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CONTENTS.

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2,150—1 9 29.

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HOW BRITISH COLONIES ARE GOVERNED.

A Lecture delivered at the S.M.E., Chatham, on February 14th, 1929, by BRIG.-GEN. SIR SAMUEL H. WILSON, G.C.M.G., K.C.B., K.B.E.

ONE often meets people who, in talking of our Empire, are prone, and perhaps it is understandable, to connect the name with the great self-governing Dominions, and to forget our numerous Colonies, protectorates and mandated territories which, scattered all over the face of the globe, form our Colonial Empire, with all its potential markets for British trade. I don't think, therefore, that at the beginning of a paper entitled "How our Colonies are governed" it will be amiss if I explain briefly what the term 'British Empire' means, and how that Empire has come somewhat haphazardly into existence. I will then, if you will allow me, deal with the responsibilities with which the Secretary of State for the Colonies is charged and indicate how, in carrying out these responsibilities from London, he is assisted by the Colonial Office and its subsidiary organizations.

I will then explain to you the various types of constitution that are to be met with in the different non-self-governing territories, and the tendency that there has been of late years to meet the demand for responsible government, a demand which since the War has been pretty general all over the world.

The first recorded act of the British Government with a view to colonial enterprise dates back to the middle of the sixteenth century, when a Charter was granted by Queen Elizabeth to Sir Humphrey Gilbert, of Compton, Devonshire. The letters patent were dated June 11th, 1578, and I had intended reading them to you; but I am not going to do so, as I find that legal documents were almost as ambiguous and boring 300 years ago as they are to-day. I will merely tell you that the letters patent gave to Sir Humphrey Gilbert the right to do practically anything he liked in any remote or barbarous lands which he might find unoccupied by any Christian prince or people, so long as he paid to the British Crown one-fifth part of the gold and silver ore he found therein. I must confess that in these days of democratic government and unofficial majorities, as an ex-Governor it makes my mouth water when I think of the power given to Sir Humphrey Gilbert.

No colony was ever founded by Sir Humphrey, as, although he took formal possession of Newfoundland in the name of his sovereign, the right was not practically asserted during her reign. Sir Walter Raleigh's two attempts in 1584 and 1587 to establish a colony in

Virginia under the same royal sanction were as unsuccessful as had been that of his half-brother, and when James I. succeeded to the throne in 1603 there was not a single Englishman settled in America.

With the seventeenth century British colonization began in earnest. In 1605, a party of adventurers planted a cross somewhere in Barbadoes with the inscription, "James, King of England and of this Island," and in the following year charters were granted by the same monarch to the two companies which colonized Virginia and New England. In 1620, the first Colonial Representative Assembly was convened in the Bermudas; and in 1631, the first British settlement in West Africa was established on James Island, in the Gambia. I visited this island in October last during a tour I made on the West Coast. The remains of the old fort and the guns mounted therein, with which we controlled the trade of the Gambia, have recently been excavated.

The eighteenth century saw many important additions to the Empire in North America, the West Indies and West Africa. It also saw the disruption of the political structure of what is sometimes called the first British Empire, when the American Colonies declared their independence. Again, it was in the eighteenth century that the laying of the foundation of a new British Empire on true and enduring lines began. Canada played a great part in laying these foundations, a part which was eloquently described in a lecture delivered by Mr. Vincent Massey, the Minister of Canada to the United States. He began his sketch in 1759. In that year, he said, a great Englishman, Wolfe, met in battle a great Frenchman, Montcalm, in the fields near Quebec, and in a short and gallant fight replaced the lilies of France with the Union Jack of Britain. This battle between French and English was fought with the chivalry of a gentlemen's duel. Whenever you visit Quebec, if you look for the monument of Wolfe and Montcalm, you will find inscribed on its base one of the most stirring and fitting inscriptions ever chiselled in stone: "Valour gave them a common death, history a common fame, posterity a common monument."

In those days the conqueror, as a rule, was none too nice in his care for the feelings of the conquered, but wisdom and justice prevailed in the counsels of the time, and to the sixty thousand French people living in Canada were granted those precious possessions, liberty of worship and freedom of language. Thus was promise given of just treatment in Canada for this old community under their new flag.

After the peace of 1783, many thousands of people moved from the new Republic into British North America, and the year 1791 was the beginning of a new era in Canada. Upper Canada (now Ontario) was established as one province with a few thousand English-speaking settlers, and Lower Canada (now Quebec) was set up as another province on the banks of the St. Lawrence with a larger population,

chiefly French. Each had its Assembly; each had its Governor; and each its nominated Chamber or Legislative Council. The grant of representative institutions to French and English alike was vastly important to the future of the Empire. It showed that British liberty and British rights were not to be enjoyed by inhabitants of Great Britain and their descendants alone, but were to belong to all those who lived under the Union Jack and were equal to the responsibilities involved.

The subsequent growth of responsible Government in Canada was important not only to British North America, but to the whole British Empire. It showed that responsible colonial government could be harmonized with membership in a great Commonwealth, and that as self-government grew, the attachment of the colony to the larger unit was not weakened, but rather strengthened. It was found possible, as Mr. Massey said in the address to which I have referred, to reconcile nationality and Imperial unity, despite all the melancholy prophecies of those who thought it could not be done, and as it became increasingly successful other self-governing communities in Australia, and in New Zealand, grew up within the Empire.

I have mentioned these points in connection with the growth of the first of our Great Dominions in order to emphasize the fact that it is the justice, freedom and fair play which are always to be found where the Union Jack flies, that have made it possible for the British race in the years that have passed since 1783 to build up an Empire such as the world has never seen before.

Just as the Dominion of Canada grew from the seeds sown at the end of the eighteenth century, so during the nineteenth century and the early part of the twentieth century, did the world see not only the birth of other self-governing Dominions, which now form part of the great British Commonwealth, but also the addition to the Colonial Empire of new colonies and protectorates all over the face of the globe.

It is of interest to pause here for a moment to take the measure of our Imperial responsibilities at the middle of the nineteenth century, as compared with those of to-day—in other words, the growth of a lifetime.

During this period little or no change has taken place in America and the West Indies, except that the vast areas in the Antarctic which are now valuable dependencies of the Falkland Isles were seventy years ago in more or less undisputed possession of whales and penguins. In Australasia, Fiji and numerous other islands in the Pacific have been added to the territories of the throne. In Asia—apart from mandated territories which were the result of the War—many native States in the Malay Peninsula and Borneo have come under the protection of His Majesty. In Europe and the Mediterranean, Cyprus has come into the picture. It is, however, in Africa that the most striking changes have occurred. I need only mention the

addition of the Rhodesias, Nigeria, the Gold Coast, and the territories of East Africa, now known as Kenya, Uganda, Zanzibar, Somaliland and Nyasaland, together with the mandated territory of Tanganyika, to give you some idea of what the "Burden of Empire" means to-day. From the sketch I have given you so far you will have realized already that the development of the various systems of colonial government followed no pre-arranged plan, and even an epoch-making event such as the summoning of the first Colonial Conference, less than fifty years ago, was but a minor feature of the celebration of the 1887 Jubilee.

In Queen Victoria's speech on the prorogation of Parliament in 1886 reference was made to Her Majesty's Colonial and Indian possessions in the following terms:—

"I have observed with much satisfaction the interest which in an increasing degree is evinced by the people of this country in the welfare of their colonial and Indian fellow subjects; and I am led to the conviction that there is on all sides a growing desire to draw closer in every practicable way the bonds which unite the various portions of the Empire. I have authorized communication to be entered into with the principal colonial governments with a view to the fuller consideration of matters of common interest."

In conveying this invitation, Mr. Edward Stanhope, the then Secretary of State for the Colonies, closed his dispatch with the prescient words:—

"I am confident that your Government will, as I do, feel deep interest in this first attempt to bring all parts of Her Majesty's Empire into joint deliberation. However modest the commencement may be, results may grow out of it affecting, to a degree which it is at present difficult to appreciate, the interests of the Empire and of the civilized world."

You will observe that it is less than fifty years ago that the oversea governments were asked to join in a round-table conference. Conference succeeded conference at irregular intervals until the Imperial Conference of 1926, with its momentous definition of the position and mutual relation of the group of self-governing communities composed of Great Britain and the Dominions as autonomous communities within the British Empire. This decision provided for their being equal in status, in no way subordinate one to another in any aspect of their domestic or external affairs, though united by a common allegiance to the Crown and freely associated as members of the British Commonwealth of Nations. A year previous to this conference, it was realized that with the growth of autonomy in the self-governing Dominions the time had come to create a separate Department of State to deal with questions affecting the Dominions; and the old Dominions Division of the Colonial Office became, just over four years ago, the present Dominions Office.

Here we may conveniently stop considering the evolution of government in the Empire as a whole and turn more particularly to those vast territories which come within the sphere of the Colonial Office. I mean the non-self-governing colonies, protectorates and mandated territories.

The immense importance of this undeveloped estate—as Mr. Joseph Chamberlain once called it—will be readily understood when I remind you that it comprises over two million square miles with a population of 50 million people, and with a trade already exceeding £500,000,000 a year. A trade which is doubling itself every few years and is capable of even still more rapid expansion.

To give you some idea of how that trade is developing I need only say that between 1905 and 1925, a period of 20 years, the value of the imports into the United Kingdom from the Colonies increased from under £20,000,000 to over £80,000,000. The value of the exports of British goods to the colonies increased in the same period from about £18,000,000 to just over £60,000,000.

In the year 1925, the total imports into the United Kingdom from the non-self-governing colonies were greater than those from the whole of India, or from any one of the self-governing Dominions. They were also greater than those from any foreign country, with the exception of the United States of America.

In the same year, the exports to the non-self-governing colonies were greater than those to any single country in the world except India, and in this connection it is interesting to note that in the period between 1905 and 1925 while the exports to India doubled, those to the non-self-governing colonies more than trebled.

Having given you these statistics in order to show the economic importance of our non-self-governing colonies, I will now give you some idea of the diversity of the problems with which the Secretary of State, assisted by the Colonial Office, has to deal.

The Secretary of State is responsible for the general control of policy, and in carrying out his obligations he has to communicate on a variety of subjects with no less than thirty-seven different overseas governments, each entirely separate from the rest, each administratively, financially and legislatively self-contained ; and all in different stages of development, with varying types of constitution, with varying rates of salary for civil servants, with varying climates and with populations composed of all kinds of races. The Secretary of State has, broadly speaking, no executive authority within the territorial limits of a colony or protectorate. His powers are exercised through the Governor, with whom alone he corresponds, and to whom alone he issues his directions. Although the Secretary of State selects for appointment the chief colonial officials, their actual appointment is made by the Governor, or High Commissioner as the case may be, who receives from the King a personal commission, and is the single

and supreme authority responsible to and representative of His Majesty.

In addition to his personal commission, the powers which the Governor, or High Commissioner, exercises are derived from the instruments called the 'letters patent' and 'instructions.'

The 'letters patent' are more or less the same in all cases; they empower the Governor to appoint Executive and Legislative Councils, and they command him to do everything that belongs to his office according to his instructions to the laws of the colony, and amongst other things to any orders given by the Crown through the Secretary of State. The "instructions" go into more detail according to the circumstances of the different colonies, and lay down such matters as the composition of the Executive Council and in some cases of the Legislative Council, and so on.

You will observe, therefore, that the Secretary of State derives his power to control the actions of the Governor through that part of the 'letters patent' which command the Governor or High Commissioner to do everything that he may be ordered to do by the Crown through the Secretary of State.

In fulfilling his obligations, the Secretary of State is assisted by the Colonial Office and its subsidiary organizations. Every dispatch to a Governor or High Commissioner bears his name. He personally sees all dispatches which deal with important questions of policy, and no dispatch which disagrees with the views or recommendations of a Governor or High Commissioner leaves the Office without being seen by me, as Permanent Under Secretary of State.

Any sketch of the Colonial Office machine would be imperfect which did not include the subsidiary organizations through which, or with the aid of which, part of its work is performed.

The Crown Agents under the general supervision of the Secretary of State act as agents in the United Kingdom for all the non-self-governing oversea Governments. They purchase stores and raise loans for those governments, and carry out on their behalf all purely business transactions. The experience of the Crown Agents in the home markets, and their standardization of supplies, result in the Colonies gaining both in quality and price. The magnitude of the financial operations of the Crown Agents on behalf of the Colonies can be measured by the fact that loans amounting to £97,000,000 are now domiciled with and managed by them; and that they pay out annually in interest thereon the sum of £4,500,000, and are at the same time trustees for £18,500,000 worth of sinking funds for loan redemption. The Crown Agents purchase in each year on behalf of the Colonies just under £8,000,000 worth of stores alone. Amongst the many other duties they perform, they select on behalf of the Secretary of State candidates for engineering appointments; and again, one of the Crown Agents acts as "Director of Colonial Scholars," and helps

in any way he can young men from the Colonies who have gained scholarships tenable in this country, and often arrive here for the most part friendless and with no one to turn to for advice or assistance —a job demanding tact and sympathy and an abiding recollection that once one was young oneself. The cost of the Crown Agents' Office is met by a small commission paid by the colonies, and in the case of the purchase of stores, it is only a fraction of that paid to any business agency for similar work.

The Colonial Audit Department, under the general control and direction of the Secretary of State, selects, trains and sends out local auditors to the Colonies, with whose accounts they deal. These auditors form a separate service, liable to transfer and with opportunities for promotion. You will readily understand the gap that this Department fills when I remind you that the proper audit of colonial accounts is as essential to good administration as is the proper management of the Colonies' finances themselves.

It is impossible in the time at my disposal to describe in detail the other subsidiary organizations of the Colonial Office, but these are 'The Tropical Diseases Bureau,' which collates and distributes information in connection with tropical diseases: the 'Colonial Advisory and Medical Sanitary Committee,' which advises the Secretary of State on medical and sanitary questions; 'The Advisory Committee on Education,' which as its name implies, advises the Secretary of State on all questions in connection with education as affecting our non-self-governing oversea territories; 'The Colonial Survey Committee,' which advises the Secretary of State on all matters in connection with the carrying out of colonial surveys and their rapid, economical and methodical prosecution; 'The Colonial Research Committee,' which administers a Parliamentary grant for the assistance of the smaller and poorer colonies in undertaking research work on matters of economic importance; 'The Oversea Defence Committee,' which is a Sub-Committee of the Committee of Imperial Defence, and advises on all questions in connection with the defence of the Colonies and Protectorates. It was as Secretary of this Committee from 1911 until the outbreak of war that I first came into touch with the Colonial Office and our Colonial Empire.

Another subsidiary organization which will shortly be added to the Colonial Office machine is a 'Colonial Agricultural Advisory Council,' whose duty it will be to advise the Secretary of State on all matters in connection with the development of agriculture in the Colonial Empire. The recent appointment of an Agricultural Advisor to the Secretary of State, coupled with the proposed appointment of an Advisory Committee, mark another stage in the development of our Colonial Empire, since the Colonies and Protectorates have agreed to pay annually into a common fund such sums as will be necessary to defray the cost of the new central organization.

In addition, there are the Imperial Bureau of Entomology and the Imperial Bureau of Mycology, which exist for the purpose of encouraging and co-ordinating entomological and mycological work not only in the colonies but also in the Dominions and India.

There are other bodies which, although in no sense subsidiary to the Colonial Office, nevertheless afford it valuable assistance in its work, such as 'The Royal Botanical Gardens, Kew,' the 'London and Liverpool Schools of Tropical Medicine,' and 'The Overseas Nursing Association.'

The unofficial members of all the above organizations are men in the front rank of their respective professions, so that it will be seen that the Colonial Office and the Colonies obtain the best advice from persons acquainted with the latest developments of medical and other science in a way that it could not expect to do from any permanent technical staff appointed to perform similar duties.

Having now briefly described to you the administrative machinery which the Secretary of State has at his disposal in London, I propose to deal with the different types of constitution that are to be met with in the Colonies and Protectorates. Previous to doing this, however, it may be convenient if I explain very briefly the nomenclature used in describing the different kinds of territory. Those to which the term 'colony' is applied may broadly be divided into five classes. The first is the 'colony' in which there is no Legislative Council, and where the Governor is the legislature. The second is the 'colony' where the Legislative Council is nominated by the Crown. The third is the 'colony' where the Legislative Council is partly elected, but has an official majority.

These three classes of 'colony' are what used to be known as 'Crown Colonies,' a term which is purposely not now used owing to the wave of democracy that has been passing over the world since the War, and to the increasing demand on all sides for representative institutions.

The fourth class is the 'colony' in which the Legislative Council is partly elected and in which the unofficials are in a majority. The fifth class is the 'colony' with an elected House of Assembly and a nominated Legislative Council, or in other words, a Second Chamber.

In all but a few of the above, the Crown has reserved the power of legislating by Order in Council, as a survival of the theory that the sovereign governs his possessions beyond the seas by virtue of the royal prerogative. The Secretary of State thus has a weapon in reserve whereby, coupled with the power to advise the Sovereign to disallow any Bill of a Colonial Legislature, he can defeat measures passed by the latter, or enact a law that they have refused to pass. It is hardly necessary to add that nowadays recourse would very

rarely be had to this weapon, and not at all unless important Imperial or local interests were involved, and then only after all efforts at persuasion had failed.

The term ' protectorate ' is used to describe a territory which is really outside His Majesty's Dominions, but which has no political relations with foreign powers except through or by permission of His Majesty's Government. The inhabitants of such territories are not British subjects, but British protected persons.

Although in theory a ' protectorate ' retains its internal sovereignty and the right to manage its internal affairs in its own way, most of the protectorates forming part of the British Empire have in actual practice and in course of time come to be in almost exactly the same position as colonies and are administered in the same way.

A ' mandated territory ' is a territory in respect of which a mandate to administer the territory on behalf of the League of Nations was accepted from the principal allied and associated powers, and the power which accepted the mandate is under certain obligations to furnish information annually to the Council of the League. There is no provision in any of the mandates for their transfer or termination.

The actual degree of authority and control to be exercised by the mandatory power in each territory is defined in the document known as the ' mandate.'

Under what is called an ' A ' mandate, the mandatory is placed in the position of an adviser rather than that of an administrator, except in the case of Palestine, where the High Commissioner actually administers the territory.

Under what is called a ' B ' mandate, the mandatory is responsible for the administration, subject to certain guarantees as to the suppression of abuses and the maintenance of economic equality as between all States, which are members of the League. An example of this mandate is Tanganyika.

Under what is called a ' C ' mandate, the mandatory is allowed to administer the territory as an integral part of its own territories subject only to certain provisions, which are more limited than those applying in the case of the ' B ' mandate. The Secretary of State for the Colonies has no responsibility for any territories administered under a ' C ' mandate."

It would be impossible in a short time to describe to you in any detail all the different types of constitution which, as you will have noticed from my description of the term ' colony,' may broadly be divided into those in which the Crown still has the control of legislation and those which possess representative institutions, but not responsible government, and in which the control of the Crown is limited to having a veto on legislation.

In order to give you some idea quickly as to how the different legislatures vary, I don't think I can do better than take a few examples and describe to you briefly how the functions of government are carried out in each case.

The constitution of Kenya provides for an Executive Council composed of the Governor as President, seven officials as *ex-officio* members, and such other official or unofficial members as the Governor may appoint; and for a Legislative Council composed of the Governor, as President, eleven *ex-officio* members, not more than nine nominated official members, eleven European elected members, five Indian elected members, one Arab elected member, and one nominated unofficial member to represent the interests of the African community.

It will be seen, therefore, that the existing constitution provides for an official majority in the Legislative Council.

For some years past, there has been considerable controversy over the representation in the Council of the Indian community, and in point of fact Indian representation has been secured by nomination. The Indians have been persistent in their demand for a common electoral roll for all British subjects, and the European population of the colony has been equally persistent in opposing any suggestion that election to a Legislative Council should be on any other than a communal basis.

Again, during the last few years there has been an increasing demand on the part of the European settlers for a white unofficial majority in the Legislative Council. The whole question has just recently been dealt with in the Report of the Hilton Young Commission, which visited East Africa last spring with a view to reporting on the closer union of the British East African territories. The report of the Commission is now under consideration, and no decision has yet been reached.

Bermuda was given representative institutions in 1620 by the Bermuda Company of London, which agreed to the setting up of a 'General Assembly,' but the Charter of the Company was annulled in 1684; since then, the Governors have always been appointed by the Crown, and government has been effected by a Governor advised by an Executive Council, and a legislature composed of a Legislative Council and a House of Assembly.

The Executive Council, which is purely advisory, is composed of four official and three unofficial members; the Legislative Council is composed of three official and six unofficial members, and the House of Assembly is composed of thirty-six members, all elected.

It will be seen, therefore, that there is an unofficial majority in both houses, and that the Governor has no power to enact legislation which is in any way unpopular locally. The Crown has, of course, the power to veto legislation, but Bermuda is one of the five Colonies in

the Colonial Empire where the Crown has not the power to legislate by Order in Council.

In the Gold Coast there is an Executive Council composed of five *ex-officio* official members with the Governor as President, and a Legislative Council composed of fifteen official members and fourteen unofficial members; so that it will be observed that there is an official majority. In 1925, the composition of the Legislative Council was altered to include for the first time elected members. Of the fourteen unofficial members, six are head chiefs elected as provincial members of the Council, three are municipal members elected to represent the towns of Accra, Sekondi and Cape Coast respectively, and there are five unofficial members, one representing commerce, one the mining industry, and three appointed by the Governor.

Ceylon is administered by a Governor, aided by Executive and Legislative Councils. The Executive Council is composed of three *ex-officio* members, and such other nominated members as the Governor may appoint, and the present Council consists of two nominated official members and four nominated unofficial members. The Legislative Council is composed of 49 members, made up of five *ex-officio* official members, seven nominated official members, three nominated unofficial members, and thirty-four elected unofficial members. Of the thirty-four elected members, eleven represent special interests and communities, and twenty-three represent territorial constituencies.

This is one of the comparatively few colonies in which the Governor does not preside over the Legislative Council.

The present constitution of Ceylon was settled by Orders in Council issued in 1923 and 1924, and by letters patent and instructions issued in 1920. It is a good example of a constitution where there is an unofficial majority in the Legislative Council, and where the Executive, *i.e.*, the Governor and his advisers, has responsibility without power.

Ceylon also provides a good example of how difficult it is to satisfy a community, which in these democratic days wants more and more power each year. Although it is less than five years since the present constitution came into existence, the Secretary of State thought it desirable in the summer of 1927 to appoint a Commission, under the chairmanship of Lord Donoughmore, to report on the working of the present constitution, and how, if at all, it should be amended. The Donoughmore Commission, after visiting Ceylon, reported in June last year, and in their desire to find some half-way house between a colonial constitution giving the Governor not only responsibility but also power, and a constitution which provides for full responsible government, have made recommendations for the setting up of a State Council and for appointing committees of this Council, each under the chairmanship of a Ceylonese Minister, to be responsible for

the administration of the different government departments. No decision has yet been come to on these somewhat novel but ingenious proposals.

Malta stands by itself in the Colonial Empire as an example of the modern theory of "dyarchy"; the present constitution having been given to the colony in an attempt to reconcile Imperial interests with local aspirations, and to put an end to a long history of controversy with the home government. In nearly all matters of internal concern, Malta has enjoyed since 1921 responsible government, *i.e.*, its chief executive officers are "ministers" responsible to the local legislature, which comprises a Senate and a Legislative Assembly. In order to ensure that the Imperial Government has full responsibility for the safety of this important naval base, certain matters are what is called 'reserved' generally or specifically in the constitution.

The Governor, who is always a distinguished military officer, has two Councils to assist him. These are an ordinary Executive Council such as we find in a self-governing Dominion, composed of Ministers, which advises him on all the non-reserved matters; and, secondly, a nominated Council composed of the Lieutenant-Governor, the legal adviser, and three officers chosen from the garrison and representing the three combatant forces. The latter Council is in the position of the ordinary Executive Council of a colony in respect of the reserved matters.

The Senate consists of 17 members, ten of whom are either elected or nominated representatives of special interests, such as clergy, nobility, and Chamber of Commerce. The remaining seven, who are called the General Members of the Senate, are persons possessing some special qualification likely to make them useful members of an Upper Chamber, elected on a restricted franchise.

The Legislative Assembly consists of 32 members, all elected to represent the eight electoral districts into which the Maltese Islands are divided.

The Governor can, if he sees occasion, summon the two Councils to sit together as the "Privy Council of Malta." Power is reserved to the Crown to disallow any law, and the Governor can reserve any Bill for the signification of His Majesty's pleasure. The Crown, by Order in Council, or the Governor, subject to the King's approval, can legislate on the 'reserved matters.'

I cannot close my description of the different types of constitution without referring to Jamaica, a colony which a few years ago I had the honour to govern, and the constitution of which contains a unique provision.

In this colony there is a Privy Council presided over by the Governor, and consisting partly of official and partly of unofficial members nominated by the Governor.

The Legislative Council consists of the Governor, as President, five

ex-officio official members, nominated members not to exceed ten in number, and fourteen elected members.

The unique feature of this constitution is that nine out of the fourteen elected members in a Council of twenty-nine can throw out any measure which involves expenditure, and that the unanimous vote of the whole fourteen elected members cannot be over-ridden by the other votes unless the Governor declares the matter to be of 'paramount importance' to the public interest.

You will observe from the description which I have just given you of some of the legislatures of to-day, that it has been no part of the policy of the British government to force either the executive or the legislative machinery of the colonies into a common mould.

I have referred to the striking changes that have taken place during the last fifty years in Africa; and I think that in the short time which is still at my disposal I must touch on the almost phenomenal way in which our African colonies have developed in the last few years, and also on the system called 'indirect rule' which is one of the most interesting features of the internal administration of these colonies. For this purpose, I cannot do better than take as an example one of the largest of our territories in tropical Africa—I mean Nigeria—the revenue, which in 1915 was not quite £3,000,000, rose to over £8,000,000 in 1925, figures which show you at once the rapidity with which trade and development went forward. When I travelled through Nigeria last August and September, in comfortable trains and motor cars, I could not help recalling the fact that less than thirty years ago those great territories were without roads and railways, and were peopled by tribes so uncivilized as to necessitate military operations from time to time, and it was borne home to me how wonderful it was that, in such a comparatively short time, this great country had been transformed by a handful of determined administrators and soldiers into the peaceful, law-abiding and rapidly developing territories that one sees to-day. When, however, one saw the young officer of the Colonial Service living in his bush hut, perhaps seventy miles away from a doctor or any other white man, and cheerfully carrying on the administration of a district as large as two or more English counties, one's wonder at the rapidity with which civilization has spread began to die away, and one realized more than ever how utterly wrong are those who are so fond of saying that the British race of to-day is not what it was. It is unnecessary, gentlemen, for me to remind you of the part played in the development of these and other colonies by officers of the Corps, for did not General Pritchard last year give you a lecture on this very question, and did not he remind you of the great work done by officers of the Corps in the development of our Colonial Empire, not only in the fields of engineering and survey, but also in administration.

I have referred to the system of 'indirect rule.' The retention of

as much as possible of the original native form of government under the great tribal chiefs and emirates plays an important part in the internal administration of our African colonies.

These administrations are looked upon as an integral part of the British machinery of government. No alien form of government is imposed on the natives from without ; on the contrary, the authority of the chiefs is strengthened and they are encouraged to realize their responsibilities in the development of their territory and in the welfare and progress of their people. The native administrations are naturally closely supervised by British officials in the territories concerned, but only in an advisory way and in order to check and abolish customs and practices that are detrimental to the best interests of the people. When I visited Northern Nigeria in August last, the Emir of Kano showed me with great pride over his headquarter offices, his treasury, his Court of Justice, his police barracks, and his prison, all situated in the walled city, and I must confess that the efficiency of all I saw was most remarkable.

In concluding, I would like once again to remind you of the important part our Colonial Empire, if properly developed, is destined to play in the future of the British race ; and I would also like to remind you that in spite of the almost bewildering diversity of the questions constitutional, economic and cultural that arise, there exists nevertheless a large measure of unity. This is due to the fact that the Colonial Empire is almost wholly a tropical and sub-tropical Empire, and that in consequence the health and economic problems in its different parts are very similar, that it is an Empire of mixed, and in the main non-European and largely primitive populations, and that the ultimate responsibility for the general control of its affairs must for some time to come fall on His Majesty's Government.

Last, but not least, I would like to say that the unity that exists is due to a great extent to the community of ideals and purpose which animate the Colonial Service, the members of which never forget that it is their duty, no matter how trying the conditions under which they have to serve, to hand down to posterity, in, if possible, a better state than they found it, the great heritage that has been bequeathed to us by our forefathers.

THE 23rd (FIELD) COMPANY, R.E., IN THE GREAT WAR, 1914–18.

(Concluded.)

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

PART VI.—APRIL, 1918—MAY, 1919.

Battle Honours during the period—" Lys," " Bethune," " Arras 1918," *" Drocourt-Queant," " Hindenburg Line." " Epehy," " Beaurevoir," " Sambre."*

GIVENCHY, 1918.

ON the 11th April, the 1st Division had taken over the Cambrin sector from the 11th Division, and on the 15th and 16th took over the Festubert and Givenchy sectors from the 55th Division, whose historic defence of Givenchy during the German offensive of April 9th and following days is well known to fame.

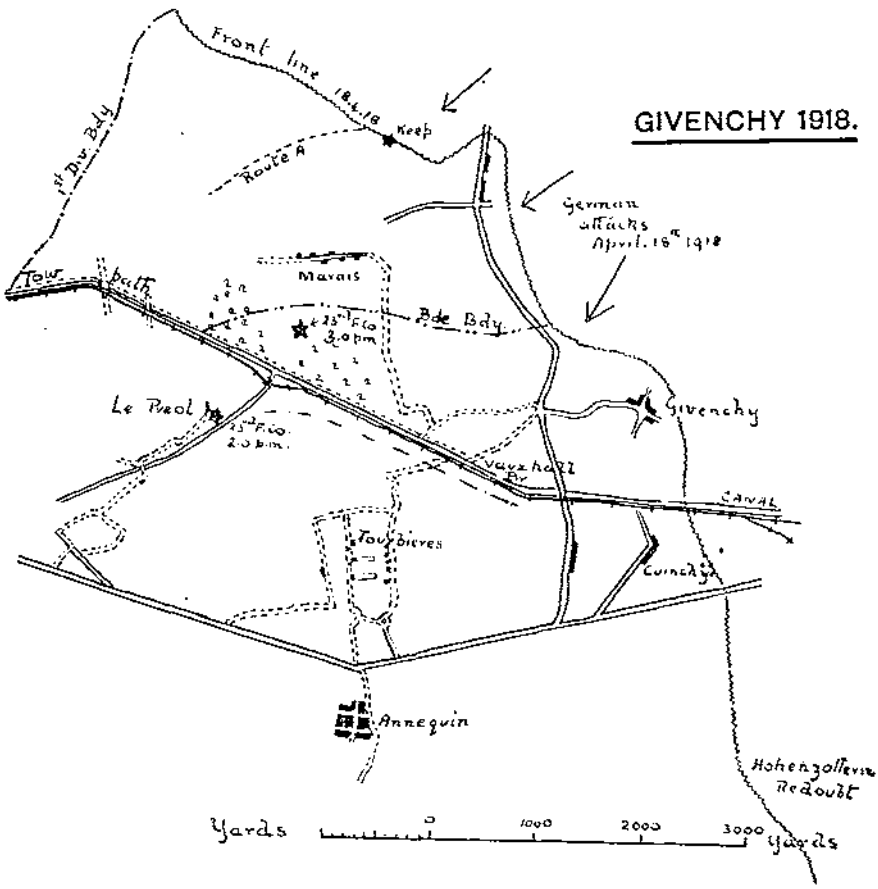
The 23rd (Field) Company, R.E., arriving by road and rail, concentrated at Annezin on April 8th. On the 9th, 2nd-Lieut. Henderson joined for duty, and was posted to No. 4 Section, 2nd-Lieut. Pocock having taken over No. 3 Section. On the 10th, the Company moved to Sailly Labourse, two sections going to work in the line in the Cambrin sector. The following day, they moved back to Fouquieres, and on the 16th back, as the diary says, " along the same old road " to N. Annequin, a mining village now vacated by the " civiles " at last, leaving all their goods and chattels, their wine and beer and stores. Steps were taken for the security of these tempting goods.

That night, the sections worked on the Givenchy defences, which had suffered severely in the fighting of the previous week.

On the 18th, in the very early hours, the area was heavily gas shelled, but the company billets being just outside and upwind of the gassed area, they escaped. This gas shelling was a curious and unforgettable sound, a continuous whining as hundreds upon hundreds of shells, fired as rapidly as guns could be worked, streamed into a restricted area, bursting with quite a gentle popping noise reminiscent of more genial and peaceful occasions. However, this was invariably the prelude to some major effort on the part of the enemy, and the Company at once " stood by " in case of need, Brigade H.Q. being informed. At 11.30 a.m., orders (timed 8.30 a.m.) were received both from the C.R.E. and Brigade H.Q., to garrison the Le

Preol locality. Le Preol was reached at 2.0 p.m., after a very rocky journey, " in record time, helped along by the enemy's shells." The keep was practically obliterated by 12-in. shells, and had the message reached the Company earlier, the sections would no doubt have been obliterated too. It was still being shelled, but Brigade H.Q. ordered the sections to move on and garrison Marais keep.

SKETCH No. 25.



The cyclist orderly, Sapper P. E. Dymond, who had brought the message to Company H.Q. from Brigade H.Q., having already gone from the Company to Brigade, arrived without bicycle and almost without clothing, for he had made his way through intense shell fire, had been slightly wounded by a gas shell which burst quite close to him, but nevertheless carried out his task most gallantly, his devotion to duty being rewarded with the Military Medal.

Hard fighting had been going on around Givenchy and Festubert, between which places the enemy had made some progress, and also along Route A, on the left flank. Eventually this attack was brought

to a stop with very severe losses without any important loss of ground. As soon as it appeared that the situation was in hand, work was awaiting the Company, for a lucky double hit by 12-in. shells had caused serious gaps in the canal towpath, not only threatening with inundation the low-lying woods in which our supporting troops were ensconced, but also blocking the main line of evacuation of wounded from Givenchy. In the first place temporary bridges across the breaches in the towpath were made, to allow traffic to get along, and by dark a temporary dam in the canal bank had been constructed of boards and sandbags, a moderately effective work. The day had been an exhausting one, for, in addition to the constant shelling of the area, the strain always attendant on waiting in position, wondering when the battle is really coming one's own way, and the rapid work on the bank in the evening, gas masks had been worn for considerable periods, always a depressing and unpleasant performance. The Company had eight casualties, including three badly gas-blistered. Two sections, Nos. 2 and 4, went up to Givenchy to work on the repair of communication trenches.

On the 19th, work on the dam was continued, now more urgent than before as heavy snow had fallen, water level in the canal was rising, and the temporary dam was failing. Luckily there was a boat-builder's yard nearby with a plentiful supply of 12 in. x 2½ in. timber; a pile sheet dam was made, being completed by Nos. 1 and 4 Sections by 6.0 p.m. This was further strengthened the following day by the construction of a second dam behind the first, both puddled with sandbags and clay and the space filled with brick and clay, the roadway then being completed on top.

During the 19th, a successful counter-attack between Givenchy and Festubert had regained an important series of trenches and dugouts, and whilst Nos. 2 and 3 Sections were engaged in wiring the bridgehead positions covering Vauxhall and Westminster Bridges, No. 1 Section, having completed its work on the dam, moved up to Givenchy to repair fire trenches, firesteps and strutting of damaged dugouts, all the woodwork having suffered severely during the bombardments of these two days. Just at a moment when the work was well under way, heavy shelling commenced, and threw the sappers and their infantry working parties into some disorder, and very shortly after Germans began to appear, and it was evident that a counter-attack was taking place. Sapper Alfred Pratt, who was in charge of a mixed party of sappers and infantry, with great courage and resolution got together his scattered men and organized them on the firestep ready to beat off the attack, showing a fine example of courage, cheerfulness and leadership. For this he received the Military Medal. During the same bombardment a sapper and a German prisoner were buried in a dugout, but in spite of the shell fire, Corporal Vick, a fine N.C.O. who had been with the Company since 1915, assisted by two

sappers, dug out these two men after two hours' hard work. Corporal Vick was awarded the Military Medal.

