet wounds ?

The Maoris had no herbs with which to treat wounds inside the *pah*, but when they got hit, they had to rip off their shirt sleeves, or something else, and use them until they got home again.

20. Where did they meet the soldiers of the 40th ?

He could not distinguish one regiment from another, but the troopers on horseback galloped around in a circle to try and cut the Maoris off. Te Huia recalled that his father fired at an officer or trooper and shot his horse, but the man got away. There were seven Maoris in one group, but all of a sudden, thirteen soldiers appeared. The seven Maoris, of which Te Huia was one, were told that Rewi, their leader, was coming through the scrub behind them and they were waiting to cover his retreat. His uncle told him to be careful and they would wait and watch and get ready, so that as soon as the soldiers appeared, they would fire on them. When the Maoris fired, some of the troopers got right on the sides of their horses and escaped from them.

21. When did they last see the soldiers ?

After that they saw no more soldiers.

22. Did the guns do much harm ?

Te Huia said the soldiers had some big guns on a ridge called "Kariponia," which was meant for "California," and they were the ones which did all the damage. The soldiers may have had one gun in the sap, but he did not think it was ever used, as it would be impossible to fire effectively from deep down.

23. When did they reassemble and where?

The Maoris reassembled right away after the fight. Te Huia and his father and relations met together beyond the *puinu* and at Otewa.

24. Did he ever fight again?

He did not fight any more. Some time afterwards, whilst with Rewi, they nearly fired upon some soldiers, but they had a soothsayer, a *tohunga*, or priest, with them, and he prophesied that they would have bad luck if they fired a shot, so they turned back.

Asked later why Orakau had been selected for the site for the battle when there was a better position on higher ground on the Kariponia ridge, Te Huia replied that the *pah* was built, so as to block the road along which the *Pakehas* would always come, so the Maoris thought best to stay and wait for them there.

He said they had a field-glass, which was not as much benefit to them in the *pah*, but when they were able to get to the top of a hill, they could see all over Kihikihi and other places.

He said that one Maori, his eldest brother, was taken prisoner, and his gun was taken from him, and whilst being escorted to the rear by two soldiers, they were stopped by twelve troopers, who insisted on taking him in charge so that they could shoot him. They made a ring round him and armed him with a *taiaha*, an ancient Maori weapon, and made him fight one of them. He killed two soldiers and then sprang over the top of the others. One struck him with the butt of a rifle in the knee, and many of their bullets grazed him. One hit him in the shoulder and the blow on his leg so lamed him that he ran practically on one leg. Eventually, he completely recovered.

A question was raised as to what the Maoris thought of Rewi as a general. They said that he was a very high man amongst them. He was related to practically all of the tribe (a very well-bred man), and they looked up to him as a man of good blood. He was a brave man and very kind to children and grown-ups alike, and they looked up to him with respect.

Te Huia said that both the beautiful girls were killed. One was wounded and died at Orakau, and the other was wounded and taken a prisoner to Te Awamutu, where she died.

The great battle was fought in March and the weather was beautiful and the *pah* quite dry. It was only a small *pah* in those days. He said they enjoyed fighting, but they did not fight for a joke, as they were very wild with the *Pakeha* and were in earnest.

Rewi and his relations went back to Kihikihi. He often moved amongst the soldiers. Indeed, after the soldiers moved up to Te Awamutu, Rewi and his companions from Paterangi just walked through the place, and the soldiers let them pass, not knowing that the great chief Rewi was amongst them. Rewi was, however, above all things, fair in his dealings and hated anything underhand.

Asked if the Maoris had thought they could beat the soldiers at Orakau, Te Huia replied they were all strong men and had they not thought so, they would not have been there.

Te Huia stated that one of the older men did not retreat from the *pah*, but stayed with the wounded, holding up a white handkerchief upon a stick, and when the soldiers rushed with their bayonets, they did not hurt him, but took him prisoner.

He attributed their escape from total destruction when they charged out of the *pah*, to the fact that they rushed between two lines of soldiers, who could not fire for fear of hitting each other.

The old man made a dignified figure, and it was most impressive to see him demonstrate the loading and use of the old muzzle-loader, the biting off the bullet from the cartridge, the pouring the powder down the barrel with the bullet on top of it, and bumping the butt on the ground, so as to settle the charge, and as he related each incident, to see him point to the place with his stick where it actually took place.

Everyone was most interested and showed great consideration for his age and standing. Many lingered, asking questions after the official recital was over, and many further questions were asked, but where he had not witnessed an incident he said, "I do not know that, I did not see." He gave no hearsay anecdotes. His quiet bearing and gentle manner, together with his wonderfully alert mind and physical activity, caused considerable surprise to those who had never met an old-time Maori warrior. Such a gathering in such a place, combined with so interesting a personage, must have been almost unique.

CORRECTIONS.

R.E. Journal, December, 1929, page 538, "Mining in 1915," lines 10 and 11, read, "the mining was carried out by Lt.-Col. D. M. Griffith, D.S.O., under the direction of the C.R.E. of the Division, now Brig.-Gen. J. A. S. Tulloch, C.B., C.M.G."

Page 608, "Afghan Wars," for "Nuttall" throughout this page and at top of page 609, read "Burrows."

MEMOIRS.

BRIGADIER-GENERAL EDWARD ROWLAND BENNETT STOKES-ROBERTS, C.B.

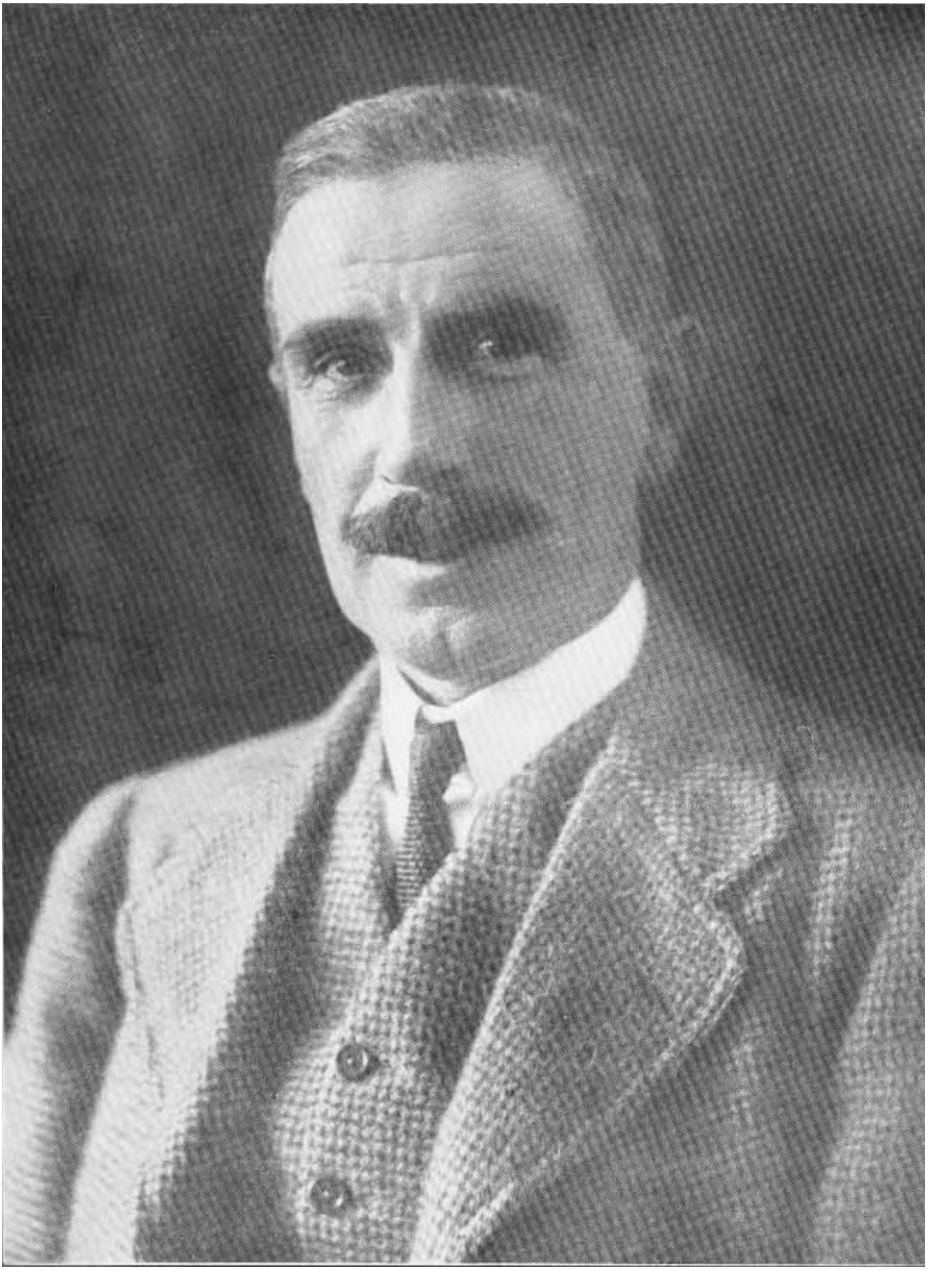
FOREWORD.

BRIGADIER-GENERAL STOKES-ROBERTS died in Mesopotamia on November 22nd, 1917, when holding the appointment of Director of Works, M.E.F. The general conditions precluded the publication of a memoir in the *R.E. Journal* at the time of his death, and, as a scholarship has been founded at Chatham as a memorial, the following memoir is now published.

EDWARD ROWLAND BENNETT STOKES-ROBERTS was born on July 10th, 1865, the only son of Edward Stokes-Roberts, who died while the subject of this memoir was still a child. He was adopted by his grandmother and educated first at Mostyn House, Cheshire, and then at Clifton College. From there he passed direct into the Shop. He obtained his first commission in the Corps in December, 1884, and sailed for India in January, 1887.

He saw active service almost at once, as he served with the Upper Burmah F.F., under Sir Robert Low, as Assistant Field Engineer, and received the medal and two clasps. He then served at Roorkee with the Bengal Sappers and Miners for a year, proceeding with the 3rd Company on the Hazara Campaign of 1888. For this, he received a clasp. He reverted to the Home Establishment in 1893, and was engaged on the work at the Cordite Factory, Waltham Abbey, from 1895 to 1900.

As a result of his work and experience there, he was offered on his return to India at the end of 1900, the job of constructing the Cordite Factory at Aravankadu, near Wellington. This was a big job, and comprised, besides the actual factory, the construction of quarters for officers and subordinates, and the Khateri Dam and power house. He had studied the question of reinforced concrete, which was then coming to the fore, whilst employed at Waltham, and he was able to make use of this knowledge at Aravankadu. He may be regarded as the pioneer of the use of reinforced concrete and of reinforced brickwork in India, and he wrote a brochure on the subject, which was thus first introduced to the M.W.S. This publication also con-



Brig-Gen E R D Stokes-Roberts

tained particulars of the cylindrical reinforced brickwork water tanks, first devised by himself, a design which has proved most useful and economical.

After attending the "Wild East" course at Chatham, he was, on return to India, in 1904, put in charge of the work at Jabalpur, under the Kitchener Reorganization Scheme.

Of this period of his career, Brigadier W. H. Evans writes as follows :—

"I made Stokes-Roberts' acquaintance at Jabalpur, in the winter of 1904–5. After completing the Cordite Factory at Aravankadu, in the Nilgiris, he had been home on leave, and on his return was appointed A.C.R.E. Reorganization, Jabalpur, a new appointment in connection with the large building programme attendant upon Kitchener's reorganization for India. I was lucky enough to be one of his garrison Engineers throughout the work, which was completed in 1908.

"We had a big job at Jabalpur: the remodelling of the old cantonment and the addition thereto of several units, and also the construction of a new cantonment on the 'Ridge,' five miles away, for a whole British infantry battalion and a large hospital, with all the attendant roads, water supply, etc.

"Stokes-Roberts was a brilliant engineer in three directions; power of organization, sound knowledge of detail and the patience to attend thereto, and the gift of being able to impart his knowledge to others. He was always out for new ideas, searching for them himself, and encouraging us all to search. He always gave us full credit for anything we did. He introduced into India the art of moulded reinforced concrete, whereby at Jabalpur he saved the State a very large sum of money. The cantilever stable-truss and the reinforced brickwork water tank were his own inventions, both of them novel, sound and economical. During his stay at Jabalpur, he wrote a book entitled, *Some Practical Points in the Design and Construction of Military Buildings in India*, embodying many of his methods, the study of which would repay any engineer to this day.

"What one becomes in after life is dependent to a very great extent upon the tutors of one's youth, and Stokes-Roberts succeeded in converting me from an unlicked subaltern into a comparatively useful officer. He lived for his work and impressed his keenness on others. We all loved him and I, for one, can never be too grateful for all he taught me. His service was wholly unselfish; there was never any thought of gain or self-advertisement, just loyalty to the Government he served, and just and generous treatment for those who served under him."

After these many strenuous years of hard work on original construction, Stokes-Roberts had a breather at Bareilly, where there was but little new work in hand.

Here there was leisure and opportunity for small game shooting in one of the pleasantest stations in India, a sport of which Stokes-Roberts was always fond, as well as of big game shooting. He was also a first-rate fisherman and an authority on the fauna of India.

Bareilly was followed by the very heavy routine work at Rawalpindi, and then at Mhow. By this time, the Great War had been going for some months, and Stokes-Roberts, like most of the officers serving in the M.W.S., had been retained in India by the Authorities as a reserve for possible eventualities in that country.

The force which was eventually known as the Mesopotamia Expeditionary Force had left India in October, 1914, and after a victorious career of a year, met its first check in its attempt to capture Baghdad. As a result, the force under Gen. Townshend was besieged in Kut, from December 3rd, 1915, till it surrendered to the Turks in April, 1916. The Tigris Corps, M.E.F., was formed for the relief of Kut, and on January 31st, 1916, Stokes-Roberts joined as Chief Engineer. He held the post for three months only, and was then appointed Director of Works, M.E.F. The difficulties for an engineer in this country were immense. The only tree the country produces is the date palm, and there is no stone. Everything in an engineering line had to be imported from India and England, and, to begin with, facilities at Basra for the landing of stores simply did not exist. Practically everything had to be started from first principles, and those who remember the peculiar stickiness of the Mespot mud and the depth to which it was possible to sink will realize that the first desideratum at the Base was some sort of metalled road, not a single specimen of which existed in that part of the country. Stone being unprocurable, it was circumstantially reported in India, at the time, that the road out to Makina Masus was made of neat cement! The eventual conjuring of order out of chaos, and of victory out of defeat, is a story of the War that is well known; and no small measure of the responsibility for this success lies in the work of Stokes-Roberts. Lt.-Gen. Sir George MacMunn, who was Inspector General of Communications of the Force at the time, and under whom Stokes-Roberts worked, has kindly contributed the following appreciation :—

"My acquaintance with General Stokes-Roberts dates from my arrival in Mesopotamia in April, '16, ten days before the fall of Kut, to take over the duties of Inspector General of Communications. Stokes-Roberts had just been appointed Director of Works to the Force. When he came to see me, he was suffering considerably from disappointment that he had been transferred from his post at the front, where he had undergone severe strain. I found him quite the most zealous, efficient and able engineer it has ever been my privilege to meet, and also the most lovable and admirable of men.

" I think I was able to cheer him up and make him feel he would have the power to deliver the goods, by promising him as much authority and initiative as he could use and explaining to him the immense work we had before us, the unlimited authority the Commander-in-Chief had given to me, and the promise I had had from the Quartermaster-Generals at the War Office and Simla of the fullest support. I also guaranteed to relieve him of all control from the Engineer-in-Chief, who, under the *F.S. Regulations*, was not concerned with the L. of C., and that he should take his orders and approvals direct from me, verbally and promptly, and from me alone, and that once he had them, he was to be untrammelled.

" Stokes-Roberts then took charge in the most magnificent way of the vast plans necessary to bring the base and L. of C. from a scale of two divisions badly found to that of ten divisions well found, working five hundred miles from their base ; roads, hospitals, water, electric light, ice, many of the piers and wharves, etc. His initial difficulties in the way of shortage of officers, sickness, and the dearth of works companies, labour corps, artificers, material, etc., were immense. These difficulties, as well as the work of ensuring that the base park complied with all the demands of the Engineer-in-Chief, were brilliantly tackled.

" He came to me constantly, to tell me of his needs, plans, and devices, and I have the most vivid sense of gratitude for all he did to help me make it possible for Sir Stanley Maude to take Baghdad, and for the troops, fit or sick, to be treated as troops who must win should be treated.

" No mere recitation of tasks can give an adequate presentation of all that Stokes-Roberts and his officers went through, especially in that hot season of 1916, when depression after the fall of Kut was rife and the hospitals crowded, without accommodation, water, lighting or ice. His appointment as Brigadier-General helped him considerably, and when Baghdad fell, and his endeavours were rewarded with the Bath, he felt, I think, that life was worth living. To none of the workers, who made that line of communications on the two rivers and that base out of a mud-pie, is the success of the campaign due more than to Stokes-Roberts, and it was to the intense grief of all that, with his frame weakened by climate and super-exertion, he could not stand up against an attack of pneumonia, and followed his great Commander-in-Chief to the grave.

" Surely of him may it be said, with the prophet Malachi : 'And they shall be mine, said the Lord of Hosts, in that day when I make up my jewels.'

" With Stokes-Roberts was Edgar, as his number two, a man also of immense energy and devotion whose premature death in his prime, a year or so ago, was undoubtedly due to the strain of those years on the Tigris."

Stokes-Roberts died at Baghdad on November 22nd, 1917, and the following year a movement was set on foot amongst the Works Directorate personnel, largely consisting of Indians, to raise funds to commemorate him. With the amount subscribed, a memorial was erected at Baghdad, a portrait was painted for the Chatham Mess, where it now hangs, and with the balance, an annual prize was instituted, " to be known as the Stokes-Roberts Scholarship, and to be competed for by N.C.O.s undergoing a construction course at the S.M.E., under conditions laid down from time to time by the Commandant, S.M.E. Preference to be given to those, if any, training for the M.W.S. in India."

In 1886, while still a young officer on the S.M.E. Establishment, Stokes-Roberts married Frances Edith Helps, daughter of Mr. Helps, of Upton Lawn, near Chester, by whom he had two sons and two daughters, the eldest son dying in early infancy. His surviving son is now Brevet-Major A. E. Stokes-Roberts, O.B.E., M.C., *p.s.c.*, The Worcestershire Regiment.

P.H.K.

COLONEL RALPH PUDSAY LITTLEDALE.

COLONEL RALPH PUDSAY LITTLEDALE was the third son of Henry Anthony Littledale, Esq., of Bolton Hall, Clitheroe.

Born on 17th February, 1856, he was educated at Marlborough College, and passed into the R.M. Academy, Woolwich, in November, 1873, passing out sixth in a batch of seven R.E. on 19th February, 1876.