That evening, the C.R.E. received the following message from Division H.Q.: "The G.O.C. sends his hearty congratulations for their gallant work to all ranks engaged in this morning's operations." It had been a hard, nerve-racking day's work under battle conditions, and every man in the Company had pulled his weight in the finest manner.

On the 20th, in addition to those sections which were still at work on the dam in the canal bank, No. 4 Section built a barrel pier raft for carrying stores, the overland roads and tracks having been so severely damaged by shell fire. The raft took 18 men or a G.S. wagon fully loaded. In the evening, Nos. 1 and 3 Sections, somewhat delayed by an enemy barrage, moved up to the line to repair gaps in the trenches for the "Boche snipers were becoming a bit of a pest." This repair work was continued on the following nights.

A feature of the fighting at this time was the constant shelling of back areas and forward roads, putting a severe strain on the mounted section, which, however, true to its reputation, never failed to deliver the goods. On the night of the 23rd, the Company billets and horse lines were shelled, resulting in 14 casualties, including Pocock, Thomas and the farrier-serjeant, and seven horses hit. Emulating the example of Driver Bianchi, the Company's first D.C.M., Driver J. Wooldridge set a fine example of quiet coolness and courage to the other drivers, quieting the frightened horses and getting his own pair clear of the shelled area. After that, he came back and helped to bind and remove the wounded, finally fetching an ambulance. No Military Medal was better earned than his.

On the 22nd, Captain Carter had been transferred to the 233rd (Field) Company, and his place was taken by Captain W. G. Smith, M.C., from the 26th Company. As may be imagined, Smith received a warm welcome on returning to his old unit, for all ranks were glad to see this gallant officer back with them again.

On the 24th April, the 55th Division having taken over the defence of the Givenchy sector once more, the 1st Division side-slipped, and the 23rd (Field) Company once again found itself in its old pleasure resort, the Hohenzollern sector, where the War was continuing to take its even course of the last three years, undisturbed by great events to the north and south.

The work was the usual round of trench and dugout maintenance, construction of machine-gun posts, and, a new item, a tank trap at the point where the reserve line crossed the railway.

On May 2nd, Lieut. Dougill joined, and on May 3rd the award of the Croix de Guerre to Major Wilson was gazetted.

On the night of May 24th, Lieut. Cowley, reputed to be one of those queer individuals who thoroughly enjoyed a good shelling or a

bloodthirsty scrap, took part with eleven N.C.O.s and sappers in a raid carried out by the K.R.R. As the party arrived at Battalion H.Q. a telephone message was received that the R.E. officer was not to go with the raiding party. "Damn," says Cowley, "I didn't hear that message." Just as the party was preparing to go over the top, a written order arrived. "Lieut. Cowley will not go with the raiding party, he will return forthwith." Putting this unwelcome missive in his pocket, Cowley shouted, "Come on No. 2," and off they went, Cowley, Lce.-Cpl. Obee and four sappers with the left party. Unfortunately, having got into the German second line, they were caught by our own barrage, and all but one sapper became casualties. The gallant Cowley died in hospital as the result of his wounds, to the great regret of all ranks.

The right sapper party consisted of Corporal Jones, Sappers Dymond, M.M., Woolcock, Braund, Dewey and Coleman. They, like Cowley's party, went over with the second wave of the infantry, and also ran into our own barrage, but withdrew until it lifted. They had started out with a Bangalore torpedo, but, finding the wire cut, dropped it, and went off in pairs to the dugouts to which they had previously been allotted. Woolcock and Dymond went to No. 1, which had two entrances, one in the support line and one in the communication trench. A German dashed out full of fight, and was faithfully dealt with by Woolcock with his bayonet, and two more who came out with the first surrendered. As voices were heard below a Mills bomb and a mobile charge were exploded down the dugout, and the two sappers made their way back with their prisoners and a wounded rifleman. Woolcock was slightly wounded.

Braund and Dewey arrived at No. 2 dugout just as a rifleman was bayoneting a German. Four more of the enemy were winkled out of the shell, and others foolishly remaining below received two more mobile charges.

Jones and Coleman disposed of their charges at No. 3 dugout without opposition.

Altogether the 23rd Company had a good night out, as evinced by the fact that 2nd-Corporal D. Jones and Sapper R. Woolcock both received the Military Medal for their gallantry.

In addition, the following letter was received by the O.C. from the G.O.C., 2nd Infantry Brigade.

"With reference to the raid carried out last night, I should like to express my great appreciation of the good and gallant work done by men of the 23rd (Field) Company, R.E., who accompanied the raiding party.

"Their presence contributed materially to the success of the enterprise, thanks to the skilful handling of their explosives, while their dash and courage in the advance to the objective was most marked.

"In saying the above, I am expressing the opinion of the raiding infantry, and I trust my remarks may be conveyed to the men who took part in the raid. I much regret that the casualties, in proportion to the numbers who took part, should have been so unfortunately high.

(Signed) G. C. KELLY, *Brig.-Gen.*,
Commanding 2nd Infantry Brigade."

The Company shortly after moved to Tourbières, where, on the night of June 1st, occurred what might have been a most dangerous accident had it not been for the courage of three men, Corpl. H. Whitty, Sapper E. Mather, and an attached N.C.O. of the 1st Camerons, Lce.-Cpl. D. McDonald. The Company billets were heavily shelled, and a shell struck a tool cart, exploding the primers and detonators, setting fire to a large quantity of guncotton. The flames blazed up to the top of the barn, which was full of straw in which the cart was standing. Sapper Mather arrived on the scene first, and with the greatest gallantry commenced to pull out the burning guncotton. In this he was shortly assisted by Corporals McDonald and Whitty, and these three eventually put out the fire and saved the remaining 100 lb. of guncotton and 50 lb. of ammonal in the tool cart, in spite of the fact that shells were continuing to fall in the billet area. For their gallantry each of these three men deservedly received the Military Medal.

The Company remained in this area until the end of August, the only work of interest being the preparation of all bridges in the area for destruction in case of further successful attacks by the enemy.

2nd-Lieut. Gates joined the unit on June 3rd, and on July 21st Major W. R. Wilson, M.C., was appointed C.R.E., 40th Division. The command of the Company devolved on Captain W. G. Smith, M.C. The new O.C. was an officer young in years, but of unusual ability; although the Company records contain little mention of outstanding deeds (probably because for a long period he kept the diary himself), those officers and men who worked with him speak with pride and affection of a quiet, gallant gentleman doing his duty to the utmost, pushing his jobs through under all conditions of battle or weather, and setting a high standard of soldierly achievement. It is with deep regret that it must be recorded that he died in 1923 as a result of the hardships he had undergone during the War.

On August 22nd, the Company moved to Boyaval, and on the 31st received orders to move at short notice. The move took place at 5.0 p.m., and at 1.0 p.m. on September 1st it arrived at Arras, moving up to assembly positions in Guemappe. Tool carts and pack animals joined the dismounted sections that night. On the following day took place the splendid Canadian attack on the Drocourt-Queant line. The 1st Division was in support of the two Canadian Divisions, and

was given the task of consolidating the line behind the Canadians, or alternatively, if the attack was more successful even than was expected, to go through and exploit the victory. However, the attack, though reaching all its objectives, did not break the enemy resistance to such an extent that the 1st Division could go through, and on the 2nd the 23rd (Field) Company was engaged in consolidating the captured trenches at Dury, Company H.Q. being at Strike Copse, on the Arras-Cambrai road.

On the 3rd, the Company (less one section) worked with the 1st Infantry Brigade on the forward road at Remy, the following days, during which the 1st Division was in the front line between Leclure and Recourt, also being taken up with road making. The night bombing was very severe at this time, and although the material damage was hardly commensurate with the effort, it was very disturbing to the night's rest.

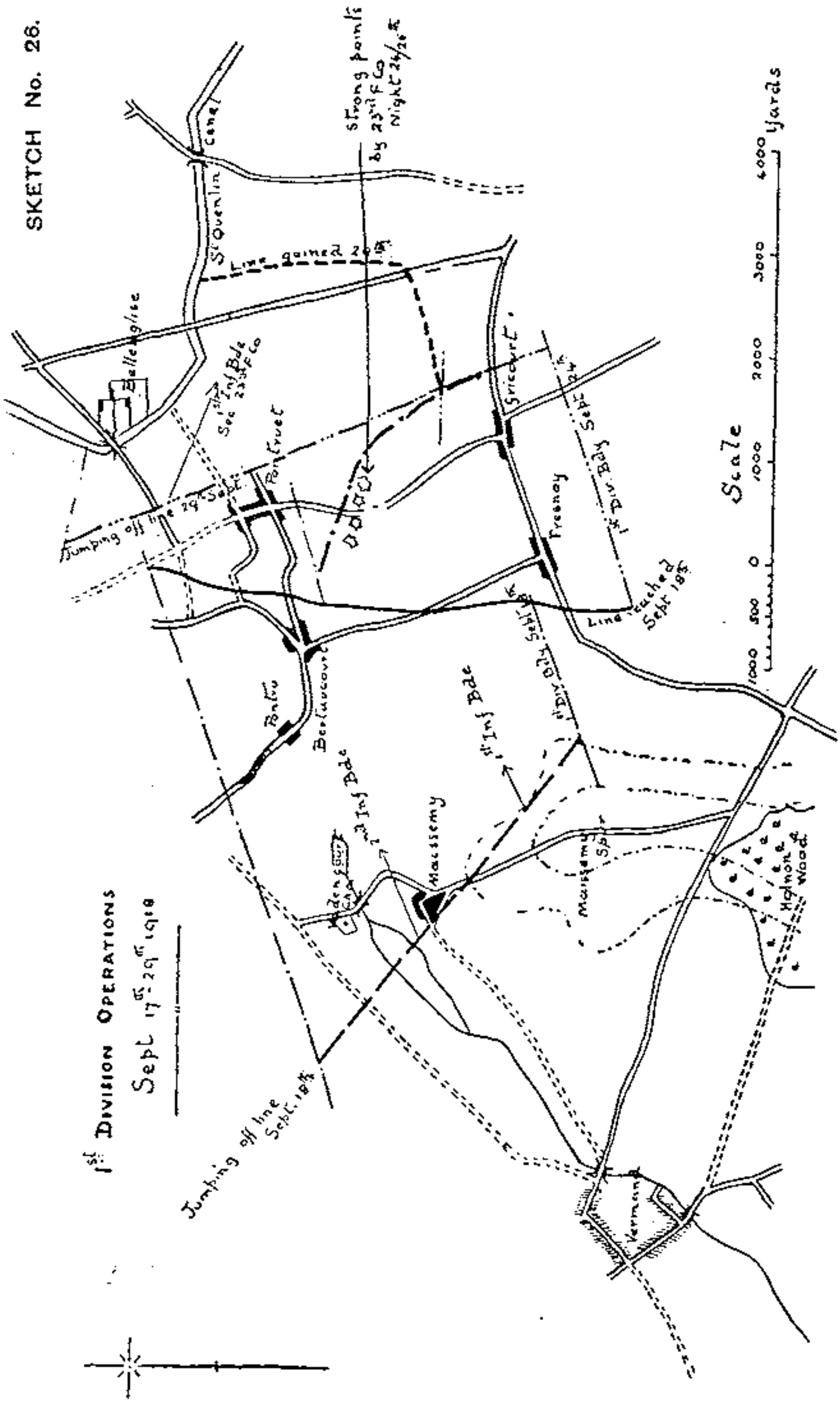
On the 8th September, the 1st Division having been relieved by the 56th, the 23rd Company moved back to Arras and thence by train to Marcelcave in the 4th Army Area, arriving on the 11th.

On the 12th, the Division took over the front from the 32nd Division between Bois Holnon and Vermand (Sketch No. 26), whilst the infantry on the 13th were making ground by vigorous patrolling, the Company moved by bus to billets on the Deuie-Meraucourt road, two sections then proceeding to erect a trestle bridge next to the demolished bridge at Caulincourt Château. The following days were occupied by the Division in gaining ground in order to obtain a satisfactory jumping-off line for the attack of the 18th, the Company being mainly engaged on the improvements to roads in the forward area. The roads were in bad condition, traffic was very great, and it was found that the mounted orderly was of far greater value than the push cyclist in maintaining communication with the C.R.E., in fact, mounted orderlies during these operations were absolutely essential.

The attack was carried out on the morning of the 18th, 1st Infantry Brigade on the right. The Company (less transport) moved up to Leaf Wood. Lieut. Roberts and Lieut. Dougill taped out the forming-up areas for the troops, and one section accompanied the 1st Brigade in its attack, to assist in consolidating the ground gained. One section was still required to work on the Caulaincourt Bridge, and another on the bridge at Vermand. The attack was successful, the approximate line reached being shown on Sketch No. 26. During the 19th and 20th, one section continued work in the 1st Brigade Area, the remainder of the Company being fully employed on the five bridges between Vermand and Caulincourt.

On the night of the 21st-22nd, the 1st Division side-slipped by a front of one brigade to the right, with a view to carrying out an attack on the 24th. Preparatory to this attack, two sections constructed a brigade battle H.Q. Roberts and Henderson taped out

SKETCH No. 26.


1st Division Operations
Sept 17th-29th 1918
St Quentin Canal
Strong points by 23rd F Co Night 24/25th
Line gained 26th
Bellenglise
1st Inf Bde Sec 23rd F Co
Pontruet
Jumping off line 29th Sept
Gricourt
1st Div Bdy Sept 24th
Fresnoy
Line reached Sept 18th
Scale
Yards
Berthaucourt
Pontru
1st Inf Bde
2nd Inf Bde
Maissemy
Maissemy Spur
Holnon Wood
Jumping off line Sept 18th
Vermand

the forming-up areas for the attack. The following method was adopted for this. The line was taped out during twilight with spun-yarn, the latter being replaced before assembly with tape, thus making it possible to test the lay-out during daylight.

The attack was very successful on the right, but on the left severe opposition was encountered about Pontruet, with the result that on this flank there was a bend back of the line. The whole Company was therefore utilized in the consolidation on the night of the 24th-25th, ten posts each to hold two sections being constructed between Pontruet and Gricourt. Work on these posts was continued on the 26th and 27th, but on the 28th the Division having now side-slipped by one Brigade to the left, the Company returned to work on the bridges.

One section was employed in removing an anti-tank minefield in the neighbourhood of Epehy, consisting of a long line of tank traps, 9 in. x 3 in. planks on 10-in. trench mortar shells, lightly covered with earth. The section had lifted the planks off for nearly a mile, when there was a sudden explosion, and Corporal Savage and Sapper Borthwick were blown to pieces. Both these men had been with the Company all through the War, and their loss was deeply felt. It was found that the traps were now arranged so as to go off whether the plank was pressed or raised, and after this accident a rope was placed round the planks and they were removed from a safe distance.

On the 29th took place the great attack on the Hindenberg line, the 1st Infantry Brigade being detailed to form a defensive flank on the canal, the main attack breaking through to the north of Bellenglise. The only part taken by the Company, however, was the construction of a tank track by one section.

On the 30th, the operations were continued, the 32nd Division north of the 1st Division swinging right-handed, the latter maintaining communication with the French on the right, who were not making any progress. One section of the 23rd (Field) Company accompanied the 3rd Infantry Brigade during this attack to assist in consolidation, the remainder of the Company being employed on advanced division H.Q. at Bertancourt, several casualties having been caused at H.Q. by shelling from a long-range gun.

On the 4th October, the 1st Division was withdrawn into Corps reserve, the Company billeting first in Marteville and then, like the remainder of the Division, in the old German dugouts of the Hindenberg line at Bellicourt.

In the orders of October 3rd, Serjt. W. N. Harris, Corporal B. Obee, Corporal W. Pilcher, Corporal J. Newnham, and Sapper J. Sewell were each awarded the Military Medal. All of these men had done consistently good work, and set a high example of courage during the previous year. Several had been recommended for special acts of gallantry on previous occasions, notably Harris and Sewell, who as far back as the battle of Loos had given fine examples of courage and

devotion to duty, and again at Givenchy, Sewell being one of the sappers to assist Corporal Vick in digging out the buried men in a dugout under heavy shell fire.

As the advance of the 4th Army progressed great difficulty was experienced in the maintenance of the roads, and on October 12th all three Field Companies of the 1st Division and the Pioneer Battalion were sent up to the forward area to assist the 6th and 46th Divisions in the restoration of communications. The 23rd Company went to Mericourt, where it carried out work on the Fresnoy-Montbrehain and Montbrehain-Brancourt roads; water supply was another difficulty, and the construction of waterpoints was another important work at this time.

On the 15th, the award of the Military Cross to Lieut. Henderson was gazetted.

By the 16th, on which day the 1st Division once more moved into the forward area, the Corps was within measurable distance of the Sambre-Oise Canal (see Sketch No. 27), and a series of operations took place with the object of securing the line of the canal. For the attack of the Corps on the 17th October it was intended that the 1st Division should pass through the leading Divisions and exploit the canal, but owing to the thick mist causing difficulties in maintenance of direction and in keeping touch with the situation, the full results it had been hoped to obtain were not achieved, though a considerable advance was made. On the 18th, 19th, 20th and 23rd further advances were made, which brought the Division nearly to the canal on its right about Petit Cambresis and to the outskirts of Catillon on the left, where a portion of line had been taken over from the 30th American Division. On the 18th, the Company suffered a severe loss in the death of Lieut. Gates, who was killed whilst carrying out a reconnaissance in Wassigny.

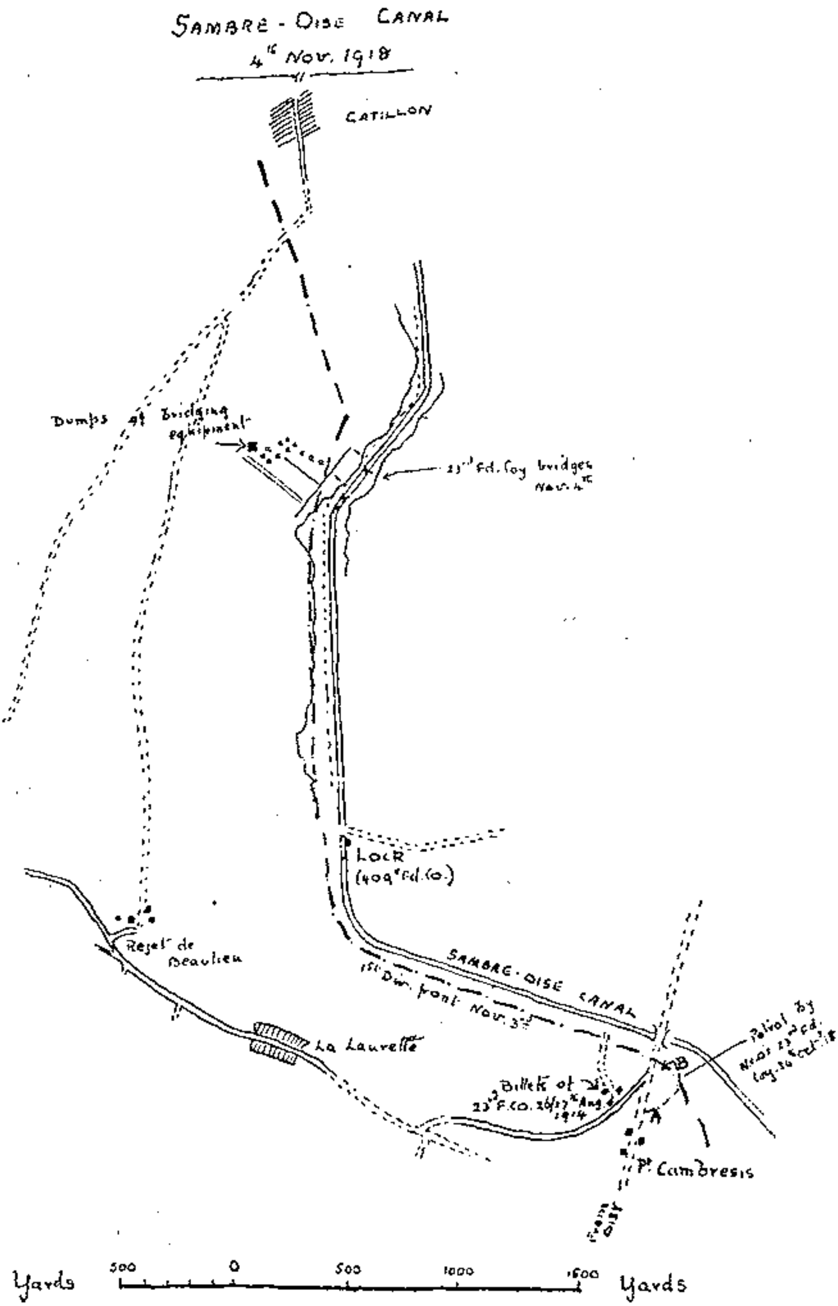
During this period of steady advance the 23rd (Field) Company, which had moved to Vaux-Andigny on the 17th and thence to La Vallée Mulatre on the 19th, was still mainly engaged on work on roads —more especially along the north edge of Andigny Forest—and in repairs to wells.

THE SAMBRE-OISE CANAL, NOVEMBER 4TH.

And now, after four and a quarter long years, the 23rd (Field) Company was to fight its last great fight within a mile of Etreux, where it had so narrowly missed a serious mishap at the very start of its honourable service in France.

That the crossing of the canal in face of severe opposition was an operation likely to take place in the near future was apparent, and the general arrangements and preparations for the attack have already been described by Lt.-Colonel C. E. P. Sankey, D.S.O., in a previous number of the *R.E. Journal*.

SKETCH No. 27.


Sambre - Oise Canal
4th Nov. 1918
Catillon
Dumps of bridging equipment
23rd Fd. Coy bridges Nov. 4th
Lock (409th Fd. Co.)
Rejet de Beaulieu
Sambre - Oise Canal
1st Div. front Nov. 3rd
La Laurette
Billets of 23rd F.Co. 26/27th Aug. 1914
Patrol by
B
A
Pt. Cambresis
Yards
500
0
500
1000
1500
Yards

A certain amount of information collected from various sources, intelligence handbooks, aeroplane photos, civilians and so on, was available, but none of it sufficiently accurate or up-to-date as to be completely satisfactory when it came to getting down to the details of the bridging operations. Direct reconnaissance of the canal and its approaches was essential, a somewhat difficult matter with the Germans still on the near bank.

In the final attack on the 23rd October, the troops of the 3rd Brigade did just get within reach of the canal bank for a short time, but had subsequently to withdraw, an N.C.O. and Sapper of the 26th (Field) Company getting good information. On the night of October 24th, two N.C.O.s of the 23rd Company, accompanied by a patrol of one N.C.O. and two men of the 1st L.N. Lancs, attempted to reconnoitre the canal banks near Petit Cambresis Bridge (Sketch No. 27). They struck off from the road at A, but were soon stopped by a swamp, into which the men went up to their knees. Attempts to cross this swamp at various points were unsuccessful. The patrol then endeavoured to move up to the bridge, but on getting to within 100 yards were fired on by a machine-gun and had to withdraw. They were able to report that the hedges in the area were very close together and very thick, only passable in a few places.

On October 29th, a most valuable reconnaissance was carried out by Lieut. Roberts, of the 23rd (Field) Company, and as it is of considerable interest as a practical report by a field company officer made under difficult circumstances and in preparation for an important operation it is given below verbatim. (Sketch No. 28.)

"Attempts to clear the enemy's strong point during the morning had failed at the point at which it was desired to see across the canal.

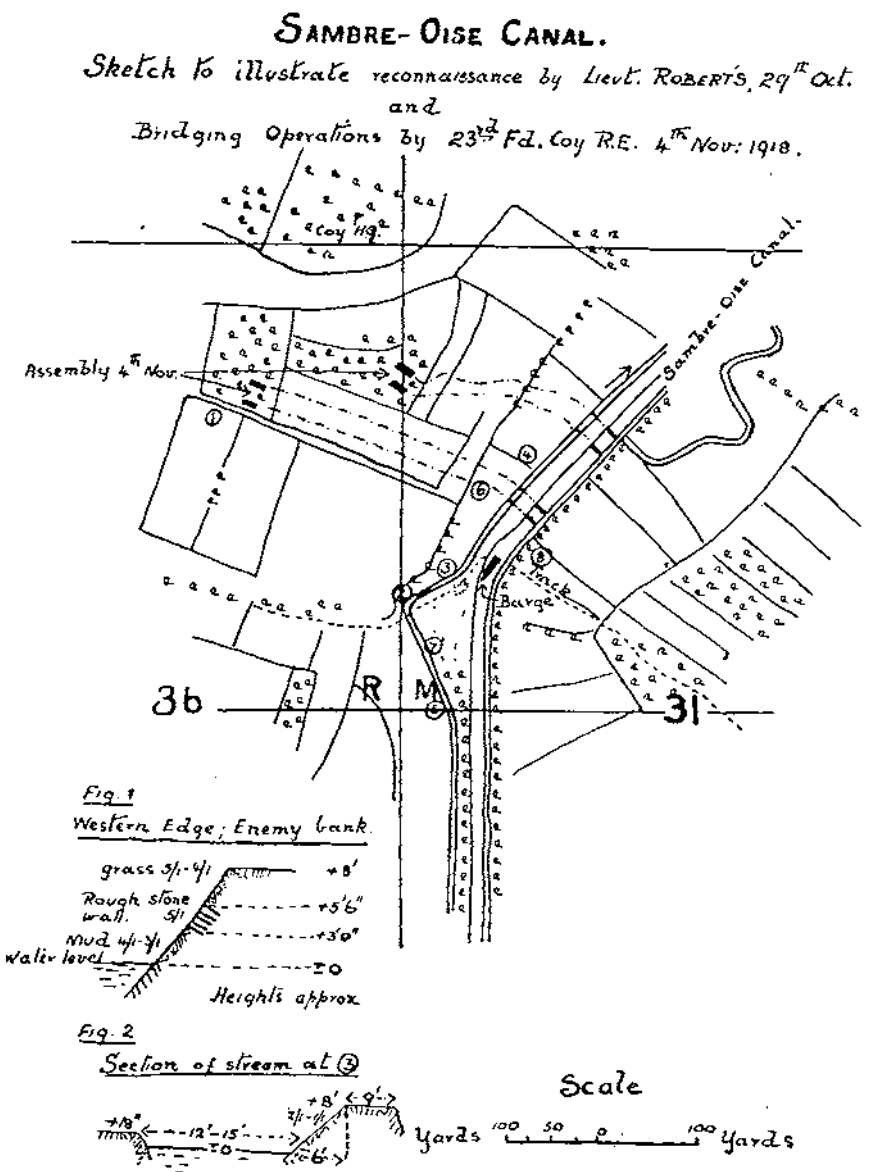
"I reached Company H.Q., where it was reported that the western bank in M. 31 had just been cleared. I proceeded with three sappers to platoon H.Q. (1), thence with one sapper and a guide to outpost at (2). From here with the sappers to the embankment this side of the canal at (3), following the track shown in the aeroplane photograph and attached plan. Returning, I proceeded northwards to (4), and southwards to (5), the following information being obtained:

"The ground as far forward as the stream or ditch running through (4), (6), (3), (2), (7) and (5) is quite firm. This stream or ditch is 12 to 15 feet wide between (6) and (5). Northwards of (6) and southwards of (5) its width lessens to six feet. It can be crossed at (3) by individuals on a few old planks left by the enemy. Its banks vary from 18 to 30 feet in height above the water level. At (3) this stream runs close up against the embankment. Attached are rough sketches of the eastern bank, as seen from the top of the embankment at (3); also a similar sketch of the western side of the western embankment. From what could be seen of the eastern face of the western embankment north and south of (3) it seemed to be the same

as the western face of the eastern bank. The height of the two embankments is the same.

" Attached is a sketch of the barge which is sunk in the canal at the bend. To me the width of the canal appeared to be about 20

SKETCH No. 28.



yards. The trees which had been felled nearly all lie with their tips away from the canal, and appear to me to be only felled to clear the field of fire.

" There is a belt of wire about six feet thick running southwards

from (3) for about 30 yards. A machine-gun could be seen firing at (8), but apparently could see nothing on top of western embankment under three feet high.

"Since the subsidiary stream is marked on the sketch plan supplied recently as a hedge, the hedges marked as such on the eastern bank seem also open to suspicion."

On the 29th October, Corporal Jones and a couple of sappers went out with an infantry patrol in Petit Cambresis, but were unable to get near the canal. They joined with a K.R.R. platoon which endeavoured to rush the enemy bridgehead post, but had to withdraw, Corporal Jones being slightly wounded.

On the 30th October, Lieut. Roberts again carried out a valuable reconnaissance of the approaches to the canal, the state of the roads and tracks and the concealment of the R.E. bridging material, which it was necessary to dump as near the canal as practicable.

As soon as the general scheme for the attack had been settled, Field Companies were allotted sectors of the canal for reconnaissance, with a view to settling the details of the bridging operations. The front allotted to the 23rd Company was approximately some 300 yards either side of the canal bend. A full scale model of the canal at the proposed point of crossing was made at the Company billet.

The Battle Instructions of the 1st Division stated that the attack would be carried out between Petit Cambresis and Catillon, the 2nd Infantry Brigade with the 409th (Lowland) Field Company on the right, the 1st Infantry Brigade with the 23rd (Field) Company on the left. The 3rd Infantry Brigade to carry out a subsidiary operation for the capture of Catillon later on. The 1st Infantry Brigade was to make its main crossing in M.31a, and a subsidiary crossing in M.26c. all troops to be screened from ground observation in their assembly areas by dawn on Z day, after which there was to be no movement of any sort before zero hour.

The leading battalions in the attack of the 1st Infantry Brigade were to be the 1st Camerons on the right, and 1st L.N. Lancs on the left. The 1st Infantry Brigade crossing was known as crossing No. 2.

The bridges for No. 2 crossing were sent up on the nights 1st-2nd, 2nd-3rd, 3rd-4th, 32 pontoon and G.S. wagon loads in all, and were dumped under trees and hedges and in orchards some 500–600 yards from the canal bank. This was no easy task. Constant shelling, cross-country routes, and heavy loads made the drivers' task a hard one. On one occasion a wagon upset in a shell hole, but 2nd-Corpl. G. Adamson, the N.C.O. in charge, in spite of the shell fire and having two horses hit, got his wagon up again, reloaded and the material safely delivered to the dump; a fine performance. About 2130 hours on November 3rd, the Company began to put the bridges together and to carry them to their final assembly positions. In addition, holes

had to be made in hedges to enable carrying parties and the attacking troops to get forward, involving in some cases cutting trees up to 9 in. in diameter. This was a somewhat ticklish job, as German patrols had to be avoided. The trees after being cut were left standing, ready to be pushed down when the time came. Subsidiary bridges over the small stream west of the canal had also to be laid. All this work was completed by 3.30 a.m. on November 4th. The final assembly positions of the canal bridges are shown on Sketch No. 28, the four first-wave bridges being in front with four of the supplementary bridges behind. The remaining four supplementary bridges were left behind at the forward dump, where they were subsequently caught by the enemy's barrage and the equivalent of two bridges destroyed. The total length of infantry single-file bridging material constructed by the 23rd (Field) Company alone was 1,692 feet, including four German steel float bridges (324 ft.), two petrol tin bridges (144 ft.), four barrel bridges (264 ft.), two cork bridges (120 ft.), 36 single span bridges (360 ft.), and 48 ladders (480 ft.), representing a really good week's work for the carpenters.

At 5.40 a.m., in the dim light of a cold misty morning, the 23rd (Field) Company sections, each of which was responsible for one first-wave floating bridge, stood to their bridges, and were joined by the infantry detailed to assist, namely, a platoon of the 1st L.N. Lancs for the northern pair and a platoon of the 1st Camerons for the southern pair. The four sections were commanded by Roberts (No. 1), Dougill (No. 2), C.S.M. Simmonds (No. 3), Pocock (No. 4). At 5.45 the barrage commenced, and the bridges were lifted and carried forward, reaching the western banks of the canal five minutes later. When the right-hand bridges got to the canal, it was found that a German machine-gun post with five men was on the bank at the exact point where it was desired to put the bridges across. Serjt. E. Cook and Sapper G. F. Daycock, without a moment's hesitation, rushed forward and killed three of the enemy, the other two surrendering. The section officer was wounded, but Serjt. Cook carried on, over the embankment with a rush went the bridges, and in four minutes from the time of reaching the bank, Cook had his bridge across the first of all at No. 2 crossing. C.S.M. Simmonds, D.C.M., was in charge of the next bridge, and in gallant competition with Cook, got his bridge across second. He subsequently took charge of two sections, and by his drive and fine example got several more bridges across in quick time. A minute later, 5.55 a.m., the remaining three first-wave bridges were in position; each bridge carried two sappers at the head to fix the heads and place storming ladders against the further bank. Two stout-hearted sappers, Sapper L. H. Saunders and Sapper J. Sewell, M.M., having anchored their bridges, leapt ashore and proceeded to clean up two German posts on the bank. Saunders was wounded in the fighting, but never-

theless returned to his bridge and carried out his job of keeping it in order during the crossing of the infantry.

Fine examples of gallantry and devotion to duty were shown by Lieut. J. C. Pocock and Sapper F. W. Kirby, both of whom were severely wounded almost immediately the bridging parties moved from their assembly positions. The former, however, continued to lead his party forward until he got to the canal bank, when he was able to go no further, handing over charge to the intrepid Serjt. Cook. Sapper Kirby continued to carry his section of the bridge to the canal, when he collapsed from his injuries, having worthily done his duty to the limit of his powers. Another gallant sapper was T. Williamson, who, having already shown his fine spirit in a daylight reconnaissance of the canal, now inspired all the men with him on his bridge by his cheerfulness under fire, his dash in being first man across his bridge, and his unconcern of danger. History relates that, when Sapper Watkins got through the barrage to Brigade H.Q. with his message that the infantry were across, the Brigadier threw his hat in the air, and ordered a tot of rum for the gallant messenger !

During this first bridging operation there was a fairly thick mist, which much assisted the parties carrying the bridges, and in addition the hostile barrage fell some way back from the canal banks, the total casualties amounting to one sapper killed and one officer and eight men wounded. After the first bridges had been placed, however, the men had to return and bring up the supplementary bridges, which were much heavier, men were tired, and progress was slow. However, by 9.15 not only were there ten bridges in position across the canal, but a corresponding number across the small streams east and west of the canal. No. 2 section was then left to maintain the bridges, and at 4.20 p.m. the remainder of the Company withdrew.

The Company was remarkably fortunate in getting their bridges across so rapidly with so few casualties, in contrast to the bitter fighting and severe shell fire experienced by the 409th (Field) Company at the lock. The writer may be forgiven if he here expresses his unbounded admiration for the splendid performance of his old friends of the Lowland Field Company on that day, an achievement which put a fitting seal to the grand record begun so well on the night of January 11th, 1915.

As a result of these operations the following officers and men received immediate rewards for gallantry and devotion to duty.

Major W. G. Smith, M.C., to whose splendid example and cheerfulness and organizing ability the success of the bridging operations, and particularly of the delicate work of the collection and concealment of the material was mainly due, received the D.S.O.

Capt. D. H. Gillespie, who had charge of the difficult and particularly unpleasant job, once the German barrage commenced, of regulating the supply of material, received the Military Cross, as

did 2nd-Lieut. J. C. Pocock. C.S.M. F. E. Simmonds, D.C.M., M.S.M., who not only took such an effective part in the actual bridging operations, but also assisted Captain Gillespie, and to whose cool courage under heavy shell fire the smooth supply of bridging material was largely due, received a bar to his D.C.M., whilst those hard-fighting soldiers, Serjt. Cook, Sappers Daycock and Saunders, received the D.C.M., Sapper Sewell won a bar to his Military Medal, whilst the following, who by their conduct under fire and continual devotion to duty worthily upheld the tradition of the 23rd (Field) Company that day, received the Military Medal: Serjt. E. Banham, Corpl. J. Bostock, Lce.-Corpl. J. P. Trussler, Lce.-Corpl. J. A. Elliott, Sapper A. Hocking, Sapper S. C. Evans, Sapper J. Newis, Sapper F. W. Kirby and Sapper A. G. Watkins, who, as Company runner, carried his messages safely and without delay backwards and forwards through the heavy barrage, and was the first man to get news to Brigade H.Q. of the successful crossing of the canal within three-quarters of an hour of zero.

Sappers Kirby and Williamson, whose individual gallantry has been referred to in the narrative, and 2nd-Cpl. Adamson, also received the Military Medal.

A very sad loss this day was that of Sapper Woolcock, M.M., No. 2 Section. This gallant sapper had been all through the War with the Company, conspicuous for his fine courage, and on this day, having volunteered for the dangerous duty at head of his bridge, he was severely wounded after carrying out his task, and died in hospital, the last man of the Company to be killed.

This was the last engagement in which the Company was to take part in the Great War, for on the 5th they rested, on the 6th moved to Lernoy le Grand, whilst on November 11th the diary prosaically remarks " Company employed packing surplus stores for removal to Bohain " ! !

The March to the Rhine, the Occupation and Demobilization.

It but remains to tell briefly the story of the occupation. The march forward commenced on November 13th, in very fair weather. The underlying weight of war, which had insensibly been ever present for four and a quarter long years, day and night, was lifted, hearts were high even if, thanks to the destruction of communications, stomachs were light. At last the great day had arrived ; " To the Rhine ! " with backs turned for good on the pestilential battle areas in which the sapper had dug and delved for so long. What can have been the feelings of the 36 stalwarts who had set sail from Southampton on that August day in 1914 and had seen the " Old Bat. " through its great campaign ?

Loads were cut down to the minimum, the souvenirs, tools and

gadgets dear to the heart of section officer, serjeant and cook, were jettisoned ruthlessly, till carts contained nothing but mobilization stores. During the early stages of the march the Company was kept hard at work removing land mines, which the thorough German had placed at every cross-road, culvert, embankment and bridge, mostly well tamped. Two officers on motor-cycles were employed keeping touch with the German rearguards and placing civilians to point out the positions of the mines. It was not until the 18th that the Division was clear of the mined area.

The people seemed rather stunned, and were in sad straits; they had no stock and no tools, little but a few potatoes. At Yves Gomezee, however, they turned out quite a creditable band, the drum filling in any gaps in the efforts of the wind experts.

At one place a large park of German aeroplanes was seen, and it was interesting to note the large numbers of bullet marks in wings and fuselages.

Towards the end of November and beginning of December the weather broke, and marching day by day became somewhat unpleasant, but none grumbled, for all felt they were on the right road. Every mile gave evidence of the German troubles, burnt-out lorries, lorries with no petrol, and with iron tyres.

A halt was called for the week-end on December 14th, and all hands turned to polishing buttons, cleaning up wagons, and harness, in preparation for crossing the frontier.

On December 16th, the 1st Division crossed the frontier at Beho, marching past the Divisional Commander with bands playing and the Union Jack flying on enemy territory at last. It was a brave sight, in spite of the rain which was "tumbling down." At the end of the day's march the men were well treated, the housewives providing big fires to dry the soaked clothing, whilst a dish of potatoes in many cases, and even a mysterious chicken, found its way occasionally into the stewpot.

At last, on December 23rd, the Company arrived at its final billet, Niederdress, where it had the village to itself. Christmas Day was celebrated under the happiest conditions, pig, poultry and something to wash them down all helping, and every section had its own sing-song.

Very soon in January and February, demobilization began, time-serving soldiers leaving early to help in the work at the depots at home, and by March and April the process was in full swing, until the day came for the cadre of Captain A. E. Green, M.C., R.E., and some 40 men to move to Antwerp on May 23rd, where they embarked in the s.s. *Arbroath* on the 29th, arriving at Tilbury on the 30th, coming to rest at Chattenden on the 31st, reduced to a care and maintenance party of C.S.M. Simmonds, D.C.M., M.S.M., and one sapper. All honour to the "Old Bat." and the men, regulars and "temporaries" alike, who had maintained its reputation bright and unsullied through four and a half hard fighting years.

AFTERWORD.

I cannot bring this tale to a close without offering my very grateful thanks to all those who have suffered my importunities and have helped me to "paint the picture," in particular Captain B. B. Edwards, M.C., R.E., and C.S.M. F. Simmonds, D.C.M., M.S.M. (late R.E.), both of whom have contributed very liberally to the narrative. My thanks are also due to the officials of the Historical Section, Committee of Imperial Defence, for unvarying helpfulness, to Major Becke, for guidance and assistance with sketches, and Mr. Woolgard (late R.A.), who kept me supplied with the Company, C.R.E.'s, and other War diaries; to Colonel C. Russell-Brown, C.B., D.S.O., Major G. Cheetham, D.S.O., M.C., R.E., Captain M. W. Salmon, M.C. (late R.E.), and Lieut. P. L. Forwood (late R.E.), all of whom materially assisted the work.

Unfortunately, a Field Works book kept by the Company, which included sketches of all the works carried out from 1915 onwards, disappeared after the Armistice, so that technical details of interest have been difficult to obtain at this distance of time.

THE 23RD (FIELD) COMPANY, R.E., 1914–18.

APPENDIX E.

Note.—As it is thought that some of the Company statistics will be of interest, the following tables are given.

TABLE I.

Casualties to the Original 1914 Personnel.

Officers.	Wounded	1	
	Sick	2	
	Transferred	3	
	Total	6	

Of the three transferred, all served throughout the campaign in France, almost entirely with Divisions.

Other Ranks.	Killed	27	
	Wounded	50	
	Sick	73	
	Transferred	32	
	P. of W.	3	(caught in the mine at Cuinchy, Jan. 25th, 1915).
	Served throughout the War	36	(of these 5 continued serving after the War).
	Total	221	

TABLE II.

Half-yearly Casualties (including wounded, at duty, and sick rejoined).

	Killed and Wounded.	*Sick.*	*Total.*	
Aug., 1914–31.12.14 ..	27	47	74	
1.1.15–30.6.15 ..	51	40	91	Cambrin and Rue du Bois.
1.7.15–31.12.15 ..	59	28	87	Battle of Loos.
1.1.16–30.6.16 ..	10	20	30	Loos sector.
1.7.16–31.12.16 ..	42	27	69	Somme.
1.1.17–30.6.17 ..	3	48	51	
1.7.17–31.12.17 ..	9	35	44	Passchendaele.
1.1.18–30.6.18 ..	48	34	82	Givenchy.
1.7.18–31.12.18 ..	38	28	66	
	287	307	594	

TABLE III.

Battle Casualties by Sections (excluding wounded at duty).

	Killed (Officers)	*Wounded (Officers)*	*Killed (O.R.)*	*Wounded (O.R.)*	*P. of W.*	*Total.*
No. 1 Section ..	2	3	16	46	3	70
No. 2 Section ..	–	2	11	47	–	60
No. 3 Section ..	–	2	10	38	–	50
No. 4 Section ..	–	2	5	56	–	63
H.Q. and Mtd. ..	–	3	9	24	–	36
	2	12	51	211	3	279

ANTI-AIRCRAFT GUNNERY.

A Lecture delivered at the S.M.E., Chatham, on March 14th, 1929, by CAPTAIN V. R. KROHN, M.C., R.A.

Introduction.—The period of a normal lecture is too short for more than a general outline of the various and somewhat intricate problems confronting the A.A. gunner. If, therefore, I appear to pass some matters of interest rapidly, the shortness of time is to be blamed.

Reasons for Ground A.A. Defence.—The first line of Anti-Aircraft defence is the aeroplane.

An aeroplane cannot, however, remain in the air continuously. The average "fighter" carries sufficient petrol for from 2 to 2½ hours' flight. Allowing for overhauls, etc., in order to keep one aeroplane patrolling continuously during the hours of daylight in summer, a complete "flight" of six machines with their pilots and ground staff is needed.

One has to remember also that the pilot himself can only fly for a limited number of hours each day.

From this we see that unless we had an almost unlimited supply of aircraft and pilots, some other form of A.A. defence must be found to supplement the defences in the air, and it is for this purpose that ground A.A. defences were introduced.

The primary *rôle* of ground A.A. is obviously the attack by fire of hostile aircraft with the object of destroying them, but there are other almost equally important *rôles* such as :—

(*a*) breaking up enemy formations to allow our fighters to deal with the units thereof.
(*b*) pointing out hostile aircraft to our own patrols.
(*c*) protecting our own artillery observation aircraft from hostile attack, by means of barrage fire, or by direct fire on the enemy machine.
(*d*) protecting our observation balloons as in (*c*) above.
(*e*) protection of vulnerable points or areas against attack by bombing aircraft.
(*f*) recording movement of all aircraft, particularly hostile. From these records very valuable information can frequently be deduced by the General Staff.

What A.A. have we got ?—At present we have to have A.A. units for the following jobs :—

i. Expeditionary Force.
ii. Defence of London.
iii. Defence of Home Ports.
iv. Defence of Ports Abroad.

For the Expeditionary Force and London Defences we have A.A. units grouped into Air Defence Brigades.

For home ports and ports abroad special organizations are arranged depending on local requirements.

The composition of an Air Defence Brigade is shown on the diagram.

Guns.—The standard gun for all purposes is at present the 3-inch 20-cwt. A.A. gun. This throws a 16-lb. shell to a maximum height of about 21,000 feet in about 30 seconds.

Actually its effective height is between 16,000 to 18,000 feet, for which the time of flight is about 25 secs.

The 16-lb. shell can be either H.E. or shrapnel. In the former case the shell breaks up into about 150 pieces averaging a little less than 2 oz. in weight.

H.E. is the normal type used, and is issued with shrapnel in the proportion of 85% to 15% respectively.

The shrapnel is used mainly against low flying attack, where the forward effect of the shrapnel bullets is useful, and also for putting low barrages over places such as bridges, where the use of H.E. would be dangerous to troops on the ground.

Experiments are being carried out with a 4·7 inch A.A. gun, but this will only be used for fixed or semi-fixed defences, as it is too heavy for mobile work.

Fire Unit.—In all cases the basic minimum fire unit is the 2-gun section.

Whenever possible, however, 4-gun fire units will be used for two reasons :—

i. Volume of fire.
ii. Better and more economical control.

How does A.A. get about?—We have at present three types of platform on which we can carry our 3-inch gun and mountings, and in each case the gun and mounting are identical :—

i. Platform travelling A.A. mounting No. 2 Mark I.

This was introduced into the Service in 1928. It is a trailer type platform with four wheels, and towed by a four or six-wheel drive tractor. In action the weight is taken on four jacks, but in an emergency the gun can be fired from the unjacked platform without danger. The platform is well sprung, and can travel safely at any speed that a Service tractor is likely to be capable of. It is steady in action, and the gun can be fired horizontally without undue shaking. It can be got into and out of action in two or three minutes.

Expeditionary Force units are now being equipped with this.

ii. Platform travelling A.A. mounting No. 1 Mark I.

This is what is generally known as the semi-mobile platform. It is square in plan, and can be fitted at will with two detachable wheels.

At each corner a girder is hinged, which carries a long jacking screw at the outer end. When in action the girders are swung outwards, forming a sort of starfish platform which can be levelled by means of the jacks. For travelling, the whole platform is jacked up, the wheels fitted, and then the girders can be folded in pairs, one girder of one pair being fitted with a sprung towing-eye which hooks on to a special towing-bar fitted to a tractor or three-ton lorry.

This platform is very steady when the gun is firing, but is sufficiently handy for moving when necessary. It takes from 10 to 15 minutes to get into and out of action.

iii. Lorry mounting.

This platform is obsolescent, but is retained as a reserve mobile mounting. It is simply a lorry chassis fitted with four jacks, the gun being mounted on the floor above the rear axle. It is unsteady in action, and generally unsatisfactory.

Why not fixed like Coast Defence.—Fixed A.A. guns on concrete platforms would be ideal for such defences as London, etc., but it would involve tremendous capital expenditure, and further enormous sums in maintenance.

Secondly, by having these semi-mobile mountings, which can be moved about comparatively easily, in the event of a war which does not involve fleet action, those guns earmarked for the A.A. defence ports abroad could be used on the L.-of-C. and so on.

Searchlights.—These are necessary for night work. Without them, our own defending aircraft are also useless at night, so that searchlights are of the first importance. We have at present two types of searchlight:—

i. 90 centimetre—mobile.
ii. 120 centimetre—used for fixed defences only at present.

A new high-current density lamp is being introduced for the 90-cm. searchlight, which gives a considerable increase in range. Up to the present there is no lamp of this type for the 120-cm. searchlight.

The efficiency of any searchlight is so dependent on atmospheric conditions that it is often misleading to give any figures as to range. Under good conditions, however, the range of the new lamp may be taken as from six to eight thousand yards, measured along the beam.

The illumination required by the gunners is greater than that required by the Air Force. When laid out for the illumination of targets for gun defences, the lights are spaced about 3,000 yards apart all over the area. This system allows for illumination to be given by three lights at a time, and is then sufficient to allow the gunner to take the measurements he requires.

When laid out for the illumination of a target for the Air Force only, the spacing of the lights is increased to about 3,500 yards.

For the gunners, it is necessary to get the target definitely into the beam. For the Air Force, it is frequently sufficient if the hostile aeroplane is to be found near the intersection of two searchlight beams which are following it by sound but not actually illuminating it. In such a case, a fighter machine can fly towards the intersection of the searchlight beams (which may even be above a bank of clouds), and locate the hostile machine either by the flame from its exhaust, or by seeing it in silhouette, or faintly illuminated by diffuse light.

Sound Locator.—The sound locator is a necessary adjunct to the searchlight, and is used for directing the light on to the target.

The principle upon which the sound locator functions is the use of the binaural effect obtained with the human ears. Briefly this binaural effect is as follows :—A sound arriving from a fixed source which is not directly in front of an observer arrives at one ear a fraction of a second before the other, thus enabling the observer to get an idea of the direction from which the sound emanated.

If the observer commenced to turn his head in this direction, there would come a time when he would appear to hear the sound at the same instant, or at even intensity in both ears. He would then be looking in the direction from which the sound emanated.

The normal distance between the ears of a human being is only a few inches, and therefore the accuracy with which direction can be determined is not very great. If, however, we lengthen this base artificially, to some feet, the accuracy is increased in direct proportion. Furthermore, if we introduce at the same time some means of amplifying the sound, we further increase the accuracy.

Both these points are achieved in the modern sound locator. Two large trumpets separated by a distance many times that of the ears, are mounted parallel to one another, and, from the narrow end, tubes, terminating in stethoscopes, are taken to the ears. The trumpets are of such a shape that amplification of the sound is obtained.

If now, these trumpets are mounted so that they can be revolved about a vertical point, the observer will be able to swing them until the intensity of the sound is even in both ears, and direction will have been obtained.

With the aeroplane target the job is somewhat more complicated, as we require direction in two senses, *i.e.*, bearing and elevation. This is achieved by using two observers, each supplied with a pair of trumpets. The trumpets, however, are now mounted on axes at right angles to one another, so that observation for direction can be obtained in two planes at right angles to one another. The movements now given are, therefore, about two axes, one vertical and one horizontal, so that bearing and elevation can be read from appropriate scales.

A further point which must be taken into account is that of sound "lag." With a fixed source of sound this does not affect the readings,

but with a moving source such as the aeroplane, the readings on the scales at any given moment would correspond to the position of the target displaced from its present position, by the distance it travelled in the time the sound took to reach the observer.

For example: At the moment of observation, the aeroplane was 3,300 yards away, or 9,900 feet.

Sound travels at 1,100 feet per second, so that $\frac{9900}{1100} = 9$ seconds, is the time it took for the sound to reach the observer.

If the aeroplane was travelling at 100 miles per hour, = 50 yards per second, then at the moment of reading on the sound locator scales the aeroplane would be $9 \times 50 = 450$ yards further along its course.

At the present time this is allowed for by the use of a certain type of sight known as the ring sight, but space will not permit of a description being given. It is hoped, however, that in the future some more accurate and automatic method may be evolved.

Signals.—As will be seen from the Table, there is a Signal Company to each Air Defence Brigade.

The units of this company are responsible for all the signals required within the Air Defence Brigade, down to Battery H.Q. in the case of the A.A. Brigades and to Sections in the case of the Searchlight Battalion.

Internal signals in the batteries, etc., are carried out with their own personnel and equipment.

The actual composition of the Signal Company is at present under revision.

A.A. Lewis Gun Sections.—There is one of these sections to each A.A. Battery. At present it consists of eight A.A. lewis guns carried in two vans or light lorries, but it is likely that these will be replaced in the near future by a multi-gun mounting, mounted permanently on a six-wheeled vehicle, as in this way a much greater volume of fire could be produced. If this scheme matures, it is likely that the total number of gun barrels will be increased.

The function of these guns is the protection against low-flying attack of units which have no protection of their own, such as ammunition, ration and supply dumps, etc. They are also used for picketing defiles, bridges, etc., on the line of march.

The existence of these guns in an area does not excuse units in that area from organizing their own A.A. lewis gun defences.

What A.A. has done and hopes to do.—Many of us still have vivid memories of seeing the hostile aeroplane in the sky, and, anything up to two miles away, some A.A. shells bursting on their own. Or one saw a hostile plane travelling on a straight course, followed about 500 yards behind by a string of A.A. bursts.

The first trouble may still occur. It was and will be due to the fact that the target turned just after the rounds left the guns, or at some time during their flight from the gun to the target. This is not

the A.A. gunner's fault, although it was frequently thought to be so, and he came in for a considerable amount of scathing comment which was entirely undeserved.

The other case was due to inexperience and the lack of efficient fire control instruments.

During the Great War, A.A. gunnery was very much in its infancy; there were few instruments, some of which were merely adapted in a vain effort to solve a problem to which they were entirely unsuited.

Since the War, however, the development in A.A. gunnery has been more rapid than almost any other contemporaneous Service development, excepting always the improvement in aeroplanes themselves, but we have, I think, kept pace with them.

It has been calculated that, it required to hit a target

at the outset in 1914, 100,000 rounds.
In 1916, 10,000 rounds.
At the end of the War, 3,000 rounds.

Now, we may reasonably place that figure at 100 rounds. Of course, in peace time a figure of this sort can only be based on estimation.

In spite of indifferent A.A. shooting during the War, anti-aircraft fire accounted for one out of every 12 hostile aircraft brought down. This is a higher proportion than is generally realized.

What A.A. cannot do.—We can compete with an invisible target only by putting up barrages, most wasteful in ammunition and the last resort of the A.A. gunner. We are, however, developing methods by means of which a barrage point is predicted, and a limited fire is opened at a given moment. If the prediction has been good, it is quite likely to have one or both of two effects if the hostile machine is a bomber, even though the aeroplane is not hit,

(*a*) It may turn it, or

(*b*) it may cause him to drop his bombs and go home.

Such results were frequently obtained from well directed barrage during the War.

Some of the A.A. Gunner's Difficulties.—(i) We are working in three dimensions, and if we consider the time factor which is all important, we then work in four dimensions.

Speed.—(ii) The speed at which our targets travel are at the bottom of our troubles. Nowadays, a slow speed is 100 m.p.h. A normal speed is 150 m.p.h.

100 m.p.h. = 50 yds. per sec. 150 m.p.h. = 75 yds. per sec.

Extreme Range.—(iii) We have to tackle our targets at extreme range in order to keep them away from our vulnerable points or areas.

This means that we are usually working at the most inaccurate part of our trajectory.

Observation.—(iv) Any observations that are necessary, such as height, etc., are made very much more difficult by not only speed, but background. Certain types of sky give us beautifully defined targets, but on most apparently clear days there is a high haze which blurs outline and frequently completely obliterates targets.

The Gunnery Problem.—Height. (i) With such a fast-moving target all the ordinary factors such as range, bearing and so on, which are common to all gunnery and which are usually stationary once they are found, are changing very rapidly in A.A. gunnery. In a search for something which is likely to remain more or less constant we find that *Height* should fill the bill. Unless disturbed, a pilot will fly at least at approximately the same height for considerable periods. Height is, therefore, the basic measurement in A.A. gunnery, and all subsequent calculations depend on obtaining the correct height.

Speed and Course.—(ii) For the same reasons, speed and course are likely to remain fairly constant. Height, speed and course are, of course, all subject to involuntary changes due to atmospheric conditions.

Three Assumptions.—(iii) In order to make any headway at all it has been found necessary to make the following assumptions:—

That for a given target:—

1. Height
2. Course
3. Speed

will remain constant over a short period.

Obviously, the shorter the period the better, but unfortunately we are limited in this by the performance of our gun. The shortest possible period at a given moment is the time that it will take the shell to reach the aeroplane (or the time of flight). This presupposes that no time at all is lost in making our calculations. I will try to show you in a minute, that we have practically achieved this now.

Measurement of Height.—As is so often the case, we have, I regret to say, put the cart before the horse in A.A. gunnery. What I mean is this. Height being the basic measurement in A.A. gunnery, it is not much use thinking about anything else very seriously until we can get an accurate height whenever we want it. At the moment we can't do this, although we can do almost everything else that is required with considerable precision.

We ought to get our height to within 50 to 100 feet, but if you asked a surveyor to get you the height of a mountain 6,000 feet high, he would take perhaps an hour to collect his instruments, another to take his readings, and calculate the answer. We want the answer in under 30 seconds.

At present we have two main systems :—

(i) The short base method.
(ii) The long base method.

(i) *Short Base Method.*—This consists of the ordinary type of Barr and Stroud rangefinder, with which all branches of the Service are familiar, only it has a 2-metre instead of a 1-metre base. Attached to it is a complicated gear box which hatches out the height for you, when you mount the instrument on a levelled stand and feed it with angle of sight as well as range. This instrument isn't so bad up to about 8,000 feet, but after that it fails miserably.

Further research on these lines is being pushed on hard.

(ii) *Long Base Method.*—In this case, we have two instruments at the ends of a base perhaps 6,000 feet long. The stations are connected telephonically and readings from one end sent to the other, where, after a single setting has been made, the height can be read off. The answer is pretty accurate, but as a service heightfinder the method is full of snags, which I will leave you to think about at your leisure. I suggest, however, that for one thing a 2,000 yard telephone line is not too easy to keep in order in a place like the Ypres Salient. I've tried it.

Here, again, research is being carried out, and we hope for answers in the near future.

Deflections.—I think it is obvious to the most inexperienced that it would be useless to fire at the aeroplane at the position in space which it is occupying at the moment of firing, because the shell takes time to get there and in that time the aeroplane is also moving, and pretty fast, too.

Example : If time of flight is 20 sec. and speed is 75 yards per sec., then distance travelled equals 1,500 yards.

Future Position.—We must, therefore, fire at some future position of the aeroplane which, assuming the height remains constant, is dependent on :

(i) Speed.
(ii) Course.
(iii) Time that it will take us to put a shell in that future position.

In other words, we must give the guns a " lead " in the direction of the target's flight. This is done by applying on the sights, deflections for travel in two senses :

(i) The vertical sense.
(ii) The lateral sense.

(i) is known as the vertical deflection, and may be " up " or " down," depending on whether the target is travelling towards or away from the guns.

(ii) may be " right " or " left." This is self explanatory.

Angular Velocity.—Up to the present we have talked at length about "speed" and "course" of the target. By this we have meant the speed and course relative to the ground.

A target may quite easily have an "air speed" of 60 miles per hour, but if it is travelling into a 60 m.p.h. wind its "ground speed" at that moment is *nil*, and its course is stationary.

Now, in actual practice, for reasons we cannot go into here, we have found that it is not convenient to try and measure the actual ground speed and course of the target. We can, however, very easily measure what we call its "angular velocity." That is to say, supposing we had a target travelling directly away from us, its angle of sight (or elevation) is changing all the time; getting less, as a matter of fact. If we measure the rate at which this angle is changing we have found the "vertical angular velocity." If, now, we made that target travel away from us and to the right, say, at the same time, its bearing relative to true north or some chosen point is also changing at a certain rate, which can be measured. This is the target's "lateral angular velocity." In this case we have a bit of vertical and a bit of lateral angular velocity, and this, if you will think for a minute, is likely to be the usual state of affairs.

If, then, we multiply these angular velocities by the time of flight which we have already mentioned, we will get angles, in the same way that, if we multiply the speed at which we travelled from London to Chatham by the time that it took us, we will get the distance from London to Chatham. These angles are the travel deflections we have just talked of. In actual fact, they are subject to certain corrections which we need not go into here, but the principle remains true.

Crossing Point.—It is interesting to note here, that although we can have targets which will approach or recede directly, giving us no lateral rate at all, we cannot have the converse except momentarily. Take any target crossing our front from, say, right to left; at first it has an approaching element as well as a lateral element. When it arrives plumb opposite us, or, in other words, reaches the point on its course which is nearest to us, the approaching element changes to a receding element, while the lateral element remains "left." The moment of changing over is known as the crossing point, and it is at this point only, that we have a purely lateral element, and it is only momentarily.

Fuze.—We have seen that we want two deflections for travel, but we want also a fuze. Actually, what we really need is what other gunners think of as range, but A.A. gunners think of it as fuze-range. This is not just to make it more difficult, but because we find that the easiest way of applying range is in terms of fuze and angle of elevation. There is a dial on the gun which has fuze curves on it, which must be followed to order by the operator. The following of any

given fuze curve on this dial automatically applies the correct elevation for that range to the gun.

This fuze must, however, be found somehow, and as it is the fuze to the future position which we require, and not to the present position, and as we don't yet know where this future position is in space, you will begin to see that our problem is not a simple one. To go a little further with this intriguing picture, until we know what the fuze is, we don't know what the time of flight is. Until we know what the time of flight is we cannot possibly get our travel deflections. So it looks as if we are dooomed to go round and round in a circle like a kitten chasing its tail. As a matter of fact, it is all worked out on a system of balancing, or trial and error, and as our instrument does it for us almost automatically, I don't think we will bother with it any more. The method is known as obtaining the " A.A. balance."

Summing up, then, we have now got for our guns :

(i) Vertical deflection.
(ii) Lateral deflection.
(iii) Fuze.

With these three things available we can fire the guns and hope for the best.

Methods of Application of Gun Data.

We can apply the data now obtained in two ways :—

(i) To dials on the gun sights in the form of deflections, etc., given above.
(ii) Or as composite elevation and training angles direct from instruments to electrical follow-the-pointer receiving dials specially fitted to the guns.

Case I.—The first system is known as the Case I method, and as the various information must be read off from dials on the instruments, shouted to the guns, and there applied to the sights, you will see that a lot of valuable time will be wasted and the result will be that the deflections, etc., are likely to be stale by the time that the guns fire. In actual fact this " lost " or " dead " time is, on an average, about eight seconds, so that unless one did something about it, at 75 yards per sec. the target will travel 8 x 75 = 600 yards, and that is what one would miss the target by. Actually, allowances are made, but so far they have been dependent on the skill of the individual members of the instrument detachments, and this is not good enough.

Case III.—The second system is known as the Case III method, and is a very different story.

Here, all the necessary data is evolved inside the instrument, and sent down continuously to the special follow-the-pointer receiving dials on the guns, so that all rounds are fired with the correct sight

settings. This means that we have eliminated completely and accurately the whole of that dead time of eight seconds, so that we can hope to be at least 600 yards nearer the 150 miles per hour target every time.

Group Fire.—With the Case I method, as it is impossible to cope with the continuously changing fuze by a corresponding continuous change at the guns, we fire groups of four rounds set at the same fuze. This is theoretically inaccurate, of course, but cannot be avoided in this method, even though we resort to an automatic fuze setter.

In Case III we can transmit the fuze continuously to an automatic fuze setter, so that each round is set at the correct fuze, so we gain here also.

The Predictor.—The modern A.A. instruments which are used to give us the data we have been talking about are :—

(i) A height finder.
(ii) An anti-aircraft predictor.

The height found by the heightfinder, is set into the predictor. The predictor is kept laid continuously on the target by two men. Other members of the predictor detachment perform comparatively simple operations such as following a curve or by means of a hand-wheel, preventing the revolution of a pointer visible in the dials opposite to them.

Further settings in the predictor are :—

(i) For the effect of the wind on the shell. The strength and direction of the wind in the district is set into the instrument, together with another setting of height of target, and internal mechanism works out continuously and automatically the corrections required, and these are automatically applied to the main data before they are transmitted to the guns.

(ii) Corrections for temperature, barometer and wear of guns are worked out and applied as a percentage correction to the height of the target. Therefore the height used in the predictor will not necessarily be the actual height of the target, but what is known as the ballistic height.

Secondary Methods.—We have under trial at the moment two secondary methods. Both are of the Case I type, but allow more or less automatically for the " dead " time I have spoken of. As they are experimental, I will not do more than mention their existence. It is sufficient to say that they are required as substitutes for the predictor either in case of breakdown or in cases where the fire unit must be split, or again, in some very forward and dangerous position where the risk of getting the very expensive predictor hit was considered too great.

Eye Shooting.—As a last resort, when all else fails the unfortunate A.A. gunner must take to eye-shooting. This is really a process of

calculated guessing, the mental calculations being based on certain rough rules. Most of the shooting in the War was carried out in this way, and it seems that to be successful is to have the gift for it, though a great deal can be learnt by study of the subject. Furthermore, modern methods and ideas have certainly gone a long way towards making eye-shooting easier.

A.A. Fire Control.—Generally speaking, it is impossible to obtain really accurate shooting without the use of instruments. The more accurate the shooting required, the more expensive and elaborate are the instruments.

This does not mean, however, that the work of the A.A. gunner becomes more difficult, but rather the reverse. The more complicated the instrument, the more completely automatic does it become, and so the actual operations performed by the members of the detachments become easier.

It is no exaggeration to say that a squad of intelligent young recruits should make an exceedingly efficient A.A. Section, and they could be trained to a very reasonable state of efficiency in a very short time.

It is the secondary system, including eye-shooting, which requires so much training.

The Case III method of fire is now the proven orthodox method of A.A. attack.

Every effort is, therefore, being made to perfect instruments and other gear to the most profitable employment of this method for both mobile and fixed defences.

Methods of Practice.—This lecture would not be complete without some mention of the methods of practice of A.A. fire. It is obvious that we cannot actually shoot at a real aeroplane unless it could be controlled by wireless, and even then it would be an expensive business, because I have always found that when we are not particularly keen on bringing down our target, we generally succeed in doing so. There were occasions in the War in which our own or Allied planes were engaged by mistake, and I don't think we ever missed.

Two Methods.—At present we have two methods:

(*a*) Full charge shooting at a towed sleeve.

(*b*) Reduced charge shooting at an actual aeroplane.

(*a*) *Full Charge.*—In this case an aeroplane tows a 20-foot long sleeve about 2,000 yards behind at heights up to about 10,000 feet. So far, for safety reasons we can only shoot at this sleeve when it is crossing our front and then only through a limited arc of fire.

We do not record a large number of actual hits, because we use a special cheap cast-iron shell which breaks up into about ten pieces. The Service H.E. shell breaks up into about 150 pieces.

Hits.—In 1928, the R.A.F. calculated that we got about one hit for 1,300 rounds fired, so that on this basis with the Service shell we ought

to do about 15 times better, which would mean a hit every 80 or 90 rounds. Of course, a hit does not by any means mean disablement. I knew a pilot in the R.F.C. who returned one day with 370 odd holes in his machine from A.A. as well as small arms fire, but no vital part was hit. The machine was, of course, written off. This year we are going to fire some H.E. shell at the sleeve, so we hope to get more definite information.

(*b*) *Reduced Charge.*—By arranging to use a very much reduced charge we have been able to reduce the ceiling of our 3-inch gun from about 21,000 feet to 8,000 feet, and yet arrange that the times of flight for given fuze lengths are practically the same as with full charge.

By making the aeroplane fly above 8,000 feet, we ensure the pilot's safety.

By providing special scales for our instruments we can make them function absolutely normally.

The only difference is that the shell is only sent to about half-way to the target, although it takes about the same time to do this as the Service charge would take to send it the whole distance. This means that deflections are of the same order, and an effective round is taken as one which bursts on the line of sight to the target at that moment. This is a more reasonable assumption than may be at first imagined, because we also take steps to check the height ordered. A.A. gunners are the first to admit, however, that this method is not so satisfactory as being able to record actual hits.

The outstanding advantage of the reduced charge method is that there is no restriction on the movement in space of the target other than range limitations, and so units get practice on all types of target which are likely to be met on service.

Conclusion.

In conclusion, I suggest that there was never a time when the Army thought so much about the future of warfare.

Modern scientific inventions have completely changed the aspect, and it is not easy to see through the fog, but I do think that there does appear, clearly, to be a great increase in the air menace.

Aeroplanes of all sorts are becoming steadily cheaper, more efficient and reliable.

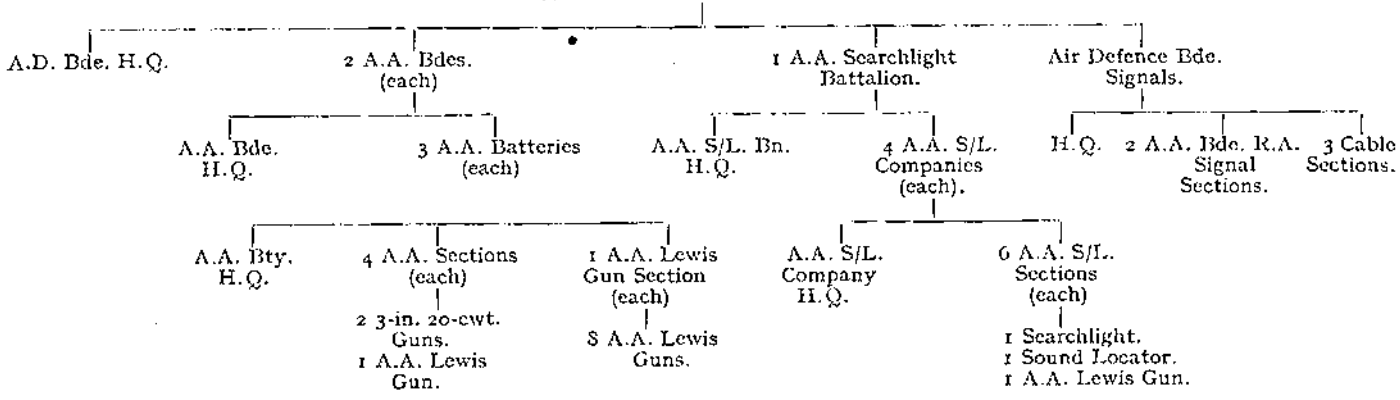
I hope I have convinced you that we have a technical reply in the gun.

Unless, however, officers appreciate the developments of anti-aircraft, and know how to handle A.A. Units, we shall not obtain the great results which the technical developments will place within our reach.

A.A. gunnery is a science—and a new science—but it is not a mystery.

ANTI-AIRCRAFT GUNNERY.

TABLE GIVING COMPOSITION OF AIR DEFENCE BRIGADE.



TOTALS :—

3-inch 20-cwt. Guns	48	
A.A. Searchlights	96	
A.A. Sound Locators	96	
A.A. Lewis Guns :		
in A.A. Lewis Gun Sections	48	168
in 3-inch 20-cwt. Sections	24	
in A.A. Searchlight Sections	96	

THE "MODERN" DIVISION.

By CAPTAIN G. S. HATTON, ROYAL ENGINEERS.

"There is these days a tendency to exaggerate the power of mechanized forces and correspondingly to belittle the action of other arms."

"If it were so, it was a grievous fault;
And grievously hath Cæsar answer'd it."
—*Julius Cæsar*, Act III, Scene II.

INTRODUCTION.

Before commencing any discussion relative to the employment of mechanized forces and other arms, it is essential to make quite sure what are mechanized forces. In order to clear up this point, the present writer has adopted two definitions employed by Major-General Sir J. Burnett-Stuart*:—

> "A mechanized unit or force is a unit or force whose capacity for fighting and movement is assessed entirely in terms of machines."
>
> "An unmechanized unit or force is one which fights and moves entirely in terms of man and horse."