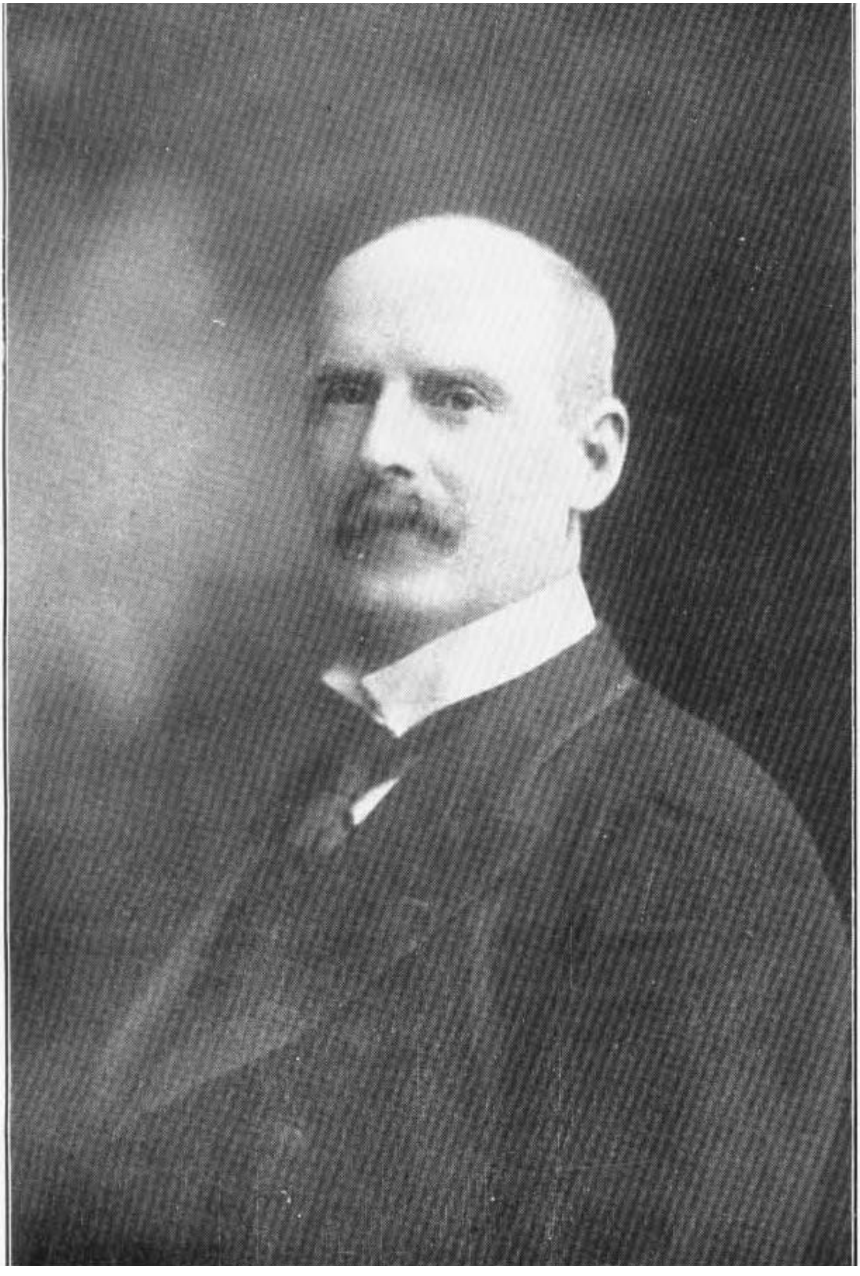
After the full course of two and a half years at the School of Military Engineering, the whole batch was antedated six months to 19th August, 1875.

Littledale was selected for service at Aldershot, where he joined the 17th Field Company.

On January 22nd, 1879, occurred the disaster at Isandlwhana, in the Zulu War, and among the troops dispatched as reinforcements was the 30th Company, R.E.

Littledale was selected as the junior subaltern, the other officers being Major and Bt. Lt.-Col. (now Sir Richard) Harrison, Capt. (now Sir Bindon) Blood, with Lieuts. F. W. Watkins, K. McKean and C. W. Sherrard. The 30th Company, after a trying voyage, reached Durban in April, 1879.

Of this episode General Sir Bindon Blood writes as follows: " I recollect how well Littledale stuck to it during the voyage, some of which was rough; staying down below with the horses in all weathers. We did not lose one of the horses during the voyage, which was very trying for them. Directly we landed at Durban,



Colonel Ralph Pudsay Littledale

Col. Harrison and I were taken away from the Company—he as A.Q.M.G. of one Division (the 2nd), and I to be C.R.E. of another (the 1st). The Company was attached to my Division and was broken up into sections under the subalterns, for most of the Campaign doing a great deal of good work, especially in bridging the Tugela and other rivers, in road-making, entrenching, etc. Littledale had his full share of work throughout, and I remember that he did right well."

The Zululand Campaign was brought to an end by the battle of Ulandi, fought by the 2nd Division and the Mounted Troops, under the Command of Lord Chelmsford, on 4th July, 1879.

The 30th Company was ordered to Gibraltar in November, but Littledale was retained in South Africa for duty on a boundary commission, which had the task of defining the boundary between Zululand and Swaziland. The boundary selected was adopted, and on 15th April, 1880, the Commission received the thanks of the Commander-in-Chief, Sir Garnet Wolseley.

Littledale was then posted to the 2nd Field Company at Pretoria, and on the outbreak of the Boer War of 1881, was besieged in Pretoria with this Company until the end of the Campaign. He was mentioned in dispatches and received the thanks of Field-Marshal the Commander-in-Chief.

He was ordered home the following year, and in January, 1883, joined the 7th Field Company at Aldershot.

In September, 1884, on the dispatch of the force to Egypt to relieve Gordon, Littledale was selected to command the Field Park and embarked in the S.S. *Rewa*, in company with a number of other R.E. officers. He seems to have established a reputation by this time of taking very good care of his men.

His first station was Wady Halfa, and he moved up the Nile as the Campaign required, but the R.E. work (except the railways and telegraphs) was not important, mainly from the lack of transport facilities. He returned to Aldershot in September, 1885, and later went through the full course of musketry at Hythe, and also the veterinary course. Promoted Captain in 1886, under the eleven years' rule, he was, in October, 1887, ordered to Mauritius to take charge of special loan work at that station.

Up to this time his work had been mainly of a military nature, including three campaigns, and it is interesting to note how, when transferred to constructional work, he developed into a first-class constructional engineer. The result is a fine testimony, not only to his own sterling qualities, but to the efficiency of his early training at the Royal Military Academy and at the School of Military Engineering.

In 1887, there was in progress, at Mauritius, work under a barrack loan for which the money was provided by the Home Government, and work under a fortification loan, with funds provided mainly by the various Colonies concerned.

Mauritius was then, and still is, a hotbed of malaria, and all the troops and individual officers, except a small garrison of R.A. and R.E. in the principal fort on the sea-front, lived up-country. Finding the work on one of the batteries going slowly, Littledale went down and lived on the site. He got the work done, but paid for it with a bad attack of malaria, which left an after-effect of deafness, from which he suffered in later years.

Two of the four new forts were constructed under his supervision, and he was also responsible for commencing the new brick barracks at Curepipe. During his tour in the island he developed in a marked degree the capacity for getting work done, especially when working with native contractors and an inadequate staff.

Ordered to England at the end of 1890, he was employed as Assistant Adjutant for Musketry at the S.M.E. during 1891.

In April, 1891, he married, and in December he was appointed Adjutant of the 1st Cheshire Volunteers R.E., with Headquarters at Birkenhead. The efficiency of the Volunteers at that date was much below the present Territorial standard and Littledale found a good deal which required improvement and alteration. The work was arduous and not very congenial; but his high sense of duty forbade any withdrawal on his part, and he stuck at his job for the full five-year term of his appointment, at the end of which he was rewarded by handing over to his successor a really efficient unit.

He was promoted to Major on 1st March, 1895, and in January, 1897, went to Glasgow as Division Officer, and was there till, in July, 1900, he was ordered to Hong Kong for special duty in charge of loan works at that station.

The engineer work at Hong Kong was then under a Colonel who was called District Engineer, and under him the officer in charge of loan work was in the position of a C.R.E., and had his own staff of Division officers and surveyors.

The work was important, as in 1898 we had taken over from the Chinese, on a ninety-nine years' lease, a large extent of new territory on the mainland, together with 600 islands of all sorts and sizes. This addition for the first time gave us control of the north shore of Hong Kong Harbour, and allowed of the fortification of the north side of the Eastern Entrance, known as the Lyemun Pass. In addition to this, all the defences at both entrances were remodelled and re-armed, and additional 6-in. and 12-pdr. Q.F. guns fitted with automatic sights were installed. There was at the same time a considerable addition being made to the Garrison, involving a good deal of barrack construction with married quarters, and the provision of a new hospital of 180 beds. Also, it was decided to push out the local land defences, which, up to then, had been limited to a local defence of forts and barracks, and to occupy the crest of the hills which run from east to west across the island of Hong Kong and on the mainland.

Littledale, in the course of two years, completed nearly all the fortification work, most of the work in the barracks for European troops, and started the hospital at Bowen Road.

Special mention must also be made of the system of hill roads on Hong Kong which he laid out personally, and which were afterwards taken over by the Civil Government.

As the Senior Officer of the R.E., he acted as District Engineer when the latter officer was away on leave, and always enjoyed the full confidence of the G.O.C. and D.E., and I may add of the War Office, which accepted practically all his proposals. His work was again characterized by his capacity of getting work out of the local Chinese contractors, with whom he was on very friendly terms.

He was promoted to Lieutenant-Colonel in January, 1902, and was ordered to Malta to complete his tour of foreign service as C.R.E. of the West Sub-District. Here his principal work was the completion of St. Andrew's Barracks. The work was not quite so congenial to him, as he was executing schemes prepared by his predecessors, but he carried it through with his usual energy to the satisfaction of the local officers and of the War Office.

In 1904, he was ordered home to Dover as C.R.E. of the Dover Sub-District.

In April, 1905, following the changes introduced by the Esher Committee, the District Engineer at Dover and the C.R.E. at Shorncliffe were abolished, and Littledale found himself responsible for the whole of the work formerly done by these officers. About the same time, the District was transferred from the Southern Command to the Eastern Command, which had its Headquarters in London. All this threw a great strain on the C.R.E., but Littledale proved equal to the occasion, and his sound advice and the thorough way in which he dealt with every question which came before him, were much appreciated by the General at Dover, and the Chief Engineer at Command Headquarters.

In January, 1906, he was promoted Colonel in the army.

In January, 1907, he completed five years' service as a Lieutenant-Colonel R.E. He was not well-placed for further employment, as the number of Colonels' appointments had been much reduced, and there were many officers already waiting for vacancies. He, therefore, elected to retire and devoted himself to his favourite hobby of archæology, combined with gardening and carpentry.

In 1914, when the war with Germany started, he at once volunteered and was posted to his old job as C.R.E., Dover Sub-District. The work was too much for one man, even of Littledale's capacity, and, in January, 1915, a new C.R.E. was appointed to Brighton, who took over the County of Sussex. This still left in his charge the greater part of Kent, including the Fortress of Dover, and the work was increased by a decision of the War Office, in May 1915, to make Shorncliffe the headquarters of the Canadians in England. Their number eventually reached 60,000 men, involving a great deal of work for huts, camps and billets. There were also quartered in his District two or three Divisions of the Central Force in billets and camps, who made continual calls for his services.

Later, as the importance of the Dover Fortress increased, it was found necessary to appoint a separate C.R.E. for the Fortress, and Littledale then moved his office to Ashford, where he remained till September, 1918, when he was relieved by a serving officer.

An officer, who was serving at Shorncliffe, writes of this period: "In my opinion, Littledale's work was magnificent. He seemed to be everywhere, and how he managed to get about as he did, I could not make out. There seemed to be no delay in beginning and carrying to completion any agreed work."

Littledale's name was included among the officers who received the thanks of the Secretary of State for War in *The London Gazette*, of 24th February, 1917.

After his second and final retirement, he resumed his research and literary labours, spending hours at the Record Office in Chancery Lane. Among other work he completed three volumes for the Cumberland Archæological Society. He also compiled the record of his own family back to the fourteenth century, a monumental work which took him ten years of research.

Littledale had the reputation, while in the army, of being quarrelsome and argumentative, but this was only one side of a complex character. He dearly loved an argument, and, when in the course of his military work his opinion differed from that held by another officer, he was apt to press his own view rather to extremes. But with him such disagreements never rankled and the stormy period was soon over.

But this defect, which undoubtedly affected his own prospects, should not be allowed to hide his many excellent qualities. He was a very quick and accurate thinker, getting to the root of a question and working it out to its logical conclusion. As one senior officer put it, "when Littledale had finished a report on any subject referred to him, there was very little left for anyone else to write about."

Capable of taking infinite pains, and ready to go into details if necessary, he never allowed the consideration of details to obscure his main object. Also, he always looked well ahead of the immediate present, so that when work was once started, it went on as if by clockwork, and there were no irritating delays.

He was a very hard worker, working long hours himself and requiring the same from his subordinates. To his juniors he must sometimes have appeared to be a hard master, but once accustomed to his methods, all his subordinates and staff liked and trusted him.

One of his Division officers, when he was C.R.E., Dover, writes as follows: " To serve under him as a D.O., was an education. When issuing his instruction on some question referred to him, he would sum up in a sentence some general principle on which the instruction was based, showing how similar cases should be dealt with in the future."

The same officer, a few years later, was given the duty of editing the 1910 edition of *R.E. Services*, and he adds: " Section I. General Principles, in the *Regulations for Engineer Services*, 1910, was an amplification of a collection of Colonel Littledale's *obiter dicta* on matters referred to him as a C.R.E." A fitting memorial of his military work.

Littledale was of more than average height and of late years put on weight, and those who did not know him well can have no idea of the real kindness of heart and unselfishness which lay behind that rather terrifying exterior. His friends found him a most charming companion, always ready to do a kindness or to help a lame dog over a stile. He probably never did a selfish thing in his life, and pushed his self-abnegation so far that he would never apply for any appointment or employment for himself. Socially, he was popular with everybody, a good shot and rider, and able to hold his own at games. But he showed his best qualities as a host in his own house, or presiding at a Guest Night at Mess. He liked nothing better than to get a few intimate friends to dinner, when he would sit on after dinner till the small hours, talking on every subject under the sun, except his work, and keeping us all interested with his conversation and anecdotes.

His end was characteristic of the man. In the bitter winter at the beginning of 1929, his own house was happily free of frozen pipes. But hearing that his neighbour, a widow and an invalid, was unable to get hot water, he went to her help, scraping snow and ice from her gutters and carrying large cans of hot water up and down steps, through the gardens and into his neighbour's house. The strain was too much for him, and after a bad night he passed away suddenly the next morning from the failure of one of the main arteries.

His wife, who survives him, was the daughter of Lt.-Col. C. L. Tredcroft, *J.P.* (late R.H.A.), of Glen Ancrum, Guildford. They had two children. His only son was killed at Cambrai in 1917, at the age of 22, while serving as a Captain in the 5th Northants Regt. His daughter, who is an M.A. of Cambridge, has inherited some of her father's literary tastes, and held for some years the post of an assistant librarian at the Bodleian Library, Oxford.

W.B.B.

PROFESSIONAL NOTE.

DRYING OUT NEWLY-BUILT DWELLING HOUSES BY HOT BLAST. ("TUBIT" METHOD.)

MESSRS. SCAFFOLDING (GREAT BRITAIN), LTD., of 43, Lansdowne Road, S.W.8., are carrying out an experiment in quick drying of newly-built and plastered houses, to enable habitation to follow completion immediately, without the danger to health which may ensue and cause rheumatism and the allied heart trouble. These diseases are to-day the most vital causes of inefficiency in the nation, and as such, are being enquired into by the National Medical Council.

The invention is a German one and Messrs. Scaffolding have acquired the rights for the United Kingdom. They are now carrying out their first experiment in their own newly-built offices at Stockwell, S.W.8.

The method used is to pass air over burning coke in an oven and force it through 20-in. pipes into the building under a certain amount of pressure. The portion of the building to be treated is previously closed externally, though all interior communications are left wide open: all external windows and flues are closed and external doors are covered with stout brown paper inside so as to assist in preventing leakage. It is claimed that the hot mixture of gases which is pumped in by the electric fan is forced through the fabric of the walls and roof and floors, drying them thoroughly during the process. The external surface of the walls of the space under treatment felt hot to the touch.

The apparatus consists of a coke boiler on wheels, about 5 ft. x 3 ft. in horizontal section, fitted with controlling louver and an electric fan to drive the products of combustion along the tubes into the building.

These gases are delivered normally at a temperature of about 150°F.; the thermometer at the far end of the flat, which was inspected, stood at 120°F. The heat, however, is regulated at the furnace and the pressure is more or less regulated by the fan. Apparently, the technique of the work is to begin with the hot gases at about 75° for the first six hours, and then gradually raise it to the normal till the drying is accomplished, and then to take about six hours to cool off gradually. After that the tubes are withdrawn and the doors, windows and other openings kept shut till the next day. The blast treatment takes from 48 to 72 hours. To avoid warping, as little woodwork as possible is allowed in the space to be dried; wooden floors, doors, architraves, mouldings, sills, are put in afterwards, though door frames and windows may be necessary.

The foreman informed me that he spent about half an hour at a time in the space under treatment, every three hours, to regulate the temperature and examine the state of the walls, etc. The hot gases contain enough sulphur fumes to be unpleasant: they cause the eyes to water and a choking sensation in the lungs, which wears off in a few minutes; also a slight feeling of vertigo which the foreman no longer experienced. The writer felt no noticeable after-effects.

The director, who was interviewed afterwards, maintained stoutly that there was no fear of the presence of carbon monoxide, as was proved by continued analysis. He held that the large amount of carbon dioxide passing through the material of the walls, tended chemically to harden the set of the plaster rendering and also the cement or lime mortars in the wall.

Efflorescence was present in large quantities both on the surface of the internal plastered walls and also of the external brick walls. The director averred that such efflorescence came out very quickly, and when once brushed off, would never appear again, as the impurities causing it combined with the penetrating gases and were carried away once for all.

The approximate price of the application at present varies from 10s. per 1,000 cu. ft. of space to be treated for 250,000 cu. ft. or more, to 35s. per 1,000 cu. ft. for 40,000 cu. ft. or less. One furnace will supply enough hot blast to treat about 27,000 cu. ft. of space.

The director said that the method had been in use all over Central Europe for some years and they had dealt with factory buildings of over 400,000 cu. metres in content. Also that in some German municipalities, habitation of newly-built dwelling houses immediately after completion was forbidden except when dried out by Tubit.

The assertion that the damp, once driven from the walls of a building by the Tubit method, can never return has yet to be proved when subject to our humid atmospheric conditions. It is hoped to make a further investigation in a year's time.

D.M.F.H.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE BIOGRAPHY OF THE LATE MARSHAL FOCH.

By MAJ.-GENERAL SIR GEORGE ASTON, K.C.B. (Hutchinson & Co., London. 1929. Price 24s.)

The biography of Marshal Foch has still to be written. In this volume Sir George Aston has provided a great deal of useful material for it, but it is by no means the whole history of his life. He has done a great service by recording for the use of future generations of soldiers the foundations on which the character of the great French Marshal, who led the allied armies to victory in 1918, was based; and in the latter half of the book he has put together a great deal of useful information of the personal part played by the Marshal in the Great War, particularly in relation to the British Army. That Foch was a man of great character is an established fact. "The key," writes Sir George, "to that character is to be found, undoubtedly, in a sincere faith in "an Almighty Providence caring for the destinies of mankind, and "this is best illustrated by the following story, in which this faith is "indicated though not publicly expressed: At the time, in April, 1918, "when the powers of Foch to co-ordinate the Allied effort developed "into the nominal command of the Allied armies, he said, 'Materially, "I do not see that victory is possible. Morally, I am certain that we "shall gain it.'"

Ferdinand Foch was born at Tarbes, in 1851, the year before Napoleon III. was placed on the throne of France. He came of good, middle-class stock. On his father's side there had been no soldiers: his forbears had been engaged for several generations in the wool trade with Spain. But his grandfather was a fervid admirer of Napoleon Bonaparte and named his son after him. As a child, Ferdinand often spent his holidays with him at Valentine, at the foot of the Pyrenees, and he was, no doubt, much influenced by him. On the other side, there was a more soldierly strain, and Ferdinand's interest in military matters was fostered by the military traditions of his mother's family. His maternal grandfather who had served under Napoleon made his home with the Foch family. From both his parents, Ferdinand Foch inherited his sense of duty, his deep religious instincts, and the loyalty and painstaking persistence of purpose which characterized him throughout his career. Tarbes was a horse-breeding centre, and there was good fishing and shooting in the neighbourhood. There the boy learnt to ride and fish and shoot. At the same time he was of a studious turn of mind, and soon became fond of reading and passionately fond of reading books of fighting and adventure, particularly books about the Great Emperor and his relations with France. The Napoleonic tradition was very much in the air at this period, and Ferdinand was reared in an atmosphere of Napoleon worship. Before he was twelve he knew every one of the Emperor's campaigns by heart.

One day, when searching for him to join the family in an expedition, his father found him sitting on the library floor surrounded by books dealing with Napoleon. "What are you doing?" inquired his father. Young Foch looked up with a harassed frown. "I want to find out what Napoleon did in his school holidays," he replied, "but I cannot find out whether he went fishing. I should enjoy it so much more if he did."