Although, perhaps, a war waged entirely by mechanized forces will come some day, the present writer's idea of the next war of any magnitude, in which we are likely to be engaged, is one in which mechanized and other arms both take part. There may be A.F.V.s with the unmechanized forces; but just as the strength of a chain is the strength of its weakest link, so is the mobility of a force the mobility of its slowest unit. Hence the poignant division into "mechanized" and "unmechanized" forces laid down by definition.

GENERAL DISCUSSION.

The Mechanized Force.

It is necessary, now, to arrive at a clear understanding of the capabilities and limitations of a mechanized force, or, as it is now officially termed, "Armoured Force."† The recent experiments on Salisbury Plain were conducted with a force of 800 cross-country vehicles, of which 300 were fighting vehicles and the remainder auxiliary or maintenance vehicles. The organization and armament of a "future" mechanized force is shown in diagram 1. This has been deduced from the actual accomplishments

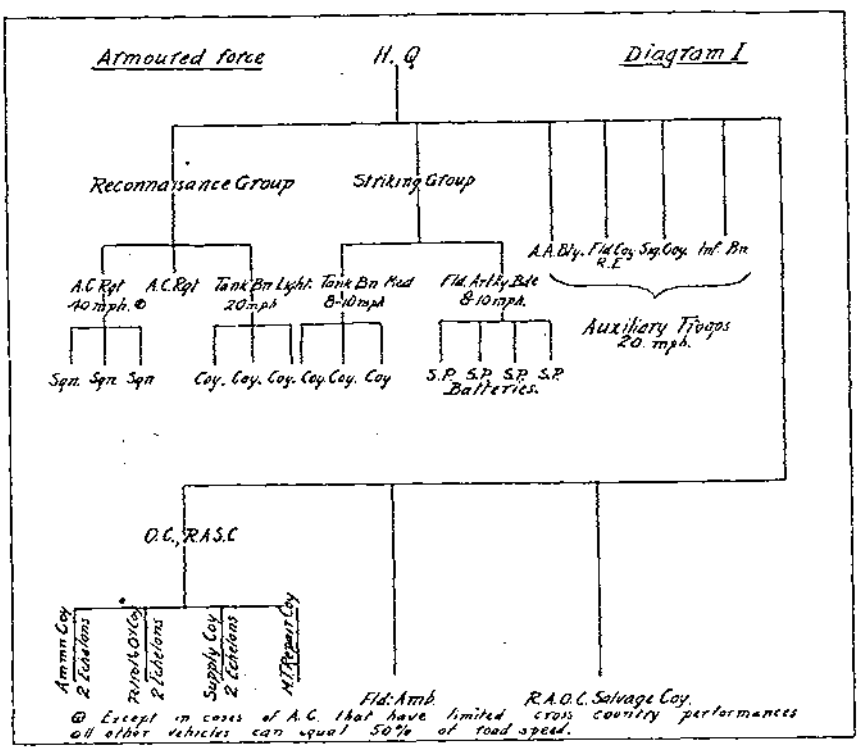
* "The Progress of Mechanization," *Army Quarterly*, April, 1928.

† Both terms are used synonymously in this article, since one is used in the quotation under discussion and the other is now the official designation.

and needs of the Experimental Armoured Force in the light of experience gained. Such a force can march and fight for ten days without returning to its base, its radius of action being about 180 miles.

One of the great limitations of this force is imposed by obstacles; it cannot operate in rocky mountains, closely wooded or very broken country, and it is very sensitive to the dangers of defiles.

Napoleon, when speaking about military obstacles, placed them in the order: deserts, mountains and rivers, the latter being a bad third. Modern developments in engineering and other sciences have tended to overcome desert obstacles rather than mountains. In order to substantiate this statement, it is only necessary to compare



Allenby's campaign in Palestine and the less important but instructive dash of the Duke of Westminster's armoured cars to Solum, with Skeen's difficulties in Waziristan in 1919. Modern developments made the first two possible; in the latter case they were of little, if any, help.

With mechanized forces, mountains, as obstacles, will undoubtedly take pride of place, and thickly wooded country take on new importance. The decisive actions of the world have, however, never been fought on mountain tops nor in dense forests, and are not likely to be in future; although mountains and woods have been, and will again be used as pivots of manœuvre.

From the limits imposed by natural and artificial obstacles, our

attention turns logically to questions of supply and maintenance. Its insatiable thirst for fuel prevents a mechanized force roaming far and wide indefinitely.* As diagram 1 shows, an armoured force is tied by its tail to railhead. The tail may be longer and less sensitive than that of an unarmoured force, but it is a very definite and sensitive tail.

An armoured force is, moreover, less liable to suffer gas casualties than its unmechanized rival. Although easily spotted from the air, in fine weather, once its general location is known, such a force is by no means easy to locate in an area represented by a semi-circle of radius 180 miles and uncertain centre.

From a consideration of the armament and capabilities as set out in the table of diagram 1, subject to the general limitations indicated above, it is possible to arrive at the proper rôle of such a mechanized force. The methods of employing it may be enumerated as under :—

(i) *Strategic Reconnaissance.* This was the true but very imperfectly performed rôle of Sordet's Cavalry Corps in 1914. Something more on the lines of Stuart's "Rides round the Federal Armies" is indicated.

(ii) *A wide turning movement, culminating in an attack on the flank of an enemy already engaged, i.e.*, a blow similar to that delivered by General Maunoury's Army from Paris against the German right in September, 1914, one however, more rapidly delivered, more intense in form, and capable of early repetition. "The Race to the Sea," 1914, would have given an armoured force a chance to show its real value.

(iii) *A special operation involving a long movement up to the limit of the force's capacity to maintain itself away from railhead.* A mission similar to that so successfully undertaken by Stonewall Jackson which culminated in the second battle of Manassas in 1862.

(iv) *Exploitation and pursuit.* As exemplified by General Allenby at Megiddo in 1918.

"Victory," said Napoleon, "is nothing; one must exploit success;" and again, "The secret of war is to march twelve leagues, fight a battle, and march twelve more in pursuit."

The devastating thing about a mechanized force is that it moves and fights at the same time, while unmechanized forces have to halt before fighting; consequently initiative and surprise must tend to rest with the former.

The Other Arms.

There are other roles in war besides those for which a mechanical force is suitable. Even if it were desirable for tactical reasons to

* A march of 50 miles means the consumption of 40 tons of fuel and oil.

mechanize the whole Imperial Army, there are certain difficulties and reasons why this could not be done. The consideration of these difficulties and reasons are outside the scope of this paper, but, as they establish the existence of unmechanized forces for years to come, the present writer proposes to enumerate the more important:—financial difficulties, dangers of too rapid transformation, difficulties of mobilization and training, difficulties of accommodation, difficulties presented by the Cardwell system, requirements of Empire internal security in tank-proof countries, imperfection in design, variations in climate, questions of policy *inter alia* with the Dominions and India.

Therefore the acid test to which "the other arms" must be put is "a war out in the open spaces," either allied with or opposed to such mechanized forces as we have been considering.*

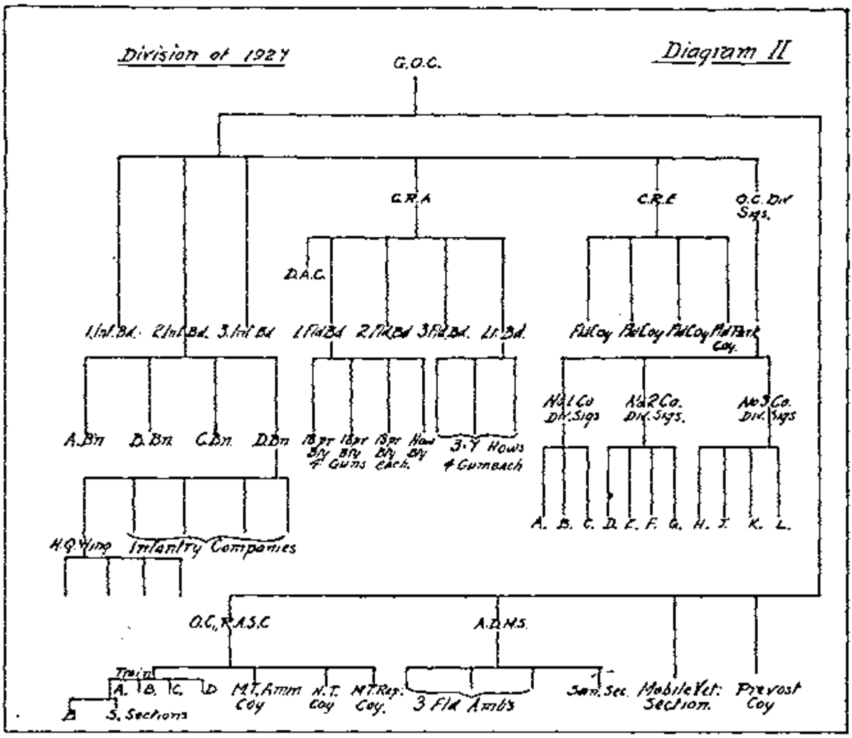
The army to-day is in a state of flux, and its armament, organization and consequently training, alter yearly. These are questions that will be discussed later; but in fairness to the critics who display "a tendency to exaggerate the power of mechanized forces and to belittle the action of other arms," we must accept these other arms as being in the condition they were in when the criticism was made. In 1927, the condition of most units was that indicated in *Small War Establishments*, 1923. Let us accept this as our standard. (See diagram II.)

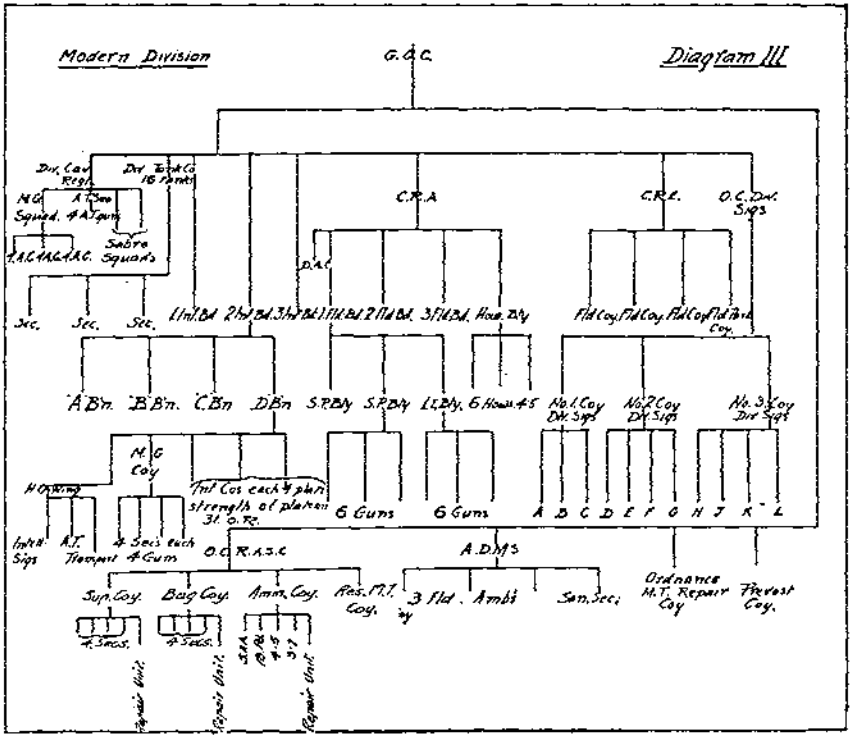
Having accepted this, and remembering the picture of a mechanical force drawn earlier in this article, one must at once confess to a personal sympathy with both the critics and "the other arms"; with the critics for the soundness of their reasoning, with the other arms for the inadequacy of their armament, organization and training. This, however is said in no carping spirit; steps are being taken to rectify their defects, and it is doubtful if their being taken earlier was either expedient or possible.

Keeping in mind Napoleon's statement that "The moral is to the material as three is to one," let us ask ourselves, "What of tanks in the last war?" "Locally decisive!" "What has been the great cry of all infantry and cavalry commanders since the War?" "Give us our own anti-tank weapon!" "Have they got it?" "On paper, yes; in practice, no!"

"A mechanized force can do little against troops in a defensive position, well chosen, with tank obstacles, anti-tank guns and mines properly co-ordinated, except keep them from moving." Don't we all know this position? Times without number, since the War, the writer has attended "Defence Schemes." Always there was a shortage of time to organize and prepare, a shortage that was nothing to the shortage of time that would exist in war. Always was the enemy coming from one direction. Never was there that

* The action of "Other Arms" against similar unmechanized forces, being less important, has been excluded from consideration by the limitation of the length of this article.


Division of 1927
Diagram II
G.O.C.
C.R.A
C.R.E
O.C. Div Sigs.
D.A.C.
1.Inf.Bd. 2.Inf.Bd. 3.Inf.Bd.
1.Fld.Bd. 2.Fld.Bd. 3.Fld.Bd. Lt.Bd.
Fld.Coy Fld.Coy Fld.Coy Fld.Park Coy.
A.Bn B.Bn C.Bn D.Bn
18 pr Bty 18 pr Bty 18 pr Bty How Bty 4 Guns each.
3.7 Hows 4 Guns each
No.1 Co Div.Sigs
No.2 Co. Div.Sigs.
No.3 Co. Div.Sigs
A. B. C. D. E. F. G. H. J. K. L.
H.Q.Wing
Infantry Companies
O.C. R.A.S.C.
A.D.M.S.
Train
A. B. C. D
3. Sections
M.T.Amm Coy
H.T. Coy
M.T.Rep. Coy.
3 Fld Ambs
San. Sec.
Mobile Vet. Section.
Prevost Coy


Modern Division
Diagram III
G.O.C.
Div. Cav Regt.
Div Tank Co 16 Tanks
M.G. Squad.
A.T. Sec 4 A.T. guns
Sabre Squads
Sec. Sec. Sec.
C.R.A
C.R.E.
O.C. Div. Sigs
D.A.C
1.Inf.Bd 2.Inf.Bd. 3.Inf.Bd.
1.Fld.Bd. 2.Fld.Bd. 3.Fld.Bd. How. Bty
Fld Coy Fld Coy Fld Coy Fld Park Coy.
A.Bn. B.Bn. C.Bn D.Bn
S.P.Bty S.P.Bty Lt.Bty. 6 Hows. 4.5
No.1 Coy Div. Sigs
No.2 Coy Div. Sigs
No.3 Coy Div Sigs
M.G Coy
H.Q. Wing
Inf Cos each 4 plns strength of platoon 31. O.R.
6 Guns
6 Guns
A B C D E F G H J K L
Intell. Sigs
A.T. Platoon
4 Secs each 4 Guns
O.C. R.A.S.C
A.D.M.S
Sup. Coy.
Bag Coy.
Amm. Coy.
Res. M.T. Coy.
3 Fld. Ambs
San. Sec.
Ordnance M.T. Repair Coy
Prevost Coy.
4 Secs.
4 Secs.
Repair Unit.
Repair Unit.
Repair Unit.

idea of all-round defence that must henceforward permeate the mind of every commander. Always the demands for anti-tank guns exceeded what the C.R.A. could spare. Always the call on the sappers exceeded what could be done with the equipment and time available. And this is the unmechanized force at its safest!

"The security of a force and its communications is the first responsibility of a commander."* This principle applies equally on the move as when at rest; but the armament and training of our divisions to-day is not adequate to provide protection against mechanized forces, when the former are on the move. The commander requires early information and an all-round sense, yet an infantry division has no cavalry. In addition to the shortage of A/T weapons in a division, such weapons as there are are incapable of coming into action on the move. The same applies to A.A. weapons. The present ideas of a large percentage of officers, on the need and composition of flank, etc., guards, require revision in view of these new conditions. There is no reserve available in the hands of the divisional commander for counter-attacking a mechanized force; yet no one will dispute the supreme value of the immediate counter-attack in war. The present mixture of H.T. and M.T. in certain units practically renders tactical unity impossible on the move.

A force, however, must advance—its commander must think of his object or objective and not of anti-tank areas. "Victory can be won only as the result of offensive action."† Offensive action implies movement, and movement, as we have seen, at once reveals all the above defects in our existing organization. The moral effect of the mere presence of a mechanized force thus has a tendency to paralyse movement. Of the effect of an attack by mechanized troops against other arms we can gain some inkling from the operations on Salisbury Plain last year‡; the most devastating results were obtained by the mechanized force.§

Experimental Stage Passing.

The mechanized force or armoured force that exists to-day is an experimental or research organization.‖ Until it is known what such a force can do, it is obviously inexpedient to equip other troops with an armament, organization or system of training to combat this new force. From this research organization we have already arrived at the capabilities and limitations of a mechanized force, as enumerated earlier in this article; now, from the same organization, we have enough information to enable us to forecast the armament, training, and organization of our other arms—the experimental armoured force has, so to speak, been working for both sides.

* *F.S.R.*, II, 2 (2) (vi).
† *F.S.R.*, II, 2 (2) (ii).
‡ Written in Summer of 1928.
§ See page 38, *Army Quarterly*, April, 1928.
‖ Since this was written its existence has been temporarily suspended.

Changes in Training and Armament Advocated.

General Difficulties in way of Mobilization—A Temporary Change of Policy Advocated.

There are certain difficulties in the way of modernizing an army. Capital is required for modernization and the army has only a small yearly income. The continuance of the Cardwell system or the introduction of an alternative system presents difficulties; other difficulties are questions of mobilization, accommodation and climate, regimental traditions and conservativeness. These difficulties become greater when we reflect that, in addition to the Regular Army, there are the Territorial Army and the armies of India and the various self-governing Dominions.

It therefore seems that we must make a temporary departure from the policy "that the organization, equipment and training of the various component parts of the Imperial Army shall follow a general standard common throughout the Empire."* and make a beginning with the Regular Army, including that part of the Regular Army that is in India.†

A return to this policy at an early date is desirable and the Territorial and Dominion Forces must, in time, be modernized at the expense of their size. The Indian Army is a different problem, as it exists for a special role.

Before building up the organization of the division, each arm must be considered separately.

Cavalry.

A regiment now consists of two sabre squadrons and one M.G. squadron, the latter being provided with six-wheel transport for its twelve M.G.s. These latter should be replaced by twelve armoured cars and a squadron leader's car (R/T)—more cars may be desirable, but are prohibited by expense. These cars should have the same cross-country mobility as the armoured cars of the mechanized force. In addition, there must be at least two anti-tank weapons‡ with the regiment. The writer feels that four are really needed; this allows of a sub-section accompanying each sabre squadron or of their being so placed as to protect the regiment as a whole. The A.C.s can, by their mobility, avoid tanks or draw them on to the anti-tank weapons of the regiment.

The load on the horse must be reduced to a minimum by mechan-

* *F.S.R.*, Vol. I, sec. 1 (3) (iv).

† Fortunately India has now accepted the principle of modernization.

‡ This weapon must be able to knock out a tank at between 600 yards and 100 yards with an angle of impact for the projectile exceeding 45°. It must be capable of all-round traverse, and of action while on the move. A weapon firing a 1-lb. shell, and answering to this specification, has been designed, together with a mechanically-propelled, lightly armoured vehicle, having a cross-country mobility of four miles per hour, and a road mobility of from two-and-a-half to ten miles per hour.

ized transport—the latter to include R/T tender and office for C.O. The idea of shock tactics will have to go in the near future, and with it the sword. Although the role of cavalry divisions and armoured brigades are complementary, henceforth the duties of cavalry are reconnaissance duties; anything else recalls the field of Balaclava, "*C'est magnifique mais ce n'est pas la guerre.*"

Artillery.

Even to-day, our medium and heavy artillery is mechanized to all intents and purposes, so is our anti-aircraft artillery. We may then leave these and turn our attention to the Field Artillery, which forms the bulk of the artillery of an army.

The superiority of mechanized over horse-drawn artillery on almost every type of ground—pack or mountain artillery having its own rôle—is generally admitted; these new machines are noisy, but it is a defect that can be modified, and the field of battle, even at night, is a noisy place where much passes unheard. The howitzers in a division, may be dragon-drawn, but for the 18-pdr., or the substitute,* which certain technical authorities demand, a S.P. mounting appears imperative.

Economy demands a reduction of personnel to find the funds for these new machines, and so the age-old controversy of six-gun or four-gun batteries should once and for all be terminated in the triumph of the former.

There remains the close-support weapon, the light artillery of to-day. A new mechanically-propelled weapon has been designed to replace the 3·5 howitzer. If we can have more guns in a division, then an eight-gun light battery is desirable; but, if not, and it seems unlikely, let us stick to our six-gun organization.

Engineers.

In no arm of the service has less been done to improve and modernize the transport and equipment since the War than in the Engineers. The truth is that sappers are expensive members of the military family; much that they need in war can, it is maintained, be obtained from civilian resources on mobilization; other parts of their equipment must be designed after the loads it will have to carry have been determined and, finally (and this is the main reason), in war the chief duty of the Engineers is to make conditions resemble manœuvres. Hence their duties and difficulties are not easily realized in peace.

* It is contended by certain authorities that the 18-pdr. is too large and heavy, too conspicuous, and fires an unnecessarily large shell—ammunition supply is a very large point—and that the lightest, fastest and most inconspicuous gun possible, firing a shell effective at 1,500 yards range, is needed. Against this the present writer maintains that modern Naval development shows the tendency of gun power to increase with armoured rivalry.

In war, the R.E. unit must often be brought up from the rear to overcome an obstacle which holds up the advance. The day when the sapper can be allowed to walk and when hand tools, as a general method of work, are economic, is past. In future, a high proportion of engineers must be moved in cross-country carriers, their transport must be mechanically propelled and must contain mechanically-driven tools. Adequate bridging equipment (light bridge* to take six-wheelers and assault equipment) must accompany the Field Park Company and anti-tank mines and a considerable stock of explosive must be within easy reach of the Field Companies.

Infantry.

Let us accept the new battalion organization—three infantry companies, a machine-gun company of sixteen guns, and H.Q. wing. The M.G.s have cross-country transport but the present type of six-wheeler is not suitable, it is far too conspicuous; guns cannot be brought into action on the move, and have to be "man handled into action" for a considerable distance.† A new vehicle is required for the anti-tank gun, referred to earlier; the same vehicle can be adapted to take a M.G., together with its ammunition. This should enable the M.G. Company to protect the battalion, both on the move and at rest, from air or other sudden attack.

The infantry companies must be capable of "light action," often at the double—their duties will much resemble the "clouds of skirmishers" of the days of Wellington and later of the American Civil War; combined with a certain amount of "winkle-ing," or "mopping up." To perform these duties the load on the soldier must be further reduced; it is calculated that mechanization of transport, combined with a redistribution of loads, will relieve the soldier of at least 7 lb. Except when working detached, companies will have no vehicles, since hot meals can be sent up from the transport lines and the day of the Lewis gun is past. Pending the arming of the soldier with a true automatic rifle (of the Browning type), the number of M.G.s in a battalion will enable the present rifle to suffice. The vehicles of the battalion forming "B Echelon" will be manned by R.A.S.C. personnel under a senior N.C.O., with an R.A.S.C. officer as Brigade Transport Officer. A high proportion of both personnel and vehicles can also be obtained from civilian sources on mobilization by the proper utilization of the Supplementary Reserve and the subsidy scheme for M.T.

* A.C.s, tanks and S.P. artillery can, by their extra mobility, make detours and regain the division after it has crossed by a light bridge of this nature.

† A new design—see *R.U.S.I. Journal* of May, 1928—for sub-sect. of M.G.s only partly fulfils this requirement. Normally, neither the anti-tank weapon nor the M.G. will fire from their vehicle.

The battalion must have its own anti-tank weapon; the same type referred to above is advocated. However many there are, they must be concentrated for training and administration—the writer prefers four as a group of the H.Q. wing.

These changes should enable the strength of a battalion to be reduced to about six hundred of all ranks.

THE MODERN DIVISION.

We have dealt in turn with each of the unmechanized arms and it now remains to build up the organization of the unmechanized division; this latter must include mechanized units and A.F.V.s, for security from attack by mechanized forces. "Whether tanks are held in rear or are made available for immediate counter-attack, it should be realized that they constitute the most valuable reserve in the hands of a commander for dealing with hostile tanks."* Of the other vehicles,† all second-line vehicles and "B Echelon" must have engines and chassis conforming to civilian practice in order to facilitate mobilization and to utilize the subsidy scheme. It is likely that this can be extended to include other vehicles, *e.g.*, R.E.

Reconnaissance Troops.

The provision of army co-operation squadrons on a basis of one per division, although actually Corps Troops, is ample. The need of cavalry is becoming more and more pressing; and in order to get that sympathy and understanding so essential to co-operation, the cavalry must be divisional and not Corps Troops. With armoured forces replacing the rôle previously carried out by large cavalry formations, a regiment per division is advocated.

Assault, Defence and Counter-attack Troops.

Tanks and infantry, with their M.G.s, are the chief means to these ends.

The principle that tanks, like other arms, must be concentrated to achieve their full effect, and the desirability of increasing, as far as possible, the number of armoured brigades (of which tanks form the basic element) prevent any great allotment of tanks to a division: but at least a company is necessary, if the "modern" division is to operate freely in a country in which mechanized forces are at large.

With the higher organization of infantry, *i.e.*, three brigades each of four battalions, there appears little scope for improvement, unless, which all of us deplore, further economies necessitate brigades of three battalions. It will, however, appear later when considering training that the Brigade Staff must be increased.

* *T. and A.C. Training*, Vol. II, Sec. 51 (8).
† Six-wheelers.

Supporting Troops.

Exclusive of the M.G.s and anti-tank weapons included in the battalion, etc., organization, these consist of artillery, engineers and signals.

By a comparison with other European divisions, it appears that only in gun power is our division below the hitting power of those of other nations. It is unlikely that more guns per division will be forthcoming, and the organization advocated below is based on the assumption that with six-gun batteries the total number of guns in a division, exclusive of tanks and purely anti-tank artillery, remains at sixty. The divisional artillery might consist of three Field Brigades each of two S.P. batteries (18-pdr. type) and one mechanically-propelled light battery. The remaining battery, 4·5-in. howitzer, would occupy a position similar to that of the medium battery in the division of 1914. If more howitzers are required, and this is now being advocated in the Commands at home, this battery must become a Brigade. The C.R.A.'s staff might remain unaltered, and the saving in officers and other ranks—including those childless parents (once in action), the O.C. Light Brigade and his staff—would effect a considerable economy in personnel.

The number and general organization of Field and Field Park Companies requires no startling alteration other than mechanization of transport; but their equipment and tools require drastic revision and modernization as already explained. Signals are more up-to-date and require little improvement except in transport, and an increase in the number of D.R.s.

Administrative Services (with the exception of the Ordnance) have reached a stage in development, not only far ahead of other countries, but far in advance of the arms of the service which they exist to serve.

The introduction of mechanization and the almost synchronous transfer of mechanical maintenance to the already heavily-burdened ordnance is in danger of proving the last straw on the camel's back. If it is so, a dangerous state of affairs will arise for the Army as a whole—a state of affairs which is rendered no more hopeful by the camel having loaded itself.

Certain administrative units must be provided with mechanically-propelled cross-country vehicles, notably the D.A.C. and H.T. Company, R.A.S.C. The latter unit must be capable of " lifting " a battalion. The M.T. repair company must remain, but the R.A.O.C. also need such a unit; and certain of the latter's personnel must be attached to fighting units as artificers for first-line repair of " A Echelon " vehicles. The veterinary establishment can be reduced two officers per division.

A comparison of the "Modern" and existing divisions is given in diagrams II and III, together with summaries of these changes in diagram IV.

Table of relative strength — *Diagram IV*

	Division 1926-27	Division Modern	Armd force
Ration Strength.	17.385	12000	4000
Sabre & Bayonet strenght	5.760	4000 auto rifles	400
Lewis guns	445	Nil x	Nil
Armoured cars	Nil	13	50
M. Guns } excluding tanks	96	196	16
A.T. guns } excluding tanks	Nil	52	4
Light tanks	Nil	Nil	52
Medium tanks	Nil	16	52
Guns & howitzers	60	60	24
A.A. weapons	116 L.G.	196 M.G.'s some L.G.	8. A.A guns
Vehicles Special	890	220	300
Vehicles Commercial type	370	700	500
Horses	5027	1500 ⊙	Nil.
Mobility	2½ mph	3 mph	8 mph
Normal daily rate of march	10 miles	15 miles	50 miles
Forced march	15 miles	20 miles	100 miles

x A few L.Gs for A.A. defence might be kept by Engineer, Signal & R.A.S.C. units

⊙ Riding & pack animals only

Programme Recommended.

The changes advocated cannot be carried out completely even in one division in one year, let alone throughout the Army.

Let us suppose that it has been decided to modernize one division on the lines advocated; there may be, and most likely are, better ways of doing it (only those with complete inside information can decide), but this forms a good basis for discussion.

The selected division would complete its reorganization in three years, and subsequently would absorb three new battalions and one Field Brigade per year—the replaced modernized units going abroad. After three years, other divisions could be modernized much more rapidly owing to the experience gained and the fact that some gradual modernization of all units in accordance with this plan could have taken place *ad interim*.

Training.

Neither the introduction of armoured forces nor the modernization of unarmoured forces will alter the principles of war; but they will

undoubtedly affect the application of these principles. The extension of the area over which operations may take place, the danger of attack from almost any point of the compass in addition to the air, introduces the need for all-round protection both at rest and on the move. The increased difficulties of command and control resulting from increased mobility will often necessitate the issuing of instructions as opposed to orders; hence the greatest initiative and a genuine knowledge of all arms will be required from subordinate officers. Commanders of units and formations in unmechanized forces as well as mechanized must learn to think in terms of a force moving at 10 miles per hour as opposed to 2½ miles per hour—no easy matter, and one which requires all commanders to make rapid decisions. The cavalryman must learn to read a map from his A.C. at 40 miles per hour. Opportunism will flourish and decentralization be the order of the day. Many actions must become automatic, resembling the almost subconscious actions of mountain warfare, but equally they must not become dogmatic routine.

The principle of concentration remains; but concentration must be consistent with effective control.

The presence of an armoured force will necessitate a "Modern" division on the march adopting a formation tending to resemble the "*Bataillons carrés*" devised by Napoleon during the period immediately preceding the battle of Jena, rendered necessary as he was very ignorant of the moves of the Prussians right up to and including the battle; a state of affairs likely to be reproduced due to the mobility of mechanized forces. This will reintroduce that bugbear, the "Brigade Group," which is disliked, as it is

(i) contrary to the accepted principle of concentration, and

(ii) too large a force of all arms for the present Brigade Staff.

With the reduction in the effective range of guns, due to the mobility of A.F.V.s, centralized control of artillery is not only unnecessary, but it is positively dangerous, except in defence or a deliberate attack.

"Control should be centralized in the highest formation, which can exercise it without risk of failure, and at the same time ensure co-operation in action between the units in the forward area."* The effect of these new conditions on the decentralization of engineer and medical units is not so pronounced, although detachments may be more common than in the past. The addition of one, or at most two staff officers, a clerk, and an office car, is all that is required to overcome the second difficulty.

With regard to individual training, the existing principles remain

* *F.S.R.*, Vol. II, 72 (5).

sound. The annual change over of "Specialists" must be larger in future. All men after their second individual training season must become "specialists"; their remaining individual training being devoted to making them, say, first machine-gunners and, later, drivers I.C. Men will thus pass to the reserve capable of taking one of many rôles in the battalion or other organization on mobilization.

It is, therefore, maintained that the Army shall continue to be trained on the lines indicated in *Training and Manœuvre Regulations*, and *F.S.R.*, Vol. II, as applicable to their new armament and organization, but that certain existing doctrines should be modified and others emphasized in the light of the above remarks.

CONCLUSION.

It may be argued that the changes recommended are too sweeping and impracticable. It is maintained, however, that the addition of 13 A.F.V.s for a cavalry regiment, together with four anti-tank guns and vehicles, the provision annually of two batteries of S.P. guns, one battery of light guns, and the mechanization of a field company's transport, are in the realm of practical politics. The vehicles at present intended for the M.G.s of the infantry can be adopted for their transport, leaving only the provision of 48 anti-tank guns, together with their vehicles and those for 192 M.G.s, to be provided in three years.

Exclusive of minor details, and measures already approved by the Army Council, the above is the programme recommended, and does not appear to the writer either impracticable or too sweeping, nor can it be contended that the acceptance of this programme, together with its resulting economies, exceeds the funds available. The transformation is not too rapid, nor do any of the likely theatres of war present an unsuitable terrain for such a force—Europe, even the Balkans, Asia Minor, Palestine, Egypt, Arabia, the greater part of Persia, India, Afghanistan (especially the southern area), the Sudan, present no unsurmountable obstacle to the "Modern" division, since man, horse and mechanical vehicle have each a high cross-country performance, while the conversion to a scale of equipment and transport suitable for mountain or forest warfare, though slow, would be as feasible a proposition for this force as for the present-day division. Neither the difficulties presented by variation of climate, nor by mobilization and sea transport, are greater than before, and the force would be as equally prepared for the passage of rivers or for amphibious warfare as is our present organization. Over and above this, the always present problem of Imperial internal security can more easily and economically be attained with the adoption of this modernization.

Both at rest and on the move, this modern division would be equipped and could be trained and handled in such a manner " as to move and rest undisturbed " by the presence of mechanized or unmechanized forces of corresponding strength. " A force adequately protected retains its liberty of action and preserves its fighting efficiency for battle."* This protection would be afforded by the presence of cavalry, including A.C.s for reconnaissance, by the ability of its A/T and A.A. weapons and M.G.s to move and fight at the same time, by the existence of a mobile reserve of tanks and S.P. artillery capable of executing an immediate counter-attack against tanks or other A.F.V.s, moreover, by the homogeneity of its organization, tactical unity on the march can be preserved and mobility increased. All these improvements, combined with the improvements in training and leadership developed by decentralization, will, in the opinion of the writer, produce in the form of this modern division a fighting formation far superior to that of the present time in operations against both mechanized and unmechanized fortes.

The answer to the tendency to exaggerate the powers of mechanized forces and to belittle the action of the other arms is to modernize these other arms. The moral effect so produced will be three times the material improvement.

* *F.S.R.*, II, Sec. 2 (2) (vi).

TEMPORARY ELECTRIC LIGHT AND POWER AT CHANGI.

By LIEUT. W. M. BLAGDEN, R.E.

FOR the benefit of those to whom the name "Changi" has no particular significance, it must be explained that the Island of Singapore has the shape of a very rough diamond—after the fashion of the Isle of Wight—and that on the eastern corner—near Bembridge, as it were—is Changi, the place selected for the site of the Army Base.

This is an isolated spot, connected to the town of Singapore—at Ventnor—by 16 miles of tortuous road, the convolutions of which would break the back of a proverbial serpent. The Naval Base, of which one reads so much in Promotion Examination and other papers, is at Seletar—Cowes—while the Air Base lies between.

When the band of pioneers first descended upon the jungles of Changi with the object of building a cantonment, one of the first undertakings was the purchase of what was then called "Fairy Point Bungalow." This was a weatherbeaten wooden structure, but it made quite a good officers' mess, and it came to us complete with a minute electric light installation—a "Delco" plant and battery. This was the origin of electric light in Changi cantonment.

When the temporary hutments for W.O.s and men had been erected in the vicinity, the benefit of civilization was extended to them by means of bare wires supported on insulators secured to rubber trees, of which there was any number. The distance was 100 yards, the pressure 32 volts, and the drop considerable. As the staff increased, the set became loaded much in excess of its powers, and a further supply was sought for. The only set that Singapore could produce out of hand—and that had to be sent down from Kuala Lumpur—was a 4½-kw. G.E.C.-Petter hot bulb two-stroke set, 110 volts unfortunately, but as beggars we had no choice, and it was hired and installed in a small and hideous hut at the cross-roads pathetically referred to as "Charing Cross." This was in point of fact the only place to put it, as the country further afield was as yet impenetrable. It took over the Fairy Point load and proved extremely reliable. Fairy Point Bungalow was turned into a quarter for the Chief Engineer, and the officers' mess was moved to a building nearly half a mile away, the Delco set being moved with it.

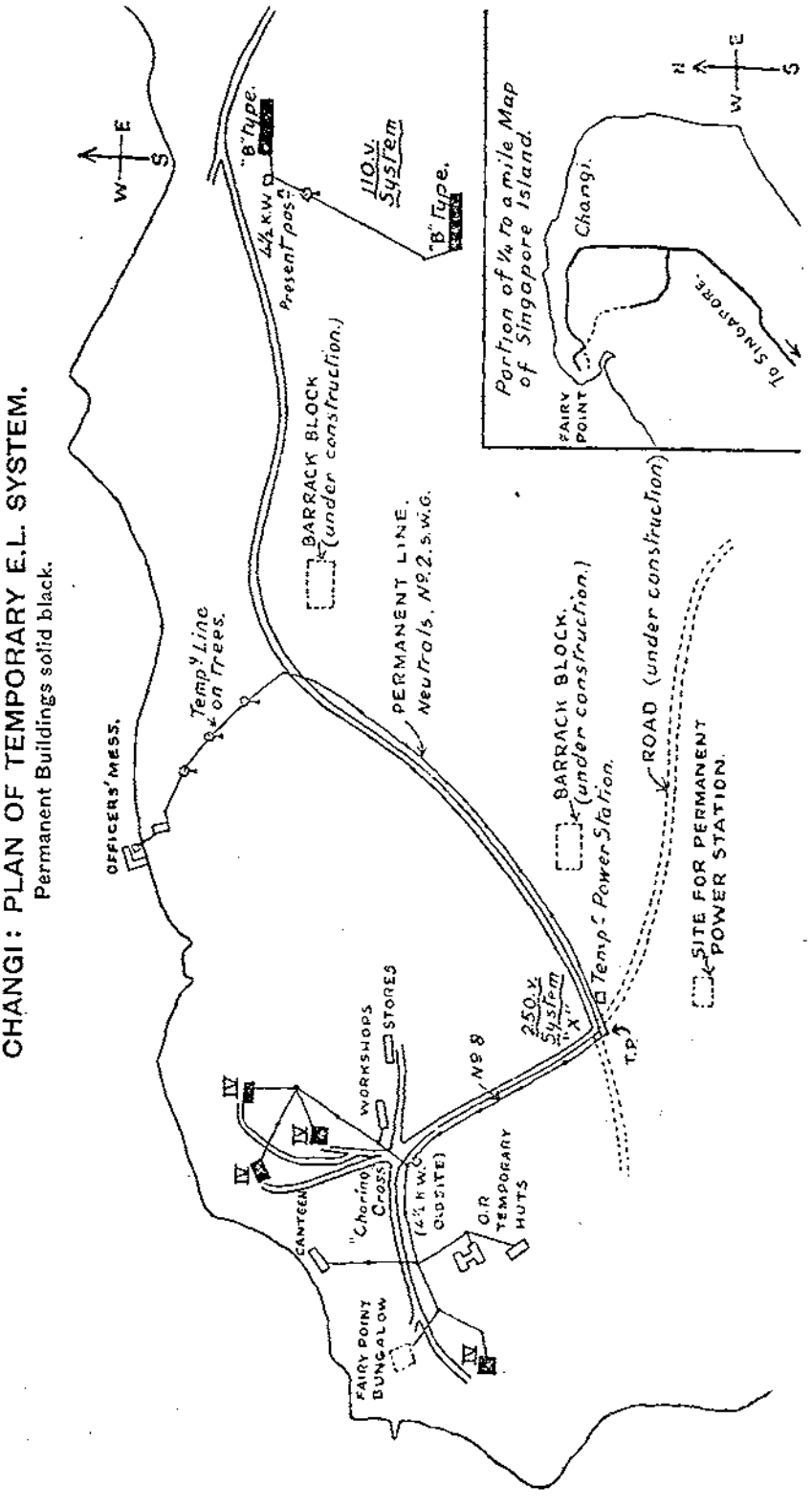
In the meantime it should be understood that, pending the development of the permanent 3-phase A.C. 400/230v. supply, a scheme had

been evolved at the War Office for a temporary D.C. supply, of a fairly elaborate nature. Three 10-kw. Bellis and Morcom 220v. sets were prepared for shipment to Changi, and we were expecting them.

By the beginning of May, four Group IV married officers' quarters had been completed and were on the point of being occupied. It was clear that the load would be too much for the 4½-kw. set. At this juncture, we took delivery from home of two 3-kw. Petter two-stroke sets, 220v., which had been sent out for casual use on the various islands as they might be needed. They were well suited for this, but not for continuous night-after-night running, yet our only resource was to put them in to take the load at Changi, until such time as the proper sets arrived. The mechanist who unpacked them groaned. Even so, he did not know what was coming to him. The sets were of the magneto-ignition variety, petrol-starting and paraffin running, and they appeared to be reconditioned war stock. There was, however, no alternative. Even if the Fairy Point load could be kept low enough for the 4½-kw. set, it was fast becoming necessary to get the officers' mess on to the main supply, owing to the decrepitude of the Delco set and battery. The battery had been partially replated, but this was a failure: lead batteries do not seem to do well in the tropics at any time, on account of the temperature. This one was normally charged at 30 amperes, which was just about four times as much as its plates were fit for, and the paste soon poured out of the new plates as it already had out of the old. The engine did remarkably well considering the hard usage to which it was subjected, it did not overheat although it was air-cooled, and the air in the engine hut at about 90° F. But when the battery got to such a state that it would run itself out on no load, and not retain enough to start the engine next day, and when the engine itself had to be decarbonized twice a month to keep it running at all, it became clear that the set was giving more trouble than it was worth.

It was decided to instal the two 3-kw. Petter sets at once, and to let them take the load of three of the new houses, and of the Officers' Mess as soon as a line could be put up to feed it. This enabled us to buy 230v. lamps for the new houses, which would be suitable for the permanent supply and which were readily obtainable in Singapore. The 4½-kw. set was to continue on its usual load with one of the new married quarters instead of Fairy Point Bungalow, which was pulled down to make room for a permanent building.

A new power station was sited at the cross-roads marked X on the accompanying plan. This rather remote spot was chosen because it was suspected that the 3-kw. sets would be noisy (they were), and because it was more suitable for supplying the Officers' Mess. The hut was designed by the Machinery Mechanist, and therefore was a collapsible, extensible affair that was put together with a spanner.


CHANGI: PLAN OF TEMPORARY E.L. SYSTEM.
Permanent Buildings solid black.
OFFICERS' MESS.
Temp.y Line on trees.
"B" Type.
4½ K.W.
Present pass.
110 v. System
"B" Type.
BARRACK BLOCK (under construction.)
PERMANENT LINE. Neutrals, No. 2. S.W.G.
BARRACK BLOCK, (under construction.)
Temp.y Power Station.
ROAD (under construction)
SITE FOR PERMANENT POWER STATION.
T.P.
250 v. System "X"
No. 8
WORKSHOPS
STORES
CANTEEN
"Charing Cross"
(4½ K.W. PORTABLE)
O.R. TEMPORARY HUTS
FAIRY POINT BUNGALOW
Portion of ¼ to a mile Map of Singapore Island.
Changi.
FAIRY POINT
To SINGAPORE
N
W
E
S

It amused the M.F.W.s very much. Being intended to be used for a few months only, it will have seen over a year's service by the time it is superseded.

The terminal pole of the permanent overhead line happened to come at these cross-roads, so it was erected forthwith, and a power line was run down the road to the old hut at Charing Cross, where it linked on to the existing Fairy Point network. It was hoped that this line would become part of the permanent three-phase line, and so it was put on permanent poles, two-phase wires being put up at first.

It was not long before troubles started. The two 3-kw. sets seemed to be in reasonable running order on their arrival, and started up readily enough when installed, but they made their drawbacks clear from the very first.

They governed very badly under all loads, alone or in parallel, the governor gear being positively catastrophic in its action, and causing the engine to cut out completely until it had slowed down almost to stopping point. Just when one had given up hope of its ever firing again, there would be a shattering explosion, and it would laboriously pick up speed. A perfectly good tyre pump was sacrificed to make a pair of oil dashpots to mitigate this effect, but it made very little difference.

The generators were compound-wound with a very low resistance series winding, and naturally were fitted with an equalizer connection and switch. Nevertheless, the resistance of the switch contacts was sufficient on several occasions to allow the field of the generator that was being taken off the bars to become reversed, so that next night it built up on opposite polarity, to the great astonishment of the operator who tried to parallel it in. When this was discovered, the switch was omitted, and the brushes on the side of the series field of each machine were connected solid, so that the trouble did not recur.

The brushes were often seized with the complaint that overtakes all brushes in this country, unless they are specially made to avoid it: they unanimously swelled owing to the humidity, so that they bound themselves solid in the holders, having sometimes to be chipped out with a chisel. The symptoms of this kind of trouble are a refusal to excite or excessive sparking. The cure is emery paper.

The armature end connections persistently unsweated themselves from the commutator riser bars.

The magnetos developed all the faults to which magnetos are prone in tropical countries, together with some additional ones occasioned by old age.

A time came when it seemed that a state of equilibrium had been arrived at between man and machine. Each set ran for the whole lighting period, 6.15 p.m. to 11.30 p.m., on alternate nights, the set that was resting being put on at the peak. The light was reasonably

good. Then, after perhaps a fortnight of respite, the main bearings of No. 2 set ran out in a grand splash of white metal, and the remnants were taken into the workshops for repair. It happened that the lathe and a few small machine tools had just been installed in a very temporary workshop hut, and provided with some second-hand D.C. motors. The remaining engine, therefore, was made to run by day as well as by night, while new bearings were cast and turned, and the crankshaft was machined into something approaching circularity. For a time, it was questionable whether the additional wear and tear that resulted from using the electric light plant to drive the workshops was not greater than the workshops could repair in the time, but after a while it appeared that we were holding our own. Meantime, the population was urged to be economical of light, and the peak was kept down within the limits of the capacity of one machine.

On one hot and sticky night, when No. 2 set was still in pieces, the generator of No. 1 set was observed to be giving a very poor voltage, and its commutator was flashing like a veritable catherine wheel. It was clear that a coil or two had burnt out, so while warning was sent round of an impending blackout, of estimated duration half an hour, the generator of No. 2 was uncoupled and manhandled to an " alert " position. Then on a given signal No. 1 was shut down, and by the rays of a candle and a moribund electric torch, the two generators were changed over, and the undamaged one was coupled up to the relatively sound engine, which, thanks to mass production, it mercifully fitted. The operation took 35 minutes, after which the light was switched on again. The burnt out armature was rewound by a firm in Singapore, and a very good job was made of it.

The next thing to go was the engine of No. 1, whose main bearings became too loose to be trusted, and were renewed. The lubrication to the main bearings of both machines was by grease cups. It is extremely doubtful if any grease is suitable for lubricating a high-speed white metal bearing, it is quite certain that " grease, lubricating, for hot climates," which contains graphite, is utterly ruinous in its effect. The journals were badly worn and scored. After this, motor-car grease was specially purchased, which has given better results.

The foregoing is but a sample of the trouble given by these machines. They never managed to develop the full 3 kw. of their rating. An interesting feature of their performance was the fact that, when running on their full capacity, a better voltage could be obtained with a weak field than with a strong one, owing to the fact that by decreasing the torque resistance of the armature one gave the engine a chance to run at a higher speed, at which it happened to develop more B.H.P.

The instruments that came with the sets were even more decayed than the machines, and all ceased to function intelligibly after a

short time, being replaced by local purchases. Even the field rheostats behaved oddly. One morning, when a set was being run to supply the workshops, it was observed that on putting resistance into the generator field, the latter became disconnected on a certain stud of the rheostat owing to a break in one of the resistance coils. The voltage quickly dropped off, and the rheostat control was moved back again to re-make the field. When this was done, however, the set built up again on opposite polarity, and the connections of the moving coil voltmeter had to be reversed to get a reading. This was a portent which could be repeated indefinitely, and, after reversing the machine back and forth until all record of the number of reversals was lost, we arrived at the explanation. This was the fact that the largest motor in the workshops had its starter handle tied up on account of a defect in the no-volt release coil. When the generator voltage collapsed owing to the breakage of the shunt field, the still rotating motor returned current into the line, and so through the series field of the generator in the wrong direction, thus reversing the residual magnetism, and causing it to excite in the opposite sense when the shunt circuit was remade.

At this time, there were three separate systems in the cantonment at different voltages, and it was decided to connect the Officers' Mess to the 230-volt supply. (We called it 230 volts by courtesy, actually it rarely exceeded 200.) The distance being about 600 yards, it was felt wasteful to put up a temporary line, so the permanent poles were put in for the line down the road, and the size of conductor required for the permanent distributor was roughly calculated. This came out at a size unobtainable at Singapore, but the two neutrals could be made of No. 2 S.W.G., which was stocked by several firms at a very reasonable price. This was bought and duly put up. It proved much more tractable than it looked, and was very easily pulled up with tensioning clamps which we cast in the brassfoundry. The Mess was about 200 yards from the nearest point on the road, but a strictly temporary line of No. 8 was run from that point on palm trees, which are very suited to this sort of thing, as they all bend the same way at the same time, and it is only necessary to allow the line to zigzag a trifle to make it perfectly safe.

We were about approaching the season of the year when a peculiar kind of storm called a "Sumatra" began to be prevalent. This blows up without warning at any time of the day or night, 4.0 a.m. preferred, usually from the S.W., and its onset is such that a dead calm can give place to a full gale within a minute. It may be mentioned in parenthesis that the salving of capsized yachts is a matter of routine organization in the local yacht club races. In the course of clearing sites for roads and buildings, it often happened that jungle trees were left in isolated positions. These, deprived of the support of their fellows, were readily blown over in *sumatras*, and, as often as

not, across the overhead line. As they were apt to be about 150 feet high, the damage done was considerable, especially with the No. 2 conductor, which did not yield until it had wrecked the terminal pole.

It was accordingly decided to cut down all trees that could reach the overhead line in falling, *i.e.*, within 50 yards of the road, and a Chinese contractor was invited to carry out the work. This was a mistake. It is here that a Chinese method of cutting down trees must be explained. This consists in cutting away the wood impartially all round the base of the tree, leaving it supported by a stump of a few inches in diameter. The workman then withdraws himself to a safe distance, and waits for a puff of wind to complete his task, thus avoiding the moral responsibility for the demise of the tree, and any consequent annoyance from evil spirits. As the direction of the wind is at all times uncertain, so is the direction in which the tree will fall. If the tree is still standing by knocking-off time, he leaves it. Some hours later, an unsuspecting person taking a walk may be surprised by a large tree falling within a few inches of his head.

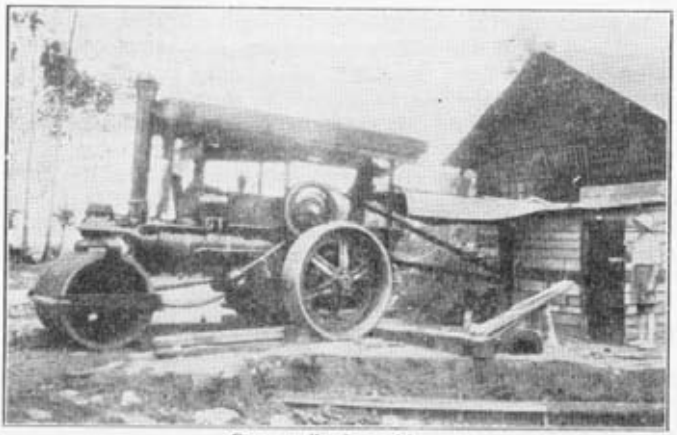
In these circumstances it is not to be wondered at that, out of a dozen trees that damaged the line, only four were blown over by tempests. The Chinese, however, soon discovered that it is better to incur the animosity of a tree demon than to meet a mechanist electrician whose line you have just wrecked, and more supervision was given and care taken.

In spite of these mishaps, no discontinuity occurred, as it was always found possible to run a length of "Maconite" cable in the ditch. It is felt that a good word should be said of "Maconite," which, though it was not suitable for permanent installation on account of its grading, and the necessity of using junction boxes which it entails, was freely employed on temporary internal wiring, for services to buildings on catenary wires, and for repairing gaps everywhere. It was even lent to Signals, whose lines also got knocked down by trees. There was a prodigious quantity of it available in store, and it was a godsend. One length of about 200 yards lay in a very wet ditch, and bridged a gap in the overhead line for over a month without giving the least trouble.

Throughout this period of trial, the arrival of the 10-kw. sets was hoped for and expected from day to day, but eventually it became known that they had been destroyed by fire on board the s.s. *Carmarthenshire* off Erith, and we were asked to carry on as best we might for six months, when it was anticipated that plant could be sent out to us.

The 4½-kw. set, which had behaved admirably throughout, was accordingly purchased outright for its original price less the sum already paid for hire, and a search was made in Singapore for further plant.

No 230-volt generating sets were available *ex* stock, nor was there at the time a suitable engine to be found. It was therefore resolved to use a steam roller as a prime mover, and look around for a D.C. generator of about 10 kw. at the correct voltage. The electrical department of the Municipality had an antique balancer set, 10 kw. a side, that they were anxious to get rid of, having changed over to A.C. It consisted of two 250v. generators coupled together. They had been built in 1905, and were of very robust construction. They were described as being in good condition, and the price asked was $100, about £12, provided we took them both away. We only wanted one at the time, but it was decided to take the pair and use



Steam roller in position.

one as spare to the other. A lot of brush gear was missing, but there was enough between the two to make up a complete set for one. The machine that gave the best i.r. test, and that a low one, was put in order, fitted with a pulley of suitable dimensions, and driven off the flywheel of the steam roller by means of a belt through the power-house wall. To produce the required voltage the roller had to do about 200 R.P.M., the pulley being the smallest that we dared put on. This was not too fast. It easily took the load of the whole of Fairy Point, which was changed over to 230v. throughout. Chocks were fitted in the ground where the roller stood, and after completing its day's work on the roads it was backed into position, coupled up, and handed over in steam to the night driver specially engaged for the purpose. This man, who had described himself as an engine driver, steam, was a Tamil, and extremely nervous. He explained that, though he was a steam driver, he really had more talent for internal-combustion engines. A voltmeter was fitted up in the cab, together

Steam Roller in position

with a lamp, the installation being connected with the power house by a wall-plug socket that received a wandering lead. The driver was bidden to keep the volts at 250 and the lamp steady. There was no governor on the roller, but it was surprisingly easy to keep the voltage constant by hand regulation. The engine could run for half an hour at a time without the throttle being touched. After a while the driver became bolder, and the light was perfectly good, except when the belt broke, or slipped in rain squalls.

The day driver became astonishingly adept in backing up into the correct alignment, and this was further facilitated by running with a crossed belt, which also gave the best results from the point of view of flicker.

In a moment of thoughtlessness we bought a field regulator, but soon found that it was entirely unnecessary, as we always wanted a full field to keep down the R.P.M. of the roller as far as possible. Altering the regulator had no appreciable effect on the voltage, as the engine merely turned over faster, the same amount of steam being admitted to the cylinders for a less torque resistance.

This arrangement has given every satisfaction for the last three months. The 3-kw. Petter sets are still used in the day time to drive the workshops, the 4½-kw. set was moved over to the two newly-erected blocks of " B " type married soldiers' quarters, where it still runs on a load of 4 kw. The roller rolled by day and illuminated by night, making the power house look like a merry-go-round at a country fair.

After about two months of this peaceful *ménage*, the news of a further delay in the anticipated delivery of the permanent plant from England, and the fact that the roller was shortly to be required to work at some distance from the cross-roads, urged us to fresh invention. The remaining 10-kw. generator was accordingly dug out of store and the missing parts of the brush gear were replaced by parts made in the workshops. An extensive search was made in Singapore for an engine of the lorry type.

Eventually we discovered a machine designed for the driving of barges by means of an outboard propeller. The engine was a 25 H.P. marine Peerless, with petrol and paraffin carburettors, 24-volt dynamo, self-starter and battery, fuel tanks, and sightfeed lubricating gear. It had never been used, having been imported for a speculator who went bankrupt, and it was in very good condition. The price asked was $700, including all the gear, which had to be taken as well. This was amazingly cheap for a new engine, let alone the propelling gear, and the offer was accepted and the set purchased.

A heavy timber frame was made to take engine and dynamo, which were direct coupled, the original flanged coupling of the balancer set being converted into a flexible one on the lines of a Hardy disc. There being no radiator, a 200-gallon tank was fixed up outside the

engine room with a kind of cooling tower of wooden planks on top—the fitter made it up out of his head as he went along—and the water was circulated by means of the pump on the engine. The exhaust was led into a hole in the ground, which was filled with broken brick and provided with a drain. This made a fairly effective silencer.

The set was soon run up, and, after a few minor excitation troubles, was put on load. The light was excellent, being very steady without any governor. The R.P.M. required for 240 volts was 960, which was not too much, except for the Tamil driver, who was petrified and explained that he was much better with steam engines. The first few nights were made eventful by this man, who shut down the Peerless after the first half hour that he was left alone with it, and started the roller, which was standing by under steam. He said that a big end was knocking, and had to be dragged back to have it explained to him that the noise he had heard was due to the valves in the water pump. He then developed an abominable habit of opening the compression taps every quarter of an hour or so, to let out the devils. This appears to be a common precaution in this part of the world, and it is very productive of sooted plugs.

The set has now settled down to routine conditions, and it is hoped that it will be the last temporary expedient that will be required The steam roller still does emergency duty during periods of overhaul, or on those occasions when the persons whose business it is to attend to these things forget to send us the paraffin that we have ordered.

It is expected that the load on the Peerless set will be well up to 10 kw. by the time that the permanent installation is running, and the married soldiers' quarters will have to be kept on the 110v. supply till that time. This is no great inconvenience, as there is a sufficient number of 110v. lamps available without buying any more, and a 230v. fan gives quite a pleasant breeze at the lower voltage.

The network is slowly being converted to 3-phase, and the voltage drop is being reduced by turning a 4-wire system into two parallel circuits, for the time being.

At this point the reader, if any, may ask himself that question which is apt to creep into the mind at the end of a Tactical Exercise : " Well, what is this all for, anyway ? " On those solemn occasions it is usual to summarize the lessons learnt during the day, and it is proposed here to state what we ourselves have gathered from this variety of experience. Many of our conclusions will be obvious, some well known, but we will be modest and include them all.

1. Lead batteries are unsuitable for the tropics.

2. Armature insulation must be very good to stand up to Singapore conditions. Mica is best, and impregnation should be very thorough. Insulation resistance test is apt to be misleading. The balancer generators which are perfectly trustworthy

gave 100,000 ohms only, whereas a small second-hand motor purchased for the forge blower gave 3 megohms and burnt out in a fortnight.

3. Brushes should be specified to be dense and non-hygroscopic. But it is better to avoid them altogether if possible. Small springs should be of phosphor bronze.
4. Magnetos are very troublesome here. The fibre insulation cracks easily, especially in the insulating flanges of sliprings. If the armature windings are made up with a lot of shellac, it will ultimately become soggy and soft, and fly out into the bearings, with devastating results. Magnetos, if not run once a week, should be stored in a dry place and aired at regular intervals.
5. Grease is unsatisfactory for lubricating high-speed white metal bearings, especially "Grease, lubricating, for hot climates," when used in hot climates.
6. Small sets can run quite safely without governors on a lighting load. Very little hand adjustment is required.
7. Such hand-governed sets need no field regulators.
8. Jungle trees in isolated positions are not to be trusted, however picturesque they may be.
9. T.R.S. cable laid just as it is on the ground, will carry a 230v. supply for a long time without failure.

NOTES ON PORTABLE MACHINERY IN THE FIELD.

By LIEUT. E. BADER, R.E.

DURING the summer of 1928, the 55th and 59th (Field) Companies, R.E., were engaged in the construction of two rifle ranges on Bellerby Moor, about 10 miles from Catterick. A certain amount of portable machinery, including an excavator, was used on this work, and some notes on its performance may be interesting to other units using machinery under similar conditions in future.

The machines were installed, run and maintained in the Field for six months by the Sappers, with no workshop facilities nearer than Catterick. Under these conditions, we were well able to appreciate the need for the various accessories usually found in a workshop, and a list of the most useful of these is given at Table V. The following were the machines used :—

(1) *List of Machinery, Bellerby Ranges*, 1928.

Plant.	*Maker.*	*Weight each.*
Two stone crushers, 16 in. x 9 in. jaws, " Kibbling " motion.	Mason Bros., Leicester.	6 tons.
One portable loco type steam engine, 5 H.P.	Ruston.	6 tons.
One portable paraffin engine, 7 H.P.	Blackstone.	2 tons.
One capstan winch, driven by petrol engine, 4 H.P.	Bamford.	¾ ton.
Two portable concrete mixers, 1/3 cub. yd., with 1½ H.P. Lister petrol engine.	Parker's " Little Giant."	11 cwt.
One No. 4 excavator on caterpillar tracks, 40 H.P. Dorman engine.	Ruston & Hornsby.	15 tons.

In addition to the above, two balloon winches were supplied for hauling trucks, but they were defective and unsuitable, so were never used.

(2) *Stone Crushers.*

The site chosen for each of these was in a shallow cut near the top of a sloping hillside. A foundation of five sleepers laid crosswise below the wheels and dogged, carried 9 in. x 3 in. wheel-bearers, and

was fixed in place on the clayey subsoil by means of 2 ft. 6 in. pickets driven flush. The crusher was then pulled into place with a traction engine and chocked up.

A corrugated-iron shoot about 20 ft. long was laid to a platform from which the crushed stone could be shovelled direct into trucks below. This arrangement necessitated a shovelling party of five men to remove the crushed stone from machine to trucks. To arrange direct delivery would have needed an elevator belt and gear, or a foundation under the crusher strong enough to allow a deep excavation to be made immediately behind it for trucks. But stores were not available, and the time and expense necessary for such work were not considered justified. To have undercut the hillside to give a slope of 1 in 1 to the iron shoot, without such foundations, would have endangered the stability of the crusher, a very " live " vibrating load of six tons.

The engine was next brought into place and lined up, a 65 ft. x 5 in. 5-ply Balata belt being fitted. The speed of the crusher was 250 r.p.m., and considerable trouble was caused at first by vibration. The crusher rapidly shook itself out of line, and had to be jacked back into place, a laborious process. This trouble was overcome by a design of braced chock, whereby the wheels rested entirely upon the chocks. A piped water supply was laid on for the steam engine.

A working party of one N.C.O. and seven Sappers, with ten infantry diggers, installed the two crushers, including shoots, in six days. Stone was brought by Decauville from various walls in the neighbourhood. It was a tough limestone, breaking sharp, with only a moderate amount of dust. This material was used unscreened, being mixed with cement and sand in the ratio of 1–2–5 approximately. It was crushed to $2\frac{1}{2}$ in. ring, suitable for 9-in. walls or over.

The steam engine was suitable for this load, although rated at only 5 H.P. and working at 45-lb. pressure. The 7 H.P. Blackstone, however, proved too small, and laboured heavily. See also the Maintenance Table, No. IV. The output, hours worked and the running details of the two stone crushers are given in Table I. About 900 tons of stone were crushed and incorporated in the works (abutment walls and target sheds).

(3) *Capstan Winch.*

This replaced the defective balloon winches, and consisted of a 4 H.P. Bamford petrol engine and winch mounted on wooden bearers and driving through single reduction gearing. The winch carried a capstan head of the usual coned type to be found on ships' winches. A 3-in. fall was used, and 1-ton trucks were drawn up a slope of 1 in 8 by taking a few turns round the capstan and pulling the running end taut. About 200 tons of stone were raised without any trouble.

The engine was somewhat crude, with an automatic inlet valve and grease-lubricated big end, but was very economical and strong enough for the work. An improvement could be made by mounting the engine and winch on a more solid bedplate. Incidentally, this plant would be eminently suitable for pile driving.

(4) *Concrete Mixers.*

These were one-third cub. yd. capacity, giving an output of 15 tons per day. The hopper-cooled 1½ H.P. Lister engine overheated and needed decarbonizing after two months' use, but gave no other trouble. The pivot bearing of one of the mixer hoppers was broken. The machines were mounted in G.S. wagons, in which they were conveniently moved about from place to place. This method also gave most of the height required for pouring concrete direct.

(5) *Excavator.*

Ruston No. 4 crane navvy, on caterpillar tracks (see Photo 1).

This machine was de-trained at Leyburn Station on June 25th. This was done by driving it from the truck under its own power on to a pile of sleepers. It then traversed the distance of two miles to the camp in six hours, including a steep hill out of Leyburn. A balance weight of one ton, and 30 cwt. of pig-iron ballast, were fitted on site, and digging started on the 27th.

Two days were then lost owing to rain, but by July 2nd Sapper Young had mastered the controls, and in the next three months the machine excavated 6,200 tons of stiff boulder clay and " limestone toppings " without serious trouble or mishap, except the failure on September 14th of the main engine clutch-thrust mechanism. This was replaced in the week-end, the firm having delivered the parts necessary in a few hours in response to a telephone call.

Table II gives the working results. The average rate of excavation was 21 tons per working hour. The limiting factors were the speed with which earth could be disposed of in trucks, and the smallness in most cases of the working face, necessitating many forward moves.

The machine was normally supported on sleepers laid crosswise when digging, but on the hard ground a few stones sufficed. It was driven up a slope of 1 in 7, down one of 1 in 4, negotiated the side of a hill sloping at about 1 in 10, and travelled twelve miles by road under its own power, averaging the not excessive speed of two and a half hours per mile !

The system of removing the excavated earth had to serve an infantry party digging in the same area as the machine and using the same Decauville Railway (see Photo 2). In the first stage, earth excavated behind the stop-butts was dumped on the 100 yards firing point, which was an eleven-foot bank requiring a large amount of earth. Trucks travelled in a circular route, later changed to out-and-return

double track and sidings, according to the alteration in levels. All trucks were pushed by hand, three men being required for each one-ton truck. There were thirteen trucks available, and at one time the output reached 250 trucks per six-hour day on a round trip of 450 yards, or an average of 42 per hour and 20 minutes per round trip for each truck, including filling. Of this total the excavator accounted for 150 to 180 trucks.

The best method of dumping earth from a truck was the use of piers consisting of 60-lb. rails supported over the proposed bank on baulks. The truck was run out on a light rail lashed above these rails, and tipped sideways. Three such piers were needed to cope with the output, two being in use whilst the third was moved forward. The 9-lb. Decauville used was too light for one-ton trucks on soft ground, and a maintenance party was continuously employed keeping it in repair. But it had the advantage of being easily bent by hand to curves as required.

The next stage was to move the digger to the stop-butt bank, where it dug earth from a borrow pit and discharged it direct without the use of trucks. Owing to the volumes and heights and the limited radius of the bucket-jib, this system was quicker than the use of trucks only when the bank remained below 4 ft. 6 in. Above this height it became necessary to discharge into trucks.

In the final stage, some shallow digging remained to be done, when all exits for Decauville track had been closed. The digger was used to tear up the earth and deposit it in loose heaps which were removed in barrows. In this case the digger working half-time kept 25 barrows in action on a 70 yard round trip; 15 shovellers were required. Details of the running data and output are given in Table II. Repairs executed, and needed at the end of the work, are given in Table III.

(6) *Maintenance of Machinery.*

The machines were installed and worked by Sappers, who showed the greatest keenness, but lacked experience. It was found necessary to arrange for proper maintenance as distinct from operating the machines. The best tradesmen in the Company were formed into a maintenance party under a skilled N.C.O. It was this party's duty to visit all machines frequently while at work, carry out running repairs during the break and dinner hour if necessary, and make note of any larger overhauls for execution during the week-end. Drivers of machines were instructed to do no repairs or adjustments without the knowledge and consent of the maintenance party. This system worked well, and practically no delays occurred during working hours due to mechanical failures. See Table IV, for repairs carried out to machinery. For digger see Table III.

TABLE I.—STONE CRUSHERS.

	Heron-Tree.	*Deer-Park.*
Crusher, 16 in. x 9 in. portable. Engine :	5 H.P. steam.	7 H.P. paraffin.
Belting	5 in. 5-ply Balata.	6 in. 4-ply Balata.
Fuel per hour, average including starting	80 lb. coal.	3 pt. paraffin.
Stone crushed, tons	400	410
Hours worked, hours	154	250
Average per hour, in crushers rated at five tons per hour, output, tons ...	2·6	1·64
Best output per day of six hours, tons	19	16

Working Parties.

R.E.

Working engines, and maintenance	2	1
Feeding crusher	1	1
	3	2

Infantry.

Delivering stone	14	14
Feeding crusher and sorting stone ...	3	3
Shovelling crushed stone to trucks...	5	5
Removing crushed stone	3	3
	25	25

TABLE II.—RUSTON EXCAVATOR.

(*a*) Summary of Log :—

Period.	Hours. Run.	Hours. Digging	Output Tons.	Tons per Hour.	Working Hours Lost. Mach.	Rails.	Moves.	Maint. out of Hours	Remarks.
25/6–13/7	56	43	742	17·3	5½	—	9½	2	Driver learning engine. Sprag jammed ; brakes and clutches.
16/7–3/8	86	74	1835	24·8	3½	2½	3½	6	Brake and clutch, clutch release stud, rack lock, keys, sprag lever, bucket, rope.
6/8–24/8	66	60	1150	19·2	5	3½	1	1	Attend carburettor. New rope.
27/8–7/9.	55	42	826	19·7	—	5½	11½	—	Move to new site. Working on narrow bank.
10/9–21/9	42	36	842	23·4	5	6	—	14	Main clutch broken.
24/9–8/10	51	28	560	20·0	4	1½	20½	—	Move to Catterick, 10 miles.
Total	356	283	5955	21·0	23	19	46	23	
Best day, 24/7/28	6	6	181	30·3	—	—	—	—	

NOTE 1.—Fuel used by Ruston : 1¾ g. per hour, or 10½ per six-hour day.
NOTE 2.—The engine was originally set to run on paraffin, but as petrol was cheaper and worked better, it was converted to that fuel.
NOTE 3.—Lost working hours : *Mach.*—mechanical defects. *Rails*—alterations to Decauville track used for discharging earth. *Moves*—machine moving to new face.
NOTE 4.—Working party : Sappers—one driver, one mate, one man checking output, arranging sleepers when moving forward and clearing obstructions from bucket. The second driver was not actually necessary. Infantry : Two men occasionally to help with sleepers.
NOTE 5.—Equivalent output : a hundred men digging by hand.

TABLE III.—REPAIRS TO EXCAVATOR.

During 350 hours work.	*On completion of work.*
Straightened sprag lever 3 times (part of travelling mechanism).	Decarbonize and grind in valves (found to have been unnecessary.
Renewed bucket hoisting rope.	Straighten bucket door.
Altered carburettor setting for petrol and retimed magneto.	Fit new main clutch fabric.
Adjusted fan belt once and clutches several times.	Repair woodwork of cab.
Adjusted jammed sprag gear once, sprag levers 3 times.	Replace link bolt on hoisting clutch.
Tightened keys on control shafts.	
Renewed one broken track bolt.	
Renewed main engine clutch-thrust mechanism.	

TABLE IV.—REPAIRS TO MACHINERY.

During work 15/5/28 to 9/10/28.	*On completion of work.*
(*a*) 7 H.P. BLACKSTONE DRIVING STONE CRUSHER.	
Big-end bedded monthly.	New glasses for water drip and lubricator.
Fuel feed pipes renewed twice. (Practical jokes during week-ends.)	Bed big and little end and renew latter if found necessary.
Renewed gas-side piston ring.	New air valve spring and hot coil.
Renewed exhaust and fuel valve and governor springs.	Repair blow-lamp.
Renewed heating coil twice.	Renew joints in exhaust and water pipes.
	Decarbonize and grind in valves.
(*b*) STONE CRUSHERS, TWO.	
Nil.	Clean and fit bearings.
	Straighten and replace one main shaft.
	Fit brushes to road wheels (wear due to vibration while working).
(*c*) CAPSTAN WINCH.	
Fit seating to lubricator.	*Nil.*
(*d*) 1½ H.P. LISTER ENGINES ON CONCRETE MIXTURE.	
Decarbonized and ground in valves.	Decarbonize.
Adjusted fuel valve seating.	