He was sent to a Jesuit school as a day boy. The Jesuit schools had a great reputation for preparing boys for the army. It was not until he was eighteen that he first left home, to go as a boarder to the Jesuit College of Saint Clément at Metz, which had a great name for preparing youths for the great military colleges at St. Cyr and the Ecole Polytechnique. It was a cosmopolitan gathering, the students coming from all parts of the world, and Foch gained much useful experience from intercourse with them and an insight into various types of character that served him well in later days. He was clever, very hard-working, and had a decided turn for mathematics; his conduct was irreproachable from the points of view both of the teachers and his fellow students, and he was popular with all. While at Metz the Franco-German War broke out in July, 1870. He immediately left to join up as a recruit in the infantry, but to his bitter disappointment never got to the front. After the armistice in January, 1871, he returned to Metz for a few weeks and resumed his studies. His best school friend had been killed fighting. On hearing of his death he is said to have muttered: "A great death, and one to be envied. You shall be avenged." He kept his vow. From that moment *La Revanche* was his life motive.

To quote the author:—" With some strange foresight of what was
" to come, Foch seems to have made a special study of German psycho-
" logy. (Metz was then occupied by the Germans.) He often mentioned
" to his companions that he had noticed certain attributes of the Germans
" which, in his opinion, should never be forgotten in any dealings with
" them, and throughout his life he retained the impression which he
" then formed of the German temperament. He seemed to realize, in
" some strange way, that the conflict in which his destiny was to be
" so deeply involved would be renewed at some future period. Not
" long before he passed away he said to a friend, 'I merely strove to
" apply the conclusions of an essay which had been given us to work
" upon at Saint Clément, when the country was being invaded by the
" Germans whom I meant some day to pursue.'

* * * * * *

" In some inexplicable way his consciousness of future greatness
" communicated itself to others. One of the professors, who knew Foch

"merely as one among his large class of young men, looked intently "at him one day, noted his eyes and his forehead, and remarked to a "colleague, 'That young man will accomplish later something immense.' "And so with others. There was nothing outstanding about his "physical appearance to cause this strange faith in his future. It "must have been a realization of his character, his great steadfastness, "great tenacity of purpose, determination and the power shown by the "expression of his face that caused his friends to foretell a great future "for the young man."

About this time his younger brother became a Jesuit priest. "We shall both serve France," Ferdinand said to him. "You to pray for her, I to fight for her: who knows which is the better service?"

When Metz was handed over to Germany, Foch, now twenty years of age, proceeded to the Ecole Polytechnique at Paris. He has recorded the fact that there he "learnt how to learn." Then, after a course at the Ecole d'Application at Fontainebleau, he became a 2nd-Lieutenant in the Field Artillery, on February 10th, 1872.

After four years' regimental soldiering, he entered the Cavalry School at Saumur. His early experience at Tarbes helped him to develop into a first-class horseman with good hands and a good seat, but the strenuous training at the School was probably the cause of the illness to which he eventually succumbed. The next seven years were mostly spent at the Ecole Supérieure de Guerre—the French Staff College—first as a student, then as an instructor, and eventually as Chief Instructor.

The chapters describing the various phases of Foch's military education are extremely interesting, because the author goes into a considerable amount of detail to explain the use and purpose of the various military training centres and discusses the Ecole Supérieure de Guerre at some length. The information he gives would be most useful to any British officer attached to the French Army. Speaking of the Ecole Supérieure de Guerre, Sir George Aston writes:—"The Ecole Supérieure de Guerre "at that time had men of distinguished mental 'gifts' (Foch never "believed in gifts) and brilliant lecturers, but amongst them all, Foch "stood out in the opinion of the officers under instruction as the most "original thinker and the most profound student. They all listened "with avidity to his lectures and they all felt that by his influence their "minds had been stimulated." Some of us will be reminded by these words of the wonderful influence of Colonel Henderson (of Stonewall Jackson fame) on the Staff College students before the South African War.

The chapter on Foch's "Rise to Reputation" is full of interest to Staff College officers of the present day, as indeed is the whole volume, the remainder of which deals with the personal part played by Marshal Foch in the Great War, and after the Armistice, with special reference to his relations with Earl Haig and the British Army. Except for a certain amount of repetition and overlapping of chapters, due, perhaps, to the limited time given to the author in which to produce the book, it is a very readable account, and will form an invaluable adjunct to the British *Official History of the Great War*.

H.B.-W.

THE DECISIVE WARS OF HISTORY.

A Study in Strategy.

By Captain B. H. Liddell Hart.

(G. Bell & Sons, Ltd. Price 12s. 6d.)

In this interesting book the author claims to have discovered what it is that ensures a decisive result in war. This is the employment of the " strategy of indirect approach " which in all decisive campaigns has led to the " dislocation of the enemy's psychological and physical balance which has been the vital prelude to a successful attempt at his overthrow."

Captain Liddell Hart has had the advantage, as military editor of the new *Encyclopaedia Britannica*, of being able to survey the whole field of military experience. In this book he gives us the result of his study. He gives us, in Part I, short accounts of many wars, ancient and modern, from the Persian War of B.C. 490 to the Russo-Japanese War of A.D. 1904; in all, twenty-seven wars embracing more than 240 campaigns. In each case he considers how far the directness or indirectness of the approach affected the issue. In a chapter devoted to conclusions he draws deductions which seem to show some confusion of thought. If the object of the author is to prove the value of the strategy of indirect approach, surely he is mistaken in saying that the lessons can be crystalized into the following two simple maxims. Firstly, that no general is justified in launching his troops to a direct attack upon an enemy in position; secondly, that instead of seeking to upset the enemy's equilibrium by one's attack, it must be upset before the real attack is, or can be, successfully launched. The second maxim can be read strategically: the first is tactical. Even in adapting a saying of Lenin's to point his moral he spoils it by introducing an application of tactics. This is the more strange as in the next chapter he goes to great trouble to define strategy.

This chapter is entitled " Construction." It concludes with a consideration of the action of strategy in producing strategic dislocation. The argument which follows does not seem to be conclusive. Is the strategy of indirect approach anything more than the application of the accepted principles of war, economy of force, mobility, and surprise?

Part II of the book contains an able analysis of the War of 1914–18, which has been added at the suggestion of critics who had seen the draft of Part I. It is valuable in that it gives a short and consecutive account of the strategy of the whole war. It is a matter for regret, I think, that these chapters did not precede those on Conclusions and Construction. The last sentence of the book reads, " It was the shock of being surprised and feeling that he was powerless to counter potential strategic moves which shook Ludendorff's nerve more than the loss of prisoners, guns, and acreage." This goes to confirm my impression that indirect approach is but a form of surprise.

It is to be hoped that Captain Liddell Hart will find himself able to give us a revised edition of this book, co-ordinating the whole of his study. If he does, I plead that he will abstain from the use of inverted commas as far as he can. To place a word in inverted commas tends so to emphasize it as to suggest that it carries some special meaning beyond that which is normally given to it. Such suggestion detracts from the clarity of the argument, for different readers will not always assume the same special meaning. If such a suggestion is not intended, then the inverted commas are not necessary.

N.W.N.-C.

THE GENERALSHIP OF ULYSSES S. GRANT.

By COLONEL J. F. C. FULLER, C.B.E., D.S.O.

(John Murray. Price 21s.)

This is an interesting, though not altogether convincing book. The author has avowedly set out to show that Grant was a general with a particularly keen strategical sense, and by no means the "butcher" he has usually been considered. His account of the fighting in the West, Fort Donelson, Vicksburg and Chattanooga, though vividly written, is somewhat too fragmentary in the main to follow his strategical deductions. In fact, one is inclined to think at times that the history is being used as a veneer to cover the "deal" or "rare wood," whichever it may be, of the author's theories as given in the *Foundations of the Science of War*.

When Grant becomes Commander-in-Chief, things improve, and there is a very clear analysis of the Wilderness campaign, of Grant's whole conception of the war, and of his dealings with Sherman at the time of the famous march through Georgia. Whether one agrees with the author's estimate of Grant's strategical acumen or not, one must be impressed by the Federal leader's strength and simplicity of character, and imperturbable nature.

This book undoubtedly throws some new light on a remarkable war, but unfortunately some of its military value is lost by the very poor maps provided, many of which face the wrong way to be read with the letterpress.

H.G.E.

MEMORIES OF FOUR FRONTS.

By LIEUT.-GENERAL SIR WILLIAM MARSHALL, G.C.M.G., K.C.B., K.C.S.I.

(Ernest Benn, Ltd. Price 21s.)

The author of this readable volume won a double brevet in the South African War. He had commanded a Mobile Column for six months in 1902 with success. When war broke out in 1914 he had only just obtained command of his battalion. How was it that with the reputation he had deservedly gained in South Africa he had not risen to higher command in the intervening years? The answer is to be found in his book. He was merely a fighting soldier, and a very modest one. It is in fact rather amazing that a man possessed of such modesty should have reached the position he eventually did, and it is quite obvious why he remained a company commander for ten years after South Africa in peace time. He found himself over age to compete for the

Staff College, and he was unlucky in not being selected for an appointment which would have qualified him for the rank of Colonel long before he gained it.

The book is the simple story of a fighting soldier written from memory. It is not a history of the whole war, for it describes only what he saw with his own eyes and records what he thought of events at the time they occurred. But he gives his considered judgment of those events clearly and briefly, and for this reason the volume will be of value to the future historian of the Great War. The declaration of war in 1914 found him at Bombay in temporary command of the garrison of a great defended port. He must have regretted the want of a Staff College training when organizing the defence of the port and dealing with the many administrative problems it involved. That he felt the need of that training is apparent when he writes of the still greater problems which he had to face when Commander-in-Chief in Mesopotamia.

Fortunately, it was not long before his battalion was ordered home, and then sent to the Western Front. The short account he gives of his experiences during three months in France as a battalion commander are of great interest, and give promise of the future greatness in store for him. Here as elsewhere he saw the humorous side of things, and his comments are cynical, if not scathing. For instance, he writes: "The "absurd worship of ground as such was an absolute negation of our "previous military training, during these early months of trench war-"fare. Instead of holding a line of observation close to the enemy, and "a line of resistance farther back, almost every man was in front line, "and there were practically no reserves. The resulting casualties, the "weariness engendered in the troops, and sickness from trench feet, and "so on, could hardly have been borne by any less stout-hearted fellows "than British soldiers." And he has something to say about the holding of salients:—"The salient I have been discussing concerned only a "small number of men, but I wonder what history will say about the "continued holding of the Ypres Salient, with its record of 250,000 "dead? One was told it was held for sentimental reasons, but, if that "was the case, I can only say that such costly sentiment is out of place "in war."

Like another fighting infantry soldier, who also without Staff College training afterwards commanded a Corps (XIX), he had differences with the Higher Command as to the line to be held—so different on the map as compared with the actual ground: and he emphasizes the necessity of higher commanders going forward, however unwelcome their presence, not only to see the ground for themselves, but also to get personal knowledge of the conditions under which the men entrusted to their care are living, before issuing their orders.

From France he was ordered back to England to take up command of the 87th Infantry Brigade of the 29th Division. Though intended for France, the new division was eventually sent to the Dardanelles. The brigadier gives us an excellent, truthful and realistic picture of the landing and fighting at Hellas, the fighting at Suvla, and the subsequent evacuation. He gives us a true picture of the conditions ashore, and many sidelights, from the point of view of an infantry brigadier possessing human as well as fighting qualities, and many sound and true reasons for the failure of the expedition.

His loyalty to his Chief (Sir Ian Hamilton, who writes the Introduction to the volume) debars him from contrasting the position of the latter *vis-à-vis* the authorities in England as compared with that of his later Chief (General Maude), who was able to get all he asked for in Mesopotamia. Writing of the fighting at Hellas he says :—" I asked General " Hunter-Weston (commander of the 29th Division) what his candid " opinion was about the Gallipoli situation (in June, 1915). His reply : " ' If you ask me as a soldier, I think it is rotten, but if as a man I think " it is splendid,' emboldened me to suggest that as neither the number " of guns, nor their supply of ammunition, was sufficient to prepare the " whole front for attack, it might be better to select certain tactical " points in the Turkish lines of defence, and take them *seriatim*. In fact, " I urged that we should ape the tactics of the Japanese during their " attack on Port Arthur. My suggestion was not, however, favourably " received. Indeed at this time among our leaders in France, and else- " where, the theory of the ' break-through ' was the predominating one. " No one seemed to have considered that, with the enemy reserves " unbroken, and the impossibility of our getting our guns forward in " time to support them, the troops who had broken through must be " overwhelmed."

He writes equally to the point when describing the condition of the 53rd Division at Suvla : " One could only wonder how the responsible " authorities at home could have ventured to send out such an untrained " formation to take part in so strenuous a campaign as that in Gallipoli. " Had the Division been sent to France it would not even have been put " into the trenches unless mixed up with experienced troops : it would " certainly never have been asked to carry out an attack until at least " it had undergone a course of training behind the lines. There was no " ' behind the lines ' in Gallipoli, and neither time nor opportunity to " train."

Sir William Marshall suggests the possibility of a single command in the Dardanelles campaign. Surely single command, as between the Royal Navy and the Army, could not have worked. It is doubtful whether the Fleet could have won through at the time of the Suvla landing. The effect of the land fighting would have had no effect on the Hellespont defences. It is to be hoped that the three Chiefs of Staff —Navy, Army and Air—will prevent a repetition of such a crime as the direction of the Dardanelles campaign in 1915.

From Gallipoli the scene is transferred to Salonika. Of events there the author provides an easily read account from the fighting soldiers' point of view only, but with some interesting sidelights thrown in.

Thence to Mesopotamia. The account of the operations from the re-organization onwards is given from a higher standpoint. The author's vision is enlarged as he rises in rank. It is to be regretted that he does not deal with the whole of the subsequent operations as he does with the recapture of Kut and the advance to Baghdad. More light is perhaps required on the failure, during the Kut operations, of the Cavalry Division to bridge the Tigris at the toe of the next loop upstream of the

Shumran bend, in which a huge bridging train took part. Was it intended merely as a feint, as Sir William Marshall believes in spite of the fact that General Maude rode over to sympathize with General Crocker on his failure? The incident may have influenced Marshall in his subsequent relations with Crocker. It was not until Marshall discovered Cassels that Marshall, himself a mounted infantry leader of repute, had any good word to say about the cavalry—the only flaw in the tone of the whole book.

The subsequent smaller operations are of quite exceptional military interest, and will repay careful study, with maps. It is to be regretted that more are not provided with the volume.

Not the least interesting chapter is that entitled " The Persian Adventure." Sir William Marshall did not see eye-to-eye with the originators of that side-show. In fact, he admits that " he hated the whole business " of the " Hush-hush " Mission known as " Dunsterforce." It was said to be the product of the " Eastern Committee of the War Cabinet," and was generally attributed to Lord Curzon's influence in that Committee. It was designed to get through to the Caucasus, where its role would be to combine such unstable elements as the Armenians, Georgians, and Azerbaijans, and organize them into an army capable of resisting the Turco-German forces. These were credited with the intention of an eastward drive towards Afghanistan, and the raising of a Pan-Islamic offensive against British rule in India. The Indian Government had undoubted grounds, through its agents, for this belief, and a Turkish Division with German officers had actually been launched on the enterprise, preparations for which had been made by German agents, who we knew had reached Kabul. But before it could effect its purpose, the victories of General Allenby in Palestine necessitated its recall, though the fact was unknown to Allenby for some time. Thus before General Dunsterville's mission was started on its journey to the Caspian, the chief reason for it had, literally, disappeared.

Sir William Marshall writes: " I was not consulted in the matter, " and knew nothing of the political reasons which prompted its despatch, " but had the Eastern Committee done me the honour of asking my " opinion, I should certainly have advised against the whole project."

The volume concludes with an interesting chapter on the advance to Mosul, which shows the author to have been not only a resolute commander in the field, but also an able statesman and diplomatist. He realized that the whole of the Mosul Vilayet must be cleared of the Turks, and did not hesitate even in spite of the protestations of the French Agent and the complications which might, and did, arise out of the Sykes-Picot agreement of 1915. This he describes as " an example of counting " the chickens before they were hatched, which was hard to beat," but he forgets the equally premature undertaking of Sir Edward Grey to hand over Constantinople to Russia before the Dardanelles expedition was launched.

Throughout the book, as Sir Ian Hamilton says in his Introduction, facts and thoughts are given full expression, as they struck the author, or rather the fighting brigadier, the evident possessor of the simplest common sense, who is thus able to discard all but vital factors. That quality of common sense, combined with magnificent powers of endurance and physical and moral courage of the highest order, is the secret of the character of the distinguished author as revealed by his modest volume of memories.

H.B.W.

THE MAN BEHIND THE SCENES.

THE CAREER OF SIR BASIL ZAHAROFF, G.B.E., G.C.B., ETC.

By DR. R. LEWISOHN.

(Gollancz, 1929, 215 pp. Price 12s. 6d.)

It would be only reasonable to expect that the life story of Zaharoff would give scope for a noteworthy piece of biographical writing, but whilst the volume under review, coming as it does from the pen of the financial editor of the *Vossiche Zeitung*, can only be classed as journalism, it, nevertheless, provides a mass of facts of much value to the student. The book opens with a wearisome explanation of Zaharoff's ostracism from Athens when a youth, and interest is only kindled when we see him in 1877 entering the armament industry as the commercial traveller for the Nordenfelt Company at £5 a week.

Thereafter we realize what a fruitful period the next 40 years was to be for armament firms. The Russo-Turkish War had just closed and for the whole of this period practically every country in Europe was either at war, or arming against war.

Nordenfelt, the Swedish engineer, had produced a quick-firing gun which was superseded by Hiram Maxim's invention, and it was this latter gun which gave Zaharoff his start in life. The three men combined in 1888—Nordenfelt, the engineer, Maxim, the inventor, and Zaharoff, the salesman—and when inevitably inventor and engineer disagreed, Zaharoff followed genius. In 1897, Maxim having produced the "pom pom," the firm of Vickers, financed by Cassel, paid one million sterling for the Maxim works. For Maxim this was the end, and he left the company in 1911, but for Zaharoff it was the beginning of a new vista. From this point the narrative is virtually the story of the Vickers Company up to recent years. The Spanish-American War, the Boer War, the Russo-Japanese War and the Balkan encounters all assisted the firm from strength to strength. From military armament they went to naval requirements and later to aircraft and high financing. A great arsenal was constructed on the Volga, and the firm had, in addition, factories in Spain, Italy, Japan and Canada, when in 1914, with a capital of ten millions sterling, in which Zaharoff had considerable interest, they faced the World War. Thereafter nearly every country in Europe proceeded to nationalize the armament industry. In England, confusion was organized by Lloyd George into a Ministry of Munitions, which produced, amongst other things, 25,000 guns, 240,000 machine guns, 4 million rifles and 258 million rounds of shell, as well as 4 battleships and 5,000 aeroplanes. The company's capital rose to 13½ millions, and Zaharoff became the confidant of the Allied Prime Ministers.

After the war, the firm's capital was raised to 26½ millions sterling to cover all manner of new interests in Poland, Italy, and Spain. Then the crash came. Complication had produced inefficiency, and in 1925, when 12½ millions had been lost, the £1 shares were written down to 6s. 8d.

Meanwhile Zaharoff, now a Grand Commander of the Orders of the British Empire and of the Legion of Honour, born a Greek and always a Greek at heart, backed Venizelos and war with Turkey, being intoxicated by a vision of a Greater Greece in Asia Minor. In this ambition he had the support of Lloyd George against the opposition of France. Kemal's five-day march to the Aegean saw the complete demolition of this fantastic and short-sighted policy, and Zaharoff passed from the public gaze a disappointed man.

The author brings out the wonderful politico-industrial fabric which Zaharoff created to gain his desires, but though he had not the vision to realize the limitations of his countrymen, nor the new economic state imposed by the war, and thereby lost half his fortune, he was nevertheless astute enough to secure his personal financial independence by dabbling in banking, oil, and the ownership of the Casino at Monte Carlo; so he lives to-day, at the age of eighty, in at least physical comfort, on the Riviera.

The narrative has a distinctly German flavour, but nevertheless it has a great lesson to teach, and we cannot but marvel that such a purely individual question as the traffic in drugs should receive such universal and active condemnation whilst that pregnant international question—the traffic in armaments—suffers comparatively little restriction.

G.MacL.R.