TABLE V.—SOME ACCESSORIES FOR PORTABLE MACHINERY.

"Sternol" belt dressing.
"Alligator" belt fastenings, with copper or gut joint.
Asbestos string.
"Klingerite" packing, two thicknesses.
Hand-hole packing rings.
Worsted for drip feed lubricators.
Cotton waste and rags.
Soft soap.
Engineer's emery cloth.
Assorted bolts and nuts, washers and spring washers.
Trek chains for haulage purposes (or steel slings).
Jacks, lifting and traversing, 6 tons.
Lubricants: Stauffer grease, axle grease. Oil, I.C. medium and heavy, also steam cyl. oil, special high grade, *e.g.*, Shell-Triple
Jim Crow.

Photo No. 1. Ruston No. 4 Crane Navvy.

Photo No. 2. Infantry Digging Party.

Portable Machinery in the Field

INTERNATIONAL BOUNDARY DELIMITATION.

River Boundaries.

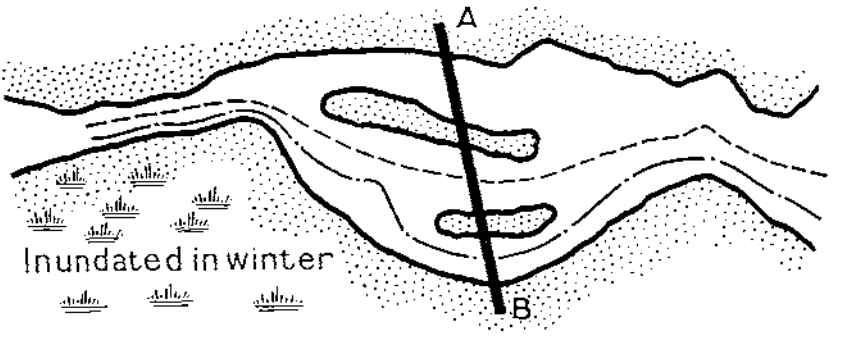


Fig. 1.

The Bay of Hela

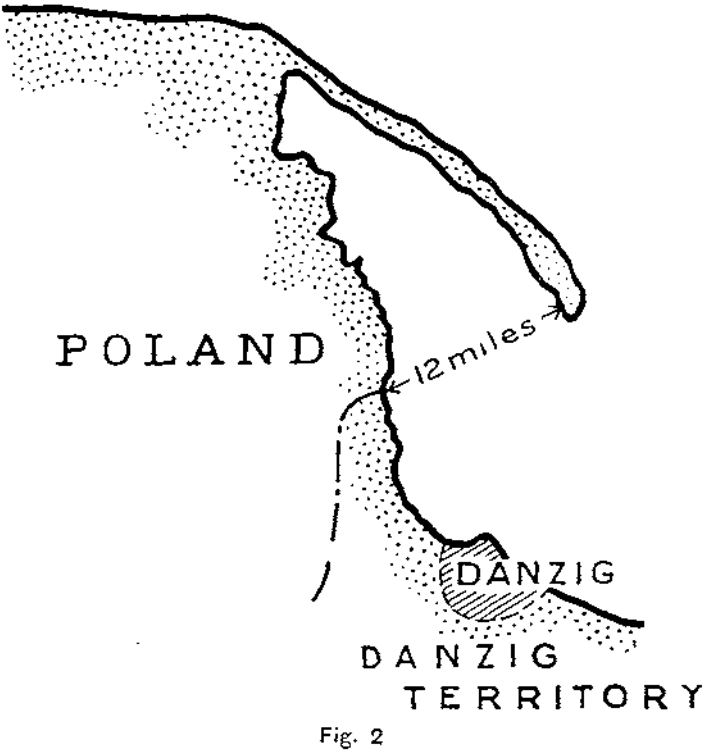


Fig. 2

INTERNATIONAL BOUNDARY DELIMITATION.

A Lecture delivered at the S.M.E., Chatham, on January 31st, 1929, by MAJOR P. K. BOULNOIS, O.B.E., M.C., R.E.

THE dictionary definition of the word " delimitation " is " the fixing or settling of a limit." It is clear, therefore, that the subject of boundary delimitation involves more than merely surveying, and that side of the question will barely be touched upon in this lecture. No boundary can possibly be delimited without a map, and, as delimitations usually take place in countries which are either completely unsurveyed or else inadequately mapped for such purposes, survey knowledge is an essential equipment for the man who goes out on the ground to do the final " fixing or settling." The object of this lecture, however, is to give some indication of the technique of actual delimitation, to touch upon some of the historical cases of difficulties and disputes, and to show some of the problems which have to be solved in the case of all boundary work. A boundary, it must be remembered, is a line, that which, according to Euclid's definition, has length but no breadth. To fix and settle a line which will separate peoples, which will put individuals under the laws and customs of different nations, clearly needs much care and thought, and above all sympathetic consideration. When, in addition, economic unities are involved, the problem of finding a line which shall produce future stability is indeed a great one.

Most of the available literature on the general subject of delimitation deals with the difficulties which have arisen in interpreting boundary treaties, owing to those treaties having been drawn up on utterly insufficient geographical knowledge. It seems hardly fair, however, invariably to criticize the treaty makers in these cases. Clearly, they must do their best with the material at hand and in nearly all cases that material has been scanty in the extreme. If one considers any map of our colonies, for instance, in the nineteenth century or earlier, it is certain that about the only features thereon depicted will be

(*a*) Rivers,
(*b*) Mountains,
(*c*) Towns and villages,

as well as, of course, that bugbear of delimitation the geographical graticule, the lines of latitude and longitude. It is so natural for a hard-pressed foreign or colonial office instantly to seize on such feat-

ures as are shown on the only existing maps, and, to the uninitiated, features like rivers and mountains seem excellent things in themselves to choose as boundaries. They will be there, they will be visible, and at any rate a river is a concrete dividing object. In fact, in past works on the subject it has always been customary to speak of "natural" and "artificial" boundaries in accordance with whether the boundary line was defined as following some topographical feature such as a river, or lake shore, or was only a line on the ground which required marking in some form or other. As will appear later, the "natural" boundaries prove more often than not to be more artificial than natural. The epithet may, indeed, be applied to the working of the minds of those who first choose the line from a map! It is natural to select such features as are shown.

Probably the best historical example of boundary delimitation difficulties being brought about by the selection of "natural" features on an inadequate map is provided by the long boundary between the United States of America and Canada.

At the eastern end of this boundary, the line was defined by the Treaty of Paris of 1783 as running up the River St. Croix as far as its "source," and thence due north to the "highlands." These highlands were further defined as dividing "those rivers that empty themselves into the River Saint Lawrence from those which fall into the Atlantic Ocean."

The first difficulty arose in discovering the River St. Croix, for no local inhabitant could be found who had ever heard of a river with such a name in those parts. Eventually, after much discussion it was decided to agree that a certain river called the Schoodic was really the St. Croix.

Then came the question of the "source." The river Schoodic has three main sources, each formed by a lake.

The position of the "highlands" or watershed between the St. Lawrence basin and the Atlantic Ocean caused years and years of dispute, for actually no rivers in that part of Nova Scotia really run into the Atlantic Ocean at all. They empty themselves either into the Gulf of St. Lawrence or else into the Bay of Fundy.

Further to the west, along the Canadian-United States boundary, another interesting case of difficulty arose. By treaty the boundary line was to run down a certain Hall stream to its junction with the Connecticut river, and thence along the 45th parallel of northern latitude. Between 1771 and 1774 this particular parallel, which also was the boundary between the states of New York and Quebec, had been determined by astronomical methods of survey, but had been fixed 3,000 yards further north than its true position was afterwards found to be. The old position of the parallel as determined by more exact methods was also found to be well north of the junction of the Hall stream with the River Connecticut.

If the old position of the parallel was accepted the treaty definition could not in fact be fulfilled, for the boundary would reach the 45th parallel well before it could attain the Connecticut river. But in spite of this, the Ashburton Treaty of 1843 accepted the wrongly-surveyed position of the 45th parallel, and provides one of the few historical instances of a boundary wrongly surveyed and contrary to an original definition being perpetuated.

Towards the centre of the Canada–U.S. boundary, similar difficulties arose. The Treaty of Paris defined the boundary as running to the most north-western point of the Lake of the Woods, passing incidentally through a "water communication" that did not exist, and mentioning a certain "Long Lake" which no one could find.

From the most north-western point of the Lake of the Woods, an almost impossible place to find in an extremely indented, more or less circular lake, the boundary was by treaty to run "on a due west course to the River Mississippi." On investigation it was found that all the sources of the Mississippi were considerably further south than they had been shown on the map by the aid of which the treaty had been drawn up. No due west line from any part of the Lake of the Woods, let alone one from its most north-western point, could in fact ever touch any portion of the River Mississippi.

Many years of dispute naturally ensued, but in 1818 the boundary west of the Lake of the Woods was accepted as being the 49th parallel as far west as the Rocky Mountains, and later this so-called geographical line was extended to the Pacific.

It may amuse you to know that it is along this eighteen-hundred-mile line, as well as in places along the 45th parallel east of the Great Lakes, that so many houses exist to-day in which strong drink may be legally consumed at one end of a room, and all the rigours of the law, and of the Volstead Act, descend upon so much as a gulp taken at the other window!

There are many historical cases of disputes arising when a boundary is defined by treaty as following a geographical line, *i.e.*, a parallel of latitude or a meridian of longitude. Probably the best is the one which caused so much argument between the Australian states of Victoria and South Australia that they referred the matter to the Judicial Committee of the Privy Council as recently as 1913.

Their boundary was to be the 141st meridian east, but the original surveys were two miles in error. This error was probably due to a wrong value for the longitude of Sydney rather than to inaccurate astronomical work on the actual line. The boundary, however, had been marked and "proclaimed" by the Governor of South Australia (in 1847), and the Privy Council would not allow the line to be altered.

Actually the two mile error was in a westerly direction, *i.e.*, nearer to meridian 140°. The most original definition of the boundary

laid down the line as between the 132nd and 141st meridians, so that the erroneous line came within that definition. Had the error been in the other sense, *i.e.*, making the line more than 141° east, it is likely that the Judicial Committee of the Privy Council could not have given their award to let the line stand.

Another interesting case of difficulty when a boundary is defined in relation to a geographical line, in this case a parallel, occurred quite recently on the western frontier of the Anglo-Egyptian Sudan. The final convention between the United Kingdom and France, signed by Mr. Balfour and M. Pichon in 1919, stated that the boundary between the Sudan and French Equatorial Africa (a post-war title) was to follow the waterparting between the basin of the Nile and that of the Congo " up to its intersection with the 11th parallel of north latitude."

Now in 1919 this looked a perfectly sound definition. The deserts north of the main tributaries of the Congo did not seem likely to contain any river which did not flow directly into that vast basin of Central Africa. Maps of the day showed an undoubted watershed between the basins to exist considerably north of the 11th parallel. Yet even before the final work of demarcating and mapping was undertaken (in 1921) it was known that another river basin might considerably complicate the interpreting of the treaty. The Shari river rises in the southern Steppes of Wadai and flows into Lake Chad, and many of its tributaries come from south of parallel 11 degrees north.

The Nile-Congo watershed, a definable geometric line, was found in fact never to reach the 11th parallel. In the Shala Mountains about 10°15' North and 22° East is the meeting point of the three watersheds,

1. Nile-Congo
2. Nile-Shari
3. Shari-Congo

and the treaty of 1919 was " out of court " as regards the stretch between the Shala Mountains and the 11th parallel, a distance of some 60 miles, whence a well-defined tribal boundary was to ensue. Luckily, in this case the country involved was of no particular apparent value—ivory was its chief commercial asset—and agreement on a compromise line was reached without the matter having to go to arbitration.

As will be seen from the above, even the general definition of a boundary presents a problem of great difficulty, the major portion of which is caused by the lack of topographical knowledge of the country over which the boundary will run.

When one gets to detailed definition the problem is in some ways harder, and, even when maps are good and accurate and of fairly large

scale, snags will always arise when a boundary line is laid down as having to follow this or that " natural " feature.

The most prolific source of difficulties are rivers, and boundaries along such will now be considered in some detail.

Rivers never divide peoples and tribes, but apart from this ethnic unsuitability of nearly every river that exists, the fact that rivers can and do change their courses makes them possibly the worst form of boundary that can be imagined. The number of disputes that have arisen in the past, owing to this unpleasant habit of rivers, is enormous, and a kind of international law has in consequence arisen which states the principle to be followed in such cases as : " If the change in the course of a river is by infinitesimally small steps, the boundary follows the river wherever it goes ; if, on the other hand, the change occurs suddenly, as may happen in flood, the new course of the river does not constitute the boundary, which remains along the old line (now possibly dry)." This principle was first enunciated by a Mr. Cushing, who is recognized as an authority on international law, about 1911, after much dispute had arisen between the United States and Mexico over the alterations in course of the Rio Grande, whose median line forms their boundary.

Canalization of rivers may also alter their courses, or at any rate the position of the main channel, and in such cases it is usual to insist on the old line in its original position with regard to the earth's surface being adhered to.

In one case, that of the Russo-Turkish boundary when it used to run along the River Pruth between Bessarabia and Moldavia (which is now a Rumanian province), a treaty drawn up in 1857 specified that should the river line as demarcated become accidentally displaced by a flood, the local authorities of both states were forthwith to have the necessary works carried out, " to return the waters of the river to their original bed such as are shown on the topographic map of the frontier." This, however, exhibits exceptional prescience on the part of the Commission appointed to delimit the boundary, and one may add, exceptional optimism.

Another major objection to the choice of a river line as a boundary is that, unless the whole of the waterway be allocated to one state, a condition which precludes all free navigation, fishing, and rights of taking water for domestic or commercial purposes in the case of one riparian, any division of a river in a civilized country complicates almost hopelessly the question of—

(*a*) Bridge ownership and maintenance.
(*b*) Lock ownership, operation and maintenance.
(*c*) Improvement of the navigability of the river in question, for instance, by " spits " on either bank designed to deepen the channel.
(*d*) General navigation.

In spite of this, however, one bank of a river is seldom chosen as an international boundary, and division is almost invariably made by either—(See Fig. 1).

(*a*) The middle or median line.
(*b*) The valley line or line of deepest soundings, called in boundary practice the " thalweg."

Both definitions present certain difficulties. Clearly, if a river's banks are steep and high, the middle line of the water, be it at low level or flood, can quite easily be found. *Bornes repères*, or mutual beacons, are put in on either side of the river, and the boundary is the line equidistant from the two pillars. But how few rivers possess well-defined banks. Even the Thames becomes a mile or two wide in places during the winter, and in many cases of continental rivers broad marshes extend to the width of half an English county.

The word " thalweg " first came into use for international boundary delimitation in 1801 (Treaty of Lunéville), and this fixing by the valley line became increasingly popular during boundary disputes throughout the nineteenth century. The trouble of the thalweg is :—

(*a*) That it is not easily found. It means in effect the laborious work of sounding the whole river bed.
(*b*) It may be indefinite, *e.g.*, two arms of a river may be of equal depth and equal rapidity of current.
(*c*) It is more than liable to change.

In some boundary protocols the difficulties under (*a*) above have led the two interested states to accept the " thalweg " as being the line most favourable to downstream navigation at periods of low water (*e.g.*, the Rhine boundary), or as the stream line of the fastest current. In reality, however, the " thalweg " means the line running along the actual bottom of the bed, or that line which the water would follow should the volume of the river be reduced to the tiniest trickle. This latter is the simplest way in which to look upon " thalweg " in one's own mind.

That such a line is liable to constant change is the reason why the " thalweg " is now losing its popularity in boundary delimitation practice. Every article in the Treaty of Versailles, for instance, which dealt with boundaries, spoke of the " course " or " channel " (*cours et chenal*) of a river, and in Article 30 of the treaty it was laid down that these words should signify—

(*a*) The median line of the waterway or principal arm in the case of non-navigable rivers.
(*b*) The median line of the principal channel of navigation in the case of navigable rivers.

Even so, the question of definition of the word " principal " arm or channel of navigation gave rise to considerable dispute during the various delimitations of the post-war boundaries of Europe in detail.

After rivers come watersheds as the most usual form of natural feature to adopt as a boundary. It must not be imagined, however, that a watershed line is necessarily a mountain line of sorts. In some cases, of course, waterpartings between basins of great rivers do lie along mountain ranges, but they never coincide with what is popularly known as the crest of a mountain range. The most outstanding case of this is the Himalayas, whose northern slopes give birth mainly to rivers, which eventually find their way southwards into India and not into Tibet. Both the Indus and the Brahmaputra, for instance, rise north of the main Himalayan crest and not to the south.

The lengthy dispute between the Argentine and Chile which was referred to the arbitration of the King of England in 1899, arose in fact from a disparity between a watershed and a crest line or mountain range. The wording of the treaty (1881) was about as bad as it could be, for the expressions used were direct contradictions of each other, *e.g.*, " . . . marked by the highest summits of the said Cordillera (range of mountains) which divide the waters "—and later on " and shall pass between the slopes which fall away to either side "—which in the Chilean translation was made into " between the sources of streams flowing down to either side."

The line marked by the highest summits was, of course, in the main range of the Cordillera des Andes, but the watershed between the Atlantic and Pacific Oceans, which was what the Chileans claimed, was many many miles to the east, and mostly in flat marshy country. So patently indeterminate was this continental watershed that a certain Dr. Moreno, of the Argentine Commission, managed to divert the course of the River Fenix from the Pacific to the Atlantic with the aid of 20 men in a week, just to show the arbitrator (Sir Thomas Holdich) what a dubious line the inter-ocean divide was.

Indeed, the main objection to watersheds as boundaries is the difficulty of finding them. So many great waterways of the world first come to life in marshes and flat bush country. This is notably true of the north and south lips of the great Congo basin. Both the Nile-Congo and the Zambesi-Congo watersheds lie in the flattest of flat forests, as with regard to the former the writer knows personally only too well.

A very nice point, as lawyers would call it, arises when a watershed or crest line boundary happens to find itself along the top of a vertical or overhanging cliff. In the latter case, as by definition a boundary is a vertical plane, it would appear that two boundaries might be claimed, one at the top of the cliff, and the other vertically below,

but the lower line cannot be either crest or watershed. If the cliff is vertical it is clear that the cliff face proper belongs to neither side, and boring into it would be a violation of sovereign rights.

There are cases on record, and one extremely interesting one is current at the moment on the northern boundary of Rhodesia, where over a large area water percolates through the top strata, and no one can say to which side it eventually exudes. Watershed boundaries as a rule only take into account running water, and there clearly must remain considerable areas of either marshy ground or dry flat terrain over which it is a practical impossibility to determine the true theoretical watershed. Contours at one foot or even three inches vertical interval would be necessary before the real line could be found, and even then, on truly flat areas, the boundary would remain legally indeterminate.

In some ways, then, the crest line or *ligne de faite* is a better line to choose amongst hills and mountains than the watershed, always assuming that for some reason or other it is essential to try and follow so-called natural features. They are mostly unnatural when it comes to the peace and contentment of the persons living on either side.

Another "natural" feature which is often used in a boundary definition is a lake, and the same objections apply to the banks or median lines of such as to rivers, only in slightly less degree.

Of "artificial" features, canals, roads, existing hedges, walls, etc., there is no time to speak.

Geographical boundaries have already been explained and criticized The only truly "natural" boundary which is efficient and more or less incapable of dispute is of course the sea coast.

One aspect of delimitation which, however, is not often given the attention it deserves is what happens to a boundary when it reaches a coast. In this the question of territorial water has to be considered. There is no international law as to the distance from a coast over which a state should claim to exercise sovereignty, but only national custom and usage. The old rule was three sea miles, or a cannon shot, but hardly any nation now adheres to this distance; six, ten, twelve or even more sea miles being nowadays claimed as territorial water. The modern profession of "rum running" has in late years brought the question of the desirability of fixing by international agreement the length of a twentieth century cannon shot, so to speak, very much to the fore again. An attempt at codifying usage and custom in this matter, which is of great value to anyone faced with a delimitation problem involving sea as well as land, was made by the Institute of International Law in 1894 at their Paris conference. The rules suggested by that Institute were briefly:—

(*a*) Six sea miles (or 12,170 yards) width of territorial water.

(*b*) The boundary of this territorial water to be parallel to the coast line, except when bays are under 12 miles broad, *i.e.*, double the width of the territorial water. In these cases the sea boundary to run six miles out from the line where the two sides of the bay are first within 12 miles of each other.

This rule of ceasing to follow the bends of a coast when a bay is less than twice the accepted width of the territorial waters claimed is pretty generally accepted, but in the matter of width of zone each nation is a law unto itself. Italy, for instance, declared for ten sea miles in 1912; Spain and France content themselves with three miles; Sweden likes four sea miles "measured from the islands, islets, and reefs which are furthest out to sea and which are not permanently covered by water."

Now, when a land boundary reaches the sea, it is international custom to consider the boundary prolonged into it by a line perpendicular to the coast. This is all very well provided the land boundary reaches the coast more or less perpendicular to it, or rather to its general line. But many cases arise in which the final portion of the land boundary strikes salt water at some creek or bay, and if a line was drawn perpendicular to either

(*a*) The actual shore or coast at the point, or

(*b*) The generalized line of the whole coast,

it is extremely likely that such a line would drive straight into land already under the sovereignty of one or other of the interested powers.

A good treaty should, in fact, define the boundary line out as far as the limit of territorial waters in no ambiguous terms. Few, however, do.

The Gulf of Danzig provided a most interesting case of this when the boundary of Poland and the Free State of Danzig came to be finally delimited in 1920. The last of the ten short paragraphs of Article 100 of the Versailles Treaty, which fixed the boundaries of this new sovereign state of 384,000 inhabitants, merely stated "thence the course of the stream mentioned above to the Baltic Sea." The stream was actually the "Grenzfliess," a brook some three feet wide. Where this brook emptied itself into the sea was just 12 miles away from the point of the Putziger Nehrung, a peninsula jutting out to almost due north of Danzig town, and already Polish terrain. A line drawn perpendicular from the Grenzfliess outlet would go straight into Hela, a village near the end of the Putziger peninsula. If drawn perpendicular to the general line of the north German coast in the Danzig neighbourhood, it would have cut right across that intensely

important sandy spit. Then came territorial water questions. (See Fig. 2).

Surely Poland was entitled to three sea miles all round the peninsula, but six miles would have brought her territorial waters so close to those of Danzig as to overlap them. The boundary was finally settled as being a straight line from the Grenzfliess outlet, to be drawn as a tangent to the circle drawn round the point of the Putziger peninsula with three sea miles as radius, thence along that circle to where the outer territorial water boundary of Poland (*i.e.*, of the peninsula) began. A satisfactory solution and somewhat unique in boundary history. Had six sea miles been accepted as territorial water distance a similar geometric solution would have been most unfair to the Danzigers for reasons that need not be gone into here.

The settling of such knotty problems is the job of the actual Commissioners appointed under a Treaty and it will be as well now to consider how these men function.

The first thing they must remember is that they are interpreters, interpreters of a treaty, nothing more and nothing less. In all their delimitation work they must constantly strive to fathom what was the intention of those minds which finally gave the treaty birth. Critical thought about the treaty itself is useless, wasted. Get on with the job, and realize that a demarcated, fixed, and settled boundary, making for contentment and happiness even if in parts it seems unjust, is the essential objective of those who implement a treaty.

The tendency in modern days is to leave more and more of the final delimitation to the man on the spot, to the actual Boundary Commissioner. Thus, in the Treaty of Versailles, half the clauses defining the new boundaries of Germany are phrased in some such manner as :—

1. " thence to a point on the median line of Lonkener See ; a line to be fixed on the ground passing north of Neu Fietz and Schatarpi and south of Barenhutte and Lonken."
2. " thence to the southern end of Pollenziner See a line to be fixed on the ground."
3. " Thence north-eastwards to the point where the River Kamionka meets the southern boundary of the Kreis (*i.e.*, province) of Konitz about three kilometres north-east of Grunau. A line to be fixed on the ground ; leaving the following places to Poland : Jasdrowo ; Gr Lutau ; Kl Lutau ; Wittkau, and to Germany : Gr Butzig ; Cziskowo ; Bathow ; Bock ; Grunau,

and in this manner really immense latitude of choice was given to the various boundary commissioners appointed. Would that it were always so. There is no question that a successful and efficient delimitation can only be effected if this latitude is given. Make the

treaty vague as to the geographical line, but intensely definite as to the wishes and intentions of the two signatories, and nine-tenths of boundary delimitation difficulty would be swept away. It has even been suggested that the treaty itself might roughly define *two* lines *within* which the finally delimited boundary has to run. It would be an understood thing that the final line should, as far as possible, divide this zone into two approximately equal parts but, within the zone, the appointed Commission could take the line hither and thither, fitting it to the actual topographical conditions, to economic unities, and to the tribal, racial, and social needs of the area in question. Those natural features so "naturally" chosen in the comfort of an office would not so often appear as lines on the ground finally settling the boundary. Rivers, indeed, would probably be avoided altogether. There is no necessity for them. Interpretation of such a treaty would demand good will and give-and-take between the Commissioners of the rival states, but then so does the implementing of any boundary clause even where the line itself is, in theory, exactly defined.

Unless the Commission is tri-national, cases must always arise, and do, in which agreement cannot be reached. There is no course open then except arbitration. It is quite remarkable, however, how few British Commissions working alone with an opposing nation ever seem to have failed to reach agreement. The natural thing when two nations commence a delimitation would seem to be to include a third nation to settle cases of dispute, but this is never done in our practice. A notable exception was the recent Turkey–Iraq Commission, to which the League of Nations appointed a neutral President, a Swiss gentleman, with casting vote.

Boundary disputes, on the other hand, are of course referred to an arbitrator, and the King, President, or Emperor of some neutral state has in the past always been called in. Since 1888, the King of England has once been called as arbitrator—by Chile and the Argentine. The President of the United States once—by Nicaragua and Costa Rica. The Emperor of Russia once—by France and Holland, and the throne of Spain has been invoked no less than three times: by

Peru and Equador in 1888,
Columbia and Venezuela in 1891,
France and England in 1909.

Our own boundary dispute with Brazil of 1904 was referred to the arbitration of the King of Italy.

The delimitation of new boundaries after a war can hardly be called arbitrational delimitation proper, but the Commissions appointed under such treaties are charged with seeing that the clauses affecting boundaries are fairly and accurately carried out. The two interested states have their own commissioners, and the function of the men

appointed by the treaty is to adjudicate between their respective arguments as to the real interpretation of the boundary clauses.

No matter which class of delimitation is in progress, the first essential for the work is clearly a map. If none of suitable scale exists, one has to be made. In probably 90 % of cases in which Great Britain is concerned the mapping, survey, in fact, has to be undertaken. Opinions differ as to the width of strip over which detail should be shown, but as a rough guide ten miles on either side of the finally selected boundary is a good figure to aim at. The scale of the map naturally will vary in accordance with the amount of detail that exists. A quarter inch to one mile (1/250,000) has been found to suffice in many uncivilized parts of the world, whereas plans at a scale of 25 inches to the mile (1/2,500) were found essential for the post-war boundaries in Europe. In this connection it must be remembered that even though an almost perfect triangulation may exist, large scale cadastral plans very rarely do, and a Boundary Commission must, even in a highly civilized country, be prepared to undertake all the processes of cadastral survey. Chains, levels, theodolites, and tacheometers are, in fact, a most necessary equipment, and knowledge of their use even more so.

A very essential thing to remember about the maps is the necessity of properly transliterated names, and above all to ensure that the correct local names are found out and recorded. In most boundary protocols two lists of names are given, as it is rare that a common system of transliteration of native names exists where two European powers are concerned.

Apart from survey, officers appointed to serve on boundary commissions in uncivilized countries have an immense amount of administration to perform. The party is necessarily large, and facilities for supply are few. An escort almost invariably accompanies the commission. Pay, discipline, rations and transport questions all demand care and thought.

In civilized countries, survey knowledge is much more necessary than is commonly realized. To know the language of the other nation, or nations, represented on the Commission, is of course an essential. An immense asset on European work after the War was found to be general engineering training. Some of the arguments for and against some particular portion of a boundary were engineering questions, pure and simple. A very important problem, for instance, arose on the Danzig Free State boundary concerning a hydro-electric project on the River Radaune. Expert engineer witnesses were brought before the Commission by both sides. A settlement of the boundary there entirely by Commissioners non-conversant with electrical power problems would probably have been most unsuitable.

When proceeding to detailed delimitation, it is usually no use

trying to consider the boundary as a whole. It is essential to divide it into sections and carry through all the survey, discussions, arguments, and hearing of local evidence, and then delimit section by section. Another point is to leave the question of mutually unsatisfactory portions of the line until the whole has been delimited according to treaty. There obviously must be some line theoretically the only interpretation of the boundary as laid down, and when that is fixed the time arrives to discuss exchanges.

Finally, there is demarcation. The distance apart and the nature of boundary pillars will vary in accordance with the nature of the country, but practice in the past has erred far too much on the side of considering the country unimportant and therefore close monumenting unnecessary. Each pillar should at least be intervisible from its two neighbours. The essential of any boundary mark is permanence. Stone pillars should invariably be used, and what is even more important and even less practised in the case of so called uncivilized countries, some form of "tell tale" should be buried before the stone pillar is erected. A brick broken into three or four pieces such that they may be fitted together again is quite sufficient, but that premises the presence of bricks. That bottles will be available, and available in large quantities, on any boundary commission, is, however, likely even in the "wilds," and no slur is here intended. A broken bottle, provided all the pieces are buried, provides just as good a "tell tale" as a brick. This habit of putting something under the boundary stone dates from early Roman days. In mediæval times national emblems were often carved upon the pillars, but nowadays the names, or even only the initial letters, of the States concerned are marked, as also the number of the stone. A very useful addition, however, is to have two lines cut in the top of the stone pointing in the direction of the two neighbouring pillars.

"Cursed is he who removeth his neighbour's landmark," but something more than oaths are required in international boundary demarcation. The position of each stone is, therefore, accurately marked on the maps accompanying the boundary protocol, but this is not really sufficient. In post-war European work some of the following precautions were taken to ensure that any boundary stone could be put accurately back into position should some "neighbour" remove it:

(1) Each stone was photographed from two positions, such positions of the camera being accurately marked on a large scale map.

(2) Distance and bearing from permanent detail, such as house corners, were measured with chain and theodolite.

(3) Distance and bearing to the two adjacent pillars was recorded. (This was invariably done.)

(4) Rectangular co-ordinates, based on some permanently marked point as origin, for a series of pillars, were computed and recorded.

In " uncivilized " work, the best that can be done is to record either geographical co-ordinates or rectangulars. In this class of country there is nothing so good as a cut lane to show to all and sundry where the boundary lies. Jubaland has one, and now the Rhodesia-Congo boundary. The natives will surely use these lanes as roads for their cattle and themselves, and thus ensure their permanence. Cutting a ditch is another excellent way of demarcating and it has precedent in

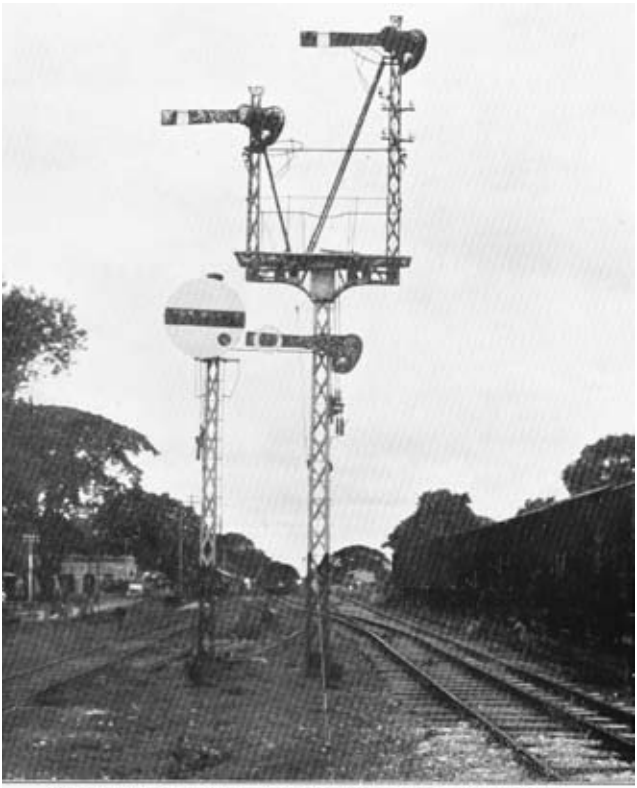
The Savoy-France boundary demarcation of 1825,
The Turkey-Russia boundary demarcation of 1857,

and will probably be more used in the future.

How to draw up the boundary protocol to a treaty is almost a subject in itself. Suffice it to say that a protocol may occupy from six pages to three or four volumes. Everything has to be thought of. There must be a detailed textual description of the boundary, a description of each pillar, all geographical data, and a record of all cases of mutual exchange or agreement to depart from the wording of the original treaty. Then come the agreements made between the Commissioners appointed by the interested states as to such things as (i) Water rights on rivers or lakes; (ii) Fishing rights; (iii) Navigation of rivers; (iv) Locks and bridges; (v) Cases of free access; (vi) Cases of free passage for special purpose, *e.g.*, to maintain a dyke in repair or for children to attend school; (vii) Waiving of customs dues in special cases; (viii) Railway conventions.

Only two or three of such things usually come within the ken of British boundary makers, but that is only because their work more often takes place in the so-called uncivilized countries. It is well to remember, however, that uncivilized countries may soon become civilized and economically important, and in drawing up a protocol it is essential to look into the future.

Even the wildest, remotest portions of the earth's surface may yet become a Canada and a United States of America.



Saidpur Yard, showing special Round Signal for Metre-Gauge.

Kartu Bridge completed, showing old Cast-iron Piers.

Kartu Bridge Completed

CONVERSION OF METRE-GAUGE TRACK TO BROAD-GAUGE IN INDIA.

Saidpur Yard, showing termination of three-rail track.

Photo of Saidpur Yard, showing Metre-Gauge slewed to one side.

Saidpur Yard

CONVERSION OF METRE-GAUGE TRACK TO BROAD-GAUGE IN INDIA.

By MAJOR E. F. JOHNSTON, R.E.

CALCUTTA is the headquarters station of the Government of Bengal during the cold weather ; for the hot weather period an annual move is made to Darjeeling in the Himalayas, about 350 miles from Calcutta. The Eastern Bengal Railway covers a little over 300 miles of this journey, *i.e.*, from Calcutta to Siliguri, and from here the journey is completed by car in about three hours, or by the 2-foot gauge Darjeeling Himalaya Railway in about six hours.

Until October 1st, 1926, the journey to Darjeeling involved two changes of gauge, one from broad to metre on the E.B. Railway and the other from metre E.B. Railway to 2-foot gauge D.H. Railway.

A change of gauge means discomfort for passengers, places limits on the time-table, in order to arrange for the important trains to arrive at transhipment points at reasonable hours, and causes delays. Delays to consignments of goods are also caused by transhipment, and loss may occur at transhipment points.

The progress of through communication on the E.B. Railway from Calcutta to Siliguri was as follows :—

The original main line from Calcutta–Poradah (see Sketch Plan) broad-gauge was completed in 1862, and was extended to Bhairamara in 1877. The extension from Bhairamara to Damukdia was completed in 1883, transhipment from here to the metre-gauge north of the Ganges (completed in 1877) was effected by ferries. The opening of the Hardinge Bridge over the Ganges (to carry two broad-gauge tracks) in 1915, and the extension of the broad-gauge 53½ miles north transferred the transhipment point to Santahar, 173 miles from Calcutta and 145 miles from Siliguri. A further stage of the change to broad-gauge was the completion to Parbatipur, 59 miles north of Santahar, in 1924.