MARLBOROUGH AND HIS CAMPAIGNS, 1702–1709.

With the Battles Described in Conjunction with Field Service Regulations.

By Lieut.-Colonel A. Kearsey, D.S.O., O.B.E., *p.s.c.*

(Gale & Polden. Price 3s.)

This book is similar to those already produced by the author on the Egypt and Palestine campaigns, and on the battles of Aubers Ridge, Festubert, and Loos, and it suffers from the same defects. The history of Marlborough's campaigns is here so condensed that many of the main lessons are missed. The mixed motives underlying the strategical and tactical schemes of this possibly the greatest of English generals must be understood before lessons can be deduced. The connections of the narrative of the campaign with *Field Service Regulations* are somewhat laboured and vague, and are unfortunately made with the 1924 edition.

This series of books would be of considerably greater value if the author confined himself to one short campaign, which he could analyze much more fully in conjunction with *Field Service Regulations*, and if even one general map were provided which could be read in conjunction with the letterpress.

H.G.E.

AFGHANISTAN FROM DARIUS TO AMANULLAH.

By LIEUT.-GENERAL SIR GEORGE MACMUNN, K.C.B., K.C.S.I., D.S.O.

(G. Bell & Sons. Price 21s.)

Afghanistan must always be of interest to the soldier, not only because it has been the theatre of three British wars, but because therein lies the crux of the problem of the defence of India. We are therefore greatly indebted to Sir George MacMunn for bringing out a compact and very readable history of the country. It is difficult to think of anyone better qualified to write such a history than the author, who knows the Frontier well and has occupied many important positions at A.H.Q. India, concluding with that of Q.M.G.

We must disagree however with the author's contention on p. 2 that " Afghanistan is part of India, using that term in its widest sense." Geographically, Afghanistan is part of the Iranian plateau; ethnographically, the people are more akin to the Persians than to Indians; and linguistically, Persian is the vernacular of the western provinces as well as the court language, while Pashtu, the speech of the remainder, is an archaic dialect of Persian. It is true that the histories of India and Afghanistan are inseparably connected, but so, at one time, were the histories of England and Normandy. Indeed, Afghanistan has many times played the part in the history of India that Normandy once played in our history—a jumping-off ground for invaders who had come from further afield. The tribes have never looked on India as other than a country in which to loot, to conquer, and occasionally to settle.

The country assumed something like its present shape only in the eighteenth century; before that time, generally speaking, it was either a province of a larger empire, *e.g.*, Persia, or divided up among innumerable petty chieftains. Indeed, up to the eighteenth century the author records little, holding out a hope, however, that archæological discoveries may provide more material for history-making.

We are given a vivid account of the state of Northern India before the coming of the British. Between 1738 and 1800 there were 13 Afghan invasions, which ceased only when Ranjit Singh raised the Sikh power and turned the tables.

The author makes a good case for the British intervention which led to the first war, setting forth the point of view that, as the political heirs of the Moghal Empire, we undoubtedly had a claim to intervene in the affairs of a former dependency of Delhi. Fears of a Russo-Persian invasion were by no means groundless; while the H.E.I. Company desired, above all, peaceable neighbours, which meant good markets.

It was, therefore, with the peaceful intention of restoring a friend to the throne of his ancestors that we invaded Afghanistan in 1839. The great Duke of Wellington had, however, recorded his opinion that it would be very easy to get into the country, but very hard to get out, and events were to prove him right.

The author is careful to show the Kabul disaster in its true light, and points out that Pollock and Nott amply avenged it, but adds that it destroyed the legend of British invincibility, and so may have been a contributory cause of the Indian Mutiny. The lessons of the war were admirably summed up by Sir J. Nicolls, the then Commander-in-Chief, whose comments are given on p. 154 of the book.

The second war is treated more briefly than we would like; the author gives deserved credit to Sir F. Roberts for his march on Kabul from the Paiwar Kotal, a feat which has not attracted anything like the attention of his Kabul-Kandahar march.

The policy laid down at the end of that war lasted until 1919, when Amir Habibullah was murdered and Amanullah reigned in his stead, invaded India and got beaten for his pains; the author does not mention that it was the bombing of Kabul by a single British aeroplane which decided the Amir to sue for peace. Unfortunately, the fact that at the subsequent peace the Amir got nearly all he asked for, and the retrogression of the British Frontier in the Khaibar in 1921 by a few hundred yards, created the impression among the Afghans that they won the war.

Had the publication of the book been delayed by a few weeks, the author would have been able to record the accession of Nadir Khan to the throne, the general who gave us a good deal of trouble in the Kurram in 1919. For the moment all is quiet, but with spring fighting may start again, which Nadir Khan, with depleted coffers and arsenals, may find it difficult to quell. Then should the Tajiks and other tribes in Northern Afghanistan elect to join the Soviet republics that bear their names on the other side of the border, it is difficult to see how Soviet, and ultimately British, intervention, can be avoided. The author might have concluded by referring to the five-centuries-old prophecy of a terrible battle to be fought on the Dasht-i-Bakwa, half way between Kandahar and Herat, a prophecy which the Afghans say refers to the British and Russians.

As regards the style, in his quest for telling phrases, the author sometimes ceases to be intelligible. What, for instance, is the "asbestos curtain of imagination"? There are many unduly long sentences ending with a dreary succession of relative clauses introduced by "and which." Then why does the author, in common with most of our race in India, refer to "Europeans" when "British" is what he means? "European" includes Bolsheviks, Germans and others. But we must be grateful to Sir George for using a light and bright style where most historians are heavy and dull.

The map, excellent *sui generis* (though, curiously enough, it omits the Nowshera-Dargai railway constructed as long ago as 1900), does not illustrate the text. We search in vain for the battlefield of Maiwand, for instance, and for many of the places mentioned in the very interesting chapter on pre-war plans of campaign. We would have liked, too, a map of Northern India to illustrate the various Afghan inroads in the eighteenth century, and something better in the way of sketches to illustrate battles, etc.

On the whole, however, the book is a very valuable addition to the literature on the subject, and no military library should be without it.

F.C.M.

THE BIRTH OF AIR DEFENCE.

"AIR DEFENCE," by MAJOR-GENERAL E. B. ASHMORE, C.B., C.M.G., D.S.O.

(Longmans, Green & Co., Ltd. Price 8s. 6d. net.)

To the future historian the Zeppelin raids of 1915 and 1916 will only be of interest as giving examples of great gallantry by both sides. Even the small searchlights of those days could not fail to pick up so large a target, and it only needed night-flying machines of the most limited performance to put a stop to this form of attack. That the performance of our machines was indeed limited is shown by the sad number of pilots who were killed in landing after having gone up in attempts to engage the raiders.

DAYLIGHT RAIDS.

The bow-and-arrow era of aerial warfare may be said to have begun with the daylight aeroplane raids of the German 3rd Bombing Squadron in May, 1917. Hitherto, aeroplane attacks on this country had, with few exceptions, been carried out by single machines. Then we got the result of the experience in the Near East of the 1st Bombing Squadron.

In May, June and July, 1917, there were six daylight raids on England. Three did not get beyond the coast, and three came well inland. In the latter, 359 persons were killed and 850 wounded by bombs, and 11 killed and 74 wounded by our own anti-aircraft gunfire. The average number of bombers was 17, and of defending aircraft 88. In the first of these attacks, one German machine was damaged in an aerial combat, and, in the third, one was damaged by anti-aircraft gunfire and finished off later over the sea by one of our machines. These figures speak for themselves. The attack had the complete mastery of the air.

"The bulk of our pilots did not succeed in finding the enemy at all, "and it is in this point that lies the main problem of air defence. Owing "to the difficulty of picking up one aeroplane from another in the air, "it is essential to give information from the ground, where observation "is easier and aircraft can be seen at far greater distances. And, to "render this information timely and effective, a great system of ground "observation and control is required."

The last sentence summarizes General Ashmore's gospel.

THE END OF THE DAYLIGHT RAIDS.

On 31st July, 1917, the London Air Defence Area was established, combining all defence units, aircraft, A.A. guns, searchlights, in one command under General Ashmore. Communications were improved, so that warning messages could be quickly received from the coast. A gun barrier was placed round London about 20 miles out, to break up hostile formations, so facilitating attack by our defending aircraft by depriving enemy machines of mutual supporting fire. Careful arrangements were made to prevent our guns from firing on our own machines by giving definite areas to each. At searchlight stations large white arrows were placed which could be pointed in the direction of hostile aircraft seen from the ground. These could be seen from a height of 17,000 feet.

As a result of these measures, the last two daylight raids, on 12th and 22nd August, 1917, were both headed off from London by the appearance of an overwhelming force of defending aeroplanes.

"The raids of 12th and 22nd August produced a decisive effect on "the mind of the German commander, who reported that 'the increased "'strength and better organization of the defences had now made it "'inadvisable to attack unless with machines that would fly loaded "'over 10,000 feet, or under cover of darkness.' Accordingly, no "further attempt was made to attack by daylight, and day flights over "this country were in future confined to a few reconnaissances by single "machines carrying no bombs."

Night Aeroplanes.

Night attacks began on 3rd September, 1917.

"At that time there seemed to be no means of meeting this form of "attack. . . . Searchlights were not sufficiently advanced in training "or material to pick up and hold an aeroplane; although they could "deal pretty well in good weather conditions with the larger, slower-"moving airship. The lights being unable to illuminate a target, the "anti-aircraft guns had nothing to aim at and could only fire in the "direction of the sound. It was necessary to find some new means of "employing them until such time as the searchlights improved.

"The slow types of machine which had been successful against the "airships were quite incapable of catching a Gotha, even if they could "find one. To fly the more efficient scout machine at night was not "considered possible. This opinion was impressed on me by the "R.F.C. commanders, who were men not in the least likely to under-rate "the possibilities of their pilots."

The raid of 3rd September is memorable for two things. First, of immediate importance, a system of barrage fire to sound was evolved by Colonel Buckle, commanding the Chatham defences. Barrage fire is looked upon nowadays as the last resort, almost the forlorn hope, of the defence, when all other means are precluded by adverse weather conditions; but throughout the winter of 1917–1918 it was the only weapon that was effective in any degree. The expenditure of ammunition was enormous and the results in planes brought down were very meagre; but, although insufficient to stop raiding, barrage fire did head off many enemy machines and so gave a very real measure of protection to London at that time.

"Secondly, of our sixteen machines that went up, three were Sopwith "Camels, efficient fighting scouts. This was perhaps the most important "point in the history of air defence. It falsified the official view, so "recently expressed, that flying these machines at night was impossible."

The scout, now called the single-seater fighter, is to-day recognized as the primary weapon against bombers, and throughout the main period of the night attacks, 3rd September to 7th March, they became available in rapidly increasing numbers. But, although by balloon aprons the path open to the enemy was restricted to a narrow strip below his ceiling, the difficulty of gaining contact with him was not then overcome. "Out of every eighteen of our pilots that went up in defence, "seventeen saw nothing of the enemy. The five raids of this first "quarter of 1918 produced only eighteen combats, only one Gotha was "brought down. We were doing some fending-off, but, so long as the "Germans could count on returning home safely, we were doing nothing "to put a stop to the raids. Hope for the future, and in my case a "certain faith, rested in the new control system and the wireless tele- "phone."

This control system was an intelligence organization by which continuous track could be kept of every enemy machine. It was perfected before the end of the war, but never actually tried out in a raid. It could give useful information to the artillery of the defence, would be of immense help to the civil authorities responsible for the issue of air raid warnings, and would, it was hoped, enable fighter squadrons to be directed by wireless towards the enemy.

But all this would be useless without efficient searchlights. It is no help to a fighter pilot to be in the same area as an enemy if, when there, he cannot see him. The failure of our aeroplane defence must very largely be set down to the ineffectiveness of our searchlight units at this time, though this does not in the least disparage the personnel of those units. The lights were in most cases not powerful enough, and the equipment could not be readily handled: this form of warfare was new, and the tactical principles which can only be deduced as the result of experience had not yet been thought out; it being war time, no practice could be obtained except against enemy aircraft, and, though raids were too frequent for the population of London, they were insufficient to allow a very rapid advance in training in view of the handicaps just mentioned.

That such conditions are a thing of the past is shown by the efficiency in recent years, in their practice camps, of both regular and territorial searchlight units.

The importance of searchlights was better illustrated in France, where, through continual practice, they reached a very high degree of efficiency. One squadron of night-fighting machines (No. 151 Squadron) was sent out to defend Amiens in 1918, and achieved conspicuous success. That it could have accomplished nothing without searchlight co-operation was most generously acknowledged.

From March, 1918, onwards, the Germans had full employment for all their airmen in France. Of greater value to them than the result of any raid was the fact that, at a time when we needed every possible man at the front, the London defences consisted of 266 guns, 353 searchlights, 159 efficient day fighters, 123 efficient night fighters as well as numbers of older machines. In addition there were the defences of Portsmouth, the Midlands, and the North.

A last raid on London was carried out on Whitsunday, 19th May, with between 30 and 40 machines, nearly twice as many as in any previous attack. The two months respite had been of great value to the defence. The improvement in the searchlights was shown by the fact that about one in six of our pilots picked up an enemy machine. For the first time, the defence showed signs of getting on terms with the enemy in night attacks. Thirteen enemy machines succeeded in getting through and dropping bombs on London, but, in one way or another, ten raiders were brought down.

"No scale of defence, however great, can secure complete immunity "from bombing; but by suitable arrangements the attacker may be "made to suffer such casualties that his efforts will die out. So long as "the London defences could only fend off the whole or part of the "bombing aircraft, attacks continued. When, in addition to fending "off, the defence could produce heavy casualties, as in the case of the "airships, and again in the case of the day aeroplane raids, the par-"ticular form of attack ceased. It was so with the night aeroplanes. "After the losses of 19th May, the Germans no longer attacked us, and "London was free from further trouble."

In each case the defence got the upper hand as soon as it could solve the problem of making contact with the enemy. In the daylight raids this was effected by ground signals. In the night raids the fighters began what is now normal tactical practice, flying towards the intersection of the searchlight beams, just as, in the past, armies used to march towards the sound of the guns.

The Future.

General Ashmore does not belong to the counter-bombing school, whose doctrine was last year described by one paper as being that "the only way to protect Westminster Abbey is to destroy Notre Dame." Writing, however, in another connection, of the raids at the end of 1917, he mentions:—

"There was at this time a tremendous public outcry for reprisals on "German towns. The outcry was freely expressed in Parliament and "in the newspapers. Von Hoeppner has an interesting comment on "the difference between the attitude in London and in Paris under the "stress of raiding. While the London Press cried for reprisals, he says, "Paris wanted to arrange with the Germans a mutual cessation of raid."

He would also like to see all air defence, guns, lights and aircraft, put entirely under the control of the Air Ministry, both in peace and war. For the defence of Great Britain alone this would have many advantages, but it seems very probable that, as in the last century, having finished one big war, we shall only have little wars to deal with for some time. It is easy to think of four or five possible theatres of small wars where air defence would be needed.

In the field, the R.A.F. will be most unwilling to reserve squadrons for what seems to be passive defence, nor could they be made full use of. The point is illustrated by what General Ashmore says about coastal raids: "It must be accepted as an axiom that no practicable scale of "*aeroplane* defence in England can be effective against surprise air "attacks on the coast-line. In fact, home defence on a large scale by "aeroplane has, in practice, to be limited to important areas—London, "for example—that are well inland. Anything in the nature of con-"tinuous patrols, flying day in and day out, in anticipation of raid, is "out of the question for reasons of expense—expense in men, money "and material.

"Such defending patrols as we can afford take time to get to their "fighting height. We gain this time by arranging our patrol lines some "way inland, leaving between them and the coast a zone that will take "the enemy an equivalent time to cross."

The above applies to forward areas if "front line" is read for "coast-line." Our bases, too, will almost always, presumably, be on a coast-line. For air defence in the field the normal weapon will therefore be the anti-aircraft gun, and it is difficult to see that anything but confusion would arise from making a sort of R.A.F. Marines out of A.A. batteries and searchlight companies in the case of a war overseas. Our army is also too small for us to be able to have duplicate organizations allowing for different possible kinds of war.

One of General Ashmore's contentions is incontrovertible. As hostile bombing may be expected within a few hours of the outbreak of war, the peace and war establishments of air defence units should be the same. But it is difficult to see how this can be arranged, in view of perennially increasing financial stringency. The units allotted to the defence of London are, moreover, all Territorial. It might, perhaps, be possible to separate these from the rest of the T.A. as a special kind of militia, who would be liable to be called up for service during the precautionary period without embodiment by Parliament, as though they were Class A reservists. It would be an easier matter to arrange that all reservists earmarked for regular A.A. units should be of Class A, remaining in that class throughout their reserve service, and not only for one year.

J.S.B.

"COMMANDO."

By DENEYS REITZ.

(Faber & Faber. Price 15s.)

This Boer journal of the Boer War is introduced by General Smuts, under whom the author soldiered, both in the Boer War and in the Great War.

Colonel Reitz, starting at the age of 17, served the South African Republics in the field from the very beginning to the Peace of Vereeniging, and he served the British Empire from de la Rey's rebellion to the Rhine, where he led the 1st Bn. Royal Scots Fusiliers.

For the last 30 years, General Smuts has shown himself beyond all doubt to be a great patriot of South Africa, and he is now one of the greatest Imperialists of the present time; Colonel Reitz, proud to serve under him, is a worthy follower.

This journal was written immediately after the Boer War, when Colonel Reitz and his brother were suffering self-imposed exile in Madagascar rather than live under British rule. It is the vivid story of a true patriot and of his development from boy to man. The early Boer successes—Dundee, Nicholson's Nek, the encircling of Ladysmith—meant to the boy rather a good game. All lived a free and practically independent life, going and coming as they pleased—"we thoroughly enjoyed the business of besieging Ladysmith, sniping at outposts, riding from camp to camp to pay visits and making regular excursions to see the guns fired into the town." Then gradually things were not quite such fun; attacks were bungled, his friends were killed or maimed, the

British would not give in, and in fact soon, by sheer numbers and ubiquity, overran the country. There followed the carrying on of the war by guerilla tactics—commanders of all strengths operating when and where they could. The weaker brethren surrendered or went home, but the remainder, all seasoned fighting men, rallied to the side of Botha, Smuts and other leaders, and the war dragged on for two years more. These two years contained constant suffering from starvation, cold and wet, constant alarms and pursuits, and although he, and the various commandos to which he belonged, had many successes in action against British columns and posts, still all the time it was a losing fight. "While matters stood thus well with us, the situation in the two Republics up North was far otherwise. Lord Kitchener's relentless policy of attrition was slowly breaking the hearts of the commandos." The inevitable end arrived, and Reitz accompanied General Smuts to the discussions for peace and the bitterness of defeat. In connection with this, he tells an amusing story of how, when the safe conduct for General Smuts provided also for a secretary and an orderly, Reitz chose to be the orderly, as he thought it meant an aide-de-camp, leaving a companion to be the secretary. On arrival in the British lines, when General Smuts was taken to lunch, Reitz found himself led to the kitchen to feed with the batmen, and subsequently, for the train journey to Port Nolloth, he was put aboard an open cattle truck with the baggage. At the next halting place, General Smuts explained the situation and Reitz's "promotion from batman to field rank in the course of one morning was the quickest known in any army."

There are many lessons to be learnt from the book, both practical and psychological. The Boer's outstanding advantages were, of course, their mobility and markmanship. Again and again the superiority of their shooting comes out, not only their accuracy at long ranges and skill in firing from behind cover, but also their unfailing success when one or both sides were surprised. Colonel Reitz is, however, also very strong on the mistake which Lord Roberts made in ordering the destruction of farmhouses and crops and constructing concentration camps for the Boer women and children. "The intention was to undermine the morale of the fighting men, but the effect was exactly the opposite from what I saw. Instead of weakening, they became only the more resolved to hold out, and this policy, instead of shortening the war, prolonged it by a year or more." "Frightfulness" employed against the wrong people has always the wrong effect. Colonel Reitz is also rather bitter against Lord Kitchener's proclamation that all prisoners taken in khaki should be shot, as he claims that in many cases captured khaki uniform was the only clothing that could be had. (At one time Reitz was wearing a grain bag as his chief garment; at another time his entire wardrobe was a blanket and a pair of sandals.) He acknowledges, however, that at least twice in one day his khaki uniform saved him from unsuspecting soldiers. He is complimentary to the British, however, in all respects on the care taken of Boer wounded left behind, and on the gentlemanly way in which they waged war—"with one exception, I had no unpleasant word from officer or private in all the time that we were out against them."

ANON.

MAPS OF IRAQ, WITH NOTES FOR VISITORS.

(Published by the Government of Iraq. Price 6s. 6d.)

This volume, containing both notes and maps, is published by the Government of Iraq, but in the foreword to the original edition it is stated that the "Notes for Visitors" should not be regarded as containing the official views of the Ministries of the Government. The maps, which originated in the Report of the Iraq Public Works Department for 1924–1927, are presumably the only official part of the work, and the notes are compiled from unofficial contributions.

The whole of the notes are full of really useful information, and it is pretty obvious that most, if not all, of the unofficial contributions come from the pens of officials who know exactly what information is wanted by visitors to Iraq. Such information has been hard to come by in the past.

The sections dealing with the history of Iraq, its present constitution, its population and its great tribes are of general interest. There is a useful temperature chart on page 7 which not only gives the average monthly maximum temperature in Baghdad but also tells the intending traveller what sort of clothes are worn by Europeans at different times of the year—information which many visitors have been unable in the past to obtain.

Following this are sections of the main routes of entry into the country and methods of transport within it, together with passport regulations, etc. Full notes are given of the various overland motor routes from Europe, viz., Beyrout–Damascus–Baghdad, Aleppo–Mosul, Aleppo–Anah–Baghdad, Darbisiyah–Nisbin–Mosul.

As many as 1,900 persons have travelled in one month by the Damascus–Baghdad road, but the combined number of passengers by the other lines does not exceed 3,000 in the whole year.

Notes are given on the coinage, the antiquities, the ancient sites and the ancient irrigation of Iraq.

There is an account of the educational and medical facilities in the country. Agriculture, export and transit trade are also touched on.

The notes on the Iraq Police and the Iraq Army are interesting. The former are a really first-class service, and no visitor can fail to be impressed by its efficiency. The Iraq Army is described as a "healthy infant," and a somewhat glowing account is given of it.

A paragraph is devoted to the Iraq Automobile Association, which is willing to admit and help travellers motoring in the country.

There are also full notes on the postal facilities, postal rates, etc.

The Government regulations for ladies travelling in Iraq are fully given, and should be most useful to any ladies who may wish to tour the country. In many districts ladies may only travel by certain routes and even then must be "accompanied" by some male escort. Ignorance of these regulations will lead to "unaccompanied" ladies' tours being curtailed by local officials.

An Appendix and notes on travel in Persia is added at the end of the volume.

The maps are most useful, but, except to those who know Iraq, give the impression that there are really good roads all over the country.

There is a warning in page 7 of the notes to the effect that there are not more than 20 miles of metalled road out of the 4,800 miles of track shown in the maps.

These unmetalled tracks go out of commission after rain, and are not roads in the European sense of the word.

The policy has been to spend what money was available for the roads in opening up a number of tracks over which traffic can move during the greater part of the year, rather than to concentrate on making a few really first-class roads.

Generally the notes and maps are most valuable, and are recommended to anyone who is thinking of visiting Iraq, either on pleasure or duty.

The solution used in binding the book is specially prepared to render the work impervious to the ravages of insects—a very useful precaution. The resulting volume is 8½in. x 13½in. by about ¼in., and is an awkward size to travel with. It is obtainable from the Crown Agents to the Colonies, 4, Millbank, London, S.W.1, and from various other publishers, and costs 6s. 6d.

G.C.G.

THE WORLD, THE AIR AND THE FUTURE.

By Commander Sir Dennis Burney.

(Knopf. Price 21s.)

Sir Dennis Burney has been well known for a number of years as an expert and enthusiast in airships. He has voiced his enthusiasm many times in Parliament and outside, and the effects of his enthusiasm have been that not only has some £400,000 been advanced by the British Government as a subsidy for his Airship Guarantee Company for the construction of one airship, the R.100, but a second airship, the R. 101, has been constructed under official enterprise, together with bases and mooring masts abroad. The R.100 and R.101 are now complete and undergoing their trials, and it is at this moment that Sir Dennis Burney launches a bomb. "Let me say at once that, as a result of the last seven years' investigation and work upon the R.100, I am firmly convinced that the airship enthusiasts not only overstated their case, but failed to realize that a vessel that could neither make a landing without elaborate extraneous aid, nor be housed or rigidly secured in rough weather, must always remain of doubtful value for commercial purposes."

Was not this said by "Neon" in 1927 and scoffed at?

It may be mentioned that he really came to this conclusion by 1926 before the R.100 was half built, but, rather than confess failure at the time, he decided to continue construction (and also incidentally not to give any warning which would have affected the construction of the R.101). Sir Dennis Burney blames the Government for spending public money unnecessarily on the R.101 and on airship bases; he does not seem to consider the hundreds of thousands which were spent unnecessarily owing to his silence.

While continuing work on the R.100 he concentrated on the theory and design of means to overcome his objections. He laid down "three distinct problems to be solved :—

(1) " How to increase the cruising speed from 70 m. p.h. to 90 m.p.h.
(2) " How to evolve a method of putting a vessel into a shed and taking " her out, in any average weather, by mechanical means.
(3) " How to develop an airship which could alight and moor without " extraneous aid, and at places at which no preparation had " been made."

He claims to have solved them respectively by the following :—

(1) The Howden propulsion system using two fuels, one a gas and the other a liquid. Equilibrium is maintained by this and weight is also saved. Further saving in weight is gained by the higher compression ratios of the engines.
(2) The mooring and docking raft. Claws on a rotary raft clasp the airship attached to a telescopic mast and the whole is then revolved in front of and run into a floating shed.
(3) The " Elliptical " design. The airship is to have an ellipse as cross section instead of a circle as at present. This is claimed to reduce resistance to a side wind and danger of overturning, both by shape and diminished height. The principal advantage claimed is, however, that two long floats can be fastened on the lower side as hulls. The object of these is to enable the airship to alight on water in the same manner as a flying boat. The theory is that, as she alights, her hulls may be automatically filled with water by means of scoops; the weight of water added to the ship will hold her down and she can then be moored to a buoy or be warped into a shed.

Neither of these two last theories have so far got beyond theory or models, and the present ships, R.100 and R.101, do not appear likely to be of use in substantiating either theory.

Sir Dennis Burney fills up the rest of his book with long dissertations on such questions as Empire Development, the Re-orientation of Defensive Power, and International Peace. One gets the impression that the master key to all problems is " An airship." Like most enthusiasts he wearies one after a time with this universal panacea.

One chapter on " Heavier-than-air Craft " is written by Mr. Neville S. Norway, where he discusses both the land aeroplane and the flying boat. Although nearly the whole book vaunts the airship, one feels that in this one chapter is demonstrated the best hope for aircraft development in the future.

H.N.K.

WONDERS OF ENGINEERING.

By Ellison Hawks, F.R.A.S.

(Methuen & Co., 1929. 185 pp. 16 plates and 28 diagrams. Price 6s.)

This book consists of a popular description of certain outstanding civil engineering achievements under such branches as bridges, docks, harbours, canals, dams, and tunnels. The history and theory underlying each branch is lightly touched upon, and the leading dimensions and costs of the projects described are given. The main interest, however, lies in the descriptions of how each of a large number of famous engineering monuments came into being. In the bridge section reference is made to the original disaster occasioned by soldiers marching in step over a bridge at Angers in 1850, when 226 men were killed. The difficulties of bridge building 100 years ago are instanced by an account of the Menai Bridge works, and the progress in suspension bridge design is illustrated by comparison with materials and methods used on the Hudson River Bridge, to be opened in 1932. It willi nterest readers of the *R.E. Journal* to learn that the contractor's designs for the latter bridge, which has a clear central span of 3,500 feet, with towers twice as high as St. Paul's, were, as is customary in the U.S.A., scrutinized by the U.S. Army Engineers before the project was approved. This section closes with an account of the tragic failures of design and erection on the Quebec cantilever bridge.

In the Dock section, much data is available as to the Port of London, whilst the recent improvements at Tilbury, which provide dry dock accommodation for 30,000-ton liners 40 miles from the sea, are mentioned. The Gladstone Dock at Liverpool is described, its chief feature being its ability to receive vessels at practically any state of the tide, which has, at Liverpool, a range of 30 feet. The floating docks at Southampton (60,000-ton lift) and Singapore (50,000-ton lift) are briefly mentioned.

The irrigation schemes at Assouan, Delta, Assiot, Zifta and Esneh demonstrate forcibly all that British engineering genius and suzerainty has done for Egypt, a fact on which a little more stress might be laid at the present juncture. The Lloyd Dam, which will irrigate 7½ million acres, and is estimated to increase the annual wealth of India by 19 millions sterling, should also provide food for thought for that vocal fraction of India's population which is now demanding complete independence.

The great achievements of Canada in hydro-electric power schemes are exampled by the Chippewa scheme, producing half a million horse power, and the Gatineau River scheme, designed for 3–4 million horse power and now nearing completion. No mention is made of the Chosen (Japan), Grimsel (Switzerland) or Shannon hydro-electric projects, all of which are now nearing completion and provide approximately 1/4 million horse power each.

The romance of the Panama Canal is described at length and though tribute is paid to General Gorgas, the medical authority who made the work possible, it is suggested that an account of this project is incomplete without the name of that great military engineer, General Goethals. The Suez Canal is not referred to, and apparently an error is made at the foot of page 147, when describing the effect of the deepening of the Welland Canal. This Canal is due for completion this year, and will contain the largest lock in the world, 1,380 feet long.

The tunnels described include the Mt. Cenis, which cost £225 per yard, compared with the St. Gothard of £142 per yard, due to the use of dynamite in place of powder and improved pneumatic drills; the Simplon, which only showed an 8-inch error of direction in 12½ miles; the Mersey Tunnel, now under construction at a cost of £5,000,000; the Otira, in

New Zealand, and the Moffat in the American Rockies. The Holland Vehicular Tunnel under the Hudson at New York, an epic of engineering skill and tenacity, is omitted, whilst all too little is made of the uncanny skill required to build the Tube Railways of London, and effect such reconstructions as Piccadilly Station.

The book closes with a description of the Collard Scheme for a Channel Tunnel at a cost of £189,000,000, and the rehabilitation of Spain is suggested as a possible result of the Gibraltar Straits Tunnel, now under discussion.

G.MacL.R.

HIGH VOLTAGE CABLES.

By L. Emanueli.

(Chapman & Hall, Ltd. Price 8s. 6d.)

This is not a text book in the ordinary sense, but simply a reprint of a series of five lectures delivered in the University of London.

The author has a very high international reputation as a cable designer and manufacturer, and the results of research given may be considered as authoritative.

In the first two lectures manufacturing methods are briefly described, also the methods of measuring and stating the electrical and mechanical properties of the insulating paper and impregnating oils separately and of the paper when impregnated. The variations of dielectric strength and dielectric losses with D.C. and A.C. of various frequencies are clearly explained.

The third lecture deals more fully with the radial and tangential voltage gradients in the dielectric of the ordinary belted type of three-phase cable, and refers briefly to the "Hochstadter" and "TSL" designs, in which the tangential voltage gradients are eliminated.

On page 62, the author states that the tangential stresses in a belted cable are of the same order as the radial stresses. This does not appear to agree with the curves given on the same page.

The electrolytic method of exploring model electrostatic fields is also described in this lecture.

The fourth lecture deals in greater detail with impregnation, the effect of temperature cycles on the cable as a whole, the formation of voids due to the inelasticity of the lead, the ionization of gas in these voids and the consequent gradual deterioration and ultimate breakdown of the dielectric.

Lecture five explains the behaviour of the cable when bent, the variation of dielectric losses with voltage and temperature, and the importance of the "time factor" when specifying the breakdown voltage of a cable.

In conclusion, various theories of cable breakdown, and devices to avoid or minimize ionization are given. It is evident that the only sure method of preventing ionization is to use hollow-cored cables and permit free expansion of the oil to take place into special tanks connected therewith.

The book is a very useful addition to the literature on the subject, and should be found useful in technical schools. It is well printed and the very few printer's errors will be obvious to the reader.

W.M.

ART OF RAPID READING.

By W. B. Pitkin.

(McGraw Hill Book Co., 1929. 233 pp. Price 12s. 6d.)

The title suggests a book of priceless value in these days of multiplication of the written and printed word, and the predominance of paper over the sword, and therefore at first reading, it may be found a little disappointing. The secret of the art is so very simple and short to tell; the acquisition of facility in the art so very difficult and laborious. The key to success is the formation of a state of mind which reads with an object. The various interests selected, it remains to discard everything else ruthlessly. Again, when reading a selected article or book, it is essential to be able to seek out the key points and to study them in detail with the omission of the less relevant portions.

The author hopes that all serious writing may eventually be arranged under the following headings: statement of subject, details, summary of facts, conclusions, bibliography.

The bulk of the book contains exercises calculated to train the eye to read quickly and considerable space is devoted to a discussion of bad habits, and unsuitable conditions, which reduce the ability to concentrate on the selected reading. Some hints for rapid reading are: Get the broad picture first, then go back and read carefully the details of interest. Read complete sentences, not odd words when skimming. Learn all the meanings of all the technical terms used in the particular branch of matter to be read. Take no notes as you read. Make them afterwards. The more you read, the better you read, but always read objectively. "Skimming" is defended as not mere eye skimming plus mind wandering, but is shown to require considerable and ever watchful concentration to pick out the salient facts.

This book should appeal to those who have been able to complete a course in Pelmanism.

G.MacL.R.

RADIO TRAFFIC MANUAL AND OPERATING REGULATIONS.

By R. L. Duncan and C. E. Drew.

(John Wiley & Sons, 1929. Price 10s.)

This handbook is from America, and is well described by its title. Beginning with instructions on learning the Morse code, it goes on to give all the abbreviations, code signs, and regulations which are in force for the expeditious handling of wireless messages at sea. The text of the International Radio-Telegraph Convention is given in full, though the date of it is not mentioned.

K.H.P.

ELEMENTS OF RADIO COMMUNICATION.

By J. H. Morecroft.

(John Wiley & Sons, 1929. 269 pages. Price 15s.)

This book is an introductory volume to *Principles of Radio Communication*, by the same author. It is an American book, using American terms and dealing with American practice throughout. Where references are made to European practice they are of little value.

The book begins by formulating the laws of electric circuits, and goes on to apply them to radio communication. A very good chapter on valves—or tubes—is followed by explanations of wireless telegraphy and telephony, and the book ends with a chapter on receiving sets, some problems, and a short, rather inadequate, index.

The middle part of this book is the best—the explanations of valves and valve circuits, and the various systems of telegraphy, being particularly clear. The first chapter employs no mathematics, and does little more than state, in some cases rather loosely, the principles of A.C. circuits, making no attempt to explain them. This would not be enough for anyone studying wireless seriously, but a more adequate treatment can be obtained from many other books.

The book is fairly up-to-date, and includes treatment of the screen grid valve and quartz oscillator, but beam wireless and mains units receive scant treatment, while the pentode valve is not mentioned.

No answers are given to the problems at the end of the book, and in some cases they are not soluble by reference to the text.

K.H.T.

TELEGRAPHY AND TELEPHONY.

By E. MALLETT.

(London, Chapman & Hall, Ltd. 408 pages. Price 21s.)

This book deals mainly with the theoretical principles of electrical signalling, the author's intention being to bridge the gap between the elementary textbooks and the many advanced treatises on particular aspects of the subject.

105 pages are devoted to line telegraphy, 168 to line telephony, 91 to wireless telegraphy and telephony, and 35 to appendixes dealing with the more difficult mathematical formulæ and solutions.

The first part opens with a description of the simpler telegraph apparatus and systems, and concludes with details of high speed apparatus. The theory of the transmission of telegraph signals, and the effects of the various factors causing attenuation and distortion of the signals and time lag in their reception are all clearly explained, as are also the various methods adopted to increase the speed of signalling on long lines, viz., repeaters, condensers, "curbing" and "loading." The effects of the various factors causing attenuation and distortion of the old "K.R." law now ceases to apply.

In the second part, telephone apparatus is described and explained, including the Strowger automatic exchange equipment. The theory of sound waves, their conversion into electrical signals and the theory of their transmission along line conductors, also artificial lines, filters, and superimposed telegraph and telephone circuits, are all ably dealt with. The importance of "loading" is again emphasized. The thermionic valve and the nickel iron alloys such as "Permalloy" will, it is expected, make transatlantic telephony possible in the near future.

A chapter is devoted to the theory of the thermionic valve and the important use of these valves as amplifiers and repeaters in ordinary line telephony and as oscillators in the "wired wireless" system which was largely used in the field during the European War of 1914–18.

Part III deals with the production, radiation and reception of electromagnetic waves and the principles and advantages of the various methods of production, viz.: Valve, alternator, arc and spark are described. The various methods of coupling both in transmission and reception are clearly explained, and the subject matter as a whole maintains a high standard.

The book will be found invaluable for the engineering student who intends to take any of the more important academic or professional examinations in "light" electrical engineering. A good mathematical knowledge is required (70% of the book is applied mathematics), but third year students at universities and technical colleges should find no difficulty in this respect.

A very useful list of references for further reading is given at the end of each chapter.

W.M.

OVERHEAD POWER LINES.

By Captain W. M. N. Morecombe, R.E.

(Chapman & Hall. Price 15s.)

A book which every Engineer officer who is concerned with power lines of any description would do well to possess—it should be very useful to all electrical and mechanical officers, especially if they are likely to be going abroad, and more so if going for a tour in India.

The Engineer officer at home seldom is confronted with more than the simple problems of barrack distribution schemes; abroad, and in India in particular, however, transmission and distribution schemes over large cantonments are still being carried out.

The author has set out in a very clear and concise way the problems connected with the design and erection of overhead power lines, of the magnitude such as are more likely to be met with by R.E. officers. With the aid of extremely clear diagrams and curves, he has assisted the designer of a line and enabled him to obtain the results of complicated calculations in an easy manner. He is also to be congratulated on having the diagrams, illustrations, etc., put in the text, thereby making the problems, etc., easy to follow.

Although the author deals primarily with transmission lines rather than distribution lines, the same principles apply to the latter.

The study and intelligent use of this book should enable Engineer officers to design and erect safe lines in the most economical way with the minimum of trouble, and do away with the element of guesswork which has undoubtedly been present in many existing installations.

The chapter on iron and concrete poles, especially in regard to the design of the latter, should be of the greatest value to those Engineer officers situated in countries where the ravages of the white ant preclude the use of wooden poles, and where climatic conditions are also troublesome to iron and steel poles, or where transportation difficulties necessitate the manufacture of poles on the site.

R.W.C.

MAGAZINES.

REVUE MILITAIRE FRANÇAISE.

(*October*, 1929.)—Lieut.-Col. Desmazes completes "*De Liao-Yang à Moukden*" in this number. Throughout this series of articles the story has not been obscured by intricate details of forces and orders, and the writer indicates clearly the reasons for the Japanese success. This instalment is devoted to the Battle of Mukden, which was by far the most decisive victory of the Japanese and in fact ended the War. Curiously enough, both Oyama and Kuropatkin decided to attack on practically the same day, but as soon as Kuropatkin saw the Japanese advance, he immediately gave up his own plans and conformed to the operations of his enemy. Throughout the battle, "combined units," drawn from various formations, were formed by the Russians, so that the natural confusion of a big battle was made indescribably worse. By the end of the battle the Japanese had reached the main railway line from the north-west and the Russian forces only just escaped an overwhelming disaster. As Col. Desmazes points out, the failure of the Russians might have been turned to good account, if the lessons had been properly applied, but the so-called brilliant cavalry leaders, Rennenkampf and Samsonoff, were largely responsible for the terrible disaster of Tannenberg in 1914.

In continuing "*Motorisation des engins de combat rapproché,*" Général Chédeville discusses the various sizes of tanks proposed by what he calls the "new school." He points out that every tank, whether small or large, has its drawbacks. If a tank is provided with a comparatively short gun, perfectly satisfactory for use against infantry, this gun will not have the muzzle velocity necessary to fight other tanks. The provision of a high-velocity gun means a bigger tank. By similar reasoning, he comes to the conclusion that tanks will go through the same stages as aircraft and will develop into a number of different designs for different purposes, *i.e.*, reconnaissance, attack, pursuit, and so on.