Energetic steps were then taken to convert the remaining 85 miles. The estimate was sanctioned early in 1925, and the work was completed in record time, and formally opened by H.E. the Governor of Bengal on October 1st, 1926.

Up to Parbatipur, the change from metre-gauge to broad-gauge had been treated as a construction job, and the broad-gauge formation was made parallel to the existing metre-gauge. North of Parbatipur considerations of expense and rapidity of completion led to the decision to treat this section as a conversion.

Plan No. 1* is an index section of the proposed line, and gives main details of the geography and the obstructions to be met on the work. It will be noted that gradients were easy, and no curves exceeded three degrees. Those curves, however, which exceeded two degrees had to be transitioned and eased so that the limit of two degrees for unrestricted speed was not exceeded.

All the work could not be carried out in the same way; for the first nine miles very special arrangements had to be made for the following reasons. Nine miles north of Parbatipur is the station and railway colony of Saidpur. This station, besides being the headquarters of engineering, traffic, and loco districts, contained also construction and repair shops for the engines and rolling stock of the metre-gauge section of the E.B. Railway, and in addition a large depot of stores for consumption in the workshops and on the metre-gauge section. Saidpur, therefore, had to have metre-gauge connection with Parbatipur, so that rolling stock and engines could proceed to and from shops, and so that stores could come up from Calcutta by B.G. vehicles and after sorting in the stores yards could be distributed to the metre-gauge. The cheapest and quickest way to allow for this was to lay down a three-rail track, whereas the remainder of the conversion was carried out with four rails, as explained under permanent way.

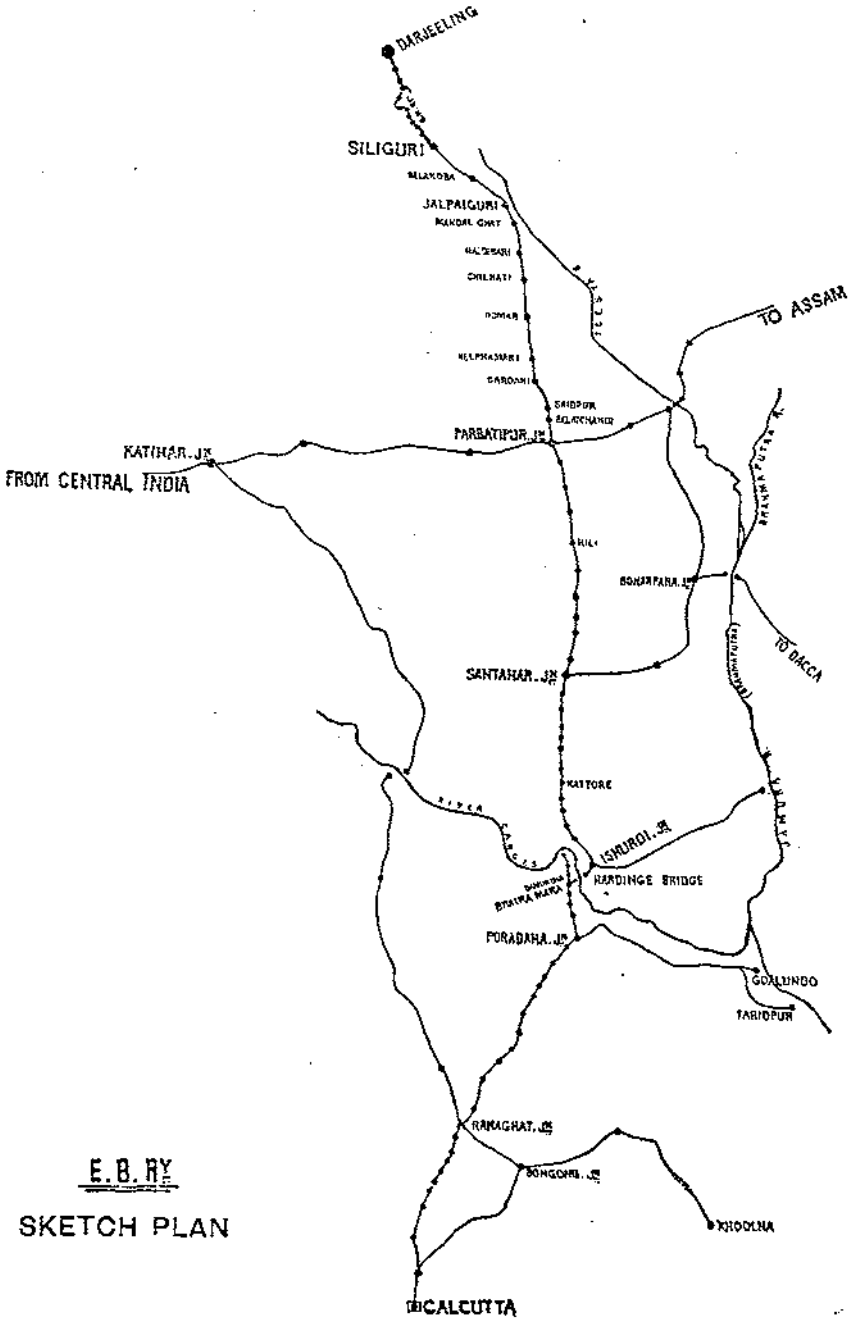
After work was commenced, a slight delay was caused by the receipt of orders to work to recommended dimensions for the broad-gauge. This meant allowing for considerably larger running dimensions and an increase in axle loads. As examples of the difference to be allowed for, it is sufficient to state that spacing of tracks in passenger yards was increased from 15 ft. 6 in. to 16 ft. 9 in., necessitating an increase in overall length from facing point to facing point of about 300 feet, and also axle loads to be allowed for were increased from 18 tons to 22½ tons.

At the same time that the project for the conversion of the metre-gauge main line from Parbatipur to Siliguri was proceeding, another large project had to be considered and completed, namely, the remodelling of Parbatipur passenger and goods yards.

Parbatipur is the junction between the main north to south line and the east and west line to and from Central India and Assam; the former line was now to be entirely broad-gauge, whereas the latter was to remain metre-gauge. This necessitated, besides considerable alterations to passenger tracks, the complete remodelling of the goods yard to convert it from a junction for metre-gauge traffic into a transhipment yard for dealing with traffic between metre and broad-gauge districts.

The details of this latter project and the methods employed to complete it are too numerous to mention in this article, but a comparison showing the details of expenditure under the two projects is

* Not reproduced.


DARJEELING
SILIGURI
JALPAIGURI
TO ASSAM
KATIHAR JN
FROM CENTRAL INDIA
PARBATIPUR JN
SANTAHAR JN
TO DACCA
ISHURDI JN
HARDINGE BRIDGE
PURADAHA JN
GOALUNDO
FARIDPUR
RAMGHAT JN
KHOOLNA
CALCUTTA
E.B.RY
SKETCH PLAN

instructive; in addition, this latter project is mentioned because the necessity for its completion vitally affected the question of staff and supply of stores.

The gross estimate for the conversion was Rs. 7,500,000, and net, after allowance for credits of old materials, Rs. 6,750,000, or Rs. 78,000 per mile (at 1s. 6d. per rupee — £5,888). The proportions in which this amount is allotted in important heads of the estimate were approximately :—

Earthwork	4½ %	
Bridges	10½ %	
Permanent way ..	71½ %	includes ballast and points and crossings
Signalling	6 %	
Interlocking		
Loco arrangements ..		

The balance of 7½% is accounted for under preliminary expenses, land, installation of electric light and power at Siliguri, salaries and other minor items.

The estimate for remodelling Parbatipur yard was Rs. 2,600,000, or at 1s. 6d. per rupee, £195,000.

The approximate distribution of this sum over different heads of the estimate is :

Earthwork	13½ %	
Permanent way ..	33 %	includes ballast and points and crossings
New platforms ..	4%	
and Overbridge ..		
Staff quarters.. ..	26%	
Signalling	17 %	
Interlocking		
Loco arrangements ..		

The remaining 6½ % is accounted for under preliminary expenses, land, salaries, etc.

The difference in the distribution of cost in the two estimates is due to the following, namely : Parbatipur is low-lying, and therefore large quantities of earthwork were required ; this had to be brought in by ballast train from outside, and very great delays were experienced in bringing in trains, as the junction is an extremely busy one. Parbatipur now became a large transhipment point for goods, and a broad-gauge engine changing station, necessitating the construction of quarters for transhipment coolies and supervising staff, and a large engine shed and quarters for drivers, firemen and running staff.

Immediately these projects were sanctioned, steps had to be taken to organize staff and the work, so that completion of the projects was obtained with the greatest possible speed. The reason for this

was that the enormous amount of work entailed had to be done under main line traffic, and it necessitated certain limitations on the traffic which it was in the interest of the railway to remove as soon as possible.

The work therefore approximated to that which an R.E. officer might be called on to perform on active service, where speed is such an important factor.

The points which arose immediately were arrangements for (*a*) work; (*b*) staff; (*c*) materials.

Although these points are set down in a certain order they are really interdependent, and consideration of any one of them involved decisions as to the others.

(*a*) Arrangements for the Work.

The estimate for the conversion was sanctioned at the end of January, 1925; the earliest date by which arrangements could be worked out and staff collected appeared to be March 15th.

It was immediately obvious that the progress of work on the bridges would be a considerable factor in determining the final date of completion for the following reasons. There were 111 bridges of 147 spans. Each bridge required considerable alteration, and 49 of them required entirely rebuilding. Although work was so organized that only one diversion was found necessary, it was necessary for the safety of the travelling public to impose a dead stop restriction, with five miles per hour speed over the bridge at each bridge during alterations. There were 10 masonry spans which it was decided to leave untouched, the track being listed to give a two-foot cushion.

There were thus left 101 bridges, each of which would require at least one four-hour block to put on a restriction and a similar block to remove restriction, and a third block for changing girders. A total of 1212 hours block, or a four-hour block on 303 working days if only one bridge per day was tackled. It was also estimated that each bridge would take at least three weeks to complete, or a total of 303 weeks or nearly six years for the whole work.

To complete this work within twelve months, and allow for contingencies and for changing girders, and for possible interference by the monsoon, besides considering the obviation of as many delays to traffic as possible, it was decided to take one bridge in each block section of the line in hand at a time. There were 11 block sections between Parbatipur and Siliguri, the time usually allowed for a dead stop restriction is five minutes, a total loss of time, therefore, on the run between Parbatipur and Siliguri of 55 minutes had to be allowed for. The Traffic Department was therefore immediately approached to alter their time-table. This required considerable re-arrangement of trains and protests from the travelling public for the delay, but was efficiently arranged by the Traffic Department. It was very

satisfactory, therefore, when, in April, 1926, exactly one year after the restrictions were imposed, most of them were withdrawn.

There was an alternative method of working on the bridges, and that was to start work from one end and work through; this would have simplified supply of materials, supervision, and the work generally, but would have necessitated alterations in the time-table every time a block section was completed and restrictions were moved into the next block section; this labour could not be contemplated, and the other method mentioned above was adopted.

Table No. 1 shows the distribution of bridges in the various sections and the progress of construction up to December 4th, 1925.

A perusal of the table shows that the section Siliguri–Belakoba was the heaviest, but it was found possible eventually to allow two restrictions in this section without any alteration to the time-table. The only other section which required special care was from Domar to Nelphamari; this was tackled by putting two restrictions and eventually three without altering the time-table after sections on either side were completed and no longer wanted their allowance of time. This section being in the middle of the run, trains could make up time lost in this section by not using the allowance on either side.

It was decided that staff could be collected and sufficient materials distributed for a start to be made towards the end of March. Under ordinary conditions of work in this part of Bengal, work should have ceased about the middle of June on account of the rains, and would not have recommenced till the beginning of October. This would have meant a considerable delay to the work; it was therefore decided to ignore the monsoon as much as possible.

In this we were assisted by a high tension electric transmission line between Parbatipur and Saidpur at 3,300 volts. By arrangement with the Electric Department a 10,000 gallon pump was borrowed, and arrangements made to tap the transmission line where required and transform down to 440 volts to work the pump. This arrangement worked so satisfactorily that there was no delay at all in the work, except during the short periods when there was too much rain for labour to be at work.

For work north of Saidpur, about ten centrifugal pumps of 2,000 gallon capacity direct-coupled to a Petter's oil engine were purchased. They were mounted on a frame to make them portable. They ran on kerosene oil and required one man each to look after them, as compared with a labour force of 16 coolies working in two shifts on an unsatisfactory lift-and-force or contractor's pump.

The monsoon in Bengal is followed by a universal holiday of about 14 days called "The Pujas." Linking, therefore, was arranged to commence about the middle of October, except for the portion Parbatipur to Saidpur, which it was expected would be complete by then.

TABLE No. 1.

SPANS.

Section.	6 ft. 6 in.		9 ft.–10 ft.		12 ft.–14 ft.		17 ft.–20 ft.		25 ft.		40 ft.		60 ft.–75 ft.		Total	Completed 4.12.25
	Total	Done	Total	Done	Total	Done	Total	Done	Total	Done	Total	Done	Total	Done		
Parbatipur–Belaichandi ...	4/3	4/3	4/2(*a*)	4/2	1/1	1/1	2/2	2/2	—	—	2/1	2/1	—	—	13/9	13/9
Belaichandi–Saidpur ...	—	—	3/3	3/3	3/2	3/2	—	—	—	—	2/1	2/1	—	—	8/6	8/6
Saidpur–Daroani	1/1	1/1	3/2	3/2	4/1(*b*)	4/1	—	—	1/1	1/1	3/3	3/3	—	—	12/7	12/7
Daroani–Nelphamari ...	2/2	2/2	2/2	0/0	4/3	3/2	—	—	—	—	—	—	—	—	8/7	5/4
Nelphamari–Domar ...	5/5	5/5	10/5(*c*)	8/3	4/4	1/1	3/3	1/1	—	—	2/1	2/1	—	—	24/18	17/11
Domar–Chilhati	1/1	1/1	4/3(*d*)	3/2	2/1	0/0	7/5	7/5	—	—	—	—	—	—	14/10	11/8
Chilhati–Haldibari ...	3/3	1/1	9/3	3/2	3/3	3/3	—	—	—	—	—	—	—	—	15/9	7/6
Haldibari–Mandalghat ...	2/0(*e*)	0/0	4/1	4/1	2/1	2/1	—	—	—	—	5/3	5/3	—	—	13/5	11/5
Mandalghat–Jalpaiguri ...	—	—	All arches			—	—	—	—	—	—	—	—	—	—	—
Jalpaiguri–Belakoba ...	2/1	1/1	5/4	5/4	4/4	4/4	2/0	0/0	—	—	2/1(*f*)	0/0	—	—	15/11	10/9
Belakoba–Siliguri	1/1	1/1	12/10	11/9	2/2	2/2	7/2(*g*)	5/2	—	—	5/2(*h*)	0/0	6/2	0/0	33/19	19/14

(*a*) 4/2—10 ft. converted to 2/2—20 ft. spans.
(*b*) Two land spans of box abutment bridge included.
(*c*) 6/3—10 ft. converted to 3/3—20 ft. spans.
(*d*) 8/4—10 ft. converted to 4/4—20 ft. spans.
(*e*) Land spans for box abutment bridge included.
(*f*) Ditto.
(*g*) Ditto.
(*h*) Land spans for Sahu bridge included.

4/3 means total of 4 spans and 3 bridges, *i.e.*, three bridges had one span and one bridge two spans.
2/0 under 6 ft. 6 in. and 17 ft. spans means spans put in at the ends of existing 40 ft. spans, and therefore number of bridges is 0, *i.e.*, they are included under 40 ft. spans.

(*b*) ARRANGEMENTS FOR STAFF.

Although the two projects, conversion and Parbatipur remodelling, were separately sanctioned, staff was organized to carry on both simultaneously under the Executive Engineer, E.B. Railway, Saidpur, who had in addition to these projects a little over 100 miles of metre-gauge open line to maintain, including a ferry ghat at Fulchari, on the Brahmaputra River.

The open line was supervised by one Sub-Divisional Officer, with the usual complement of staff. The two projects were split up between two Sub-Divisional Officers as follows :—

Sub-Divisional Officer, I.—Parbatipur remodelling and conversion Parbatipur to Domar, 32 miles, including Saidpur headquarters, plus brick and lime manufacture.

With 2 Permanent Way Inspectors.

No. 1—Parbatipur remodelling and main line to Saidpur inclusive.

No. 2—Saidpur exclusive to Domar inclusive.

Each Permanent Way Inspector had one Assistant Permanent Way Inspector when available.

With 3 Works Subordinates.

No. 1—For Parbatipur remodelling and staff quarters.

No. 2—For bridges Parbatipur to Saidpur and brick and lime manufacture, and Saidpur colony, with one assistant.

No. 3—For bridges and station alterations Saidpur exclusive to Domar inclusive.

Sub-Divisional Officer—Construction.

Domar exclusive to Siliguri, including ballast quarry at Siliguri and its eleven miles of siding, with two Permanent Way Inspectors and three Works Subordinates organized on the same lines as for No. 1 Sub-Divisional Officer.

Office Work. The estimate allowed a hopelessly inadequate staff for this, and work suffered, especially the accounts; these were complicated by the fact that, owing to the decision to allow for recommended standard dimensions, an entirely new estimate had to be prepared; a further complication was then added in the shape of new rules for allocation of expenditure. The immediate result of this was that the estimate on which booking of expenditure had to be made was not sanctioned until July, 1926, when the bulk of the work had been completed and expenditure incurred.

Labour. The recruitment of labour became a serious problem, a sufficient staff for work up to Jalpaiguri was eventually raised, but between Jalpaiguri and Siliguri it was almost impossible to attract labour. Work in Siliguri itself was often seriously delayed by wholesale desertions from the labour staff, all due to the bad climate. Eventually labour had to be recruited at enhanced rates of pay, and special arrangements for housing them and for transport to their work had to be made.

Linking and permanent way work were completed by departmental labour, the remaining work being let out to contractors.

There were large numbers of petty men, each of whom could take on small jobs, but they were not contractors in the true sense of the word, all supervision of works and the supply of materials had to be done by the railway, the contractors becoming suppliers of labour only.

(*c*) Arrangements for Materials.

Under this heading is included,

(1) Bricks, mortar, cement, steelwork, etc., for buildings and bridges.

(2) Permanent way materials, including tools for gangs.

(3) Tools and plant.

All requirements were worked out by early February, and indents were placed, but supply was slightly delayed owing to changes in policy and design as already noted. A considerable time was spent in the calculation of stores required, as it was essential to know exactly what materials were to go to each bridge, building, or work, so that the ballast train arrangements could be worked out, and it was subsequently found that the time had been well spent.

Rails were 75-lb. F.F., and joints were strengthened by the use of Joyce's patent fish plates. These plates had been used with success on the B.N. Railway, and were used here so that the light section, *i.e.*, 75-lb. rail, could be used for the expected axle load, causing a saving of about Rs. 3,000 per mile of track.

Sleepers were of sal, and were obtained mostly from the Central Provinces of India. They were of the usual size, 9 ft. x 10 in. x 5 in. About 200,000 were required.

Crossing sleepers of the same section, but up to 16 ft. long, and bridge timbers varying in size from 8 ft. to 9 ft. long and 10 in. wide, and from 8 in. to 10 in. deep, about 1,000 in number, were also obtained from the same source.

Other materials required included,

Bricks in 1925 .. 10,000,000
„ in 1926 .. 7,500,000 } of all classes.

Steel Girders.

21 spans of 6 ft. 6 in.
56 „ „ 10 ft.
27 „ „ 12 ft. to 14 ft.
21 „ „ 17 ft. to 20 ft.
1 „ „ 25 ft.
21 „ „ 40 ft.
2 „ „ 75 ft.

Ballast, 1,500,000 cubic feet.
Ballast was distributed from Siliguri.
Bricks, mortar, etc., from Saidpur.
Balance of materials were distributed from Parbatipur.

A total of at least 200,000 tons of materials had to be arranged for and dealt with, and eventually distributed to the work by ballast train (metre-gauge). The average load of a metre-gauge train was 50 (trucks) x 10 (tons) (assuming full loads) = 500 tons per train. There were thus 400 train loads of materials to be distributed on the open line where there was heavy main line traffic. This, therefore, required special organization. Delays to ballast trains were inevitable, but they were reduced as much as possible in the following manner:

Arrangements for Ballast Trains.

Two sidings for stabling ballast trains were put down, one at Nelphamari and one at Belakoba, so that traffic yards could not be blocked by stabled ballast trains. Time-tables for running trains were obtained from the Traffic Department. These time-tables allowed for one up train in night and early morning, loaded with permanent way material, and one up train in late afternoon for empty stone train returning. One down train in early morning for loaded stone train, and one down train in evening for empty permanent way train.

Loaded trains would run from their terminal station and arrive at destination anywhere on line in the early morning. After unloading they would wait until they picked up the time of the return special. Owing to the amount of traffic on the line, and to avoid detentions to all trains by the late running of one, orders were issued that, if a train missed its return timing for any reason, it was to wait and pick up its timing the following day.

The time-tables for ballast trains are given in Appendix I as a matter of interest.

Although "A" up and "B" down timings were arranged for permanent way ballast trains, and "D" up and "C" down for stone ballast trains, other trains with other materials would run to these timings when dates were available.

In arranging for distribution of materials the following points had to be considered :

1. Only one train could work in one section at a time.
2. Permanent Way Inspectors had to be kept well fed with materials.
3. It was important to know on what days and in which sections trains would work, so as to allow for blocks for alterations to bridges.
4. All trains must be fully occupied.

The problem was tackled as follows :—

First, a programme for distribution of permanent way material was got out.

One mile of material per train was found to be a satisfactory quantity for one metre-gauge train. These rakes were arranged two running and one spare loading. Running trains were labelled B.T.C.4 and B.T.C.5, and had two engines and two guards. In addition to distributing permanent way, linking trains were detailed to bring back released metre-gauge sleepers. The trains were therefore allowed two days per trip.

An abstract of programme between December 17th and 29th is as follows :—

DECEMBER.

Date.	*B.T.C.4.*	*B.T.C.5.*
17th ...	Dept. Parbatipur 01.15 hours, unloaded mile 277, stable.	—
18th ...	Complete work, load M.G. sleepers and return as "B" Down.	Parbatipur Dept. 01.15 hours, unloaded at mile 303, stable.
19th ...	Engine to Shed.	Complete work, load M.G. sleepers and return as "B" Down.
20th ...	Parbatipur Dept. 01.15 hours, unload at mile 250, stable.	Engine to Shed.
21st ...	Complete work, load M.G. sleepers and return as "B" Down.	Parbatipur Dept. 01.15 hours, unload at mile 304, stable.
22nd ...	Engine to Shed.	Complete job, load M.G. sleepers and return as "B" Down.

DECEMBER.

Date.	*B.T.C.4.*	*B.T.C.5.*
23rd ...	Parbatipur Dept. 01.15 hours, unload at mile 278, stable.	3 days' leave to staff.
24th ...	Complete work, load M.G. sleepers and return as "B" Down.	
25th ...	Christmas Day } 3 days'	
26th ...	*Nil.* } leave to	Parbatipur Dept. 01.15
27th ...	*Nil.* } staff.	hours, unload at mile 305, stable. Complete work, load M.G. sleepers and return as "B" Down.
28th ...	Parbatipur Dept. 01.15 hours, unload at mile 251, stable.	Engine to Shed.
29th ...	Complete work, load M.G. sleepers and return as "B" Down.	Parbatipur Dept. 01.15 hours, unload at Mile 279, stable.
30th ...	Engine to Shed.	Complete work, load M.G. sleepers and return as "B" Down.
	etc.	etc.

This programme was then plotted on a form (see Table No. 2). This showed clearly what sections were occupied. It was then possible to plot on the form the sections in which stone ballast trains could work and their orders were issued accordingly.

Blocks for alterations to bridges and arrangements for supplying materials and girders for bridges could also be made from this form and orders issued.

Land is always a troublesome proposition, and negotiations for it should always be opened up about a year before any work starts. However we were lucky in this project, as we required very little and had the close co-operation of the Civil Department. Earth for widening the bank was obtained, where necessary, by private arrangement with the cultivators.

Earthwork.

The existing bank averaged 17 ft. in width, with an average height of about 5 feet. This width had to be increased to 20 feet, formation level being kept the same. The original bank was first thoroughly benched, fencing was shifted, and then earth thrown up till the required section was obtained.

Bridges.

There were 111 bridges, totalling 147 spans varying from 6 ft. 6 in. to 75 feet. In each case girders had to be changed to take broad-

TABLE No. 2.

TABLE FOR DECEMBER 17TH TO 29TH.

Section.	Miles.	17	18	19	20	21	22	23	24	25	26	27	28	29
Saidpur-Daroani	242½—250							M	M					
Daroani-Nelphamari	250 —255	M	M		x	x							x	x
Nelphamari-Domar	255— 265	B		M										M
Domar-Chilhati	265 —275						M						M	
Chilhati-Haldibari	275 —280½	x	x					x	x				M	
Haldibari-Mandalghat	280½—289			B	B									
Mandalghat-Jalpaiguri	289 —295	B			B			B						
Jalpaiguri-Belakoba	295 —305		x	x		x	x				†	†		
Belakoba-Siliguri	305 -318¾	†	†	†	†	†	†	†	†	†	†	†	†	†

† Stone trains. x Linking trains. M. Material trains. B. Line blocked.

gauge loads, and extensive alterations were required to the masonry. 47 small bridges were entirely rebuilt, 52 were altered, and the two larger bridges, Kartu, three 60 ft. spans, and Sahu, one 40 ft. and two 75 ft. spans, were entirely rebuilt, ten masonry arch bridges were considered safe and allowed to remain, the cushion to top of arch was, however, increased to two feet in all cases.

Bridges are placed in two classes, those of over 1,200 ft. waterway being termed major bridges, and those under 1,200 ft. waterway, minor bridges. There were 18 major bridges. The two already mentioned and the Talma, two 40 ft. spans and one 60 ft., and 15 bridges of spans varying from one 40 ft. to three 40 ft. All of these bridges, except one of two spans of 40 ft., and the Kartu and Sahu, were considered strong enough; they therefore required alterations only to bed stones to allow the correct depth for B.G. girders, formation level having been kept the same. In some cases, where abutments were of the box type and did not allow room for B.G. sleepers, short land spans were added. The Kartu and Sahu bridges as they existed were bow-type girders supported on piers and abutments of 2 ft. 6 in. diameter cast iron screw piles, two piles to each pier, connected by a capping girder. These piles had been put down many years ago, and it was impossible to ascertain

(*a*) whether they had been corroded by the filling or by action of water,

(*b*) what load they might be expected to carry safely.

It was therefore necessary to rebuild both.

The Kartu, three spans of 60 ft., was designed to be on the original centre line; a diversion was therefore made about $\frac{3}{4}$ mile long with one span of 60 ft. This temporary bridge was built on wooden pile abutments. A factor of safety of three in Wellington's formula $\frac{(12\ WL)}{S+1}$ was used, and the bridge showed no sign of failure during the three and a half months it was in use.

Open founds were allowed for in the abutments, but there was so much water present that it was found impossible to adhere to this design. Founds were therefore built on wooden well curbs 25 ft. x 14 ft. 6 in., sunk four feet below L.W.L., and filled to a height of 4 ft. with 1 : 3 : 6 concrete. These have proved satisfactory, and are well protected by the guide bunds and stone pitching. The new bridge was completed in four months, the work done including 1,000,000 cubic feet earthwork, sinking oval wells 20 ft. x 11 ft. for 50 feet, and about 13,000 cubic feet masonry. Masonry consisted of first class burnt bricks, 10 in. x 5 in. x 3 in. laid in 1 : 5 cement

mortar ; this mortar was strengthened to 1 : 4, and then 1 : 3 towards top of piers and abutments. Well sinking was carried on day and night, and was much delayed by large stones jamming in the teeth of the dredger. Each well had two compartments, and dredging with eight cubic feet dredgers worked from steam hoists was carried on simultaneously in both compartments till steining was sunk near water level ; dredging operations were then transferred to the other well while steining was added to the first. The final set of the wells was obtained by firing small charges of dynamite. Sidings from the main line at site of work were laid down, and sanction for their use obtained from the Senior Government Inspector of Railways. These sidings were isolated by trap switches from the main line ; these trap switches were coupled to the siding points in main line, which were locked with one-way lock, the key of which was kept at the next station. The working of the sidings was covered by working rules arranged by the Traffic Department.

The Sahu Bridge, two 40-ft. and two 75-ft. spans, was designed to cross the river at a different angle from the existing bridge. Colonel Sir G. R. Hearn had studied Bengal rivers, and had decided that bridges should not cross them at right angles to the stream at the point chosen, but at right angles to the general course of the river. This was done in the case of the Sahu Bridge, the old alignment being used to complete the guide bunds. The centre pier of this bridge, which carried two 75-ft. spans, was built on an oval well 25 ft. x 14 ft. 6 in., sunk 35 feet, and the other two piers were built on similar wells to the Kartu, sunk 30 feet.

Masonry and mortar were the same for both bridges, and a siding was laid down for this bridge, as in the case of the Kartu.

Between Parbatipur and Saidpur, ordinary standard broad-gauge girders were used, but, as there was a three-rail track to take both metre-gauge and broad-gauge, special timbers had to be used. These timbers were calculated to be 10 in. x 10 in., and they had to be spaced at 20 in., the maximum for metre-gauge, this to be the permanent track. Between Saidpur and Siliguri, as a temporary measure, four rails were laid on the new broad-gauge sleepers, and it was found that bridge timbers 10 in. x 8 in. were sufficiently strong as a temporary measure. The usual size of timbers being 10 in. x 6 in.

As in the arrangements for distributing materials, etc., a complete programme for changing girders had to be worked out, so that traffic on the one hand and the work of the conversion on the other were not delayed.

Work started on 24.3.26, and was timed to finish, except for Kartu

and Sahu, on 20.5.26. An abstract of the programme between Jalpaiguri and Belakoba is attached :

Bridge No.	*Mileage.*	*Spans.*	*Date of change.*
191	295/20-21	One 13 ft.	30.4.26
192	296	One 6ft. 6in.	30.4.26
193	297/7-8	One 13 ft.	1.5.26
194	298/3-4	One 6 ft. 6 in.	1.5.26
195	299/9-10	Two 10 ft.	3.5.26
196	299/22-23	One 10 ft.	3.5.26
197	300/17-18	One 13 ft.	3.5.26
198	301/17-18	Two 40 ft. and two 17 ft.	4 and 5.5.26
199	302/19-20	One 10 ft.	6.5.26
200	303/4-5	One 13 ft.	6.5.26
201	304/10-11	One 10 ft.	7.5.26

All girders except 40-ft. spans were man-handled into track; staff required was Bridge Inspector, Permanent Way Inspector, and two gangs of one mate and 18 men, of which one gang were Bombay Khalassies.

Permanent Way. All 75 lb. F.F. on wooden sal sleepers 9 ft. x 10 in. x 5 in., except for points and crossings, where 90 lb. F.F. "R" section rails were used. Bearing plates were not used ; sleepers were adzed for the rail seat before issue to the line.

Between Saidpur and Parbatipur the old M.G. track was dismantled and new track (three-rail) was laid, the new work being joined up to existing work to pass traffic, with specially prepared junction fish plates.

The left-hand rail was spiked to sleepers first, track straightened, and then metre-gauge rail spiked with a metre-gauge rail gauge and B.G. right-hand rail spiked with B.G. rail gauge. Working hours were limited to from 8 a.m. to 12 a.m. daily, but progress was usually half mile a day.

For the linking north of Saidpur special arrangements had to be made. It was necessary to keep the metre-gauge running without restrictions until the last possible minute and, at the same time, have the broad-gauge ready to bring into use for main line traffic throughout a distance of 75 miles in 12 hours. Broad-gauge track had therefore to be laid and straight, and also there had to be M.G. rails straight and properly supported.

The problems encountered were :

(1) Metre-gauge rails varied in length from 30 to 36 feet, whereas all B.G. rails were 36 feet.

(2) Metre-gauge rails were fished with a plate 18 in. long of club fashion, *i.e.*, the plate fitted round the bottom flange of the rail ; this prevented the placing of a B.G. sleeper under the joint of the metre-gauge when it was necessary to do so, to keep B.G. sleeper spacing correct.

It was decided to carry out the linking as follows, the plan worked very well, metre-gauge traffic ran safely and without diminution in speed, and the first up inspection special of the broad-gauge, the first train to use the new B.G. track, travelled at 40 miles an hour with perfect comfort and safety.

First, metre-gauge track was opened out and B.G. sleepers interspaced between M.G. ones. The next day, the left or west B.G. rail was fished up for several rail lengths, and sleeper spacing marked on the rails. The M.G. was then dismantled and the west B.G. rail spiked to B.G. sleepers.

2. The east or right M.G. rail was then spiked to the B.G. sleepers with the aid of a special gauge.
3. Metre-gauge track was completed by spiking west M.G. rail, using a M.G. rail gauge from east rail.
4. Broad-gauge was completed by spiking B.G. east rail, using B.G. rail gauge from west rail.

To overcome the second problem detailed above, a certain number of M.G. fish plates were planed in the loco shops at Saidpur to take off the bottom flange. These were substituted for the club-shaped fish plates only where metre-gauge rail joints coincided with broad-gauge ones, where sleeper spacing at joints of B.G. track was interfered with. Where M.G. joints occurred in the middle of B.G. rail lengths, fish plates were not altered and sleepers left slightly out of their final spacing to be corrected when the M.G. was dismantled. It is perhaps unnecessary to state that the number of M.G. fish plates planed was kept at a minimum for two reasons, one was the cost and the second the time required.

All work was done between trains without blocking the line, and progress, not including a final packing, was from half to three-quarter mile a day with 500 men.

Points and Crossings.

All turnouts from the main line for passenger train loops were 1 in 12 with 36-ft. spring switches, and for goods sidings 1 in $8\frac{1}{2}$ with 15-ft. switches. All turnouts in the main line were 90 lb. F.F. rails "R" section.

Turnouts in goods loops and sidings were 1 in $8\frac{1}{2}$ 75 lb. F.F. rails.

There were two methods of arranging for installing the broad-gauge points and crossings.

(*a*) To link them up ready at the side and slew in at the appointed time,

or (*b*) Slew out the metre-gauge at the position of B.G. turnouts and lay broad-gauge turnouts in their final position.

The second method was accepted in order to allow the Signal Department to fit all their locking gear and to reduce the amount of work to be done during the actual period of change over from metre to broad-gauge. Everything that tended to reduce or obviate work in the final change was considered. Photo of Saidpur Yard shows M.G. slewed out to one side.

For the three-rail track between Parbatipur and Saidpur the metre-gauge had to turn out from the track first before any B.G. turnouts could come in. Sanction for the use of the three-rail track had to be obtained from the Senior Government Inspector of Railways, Calcutta, and after discussion he approved, but ordered for the metre-gauge single interlocked switches with special signals.

At Parbatipur, the junction between east and west metre-gauge, south broad-gauge, and north mixed-gauge, very special arrangements had to be made. The lay-out was designed and drawn on a scale of 40 ft. to 1 in. Each diamond and turnout lettered, and then full-scale drawings of each prepared. Diamonds and turnouts were manufactured in the E.B. Railway signal shops and lettered and sent up to Parbatipur. They were all linked up between tracks and slewed into position between trains to a programme previously worked out.

This work was included as part of Parbatipur yard remodelling, which is too big a work to be included in this account; it is only necessary to say that organization of the work was the crux of the job.

Staff, stores, etc., were arranged, every little detail of work to be done was tabulated, and then a programme of every day's work made out and issued to traffic and loco, as well as engineering, staff about a month before work actually started.

Between Saidpur and Siliguri two methods of dealing with the laying of points and crossings were employed.

The plan of Daroani Station shows both. This plan also shows details of the work left for the actual period of change over. This plan was issued to the engineering representative, together with the following programme of work, and shows how the actual change over took place. It will be noted in plan that there is a three-rail track in front of platforms.