Lieut.-Col. X . . . begins "*Un cas concret de tactique générale*" in this number. He takes as situation that of the 9th Corps on the right of Von Klück's 1st Army, at the battle of the Marne, when Von Klück decided to strike at and outflank, if possible, the French forces coming up from Paris on his West. The article is too detailed to be interesting to the casual reader, but the various considerations affecting the plans of the different commanders are clearly set out.

"*L'armée soviétique,*" by Capitaine Malraison, is an important article on the present-day Red Army. He describes the terms of service, more onerous than in any other nation, together with the sub-division of the Red Army into active and territorial formations. The Ogpu, numbering

100,000 and organized as the secret police of the Communist Party, are then described, and we must remember that the actual Communists are a comparatively small part of the Russian people. Finally, Capitaine Malraison discusses the efforts of the Soviet Government to militarize the Russian people, and gives his views on the efficiency of the Army. Although considerable progress has been made in its training, the writer does not consider the Army in any way up to the standard of a modern force. We must always remember that a Russian Army has hardly ever been successful *out of Russia*, and it is unlikely that the present Army is an exception to the rule.

(*November*, 1929.)—Général Vanbremeersch has a complete article, entitled "*La reprise de Bab-Hocêine et d'Oued-Hamrine*," in this number. He describes a minor operation in Morocco of September, 1925, where the French retook certain positions which they had lost previously. The article may be of value for careful study, but the map is so bad that the operations are most difficult to follow. For the general reader there is little interest. In conclusion, the writer discusses the best composition of troops in this mountainous country and points out that the use of tanks and artillery on wheels is frequently rather a nuisance than a help on account of the difficult conditions.

Général Chédeville completes "*Motorisation des engins de combat rapproché*" in this number. After describing his views on the big tank for breaking through a hostile position, the reconnaissance tank and the types of vehicle required for the transport of infantry (where he suggests that the reconnaissance tank must have tracks, not wheels), he then gives his conclusions. Briefly, his opinion is that the infantry will require three types of tank, viz., a co-operating tank (*char d'accompagnement*) of about 17 tons, carrying a shortened 75-mm. gun, a lighter reconnaissance tank of considerable speed, and a pursuit tank (*char de chasse*) also of about 17 tons but armed with a small high-velocity gun. Then he suggests a "land cruiser" of 30 to 35 tons, protected against direct hits from field artillery, and, finally, a break-through tank (*char de rupture*), weighing 70 tons. It does seem that, even if the writer's reasons are correct, it will be impossible for so many tanks to be produced in large numbers, and one wonders how many bridges will carry a 70-ton tank.

The conclusion of Lieut.-Col. X . . . 's "*Un cas concret de tactique générale*," reads like a glorified staff college scheme, complete with detailed comments by the instructor. One almost misses the use of red ink. The article is either worth reading carefully, together with the map attached, or not at all, but at the end the writer explains the principles brought out even in a comparatively simple exercise of this kind. These principles bear a very close resemblance, as indeed they should, to our own principles of war as laid down in *F.S.R.*, Vol. II.

Commandant Tournoux begins an interesting article, entitled "*Les fortifications permanentes belges et françaises*," in this number. Although the role of these fortresses has generally been belittled by the Allied writers, Commandant Tournoux points out that the existence of Liége, Namur and Antwerp, together with the series of French fortresses, had a considerable effect on both the plans and the operations of the Germans in 1914. He quotes largely from the writings of various German generals and it will be seen that the menace of the fortresses is taken seriously by them. In fact, Von Bülow, commanding the German 2nd Army, was probably affected throughout the German advance by the original difficulty of capturing Liége. In this instalment the Belgian fortresses and the Schlieffen plan, based on the French fortresses, are considered.

"*L'armée italienne en* 1929," by Commandant Conquet, is a detailed description of the present-day Italian Army. As the writer points out, the development of the Army under Mussolini has not been blazoned abroad like his political and economic works. We must realize, however, that the Italian Army is progressing and that Mussolini has undoubtedly produced a feeling of good military morale, which did not exist after the Great War. In this instalment, details are given of the organization of the Italian division and of the number of men available. In a country whose birthrate is increasing and where the land frontiers are protected by mountains, it is natural for infantry to preponderate throughout the Army.

(*December*, 1929.)—"*En relisant Clausewitz*," by Général Lemoine, is the first of a series of articles designed to explain the general tendency of thought of the great German military writer. Général Lemoine points out that most of his books are really unfinished and that it is left to the reader to decide exactly what Clausewitz thought when he wrote his books on war. In this instalment, the writer discusses Clausewitz' attitude in face of the principal difficulties affecting a commander in war, viz., the multiplicity of factors, their variability, the difficulty of appreciating them, the danger of outside abstractions, and the character of the principles involved. The reasoning of the instalment, however, seems rather academic and there is a tendency towards platitudes, a tendency very difficult to avoid in an article of this description.

"*Le renseignement et la manœuvre*," by Capitaine Mousset, describes an example of the common fault of failure to reconnoitre before an advance. The example taken is from the 19th Corps of Von Hausen's 3rd German Army which marched into a deployed French position early in September, 1914, shortly before the battle of the Marne. The action is described clearly without too much detail, but we must remember that, although "time spent in reconnaissance is seldom wasted," it is remarkable how often commanders fail to reconnoitre, and to interpret reports, before setting their troops in movement.

Commandant Tournoux completes "*Les fortifications belges et françaises*" in this number. He quotes continually the German writers regarding all the French fortresses, and it is quite clear that they had a very considerable effect on the German advance, and might have had still more effect if they had been brought up to date. It was, in fact, on account of the French fortress system that the German attack was launched through Belgium, and it was probably the violation of Belgian neutrality which caused the final defeat of the Germans. Commandant Tournoux considers that the day of the fortress is by no means over and it certainly does seem that by the construction of modern fortresses, the French can do a great deal to protect their north-eastern frontier.

"*L'artillerie du 21e corps d'armée le 26 Septembre*, 1918," by Lieut.-Col. Aublet, describes the organization and action of the artillery in one of the great successful blows of the autumn of 1918. Full details are given, but one cannot help feeling that the conditions described are unlikely to occur again, as the author indeed says at the end of the article. The enormous mass of artillery and the careful preparations required are familiar to most officers who served in France during the Great War.

Commandant Conquet completes "*L'armée italienne en* 1929" in this number. The instalment deals with the air force, colonial troops, carabinieri and militia. The air force has expanded from 80 machines in 1922 to 1,200 in 1929, an indication of the result of Mussolini's determination to have efficient armed forces. The militia is, perhaps, the most interesting part of the Italian forces, as it is a new Fascist organization. Men are trained from their youth up and a considerable proportion enlisted in militia "legions," who will take their place with the regular army in the field. The whole article is well worth reading by anyone who wishes to find out how Italy has advanced militarily, as well as politically, during the last seven years.

H.A.J.P.

VOENNO-INGINERNA BIBLIOTICA

(Bulgaria, Military Engineers' Journal).

This journal was founded after the Revolution of June 9th, 1923. General Volkoff, an engineer and artillery officer, who at the time was i/c. Map Section, G.S., at the War Office, had largely organized the *coup d'etat*, and became War Minister. His accession to the virtual command of the Army gave some impetus to technical and scientific study.

The journal is quite well got up, and appears every two months in issues of about 160 pages, costing 40 levas (1s. 4d.) each number.

Its object, as declared on the back page, is to "Spread a knowledge "of military engineering in the Army and in society, and thus to assist "the Government in the preparation of the country for national defence." Of the 6–12 articles in each issue, not more than two are indigenous—the remainder being translations from engineering and general military publications in other countries.

The Bulgarian contributions are, judged by the standards of France or our own country, of a very elementary character.

(*January–February*, 1929).—1. In a rather lengthy article entitled "Radiotelegraphy," Colonel T. Petrescu examines the uses and role of short-wave length R/T stations in the field, and pleads for the registration, for military use in emergency, of amateur owners of wireless sets. In support of this he quotes a proclamation or appeal, issued in the Soviet publication, *Radio Vcem* ("Radio for all") of 1.4.1928, which is not without interest at the present moment. The appeal runs:— "Convinced that another war is possible—nay, inevitable—we are "obliged to put all our radio-technical resources at the disposal of the "Army. At last the question of putting owners of private sets (' radio-

" amateurs ') at the disposal of the State is capable of solution. The
" militarization of all radio-amateurs—that is to say, their military
" instruction and the registration of their instruments, and the formation
" of the amateurs themselves into groups of specialists—is, therefore, a
" problem which demands immediate attention. Let our watchword be,
" '*Short-wave length owners! Prepare yourselves and your stations for*
" '*the coming war! Organized cadres of militarized wireless amateurs*
" '*are the best answer to Chamberlain!*' "

2. In " Roads or Railways? " Engineer Ivan Dankof goes at some length into the statistics of other countries concerning road and rail transport.

He considers that as far as Bulgaria is concerned, the answer to this question is " Roads *and* Railways." In some official quarters, he says, it is held that railways have had their day, and that any money available for their further development would be better spent on roads. This, he contends, is a great mistake—the railway system is still very far from adequate even for the needs of the country at the present, without taking into account increasing population and developing industry. Railway transport is still much cheaper than road—costing about 5-6 centimes (gold) per ton-kilometre. (Road rate is not mentioned.)

(*May–June*, 1929, Jubilee number, 1879–1929). 1. " Survey of the development and services of the Bulgarian Engineers " (on the occasion of the fiftieth anniversary of their formation). Major Kotseff reviews the development of the engineers in Bulgaria from the formation of one pioneer company and one instructional company under Russian officers in 1878, up till the present time.

By the outbreak of the Balkan War, 1912, the engineers had grown to 9 Pioneer Bns., each consisting of 2 " Pioneer " and one " Bridging and Telegraph " Company.

The performance of the engineers in this war left much to be desired, owing, the author thinks, to inadequate specialized training and to too small a cadre in peace time. He tactfully makes an exception in favour of Captain (now General) Volkoff (who was Minister of War at the time the article was written), whose handling of a pioneer company at Lule Burgas was described as brilliant.

On mobilization for the World War in 1915, 10 Pioneer Battalions—one per division—of the same composition as in the Balkan War—were raised. These were increased by additional Bridging and Telegraph Companies as material became available from Germany.

In describing the immediately post-war period (1919), the author mentions one interesting item. He says the Inspector of Engineers at the time of demobilization introduced an organization which it was proposed to adopt " had we been victorious." This consisted of 1 Pioneer Battalion per division (eight in all), each battalion consisting of 2 Pioneer Companies, one telegraph and one bridging company. But this was premature. By the Treaty of Neuilly, " we were compelled " to reduce our engineer services to 3 Pioneer Battalions and 2 Cyclist " Battalions." It would be interesting to know to what extent the organization proposed " had we been victorious " underlies the paper organization adopted in deference to the Treaty of Neuilly. Also what part is really played by the cyclist battalions, which, incidentally, have very few bicycles.

2. In "Pontoon Companies from the Liberation (1877) till the present time," Major Popvontseff outlines the development of Pontoon Companies in the Bulgarian Army from its foundation, and then cites in detail the principal bridging operations undertaken during the World War, the greatest achievement apparently being the construction of a bridge 138 m. long over the Struma at Rupel, about the place where Gen. Sarrail had the railway bridge blown up on New Year's Day, 1916.

(*September–October*, 1928).—In an article entitled "Military Camouflage," but which deals exclusively with the interpretation of aerial photographs, Captain Velinoff gives some very useful though quite elementary instruction on this subject.

He shows some photographs of our (British) positions on the R. Struma in 1917, and demonstrates from these, and other photographs, how gun positions were given away by tracks to and from them; more especially when two or more tracks converge at a position. He emphasizes the necessity of limiting movement to one single route, and of obliterating wheel marks. On the Bulgarian side this was on occasions successfully done, by sprinkling brushwood and also ashes over the suspicious marks. The Bulgars seem to have got very satisfactory information about our positions from these photographs, which appear to be of about the same standard as our own at the time. The height from which reconnaissance was made is not stated.

A.C.B.N.

MILITAERWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*May–June*, 1929).—*Army and State.* On the plea that impressions gained by an individual help us to a truer picture than any other kind of historical record, Col. Heller makes a study of two historical reports hitherto unpublished, one by the Austrian Archduke Albrecht, addressed to the Emperor Franz Josef in August, 1866, shortly after the preliminary peace between Prussia and Austria had been concluded at Nikolsburg; and the other a report by the Duke of Würtemberg, an officer in the Austrian service, who visited the German troops before Paris early in 1871, giving a complete account of his impressions. The two reports might easily bear sub-titles, "The Causes of Defeat" and "The Causes of Victory" respectively, and are thus interesting enough to soldiers, even apart from their vividness, which is a charm that aids instruction.

The Campaign against Roumania, 1916 (*continued*). Lt.-Col. Kissling's lecture carries on the tale with the conquest of Walachia and the Dobruja, the occupation of Bucharest, and the pursuit to the Sereth-Danube line. The chief point that he brings out is the value of unity of command, claiming that it happily overcame all obstacles on the side where it existed, the Germans, Austro-Hungarians, Turks and Bulgarians being all under the command of the Emperor William, and that the lack thereof ruined the other side, the Roumanians and Russians. There were a great many other factors which contributed to success, as the author abundantly shows; and it is an exaggeration to attribute it all to unity of command, the importance of which is nevertheless not to be denied.

Lt.-Col. Kissling thinks that the entry of Roumania into the War, with an army inexperienced in war and badly led, and regarded by its Russian ally with mixed feelings, gave the Central Powers just that opportunity they so badly needed at that time, to restore the strategical balance. Otherwise the armies of the Central Powers, hemmed in and condemned to position-warfare on all fronts, might have collapsed even in 1916. The conquest of Roumania opened up to them wide territories, rich in resources.

Contributions to the History of Armoured Trains. The first suggestion of an armoured train emanated from a French naval officer, Montgéry, over a century ago. An armoured train appears to have been first used in Bohemia in 1848. Major-Gen. Kerchnaue follows the A.T. through the various campaigns, including the Egyptian war of 1882, the Soudan 1897, and the Boer war, to its use in all theatres of the Great War. Two excellent examples of A.T. action appear to be purposely omitted, as having recently appeared in *M.u.T.M.*, viz., in the Ukraine (*v. R.E. Journal*, March, 1929) and in Esthonia (*v. R.E. Journal*, December, 1929). Against this the good story is told of a German subaltern in the Herrero campaign, who, taking reinforcements up-country by ordinary train, was driven off by the enemy, took the train back, armoured it, and repairing the permanent way as he went, broke through and relieved the beleagured garrison. Subsequently, with the assistance of the navy (which has always played an important part in improvisations of this nature), with naval guns and personnel, he defended and kept the line open from Swakopmund to Windhoek, until reinforcements arrived from Germany.

F.A.I.

REVUE MILITAIRE SUISSE.

(1929. Nos. 7 to 12 inclusive.)

Tactique et technique. The original article appears in No. 7 and is contributed by Capt. Joho; he briefly indicates therein some of the developments which have taken place in recent times in tactics owing to new inventions and discoveries. He points out that it is now impossible to deal with tactical problems in old-fashioned ways; technical factors have to-day acquired an immense importance, and, as the Great War has shown, play a formidable part in a battle.

The *savoir technique* is, in many respects, intimately bound up with the *pouvoir tactique*; the former forms an essential part of the foundation upon which the art of leadership should be built. Capt. Joho is of opinion that the *arme du génie* should, to a greater degree than has been the case hitherto, be considered as an *arme combinée*, in the same way, indeed, as are the artillery and the air force. In consequence, engineer units should only be placed under "the orders of the other arms" in exceptional cases, and only when missions of short duration have to be carried out.

Les gros appareils de bombardement. The original article is contributed to No. 7 by Lieut. E. Naef; he furnishes particulars therein of certain types of bombing machine.

La guerre aéro-chimique et la défense anti-aérienne. Three further parts of the article under the foregoing title by M. S. de Stackelberg appear in Nos. 7, 8 and 9 of the *Revue.* Particulars are given in No. 7 of a portable type of electro-mechanical position-finder for use in connection with anti-aircraft artillery. It is stated that in the case of the Saint Chamond position-finder, the guns can be placed at a distance of 500 m. from the observation station; each such station can be used for controlling the fire of 4 guns employed in 2 sections, which can thus be located 1 km. apart—the individual guns of each section may be placed 50 m. apart. A few particulars are also given in this number of the *Revue* of certain types of anti-aircraft artillery.

Problems connected with fixed and permanent defences in relation to aerial warfare under conditions likely to prevail in the future are discussed in No. 8. M. de Stackelberg deals first with the subject of mobile anti-aircraft defence in relation to field warfare, and then states his views on the "future of fortresses and fortresses of the future." Problems connected with the defence of towns are also touched upon in No. 8.

The air attacks on Paris during the Great War, and the lessons to be derived therefrom are dealt with in No. 9. Particulars are given of the German air-raids on Paris in 1918; a tabular statement is provided in which the numbers of German machines engaged in each raid, the numbers which succeeded in penetrating within the French fortified area, the numbers of bombs dropped and the numbers of German machines brought down are set out in detail.

M. de Stackelberg suggests that a belligerent acting on the defensive requires at least five times as many machines as those employed by an attacking force in order to make sure of beating off enemy machines. The results of the aerial warfare during the Great War, so far as the principal Continental Powers are concerned are tabulated; the following particulars may be of interest:—

Belligerent.	*Nos. of enemy machines brought down.*		*Ratio of (a) to (b)*
	(a) By gun-fire.	*(b) In aerial combat.*	
Germany	500	2000	1 : 4
France	1520	6554	1 : 4·3
Italy	129	540	1 : 4·2

M. de Stackelberg is of opinion that the foregoing statistics cannot be used as an argument against the efficacy of anti-aircraft artillery; it alone proves, he thinks, that France had gained supremacy in the air, and that her pilots dominated the situation. The evidence available indicates that, as in the case of terrestrial conflicts so also in the case of aerial conflicts, it is the waging of war in a downright offensive spirit which gives the greatest promise of a successful issue to a campaign. Consequently, it is essential that anti-aircraft artillery should always be in a position to seize the initiative and to carry out offensive operations so that it may dominate the aero-chemical arm while the assailants' formations are still distant from their objective; only in this way can the national territory be spared the ravages of a barbarous type of warfare.

De Vercingétorix au maréchal Foch. The original article is contributed by Col. F. Feyler to No. 8; it contains an interesting review of an important publication recently issued by the Librairie Larousse, *Histoire de l'armée française*, which has been compiled under the direction of Col. J. Revol, as editor.

Méthode de Combat. The original article is an anonymous contribution to No. 9; it deals with the tactical handling of artillery and the co-operation of this arm with the infantry.

Ce que vaut l'interdiction de la guerre chimique. The original article is contributed to No. 10 by M. de Stackelberg, who points out therein that the Protocol of 1925, which forbids the use of poison gases in warfare, has been signed by 18 out of the 50 members of the League of Nations; nevertheless, this does not by any means suggest that a stop has been put to the development of measures for the utilization of the chemical arm in warfare. On the contrary, research work in relation to this branch of warfare is being actively pursued in many countries; the directions in which this work is proceeding both in relation to the offensive and also the defensive aspects of chemical warfare are briefly set out and discussed in the original article.

L'avenir de l'aviation. The original article is contributed to No. 11 by M. de Stackelberg, who discusses the subject mainly from the point of view of possible future discoveries which will tend to render aerial machines less vulnerable to attack from anti-aircraft artillery, and which at the same time will make them more formidable weapons for bombing purposes.

Un débat sur les responsabilités de la guerre européenne. The original article is contributed to No. 11 by Col. Feyler, who deals therein with the hostile reception accorded in Germany to Vol. I of the French Diplomatic Correspondence, recently published by the Commission appointed to investigate matters bearing on the origin of the Great War. The subject is carefully examined by Col. Feyler, who refers to the propaganda which has been in progress in Germany since the termination of hostilities with a view to reversing the verdict on the question of Germany's responsibility for the outbreak of the European conflagration in 1914, as set out in the Treaty of Versailles. He points out that the popular agitation which has been going on in Germany on the subject is simply a political manœuvre, and, regrettable though it certainly is, this propaganda can serve no useful historical purpose; the facts which have been made public in the State papers now made available to all historians will provide the true answer to the question: who was responsible for starting the World War?

A dépense égale, la plus forte aviation fait la plus forte armée. The original article is contributed to No. 12 by Lieut. E. Naef; it contains what is really a plea for recognizing an air force as the real and chief arm for the defence of a State.

W.A.J.O'M.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1929. TOME II.—NOS. 4 TO 6 INCLUSIVE.)

Les opérations de l'Armée belge—1914–1918. Events relating to a part of the period of stabilization, during which the Belgian Army held a portion of the Allied line along the Nieuport-Furnes Canal, are dealt with in the three numbers of the *Bulletin* under notice: the contents of No. 4 relate to the period May–Dec., 1915; those of No. 5 to the period Jan. 1st to June 5th, 1916; and those of No. 6 to the period June–Dec., 1916.

An account is given in No. 4 of the negotiations which took place between the Commander of the French XXXVI Corps and the Chief of the Belgian General Staff, in relation to the proposal made on Nov. 15th, 1915, by Joffre, that the part of the front near Steenstraat, then held by the French, should be handed over to the Belgians. A detailed description is also given in this number of the *Bulletin* of the manner in which the Belgian front was organized in the spring of 1915, and the measures taken to strengthen this part of the Entente line.

An appreciation of the situation, which was prepared by the Commander of the French XXXVI Corps, is given in No. 4; in it are set out the plans for meeting any attack which the Germans might launch against one or other of the sectors of the Entente front extending from the sea to Ypres. The text also appears in the same number of a letter from King Albert to the Commander of the French XXXVI Corps; it contains a criticism of the French proposals.

A general survey of the military situation during the first six months of 1916 is given in No. 5. The Germans had launched their great offensive against Verdun on Feb. 21st; only when the British and French troops moved to the attack on July 1st, and the Somme offensive began, was the enemy driven to assume a defensive attitude on the Western Front. During the first five months of the year no movement of any importance took place on the German Eastern Front. The Russians were not fit, after the heavy defeats of the previous year, to undertake further operations at this time; they were engaged in carrying out a reorganization of their Army, and thus gave the Germans a free hand to deal with the French at Verdun. On May 15th, the Austro-Hungarian Army launched its offensive in the Trentino against the Italians, but made only slight progress. In the Balkans, the Army of the Orient, created by the Entente Powers in Oct., 1915, grew steadily in strength; it was joined during the early part of 1916 by the Serbian Army, which had recovered from the effects of its retreat in the winter of 1915. During the first six months of 1916, the strength of the Serbian Army had been gradually raised to 300,000 men.

The dispositions of the Belgian forces during the period Jan. 1st to June 5th, 1916, are given in some detail in No. 5; a sketch map, showing the sub-divisions of the Belgian front, is included in this number of the *Bulletin.* The operations of the Belgian Army during this period are also briefly described therein, and a short review is given of the tactical developments of this period.

A review of the military situation during the latter half of 1916 is contained in No. 6. The Entente Powers had now assumed the offensive. The first of the grand attacks was launched by the Russians; Broussiloff advanced between the Pripet and the Roumanian frontier on June 4th, 1916, and broke through the enemy's front. To meet the situation thus created, the Central Empires were compelled to withdraw troops from the Western and Italian fronts. The Russian advance was not checked until Sept., 1916; by this time they had reconquered the Bukovina. The Franco-British offensive on the Somme continued until the middle of Nov., 1916; it compelled the Germans to abandon their operations against Verdun, where the French reoccupied an important part of the area which had been won at a very heavy cost by the Germans. The Italian Army had in June reconquered a part of the territory in the Trentino, lost by it during the previous month. At the beginning of August, the Italians launched an attack against the enemy's lines on the Isonzo; these operations continued for three months, and heavy losses were inflicted on the Austro-Hungarian forces, which were at the same time also feeling the heavy pressure of the Russian Army. On the Balkan front, the Army of the Orient was engaged in offensive operations during the period Sept.–Nov., 1916.

Although successes were obtained by the Entente Powers on the several fronts, and the situation became critical for the Central Powers, a decisive defeat of the latter was not secured. In the meantime, on Aug. 27th, 1916, Roumania declared war against Austria-Hungary and her Army invaded Hungary. Roumania's success was very temporary, and, contrary to all expectations, her entry into the conflict proved most unfortunate for the Entente Powers: it enabled the Central Empires to win an important victory towards the end of 1916. The moment now seemed opportune to the Central Powers for a move to negotiate a "German Peace"; it was made, but fortunately proved unsuccessful.

The proposal to extend the Belgian front, to which attention is called in an earlier part of this notice, is further dealt with in No. 6. The text of a Note, dated April 24th, 1916, in which Joffre outlines the role to be assigned to the Belgian Army is also published in this number of the *Bulletin*. The Belgian Army eventually took over the section of the line Steenstraat-Boesinghe. The dispositions of the Belgian divisions subsequent to this event are set out in some detail. The operations of the Belgian Army during this period, matters affecting the troops, and the further developments which took place in relation to tactics are also described in No. 6.

La tactique des renseignements. The final part of the article, by Col. Tasnier, under this title appears in No. 4; it deals in some detail with the following matters: the distribution of intelligence; its utilization; the external duties of officers of *2es Bureaux*; and the special features of the *2e Bureau* of a division. The duties and responsibilities of the intelligence officers of infantry regiments, and of artillery and of aviation formations are also discussed. In the concluding section of the article, Col. Tasnier sets out the manner in which instruction in intelligence duties should be carried out in peace-time in the case of the rank and file as well as of officers.

La survie d'un peuple. The 4th, 5th and final parts of the article, by

Major Delvaux, under the foregoing title appear successively in the three numbers of the *Bulletin* under notice.

The retreat of the Serbians from the Danube to the Adriatic is dealt with in No. 4. Attacked at the end of Sept., 1915, by the Germans, Austro-Hungarians and Bulgars, abandoned by her Greek Ally, and insufficiently supported by the Entente Powers—owing to commitments on other fronts—Serbia was faced with annihilation. The Serbian Army of 230,000 men had to contend with an Austro-German Army of 350,000; further, Bulgaria had mobilized another 400,000 men. In the circumstances, no other course was open to the Serbian Army but to retreat rapidly towards the shores of the Adriatic across the fields of Kossovo; in doing so, it put up a stubborn fight with the portion of the Bulgarian Second Army encountered on its march. An interesting account is given in No. 4 of the operations connected with the Serbian retreat; eventually, 130,000 men, after having endured intense hardships, succeeded in making the passage of the inhospitable and almost impenetrable mountains of Albania.

The operations undertaken by Austrian and German submarines with a view to preventing supplies from France and Italy reaching the Serbians and the naval operations in the Adriatic are also described in No. 4.

The measures taken to reorganize the remnants of the Serbian Army and the arrangements made for its transfer to the Salonika front are dealt with in No. 5. The Entente Powers having decided that the remnants of the Serbian Army should, in the first instance, be transported to Corfu, a notification of this decision was sent to the Government at Athens accordingly; a French naval squadron appeared at Bizerta, and occupied Corfu on Jan. 11, 1916. The arrangements made for the transfer of the Serbians from the mainland to Corfu are fully described in No. 5; their withdrawal was covered by Italian troops sent to Durazzo and Valona for this purpose. On Feb. 22nd, 1916, the last Serbian soldier at Valona embarked for Corfu, and a Serbian Army of 120,000 men had by that date been collected on the island. However, a Serbian cavalry division—13,000 men and 10,000 horses—still remained in Albania and was not withdrawn until April, 1916.

The Serbian campaign gave rise to differences between the Enemy Powers; these are briefly touched upon in the original article. Matters relating to the administration by the enemy of the invaded territories, the steps taken at Corfu to assist the recuperation of the Serbian Army, the work of the "British Adriatic Mission," and the abortive negotiations which took place between the Entente Powers and the Athens Government in connection with the proposal to disembark the reconstituted Serbian Army at Patras, and to transport it by rail *via* Athens and Larissa to the neighbourhood of Ekaterini on the Aegean Coast, are fully discussed in No. 5.

The offensive operations on the Macedonian front during Sept., 1918, are dealt with in No. 6. In this number the article opens with a review of the events of 1915–1918, following the occupation of Belgrade by Austro-German troops in Oct., 1915, which was succeeded by the invasion of Serbia by the Bulgars on the 11th *idem*, and the disembarkation on the 12th *idem* of Sarrail, the C.-in-C. of the French Army operating in Serbia, at Salonika.

Successful operations carried out in May, 1918, in the neighbourhood of the heights of Jarebitchina by the Greeks, supported by a French Colonial division, prepared the way for the offensive of the September following. At the latter date, Franchet d'Esperey was in command of the " Armée d'Orient," which was constituted as follows: 8 French divisions, 4 British divisions, 1 Italian division, 6 Serbian divisions and 9 Greek divisions (total: 28 divisions—600,000 men). Opposed to it was a Bulgar force grouped in 4 armies, consisting of 445,000 men and 1,270 guns, exclusive of the 3 Austrian divisions occupying the region W. and S.W. of Lake Ochrida. The successive operations which had to be carried out to break through the Bulgar front, and the manner in which they were conducted are described at some length in No. 6.

An armistice, bringing hostilities to an end on the Salonika front, was signed on Sept. 29th, 1918: the terms embodied in the document are stated in the original article.

La bataille d'Aubers, de Festubert et de Loos (1915). The original article is in two parts, which appear in Nos. 4 and 5; the account of these battles is based on the materials provided in Vol. IV of the British *Official History of the Great War.*

Étude des raids faits à Kippe par des troupes de la 1 *D.I. dans la nuit du* 18 *au* 19 *Août*, 1918. The original article is contributed to No. 6 by Capt. Daubechies; he sets out the objectives assigned to the troops detailed to carry out the raid; the character of the region in which it took place and the enemy's defensive arrangements; the plans on which the infantry attack and artillery action were based; the execution of the attack and the results obtained. He further furnishes comments on the operations and on the lessons to be learnt therefrom.

W.A.J.O'M.

HEERESTECHNIK.

(*April*, 1929).—*The Influence of the Technical Development of the Firearm on Infantry Tactics.* Having enunciated the principle that the foundation upon which tactical methods must be built up is weapon-effect, the author shows how the hand firearm has gradually improved to become eventually the chief weapon of the infantry, and traces how the fighting methods of the latter in the course of time have been modified and re-moulded in accordance with the increased effectiveness of the weapon. It follows from his initial proposition that the best tactics is that method of fighting which permits the utmost use of the possibilities of the hand firearm.

The technical development of the firearm, hand or otherwise, has in general been carried out on the following lines:—The creation of a safe means of ignition, increased handiness, increase of rate of fire, increased accuracy, increase of range, flatter trajectory, improved state of a fire-preparedness, increase of effect on the target. These individual points have come sometimes more and sometimes less into the foregound. It has happened in the course of time that technics " faint, but pursuing," has done no more than strive to keep pace with the soldier's urgent demands. At other times, again, technics has made progress not desired by the soldier, but which has on the contrary filled him with uneasiness and mistrust, so that, especially after long periods of peace, powerful opposition has arisen against the introduction of improvements.

The saying is trite that the invention of gunpowder transformed warfare. Looking back through history it is not difficult to see the truth of this statement, but the transformation took place so slowly that it may well have passed unnoticed while it was in progress. It covers a period of three and a half centuries, from the invention of gunpowder, popularly ascribed to the monk, Berthold Schwarz, in 1320, until the first order was given for every infantry soldier in his army to be equipped with a firearm, by the Elector of Brandenburg, Frederick III, in 1689.

This example was followed by other States, and the pike, as an alternative to the firearm, disappeared from the great armies of Europe. The invention of the bayonet, however, re-introduced the pike in another form, when, as an addition to the firearm, it gained sufficient repute for the Russian General Suvaroff to say a hundred years later, " The bullet is a fool, only the bayonet is wise."

The infantry firearm, starting with a weapon made at Liége in 1414, capable of being served and fired by one man, but incapable of being aimed, owing to its heavy support and forged-on spike for taking the recoil, is then traced by the author through its various stages of match-lock, wheel-lock, and flint-lock.

The drill for loading and firing is similarly traced from the two hundred motions laid down as necessary for these purposes by Maurice of Orange in his " Manual," until it was reduced by Frederick the Great to twenty-three motions : and the changes in tactics are followed to 1806, when the better drilled Prussians were forced by the French armies of the Revolution to abandon their idea that " skirmishing brings out the natural coward in the soldier and kills the spirit of the offensive."—(*To be continued.*)

The Berlin Automobile Exhibition, 1928. After an interval of seventeen years there has taken place again in Berlin a large international automobile exhibition of cars, lorries and motor-cycles, which both in extent and in number of exhibitors has created a record among international automobile exhibitions. By the number of firms exhibiting there were—in cars, 24 German to 38 foreign ; in lorries, 25 German to 9 foreign ; and in motor-cycles, 34 to 13. These figures are taken as proving that in the two latter classes Germany's leading position is so well assured that foreigners do not find it worth while to compete. The increase in the total number of motor-vehicles in Germany in one year, viz., 29%, shows, however, that the country is still the best of markets for such goods.

The number of types of car shown per firm has risen from 1.7 to 2. This is looked upon as a bad sign, partly referable to unstable economic conditions in Europe. Salient points of interest were : that the light European two-seater, four and six-seater approximate more and more to American lines : that there is a great increase in high power eight-cylinder engines : a promising further development of clutches and gears :

and that the flexible axle and the worm-wheel drive have made their appearance.

As regards engine-details, the light metal piston is firmly established, being found in 90% of the car-exhibits. A notable example is the Bohnalite, which has steel inlays, actually of Invar steel, possessing a very low co-efficient of expansion. This piston has made great headway, and is said to be installed already by two hundred firms.—*(To be continued)*.

The Degree of Accuracy to be expected of Guns and Trench-Mortars, by Lt.-Gen. Baron Botzheim. The justification for an article of this nature appears in the first few lines, in which the author points out the surprising fact that generally in judging of the capabilities of guns and trench-mortars their degree of accuracy in hitting—the opposite of strewing—is but seldom consciously taken into account. What may contribute much to this neglect is that in military literature the tables giving the most important particulars of guns, etc., contain no mention of this point, and that it is almost entirely missing from the *Training Regulations* and from tactical handbooks. And yet the question of accuracy forms an essential factor in determining how far different kinds of guns, especially at longer ranges and against small targets, are actually capable of carrying out the different kinds of tasks allotted to them, with the ammunition at their disposal and within the appointed time. There is also the further question of whether in certain cases the "shorts" to which one's own infantry are exposed occur owing to normal strewing.

There is nothing new to the older generation of Garrison Artillery officer about such questions. He has always been accustomed to work them out. The calculations of percentages of hits, and consequently the amount of ammunition required against small targets, were twenty years ago the Garrison Artilleryman's daily bread; and special significance was accordingly attached to the factor "accuracy" as compared with other factors, *e.g.*, rate of fire, ranging, etc.

The increasing introduction of heavy field howitzers into mobile warfare also emphasized the value of the latter factors, since these heavy pieces could generally attain their object, *e.g.*, against field artillery in the open, better with a certain amount of dispersion than by accurate shooting at a point.

For the Field Artilleryman, firing chiefly shrapnel, there was before the war little occasion to concern himself greatly with the dispersion which would occur at the longest ranges; but during the war, ballistic questions were forced upon the artillery by the large amount of unobserved shooting according to plan, and the accuracy necessary for a good barrage.

In all countries there is now taken as a starting-point a mean dispersion in length of about 1%, and a mean dispersion in breadth of 1 to 2 per thousand of the range. With increasing calibres the former decreases to ½% and less. The maximum dispersion to be expected is 4 times the mean dispersion, but under war conditions, with worn barrels and inferior ammunition, such as is manufactured in war-time, the dispersion may rise to 2 or even 3 times this distance. Theoretical examples are then given and the figures are compared with the actual dispersions of the present-day guns and trench-mortars of the German Army.

Of the 1916 field-gun the dispersions in length and breadth respectively should be :—

At 5 km., 50 m. and 5 m.
At 10 km., 50 m. and 10 m.
At 14 km., 150 m.

Actually at 6 to 7 km., there is a length dispersion of 50 to 60 m. At 10 km. the length dispersion has risen to 110 m. and the breadth dispersion to 30 metres. Even the strewing at a range of 2 to 4 km., viz., 20 to 30 m. in length and 1 to 3 metres in breadth, shows that, allowing exact registration, it will take between 10 and 20 rounds to get a hit on a small target like an m.g. nest, single gun, dugout, trench-mortar or bridge. Theoretically the 7.7 cm. gun takes 100 to 150 rounds to get a direct hit on a target 5 m. x 2 m. at 6 to 7 km. : actually, as the above figures show, it is much worse. At 10 km., where observation is no longer possible, effective fire against small targets is hardly attainable. An increase of range of this gun to 14 km., which has been proposed and which is certainly constructively possible, would render effective fire in the above sense more illusory still.

With larger guns so much damage can be done by splinters that we are no longer justified in demanding a direct hit. The author sums up the various types as follows : The 1916 field-gun, accuracy as shown above is less than might be expected theoretically ; the 1916 light field howitzer, though not heavier than the 1916 field-gun, is ballistically very good ; the 1917 10 cm. gun is more accurate than the 7.7 cm. at all ranges, its dispersion at medium ranges being not greater than standard ; the long heavy field-howitzer, 1913, dispersions are greater than with the light field-howitzer, although the opposite should be the case ; the 1916 15 cm. Krupp gun, built to outrange enemy guns firing 17 to 18 km., is a distinct type of overloaded gun with bad strewing and quick barrel-wear ; the light mortar, accurate at all ranges, so that with quite sufficient mobility and fire-preparedness it was rightly known in war as a " wonder of technics."—(*To be continued.*)

The Piezo-electric Effect and its use in Wireless (*continued*). To be of practical use for wireless purposes a crystal must satisfy three conditions : (1) It must possess the piezo-electric effect. (2) Its period of natural oscillation must be calculable in advance. (3) It must have a practically utilizable decrement of damping.

Since in present practice only quartz crystals are used, the article deals only with such. As explained in the last number, a quartz crystal in order to possess piezo-electric effect has to be cut in a particular manner.

The natural frequency of a quartz slip can be calculated immediately with sufficient accuracy from the formula

$$f = \frac{v}{2 . l}$$

where v represents the velocity of propagation in quartz, being the number of cm. travelled per second, viz., 545,000 ; and l (or d) is the length (or depth) of the crystal in cm., depending upon whether the oscillations to be measured are longitudinal, or at right angles to the longitudinal axis.

The wave-length of a sender, etc., which can be controlled by a piece of quartz of given length (or thickness), can be most simply calculated from

$$\lambda \text{ (metres)} = 1.1 \times 10^3 \times l \text{ (cm.)}.$$

The range of waves for which pieces of quartz can be prepared is very great, since for longer waves the length, and for shorter waves the breadth of the crystal can be used. For thickness oscillations the limits in size of the crystal are from about 9 mm. to .2 mm., corresponding to wave-lengths of 1,000 metres and 20 metres respectively. These, then, are the limits of waves to be measured by quartz through its oscillations at right angles to a longitudinal axis.

For shorter waves still, either a harmonic must be used or a suitable longer wave is produced by quartz control and reduced by frequency transformation to the desired smaller value. These proceedings are of great practical significance, since it is precisely with short-wave senders that the exact adjustment to and maintenance of the sending wave are of the utmost importance.

The author then gives us certain notes on the preparation of quartz-crystals, and of Cady's two methods of using them for wave measurement.—(*To be concluded.*)

(*May*, 1929).—*The light limbered Telephone-wagon.* This wagon started issue to the troops last spring, following three earlier trial vehicles of 1926, 1927 and 1928, but differing in construction and equipment essentially both from the then existing service article and from the trial vehicles. These notes on the new wagon are accordingly considered necessary.

The following conditions were considered essential for the construction :—

1. To replace the small sprung telephone-wagon 1905 by a light limbered vehicle with its centre of gravity as low as possible so as to improve cross-country powers.
2. To solve the question of a Universal type Telephone-wagon.
3. To standardize with the body of the small wireless-wagon.
4. To arrange the equipment more accessibly and more purposefully.

On account of repeated complaints from the troops wood has been abolished from the superstructure and its place has been taken by sheet steel. It has been proved with this material that fears of the equipment suffering through overheating from the sun are not justified. The doors have been made dust- and water-tight.

Light metal has been used wherever possible, viz., Lautal, hard sheet aluminium, and Silumin.

The distribution of equipment is office and instruments on the limber, line stores on the rear wagon.

The brake-lever, as in artillery vehicles, is on the saddle side of the rear wagon.

The axle is dropped to get the weight low and to be of the same pattern as that of the wireless wagon, which has its axle dropped on account of the engine.

The wagon is drawn in the infantry by a pair of horses, in the cavalry by six, and in the other arms by four. It carries four men, two on the limber and two on back seats on the rear wagon. Its weight empty is 740 kilos, loaded but without crew 1,240 kilos.

A provisional list of stores was issued in May.

The Influence of the Technical Development of the Firearm on Infantry Tactics (*continued*). This instalment covers the period 1806–1866.

The eighteenth century, in which the idea of mass-fire had been dominant, produced no essential improvement. As regards the care of the firearm mass-fire had been directly detrimental, since all that was required of the weapon was that it should shoot, and how it shot was considered of small importance. A very small percentage of hits was reckoned with, estimated at one hit to fifty shots fired.

The nineteenth century, however, from the end of the Napoleonic wars was a period of continuous development, slow at first but very rapid towards the end. Napoleon himself, the artilleryman, had done nothing for the infantry weapon. The unreliability of the flint-lock was great, and often led to fighting with the butt. What brought the first progress was an improved method of ignition. The period itself is known as the "scientific" period, and not without justification, since it was scientific discoveries which created the possibility of further development. In 1786 potassium chlorate was discovered by Berthollet, and in 1799 fulminate of mercury by Howard. The two substances were used for firearms by the Scotsman, Forsyth, in 1807; and in 1819 a successful percussion-cap was made. The old mechanical arrangements for ignition were quickly driven from the field by the new "chemical lock," for its superiority was enormous. It had one twentieth of the number of missfires of the flint-lock, was twenty times as accurate, and permitted a slightly higher rate of fire. All the military nations went over to percussion by converting their flint-locks.

Weapon-technics were also striving to utilize the long-known advantages in accuracy and range of rifling also for the universal army-weapon. Such a rifle was expensive, wore out rapidly, got leaded up, and was very slow to load, so that the rate of fire fell to less than one-half. The problem of the army weapon of precision was eventually solved by the French captain, Minié, who inserted a small iron cup in the base of the bullet, which allowed the gases to pass through and press the soft lead walls of the bullet outwards into the rifling. Again all nations re-armed.

Whereas chemical ignition, though a great step forward, was not revolutionary, the introduction of the rifle opened the way to great tactical changes, owing to reduction of calibre and great increase of range of effective fire, viz., loose formations and open-order fighting, the line of skirmishers, decentralization of command, the utilization of cover, etc.

Still the rate of fire had not increased; it had even diminished. A hundred years earlier one had striven to increase the rate of fire. Now in many an army the principle of overwhelming the enemy by volume of fire was ignored, and it was believed that the same object could be attained by greater range and greater accuracy.

Only Prussia took a whole step forward by introducing the breech-loader. In spite of all resistance, this rapid-firing device carried the day. Military circles indeed resisted stoutly, the danger of running out of ammunition being conjured up, as again later, before the introduction of the magazine-rifle and of the machine-gun—and now of the automatic-rifle.

It took sixteen years from the recommendation of the Proof Commission in 1839, who had even gone so far as to call it " a great gift of Providence," before the Prussian Army was equipped throughout with the needle-gun, and eleven years more before it " formally surprised the military world by its success on the battlefields of Bohemia."—(*To be continued.*)

The Berlin Automobile Exhibition, 1928 (*continued*). Battery-ignition has increased to a very great extent, only 32% of the vehicles shown still having magneto-ignition. Considering its extreme reliability magneto-ignition is unwillingly given up, but battery-ignition has made rapid headway owing to its cheapness.

Carburettors have had to accommodate themselves to the demand for maximum starting acceleration. Thus the new Zenith carburettor has essentially new features, including a small petrol pump connected with the throttle-lever, and thus giving a spurt of petrol out of the accelera-tion-jet, which ensures sudden powerful engine-acceleration.

The very neat appearance of modern engines with flanged-on gear-box is shown by photographs of the 4.6 litre 8-cylinder 80 H.P. Daimler-Benz, and 2.5 litre 6-cylinder 50 H.P. Wanderer.

Exhibited only as an engine was the U Double-piston two-cycle engine of Zoller, of which two excellent photographs were shown in *Heerestechnik* (Dec., 1929) after the Paris Exhibition. The object of these two-cycle engines is to produce something highly elastic like a steam-engine, so as partly, and perhaps later, entirely to do away with gears. Meanwhile they must be looked upon as being in the trial stage.

Special mention must be made of three American (Cadillac, Lincoln, La Salle) 8-cylinder engines in V form, on account of compactness and smooth working, of great promise for future increases of power and length.

Practically all modern cars have engine and gears together, although three years ago only 75% were so built. Plate-coupling, now in 90% of all vehicles, has contributed to this change.

Dry multiple-plate clutches are gaining on the dry single plate which the majority possess.

That with increasing engine-size the engine itself takes up a portion of the elasticity and power of accommodation to differing resistances is shown most clearly by the great increase in three-speed gears, now as many as 60%.

As revolutions have increased very much lately it was natural to call upon clutch and gears to share in the work of gaining increased elasticity. Two improvements on these lines, the N.U.G. Presto and the Erdelen automatic-clutches are then described with diagrams.—(*To be concluded*).

The Diversion of Industry on to War-work. A tendencious article full of indignation against the French Yellow Press, which is accused of constantly repeating statements to the effect that Germany, owing to the rapid development of its industry since the War, would "in the shortest time" be able to equip a new German Army and to maintain it in the Field. These statements are said to be among the favourite reasons for France's refusal to disarm, and it is claimed that this article proves them to be both untrue and opposed to common-sense. The article produces some of the difficulties of conversion, but is naturally unable to prove anything, unless it be the indignation of the writer. That such a diversion of industry on to war-work must take place the writer is obliged to admit: what makes him angry is that the Jingo Press abroad should pretend that it is an easy matter. He points out various reasons why the diversion of German industry to war-work would be more difficult now than in 1914:—

(1) Less peace-time production of war-material, owing to (*a*) smaller army, (*b*) no foreign armies now supplied, as was the case up to 1914.
(2) Recent legislation concerning labour has made mass-production much more difficult.
(3) There is a great lack of capital in private hands, so that from the first enterprise and undertakings would be thrown upon the State.
(4) Greater electrification has made greater vulnerability, so that in many places reserves of power would have to be provided.

In these respects it is claimed that all other industrial nations are far better off than Germany. Against them only one point is produced, viz.: increased standardization and rationalization have made it possible to make a better use of unskilled labour.

Who is to assess the comparative values of this point and the other four? The Chauvinists are of course wrong if they make out that the diversion can be made in Germany or in any other country easily or in a very short time. They would be right if they confined themselves to saying it will be done in every country in the shortest possible time.

The Degree of Accuracy to be expected of Guns and Trench-mortars (*concluded*). The light trench-mortar's dispersion from 200 to 800 metres' range is in length 10 to 35 metres, and in breadth 1 to 3 metres. It is thus reasonably accurate against small targets at these ranges. Above 900 metres' range and with high-angle fire at all ranges there is no possibility of shooting at small targets without a disproportionate expenditure of ammunition, although splinter- and moral-effect remain. But, 4–5% dispersion in length and 1% dispersion in breadth cannot be denied, and in face of the theoretical possibilities it must be admitted that the light trench-mortar is ballistically of absolutely small value—primarily accounted for by its short barrel and muzzle-loading.

Lamentable as this fact is, it is necessary to have the point clear so as to counteract erroneous views as to the results to be expected, and consequent nature of employment.

Taking next the medium trench-mortar, if its accuracy at short ranges can be considered just sufficient, in all else it resembles the light T.M. and its ballistic performance must accordingly, from the theoretical standpoint, be ranked as absolutely of minor value. Its chief effect and performance thus lie, not in its accuracy, which is only to a certain extent sufficient against small targets at the short ranges which were usual in trench-warfare, but in its greal moral and destructive splinter and air-pressure effects against living targets.

Against this, however, it cannot be sufficiently emphasized that it is only the destruction of the hostile heavy weapons which finally makes the way clear for our own infantry, and must therefore be striven for. The crew of the hostile heavy weapon can generally be replaced immediately, while the weapon itself cannot.

There follows a table of dispersions in length of the field-guns, howitzers and mortars already discussed, comparing them with the corresponding weapons of 25 to 30 years ago, from ranges of 1 to 10 km., as far as these apply.

These tables show at a glance a regular and all-round deterioration in accuracy. The older weapons had on the other hand less fire-preparedness, a lower rate of fire, and shorter ranges ; but smaller weights and entirely sufficient mobility.

After this revelation the author feels that he must console. "It may, therefore, be taken as certain that, when the present work of systematic investigation of the factors affecting the accuracy of guns and T.M.s, especially at the tactically important longer ranges, is finished, a real improvement in ballistic performance will be attained." He detracts somewhat from the certainty by adding "provided that the troops, the designer, and the manufacturer hold firmly to the fact that accuracy is of paramount importance."

Practical hints are then given for bringing home to the troops and to leaders the importance of a correct appreciation of the accuracy factor.

The Piezo-electric Effect and its use in Wireless (*continued*). Describes Giebe and Scheibe's practical and most useful wave-measurer, which utilizes the light-phenomena appearing in a quartz-crystal when resonance occurs. The existence of a state of resonance is thus established, and the measurements thus made are accurate to 10^{-4} of the frequency.

To tune a sender it is usual to place three of these quartz-cells in parallel with the variable condenser of the closed oscillating circuit, one at the desired frequency, and the other two at frequencies differing .1 to ·2% above and below respectively.

The disadvantage of all quartz wave-measurers is that there must be a quartz-cell for every wave to be measured, or preferably even a set of three, as just indicated.

Besides for wave-measuring, which is their most important and widespread use in wireless, crystals have also other uses, viz., for control of senders, and for tuning the received wave in receivers.

Their method of employment in sender-control is at once understood when one considers the crystal as replaced by a closed oscillating circuit. Such a way of regarding it is justified, since when resonance occurs the crystal behaves like a closed oscillating circuit.

Especially with short-wave senders it is usual to use an H.F. choke parallel to the crystal, for increasing the energy oscillating in the grid circuit by damping H.F. disturbance.

Because of the limit of thinness of the crystal, wave-lengths below 20 metres can only be controlled by quartz-crystals when the frequency of the latter's wave has undergone transformation. This is done, for example, by the short-wave sender at Nauen.

In reception the quartz-crystal is exclusively used for tuning. The extreme accuracy it gives is essential for short-wave reception.

In this case the *direct* piezo-electric effect is used, the crystal being on a tail, with one pole only connected to the grid-circuit, and the other disconnected. When resonance occurs crackling is heard in the telephone, and the crystal is then switched off.

The new All-Metal Dirigible. A short description is given of this American airship, which is chiefly remarkable for its external hull being made of Duralumin corrugated sheeting strips, and its method of propulsion, viz., steam-turbines with ordinary gas and oil as fuel.

A new type of Anti-Aircraft Machine-gun. Shows a photograph of four machine-guns lying side by side on a common mounting, machinery-driven, and said to fire 2,000 rounds a minute and to have a range of 3 miles.

(*June*, 1929).—*The Influence of the Technical Development of the Fire-arm on Infantry Tactics* (*continued*). After the rapid fire of the breech-loader had won a signal success for the Prussians over the Austrians in 1866, all military nations re-armed with the breech-loader. This was done either by conversion of their muzzle-loaders, or by introducing a new weapon; which latter case gave them the advantage of making a material reduction in calibre, to 11.5 mm., and less. Among the nations which adopted the second course were the French with the Chassepot. But the introduction of a new weapon, however superior in itself, does not guarantee any real superiority in battle until :—

(1) The troops have got to know the new weapon, and to recognize wherein its superiority lies.
(2) Appropriate tactical methods have been devised,
(3) Training has been such as to ensure complete exploitation.

The French with their small-calibre Chassepot had the ballistically superior weapon, but, for lack of the foregoing, achieved no more with it than to cause casualties to the Germans at ranges which came as a surprise to both parties. The war of 1870–71 proved as surely the superiority of the small-calibre rifle, as that of 1866 had proved that of the breech-loader, only obscured by the fact that in the later campaign victory rested, for entirely sufficient other reasons, with the side possessing the ballistically inferior weapon.

The nations found themselves compelled to re-arm, and this re-armament gave them the opportunity of introducing the great improvement of the metal cartridge-case. The new weapons, amongst which were the 1871 Mauser and the Bavarian Werder, had reached a pitch of excellence, which should have brought about a development in tactics. This development took place only to a small extent, or hardly at all.

The Russo-Turkish war, eight years later, showed how little had been learnt from the lessons of the Franco-German war. It produced, however, a new weapon. The Turkish infantry used at Plevna, besides their good Martini-Henris, the Winchester carbines of their cavalry, who were condemned to inactivity. The magazine-rifle, which had already appeared in several forms, and which had even been introduced into one army—the Swiss—in 1869, thus made its entry into war.—(*To be concluded.*)

F.A.I.

CORRESPONDENCE.

NEW ZEALAND NEWS.

THE Officer Commanding the Southern Depot Corps of New Zealand Engineers has kindly forwarded the photograph reproduced, together with the accompanying letter :—

King Edward Barracks,
Christchurch,
11*th Nov.*, 1929.

The Editor, *R.E. Journal.*

SIR,

I am enclosing herewith a photo showing the training carried out by this Unit on a recent half-day parade (three hours).

It will be noted that full equipment for the assault bridge for this gap was not available and that the service trestle bridge was not completed. You will also note that petrol tins only are available in N.Z. for assault bridging.

In addition to the work shown in the photograph, remaining sections had erected on this day a swinging derrick and some 50 yds. of double apron fence.

This work is a normal programme for one half-day.

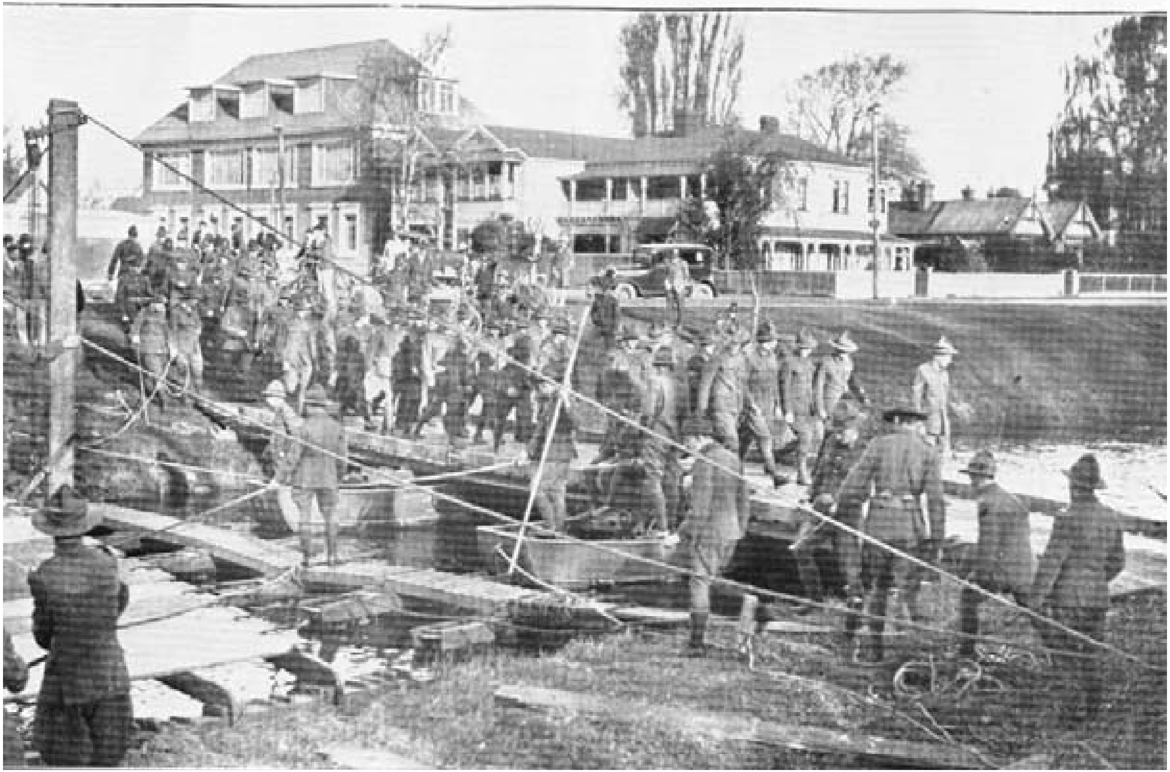
I would like to add that this photograph was taken without the Unit being warned, hence the rather untidy look of the odd stores, etc.

It is, however, sent to you not for criticism, but to show you what sort of work is carried out by the Sappers in New Zealand. A higher standard of work is of course reached at the annual Camp.

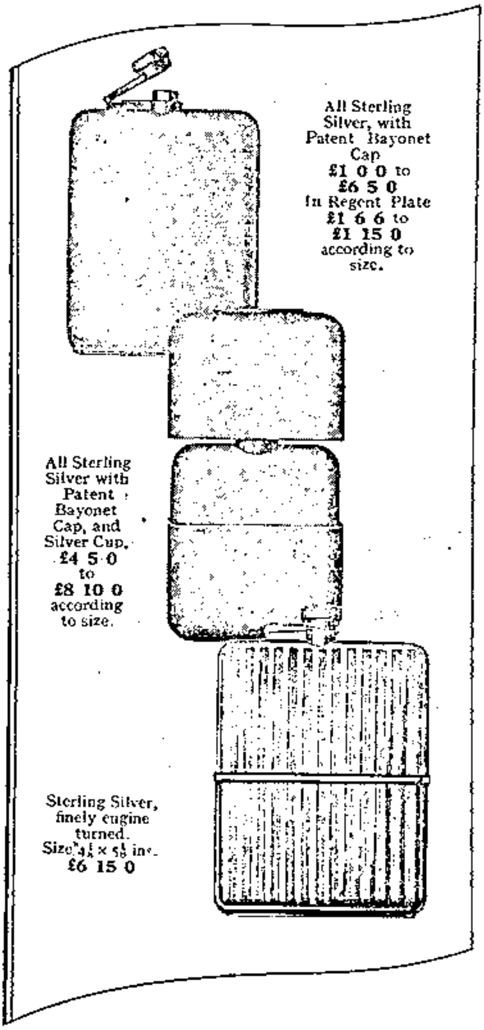
Yours faithfully,

J. W. DOW, *Major, N.Z.E.,*
Commanding Southern Depot
Corps of N.Z. Engineers.

NEW ZEALAND NEWS.



Engineer Training.



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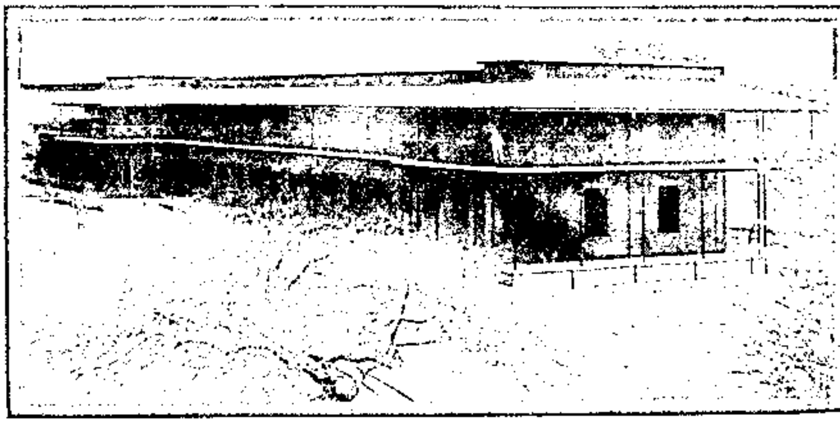

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