This was necessary so as to ensure that both broad-gauge and metre-gauge centre lines conformed to standard dimensions.

M.G. centre of track to face of platform = 4 ft. 5 in. B.G. centre of track to face of platform = 5 ft. 6 in. Difference 1 ft. 1 in.

½ M.G. = 1 ft. 7 11/16 in.
½ B.G. = 2 ft. 9 in.
Difference = 1 ft. 1 5/16 in.

CONVERSION OF METRE-GAUGE TRACK TO BROAD-GAUGE IN INDIA.

DAROANI

SEPTEMBER 29TH 30TH

1926

WORK FOR 29TH SEPT AFTER 2DN

DISMANTLE M.G. & LINK B.G. AT = 2:36 75LBS 4 RAILS

C.D = 2. 90LBS RAILS

E F = 1. 36' 75LBS 4 RAIL

I J = 1. 36' " " "

K L = 1. 36' " " "

W X = 1. 36' / 1. 18. 3" " " "

Y Z = 1. 36' " 6 "

α β = 1. 36' " " "

= 1. 16' 7 5/8 RAIL 6 AT ONE END

4 AT NORTH END

= 1. 25. 4 3/8 RAIL 90LBS 4 1/2 BOLT SPACING

AT SOUTH END OF RAIL

JOYCE'S COMPOUND FISH PLATES

AN BN = 4. 36' 75LBS 4 RAIL

WORK FOR 29TH SEPT BEFORE 2 DN

DISMANTLE M.G. & LINK B.G. . . = 3. 36' 75LBS 4 RAILS

M.G. CROSSING TO BE DISMANTLED & SUBSTITUTED BY SINGLE RAIL FOR PASSING M.G. TRAINS

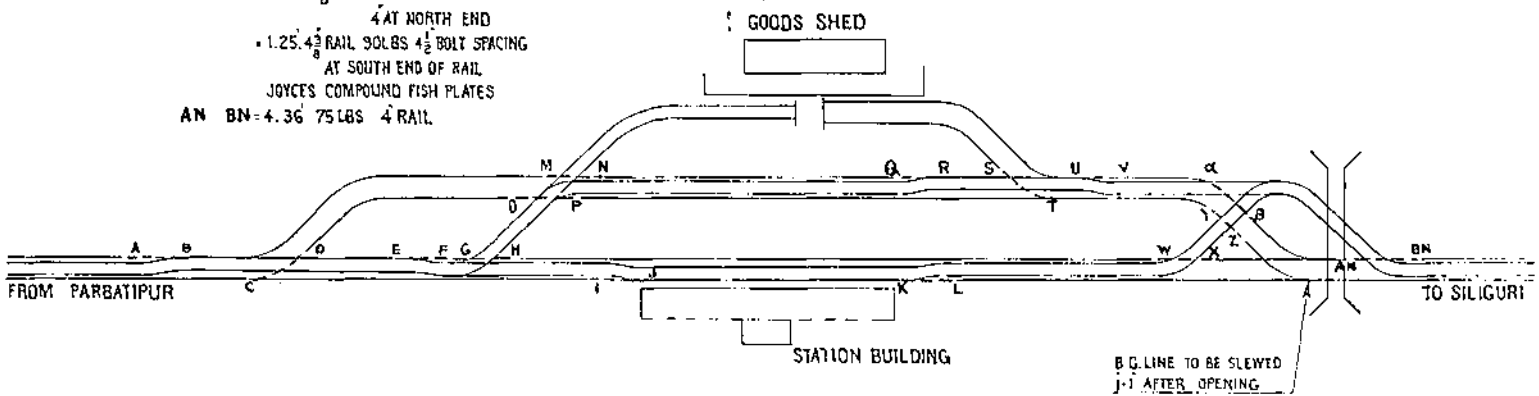
O P = 3. 36' 75LBS 6 RAILS

M N = 3. 36' " " "

Q R = 1. 36' " " "

S T = 1. 29. 9 1/8 " " "

U V = 1. 36' 6 BOLT SPACING RAIL



Arrangements for the Change Over.

By the beginning of September the main line had been linked through, there were gaps only at station yards. The plan of Daroani station yard shows what was left to do at each of the nine stations.

Instructions for the staff were then issued, and an officer or senior subordinate was detailed for each station. He was also made responsible for the track in the down direction between his station and the next. A copy of the instructions issued to the staff at Saidpur and Daroani Stations is attached to this paper (Appendices II and III).

The date fixed for opening the new line was October 1st. The line had first to be inspected by the Senior Government Inspector of Railways, and his inspection was arranged to start from Saidpur at about 07.00 hours on September 30th. The section Parbatipur to Saidpur had been passed previously.

All traffic was cancelled for one day only, and the following extract from the traffic circular gives details of the arrangements made as regards passenger trains and coaching stock. Goods traffic had been previously curtailed, and by September 28th no metre-gauge goods vehicles were left on the section.

Passenger Train Arrangements in Connection with the Opening of the Broad-Gauge to Siliguri.

The Actual Conversion from Metre-Gauge to Broad-Gauge will take place between the passage of 2 Down Mail (Metre-Gauge) on September 29th and 37 Up on September 30th.

The last Metre-Gauge train to run over the Section Siliguri–Parbatipur will be 2 Down Mail leaving Siliguri at 15.30 hours on 29th September. A special with the rake of 13 Up will run from Siliguri to Parbatipur in front of 2 Down to the following timings :—

Stations		D Rake of 13 Up.	Stations.		D Rake of 13 Up.
		H. M.			H. M.
Siliguri ...	... Dep.	14 ... 20	Domar ...	... Arr.	...
Belakoba ...	... Arr.	...		... Dep.	17 ... 31
	... Dep.	15 ... 6	Nelphamari	... Arr.	...
Jalpaiguri ...	... Arr.	...		... Dep.	18 ... 4
	... Dep.	15 ... 37	Daroani ...	... Arr.	...
Mandalghat ...	... Arr.	...		... Dep.	18 ... 24
	... Dep.	15 ... 58	Saidpur ...	... Arr.	18 ... 50
Haldibari ...	... Arr.	16 ... 22		... Dep.	19 ... 0
	... Dep.	16 ... 32	Belaichandi ...	... Arr.	...
Chilhati ...	... Arr.	...		... Dep.	19 ... 15
	... Dep.	16 ... 58	Parbatipur	... Arr.	19 ... 36

After the passage of 2 Down Mail, the Line will remain closed in the hands of the Engineering Department, until it is opened as Broad-Gauge on September 30th.

The first BROAD-GAUGE train to run over the Section will be 37 Up leaving PARBATIPUR at 15.40 hours on September 30th and running to the present Metre-Gauge timing.

The trains running between PARBATIPUR AND SILIGURI on the 29th, 30th September and 1st October will be as follows :—

September 29th.

15 Up, 1 Up, 13 Up will run as usual.
37 Up will be CANCELLED.
14 Down and 2 Down will run as usual.
16 Down and 38 Down will be CANCELLED.

There will be NO UP THROUGH SERVICE leaving Calcutta on SEPTEMBER 29TH and NO DOWN THROUGH SERVICE leaving Siliguri on SEPTEMBER 30TH.

The Down special with the rake of 13 Up arriving at PARBATIPUR at 19.36 hours will work forward to KATIHAR at 20.6.

The rake arriving PARBATIPUR as 14 Down at 12.25 hours will be worked forward to KATIHAR as an empty stock Special at 13.30 hours.

The rake arriving PARBATIPUR as 2 Down at 20.17 hours will be worked forward to LALMANIRHAT as an empty stock Special at 21.10 hours.

The Siliguri-Amingaon through carriage will go forward to Lalmanirhat by the 21.10 hours Special and be transferred to 3 Up Mail at Lalmanirhat.

September 30th.

ALL TRAINS CANCELLED.

Except 37 Up BROAD-GAUGE which will run through to SILIGURI to the present METRE-GAUGE timing leaving PARBATIPUR 15.40 hours and arriving SILIGURI 21.40 hours.

AN ENGINEER'S SPECIAL will leave SAIDPUR at 7 hours. This train will be an Engineering train and will NOT be worked on Line Clear. DIVM and DLR will accompany this train which will be made up as follows :—

Bogie Brake and Third.
Bogie Third.
Bogie Composite.
Saloon 1010 for Dy. CE.
CE's Saloon No. 1409.
AGE Saloon.
SGI's Saloon No. 1410.
Saloon 1009 for SE and ASE.
Saloon 2 for DIVM and DLR.
Saloon 148 for XEN and SDO.
Luggage Van.
Luggage Van.
Brake-Van, 4-wheeled.
Inspection Saloon 1411.

This train will be made up at PARBATIPUR and leave for SAIDPUR at 6.30 hours working on Line Clear to SAIDPUR.

The LINE will be opened as BROAD GAUGE, Section by Section, after the passage of this Special. The OPENING messages will be issued in accordance with the SGI's orders by XEN, SDP who will travel with this Special on the Agent's instructions. Restrictions in speed below 25 miles per hour will be imposed as Restrictions on Working Time Table No. 128 already issued.

Two Light Engines (coupled I. class) will follow the Special as soon as

the line is opened and WILL WORK on LINE CLEAR (NEALE'S TOKEN). These Engines will be in the charge of an Engineering Department Official who will accompany them from Saidpur to Siliguri.

The Engineering Special will be stabled in the Loco. Yard at Siliguri on arrival.

October 1st.

TRAINS WILL RUN TO THE NEW TIME-TABLE except that 15 Up (6.20 hours PARBATIPUR to SILIGURI) and 22 Down (9.36 hours SILIGURI to PARBATIPUR) WILL NOT RUN.

AN UP GUESTS SPECIAL IN connection with the Inaugural Ceremony at SILIGURI will leave CALCUTTA 20.56 hours on 30th and run from PARBATIPUR at 4.33 hours on 1st arriving SILIGURI at 9.45 hours.

An Up Empty Stock Special (rake arriving PARBATIPUR as 13 Up 3.26 hours on 30th) will leave PARBATIPUR 9.15 hours arriving SILIGURI 14.55 (after crossing Down Guests Special at BELAKOBA) to work 16 Down. This rake will be strengthened by 1 BC before leaving CA as 13 Up on 29th.

The Down GUESTS SPECIAL will leave Siliguri at 13.20 hours and arrive PARBATIPUR 18.7 hours leaving at 18.17 hours for CALCUTTA.

37 Up will be detained at Jalpaiguri to cross the Down Guests Special and at BELAKOBA to cross 16 Down.

As 2 down mail cleared each section of the line, the line was taken over by the Engineering Department, and gangs immediately got to work. The last station to be taken in hand was Saidpur at 20.00 hours.

Saidpur was ready for inspection at 7 hours on September 30th, and the inspection special left at 7.30 hours. By this time telegrams had arrived from every station to say that the main line had been linked through, and that a crossing loop was available also at practically every station. The line was declared open for traffic when the special arrived at Siliguri at about 15.30 hours, and the first train left Parbatipur at 15.40 hours.

The time taken to organize the change over was well spent, as there was no hitch anywhere. At Saidpur there was a slight miscalculation, the rails for joining up had been measured by day, and an allowance for contraction was made by slotting the fish plates; however, when the work came to be done it was found that the allowance was not quite sufficient. This was soon rectified.

The conversion was formally completed and opened to traffic by Sir George Stephenson, H.E. the Governor of Bengal, the following day, October 1st, 1926, by a small but impressive ceremony, to witness which many guests had been invited from Calcutta and Darjeeling.

APPENDIX I.

TIMING OF BALLAST TRAINS.

UP.

Stations.	*Miles.*	*Minutes run.*	"A."	"D."
Parbatipur ...	...	... ...	Dep. 1.15	13.00
	4½	27		
			Arr. 1.42	
Belaichandi ...	...	... ...	Dep. 2.00	Pass 13.27
			x 544 Down	
	4	24		
			Arr. 2.24	
Saidpur ...	...	... ...	Dept. 3.00	Arr. 13.51
			x 16 Down	Dep. 14.06
	7	35		Water.
Daroani ...	...	... ...	Pass 3.35	Pass 14.41
		27		
			Arr. 4.02	
Nelphamari ...	...	... ...	Dep. 4.30	Pass 15.08
			x "C" B.T.	
	10	44		
Domar	...	... ...	Pass 5.14	Pass 15.52
	10	43		
Chilhati ...	...	... ...	Pass 5.57	Pass 16.35
		32		
			Arr. 6.29	Arr. 17.07
Haldibari ...	...	... ...	Dep. 6.39	Dep. 17.27
				x 2 Down
		34		
			Arr. 7.13	Arr. 18.01
Mandalghat ...	...	... ...	Dep. 7.28	Dep. 18.10
			x 14 Dn.	x 224 Dn. and
		43		"B" Dn.
Jalpaiguri ...	...	... ...	Arr. 7.59	Arr. 18.41
				Dep. 19.36
				Precedence to 223 Up
				and 544 Down.
Belakoba ...	...	... ...	... ...	Pass 20.19
Siliguri ...	...	... ...	... ...	Arr. 21.12

"A" is for a linking train due to distribute sleepers, rails and fastenings, leaving Parbatipur fully loaded.

"D" is the empty stone train returning to Siliguri.

In addition, any Up B.T. running between sections had to take up these times so that B.T.s always ran to special times.

TIMING OF BALLAST TRAINS.

DOWN.

Stations.	*Miles.*	*Minutes run.*	"B."	"C."
Siliguri ...	...	... ...	... ...	Dep. 23.05
		53		
Belakoba ...	...	... ...	... ...	Pass 23.58
		43		

Stations.	*Miles.*	*Minutes run.*	"B."	"C."
Jalpaiguri			Dep. 17.05	Pass 00.41
		31		
			Arr. 17.36	
Mandalghat			Dep. 18.04	Pass 01.12
			x "D" Up.	
		34		
			Arr. 18.38	Arr. 01.46
Haldibari			Water	xUp Goods
			Dep. 18.48	Water.
		32		Dep. 01.56
			Arr. 19.20	Arr. 02.28
Chilhati			Dep. 20.05	Dep. 03.00
			x 37 Up.	x 15 Up.
		43		
Domar			Pass 20.48	Pass 03.43
		44		
			21.32	04.27
Nelphamari			x Up Goods	x "A" Up
		27		
Daroani			21.59	04. 54
		35		
			Arr. 22.34	
Saidpur			Water	05.29
			Dep. 22.44	
Belaichandi			23.08	
		27		
Parbatipur			23.35	

"B" is for linking train to return to Parbatipur.

"C" is for loaded stone train to run out from Siliguri to distribute ballast.

Any other trains running on the section run to these times if no linking or stone train is running.

APPENDIX II.

Eastern Bengal Railway.

Saidpur Station Yard.

Work will be done on 29th September as per ferro.

If necessary 13 Up can be dealt with on Main Line.

DIVM's Saloon will leave 8 down siding by 2 Down of 28th, so that points of siding can be dismantled and G.H. linked on 29th morning.

All other trains will be dealt with on Main Line. M.G. points to be clamped, locked and spiked for Main Line.

Work should be finished by 12 hours. Break off for rest and commence work again at 19.30 hours, and complete yard as per ferro.

Ferro explains itself.

AEE/SDP is kindly arranging for lights.

Mr. Rogers is in charge.

He will join the Special on the morning of 30th at S.D.P. at 7 hours with 200 coolies with tools, etc., and 10 sets of restriction boards (SEN has orders for these) in case he is wanted on the line. He must be prepared to stay out one night.

APPENDIX III.

EASTERN BENGAL RAILWAY.

DAROANI STATION AND TRACK D.W.N.–S.D.P.

Sept. 25th. Mr. S. K. Bhattacherjee will take post. (S.D.O. Cons. will send you a Swiss cottage tent).
Assure yourself that labour is present and has tools.
See that all fouling marks are in correct position.

Sept. 26th. Detail labour to works by names of mates for 29th and 30th, and make them do their jobs under a block, and note time taken and what unforeseen circumstances are encountered.
Then restore M.G.

Sept. 27th. Pack up facing points and loop.
Trolley to Saidpur and back.
Carry on linking B.G. goods if space is available.

Sept. 28th. Carry on linking B.G. goods and see Main Line.

Sept. 29th. Commence work at 7.30 hours.
Clamp, spike and lock M.G. points for the Main Line, keep keys of locks yourself. All M.G. trains will be dealt with on Main Line.
See ferro for work to be done.
Pack up and finish off work properly.
You should be able to break off about 12 hours.
Allow men to rest until 19.00 hours. See that they have their meal before returning to work at 19 hours.
Immediately 2 Down Mail has passed dismantle M.G. and complete the B.G. yard. You should be able to do this in 3–4 hours.
Clamp and lock B.G. points for B.G. Special to run through on Main Line.
I have arranged for four Storm King Lamps for work at night; you had better have some flares too.
Whitewash fouling marks again.

Sept. 30th. If yard is complete send out a man to Up Outer Signal with Green Hand Signal Flag. If yard is not complete send out a Red Banner Flag.
I hope we see the Green Flag when we arrive at about 7.30 hours.
Pack up any soft places found by Special.

Oct., 1st, etc. Complete Yard in all respects.

CHARACTERISTICS OF A GOOD LESSON.

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

INTRODUCTION.

Training and Manœuvre Regulations state: "An Officer's first duty is to be a capable leader in war. *But it is almost of equal importance that he should be an efficient instructor in peace . . .*"

Many officers instruct their men by practical work in the field, supplemented by lectures indoors. *Training and Manœuvre Regulations* give hints on how to carry out a lecture, but the writer is of the opinion that a far better means of giving instruction to men is by means of a *lesson.*

In a lecture, the officer normally tells the class certain facts and probably gives the reason for such facts. In a lesson, the students are encouraged to find out facts and solve problems by reasoning for themselves. In these days, in which it is generally recognized that modern warfare demands intelligent co-operation on the part of N.C.O.s and men in place of the old blind discipline, it is imperative to develop the reasoning power of the soldier to its fullest extent, and to teach him how to acquire knowledge for himself without always relying on someone else to help him. A lecture can never do this.

It may be argued that the time required to prepare and conduct a lesson is more than that required for a lecture and that more ground can be covered by the latter, in any given length of time. If, however, the lesson be conducted efficiently, the instruction will undoubtedly be better absorbed and will avoid the necessity for frequent repetition, and, on the whole, time will be saved rather than wasted. In addition to the mere absorption of knowledge in every lesson, the mental capacity of the students is being increased.

With these points of view in mind, the writer submits the following notes on the characteristics of a good lesson, feeling that, although they are merely commonsense and of a somewhat elementary nature, they may prove of interest to officers who have not considered very deeply the question of a delivery of a lesson as opposed to a lecture and may provoke criticism and discussion from others.

Although, in these notes, the conduct of a lesson in a classroom is primarily discussed, the principles that the writer has in mind are equally applicable to all forms of instruction, whether carried out indoors or in the field, and whether the subject is of a practical or theoretical nature.

DEFINITION OF A LESSON.

First of all, it is necessary to be quite definite as to what a lesson is. A lesson is an attempt on the part of a teacher to make his students absorb a piece of knowledge in such a manner that they can thoroughly appreciate it, and use it intelligently in problems which may confront them. The more fully this is done, the better will be the lesson.

PROBLEM BEFORE THE TEACHER.

The problem before a teacher is how best to transmit a certain piece of knowledge to a certain class of students, within a certain limit of time, and ensure that this piece of knowledge really becomes part of their own knowledge, and is not merely accepted as true by the students, because he has told them so. Considering ourselves as teachers, let us think out the best method of solving this problem, and so arrive at what the essentials of a good lesson must be. We have decided what is required of us. What are the factors affecting the conduct of a lesson? The teacher himself, the piece of knowledge to be transmitted, the mentality of the class and the time allowed for the lesson. Bearing these four factors in mind, how is a teacher to set about his task? Firstly, he must prepare his lesson, secondly, he must deliver it to his class, and lastly, he must satisfy himself that the class has absorbed the knowledge required. Let us discuss the essentials of the lesson under these heads, namely, Preparation, Delivery and Benefit to the class.

PREPARATION OF LESSON.

What are the essentials in preparation? The teacher must firstly take steps to acquaint himself with as much knowledge as is necessary (always far in excess of the knowledge to be passed on to the class) of the subject he proposes to teach. Furthermore, he should ensure that it is accurate and is likely to be beneficial to the type of student he is teaching. From the information at his disposal, he must now, having in view the time allowed to him and also the mentality of his class, fix firmly in his own mind a very definite conception of exactly what he proposes to teach. He then must decide how best to do this. He should try, whenever possible, to present his lesson in the natural form in which the problem is likely to arise in real life. For example, if he is teaching how to find the area of a rectangle, he must give some example to his class which will make the class realize the necessity for wanting to find the areas of rectangles in everyday life. Throughout the lesson, he must try and arrange a series of problems in a natural and logical order for the class to solve. These problems must be so arranged that the class can solve them with a reasonable amount of thought within a reasonable time. The steps or series of

problems must be such that it is not too big an effort for the mentality of the class to bridge the gap between them.

While arranging these problems for his class to solve, the teacher must remember the exact purpose of his lesson. He must think out what questions are likely to arise in the minds of his students, and how best to answer them. He may have to explore by-ways and decide whether to accept or reject them. He must decide what to include and what to exclude from his fund of knowledge. He should now rehearse his lesson, bearing in mind his particular faults and making use of his good points as a teacher. As a result of his rehearsal, he may find faults in his proposed lesson. A frequent fault will be that of over-estimating the amount of work that can be got through in the allotted time. After having altered his proposed lesson as necessary and after further rehearsal (if required), he must then finally decide on the matter of his lesson and the method of giving it to his class. He must then take steps to ensure that all the necessary materials for himself and his class are available for use when he comes to the delivery of his lesson.

Delivery of Lesson.

We will now suppose that the teacher, having very thoroughly prepared his lesson, with due regard to the subject, mentality of his class, and the time factor, and being quite self-confident and sure of what he wishes to do, is now faced with his class and is about to start his lesson. If such a thing were possible and his preparation had been perfect, if he had a perfect idea of the mentality of every member of his class, and knew exactly his own personality as a teacher, then his delivery should follow exactly along the lines of his preparation. Obviously, of course, this cannot happen in practice. However thorough the preparation, the class is bound to behave differently to the manner in which the teacher assumed it would. Someone will be unusually stupid, someone else asks an unexpected question. Someone else is tired after a dance the night before. Other distractions may be present besides these. The room is cold. It is the last lesson of the week, and so on. The teacher must, therefore, be prepared for unforeseen eventualities, and must be able to adjust his lesson to the needs of the moment.

What must the teacher do first, when he commences his delivery? He must appeal to the interests of the class. He must obtain their attention and hold it. He must, therefore, start his lesson with something which is familiar to them, of interest to them, and which they can readily understand. By this means, he has attracted their attention and interest. He must now continue to hold it. He must ensure that, as far as possible, the class enjoys the lesson. At the same time, he must see that the class is obtaining the knowledge

required. Both these ends can be obtained by (as already stated in the preparation of the lesson), getting the class to discover facts for itself, to reason out the whys and wherefores, to arrive at correct conclusions, under the guidance of the teacher.

The lesson should unfold itself in an apparently natural manner. The class should be surprised by the very simplicity of the subject it is investigating. The class must, in fact, work hard quite unconsciously. Every effort must be made to appeal to the eye by the use of sketches and summaries on the blackboard, by maps, photographs, pictures and models. These sketches, etc., should be presented to the class at the precise moment they are required, and should not be in view of the class before that moment or the attention of the class will be distracted by them.

The class must have confidence in the teacher. It must like and respect him. The teacher can only hope to achieve this by having a thorough knowledge of his subject, and a true understanding of the difficulties of his students and a real desire to help them. At the end of a lesson the teacher should gather up the threads of the lesson into one harmonious whole, and "tidy up the mind" by means of a clear and concise summary of the main points of the lesson. Should the teacher find that he is unable to cover the amount of ground that he had hoped, he must never try and cram the remainder of his lesson into the last ten minutes. He must merely break off at the end of one of his intermediate steps, gather up the threads of the lesson, as far as it has gone, by a summary and always leave himself time to ask questions on what he has had time to teach. He can then carry on in his next lesson at the point where he left off.

BENEFIT OF LESSON TO CLASS.

After his delivery, the teacher must satisfy himself as to what extent the class has benefited. He can do this by means of questions and problems necessitating an application of the matter he has been teaching. If the lesson has really got home, the members of his class will talk about it to him, and amongst themselves, long after the lesson has been taught, and this is the real test of the benefit of a lesson.

The personality of a teacher when delivering a lesson, his powers of description, his illustrations, his ability to paint vivid pictures, all help greatly towards the impression a lesson makes upon a class.

SUMMARY OF THE CHIEF CHARACTERISTICS OF A GOOD LESSON.

Having now discussed the three aspects of a lesson, let us try and summarize the essential points of a good lesson. They appear to be:

(1) *Thorough preparation on the part of the teacher, ensuring that:*

(a) The aim of the lesson is absolutely clear.
(b) Unnecessary matter is rejected.
(c) Matter of lesson is within average intelligence of the class and likely to be beneficial to them.
(d) Matter is presented in simple, clear and logical form, and when possible in the shape of a series of problems of gradually increasing difficulty, to be solved by the class without conscious effort.
(e) Subject is taught within allotted time.
(f) All necessary apparatus is present.

(2) *Delivery of lesson to be such that :*
(a) Attention of class is attracted by commencing lesson with something familiar and known.
(b) Class enjoys lesson and proceeds by a number of easy steps as outlined in (1)(d).
(c) Class has confidence in and respect for the teacher.
(d) Class has a clear and concise summary of the lesson presented at the end.

(3) *Benefit from lesson is ensured by :*
(a) Questions and problems set by the teacher.
(b) Encouragement by the teacher for further discussion by the students.
(c) Teacher using his own personality to make as vivid an impression on the class as possible.

Illustration.

In the foregoing notes, it has been stated that the teacher should try and arrange a series of problems in a natural and logical order for the class to solve. It is thought that perhaps an example would help to make the writer's meaning clearer as to what is meant by this.

Suppose the subject to be taught is *the meaning of a scale and the necessity for a scale line and its use on* 1-*in. and* 1/20,000 *maps.* The class can be considered to be composed of normal candidates for Second Class Certificates of Education, and to be conversant with conventional signs on both these maps. It is improbable that the above matter could be taught to such candidates in one lesson, but for the purposes of illustration, this amount of matter has been chosen as it shows a fair number of steps. Any lesson could be broken off at the end of any one step, and be taken up at that point in a later lesson.

Step one.—The students are given some simple object such as a match box or an ink pot, and asked to draw a plan of it. This is readily done by tracing round the outline of the object placed on a piece of paper.

CHITRAL.

Passing ladders on the road in Chitral.

The Chitral road and river (in flood) at dawn.

The advanced guard. Q.V.O. Corps of Guides and K.G.O. Bengal S. & M.

The old bridge and fort at Ghairat, built in 1896 and looted for firewood by Chitralis. New bridge has recently been built.

The Advanced Guard

Swatis crossing temporary bridge, Mastuj. Piers of new bridge in background.

Swati caravan crossing temporary bridge, Mastuj.

Junction of the Chitral and Lutkoh rivers.

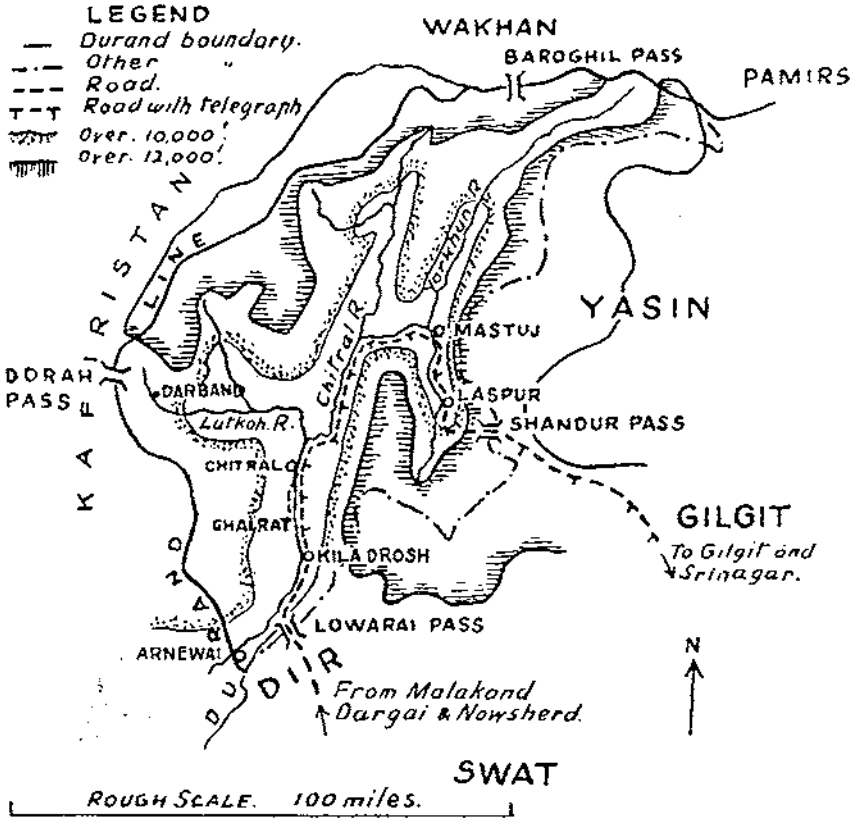
View up the Chitral river from Drosh.

Junction of the Chitral

CHITRAL.

By INGENIATOR.

THERE can hardly be a country in the world so strangely isolated as Chitral. Situated in the centre of the largest land mass on the globe and in the temperate zone, it is yet almost entirely cut off by natural features and local conditions from intercourse with its neighbours.



It is nearly unknown, and has probably been heard of only by those who follow the minor and madder activities of the British Army. I was so fortunate as to be ordered there on temporary duty in 1926, and I found the trip so enjoyable that there may perhaps be some interest in it for others.

To describe Chitral fairly would require a vocabulary as prolific as Shakespeare's and as apt as Milton's. One can only deplore the inadequacy of calling the country mountainous; it has been torn and twisted, slashed and shivered by nature in a frenzy. Such a hopeless tangle of abysmal valleys and unattainable heights must be seen to be realized.

In shape it is roughly an oval 180 miles long and 80 miles broad, with its major axis lying N.E. and S.W., and it covers the catchment area of the Chitral River, which flows down to join the Kabul River away south in Afghanistan. It lies right beyond the Pathan country, and its inhabitants form a race of their own. To the south, at the head of the Panjkora valley, lies the country of the Nawab of Dir. To the south-west and west is an outlying and little known district of Afghanistan called Kafiristan; to the north is the Wakhan—that narrow strip of land ceded to Afghanistan to perfect its buffer effect and ensure that British and Russian territory should nowhere meet; east is Yasin, which leads to Gilgit and from there far south by Astor and Baltistan to the plain of Kashmir.

The boundary on all sides is mountain, and, except at Arnewai, where the Chitral River has its exit, is probably nowhere lower than 10,000 feet. The routes across this boundary can be counted on the fingers of one hand. The Lowarai Pass (10,000 feet) is the entrance of the main route from India which leaves railhead at Dargai (50 miles from Nowshera), crosses the Malakand Pass, and traverses Swat and Dir for about 80 miles from Dargai to the Lowarai. The pass is open to pack transport for four months of the year, but for the rest is closed by snow. In the winter, only the expert local mountaineers can cross it at the risk of their lives, and letters are sometimes held up for three weeks.

The next gateway of the country is Arnewai; this is the only approach which does not lie across a mountain range. It leads into Afghanistan, which is as good as saying that there is little trade or traffic on it. There is an Afghan military post at Arnewai.

The third gateway is the Dorah Pass on the west side leading into Afghanistan. It has no made track of any sort across it, and warrants no further mention.

The fourth is the Baroghil Pass on the north, which leads into the Wakhan. It is used by traders' caravans going to Kashgar and Yarkand about once a year.

The last gateway is the Shandur Pass, on the east, leading into Yasin. This is the pass used by the first British troops to enter the country—the Gilgit garrison under Lieut. Fowler, R.E., in the relief of Chitral. It has a track of sorts across it, and takes the telegraph line to Srinagar. There is no line over the Lowarai, as it would stand little chance of life in the Pathan country the other side.

The routes in Chitral are really confined to one—the main artery of

the country. A pack road, with suspension bridges maintained by the Government of India, leads from the Lowarai up the Chitral River, connecting the main villages—Kila Drosh, Chitral, Mastuj, Laspur and the Shandur. A few short routes leave this and wind up side valleys to other villages. Between Drosh and Chitral this road is quite good, and it would almost be possible for a stout driver to take a Ford along it. The Mehtar of Chitral has been encouraged to bring up a car in bits from India and have it assembled at Drosh for this purpose, though I have not heard that the feat has been accomplished. If it were, the Mehtar might be induced to maintain the road himself.

A walk along this road is nothing if not awe-inspiring. A brown waste of tortuous mountain so steep that in places one has to crane one's neck to see the sky; the foreground a welter of gnarled and knotted crags; at quarter-mile intervals a tuft of grass or a splotch of moss; and below, the roaring of the river. At one point above Chitral the road across a precipice is so narrow that ladders are provided for passing. When two parties meet, the ladder is stood against the rock and one man climbs the ladder while the other passes beneath him.

Suddenly one swings a corner round a rock, and there before one, not a hundred yards away is a green and sheltered village. All the side *nullahs* bring down debris, which collects where it debouches into the main valley as a " fan "; on these fans the *nullah* water can be spread by digging channels, and here the villages spring up. And they are most fertile. Wheat, rice, maize all growing in profusion. Most wild flowers indigenous to England are found, but best of all is the fruit. Apricots, mulberries, melons and peaches grow naturally. Apples, pears and plums can be imported with success.

The apricots are almost a staple food of the country. The village houses are well made and comparatively clean. The natural supply of most excellent iced water is limitless.

Of the villages, Chitral is the largest, and there the Mehtar has his palace, the Assistant Political Agent his house, and the Scouts their headquarters. There is quite a large bazaar. The only other bazaar in the country is at Drosh—25 miles downstream—and it is here that the Chitral garrison is cantoned. Mastuj has a Post Office, the last and most northerly mark of the British Raj in Central Asia. The garrison consists of one battalion of Indian infantry, of which one company is on detachment in Chitral, one section of Sappers and Miners, and a section of guns. The battalion, the Pack Section, R.A., and a hospital, are quartered up in the fort. Two Sappers and two I.A.S.C. officers live in lower Drosh in a " chummery " with a pretty garden. The Chitral Section, K.G.O. Bengal Sappers and Miners, have their lines here, but as they are the only part of the force that has the run of the country they are seldom there. They prefer to be

away on their own on the road, generally repairing or rebuilding the many suspension bridges.

One might justifiably ask why is a garrison maintained up there in such an outlandish spot; for the country is too terrific to be possible as a route of invasion of India. Yet since the insurrection of 1895 the garrison has always been there. It is kept up for various reasons, of which the chief are three. First, the garrison removes the possibility of further local trouble. The Chitralis are a murderous, patricidal race. Secondly, if we were not there, someone else might be. Thirdly, it forms a useful and very advanced feeler towards an area of foreign development in Central Asia which has given us more than one *mauvais quart d'heure*, and it lies on the flank of any possible operations near Kabul.

The history of Chitral before the war in 1895 is untraceable. On the war several books have been written—all of entrancing interest and well worth reading. The Chitralis themselves are Mussulmans of a very degraded type. There are both Shiahs and Sunnis amongst them. And there is a tribe of Kafirs (divided into red and black Kafirs) who practise pure demon worship. The red Kafirs hold a yearly feast in their head village which takes the form of a mystery play, and the theory has been advanced—not unknown in other parts of Asia—that the red Kafirs are a relic of Alexander's lost army. The king of Chitral is known as the Mehtar, and the native language is one of the many derivatives of Persian and is known as Kohar.

As each village, almost each house, is entirely self-supporting, there is no trade in the country. But I was fortunate in seeing something of a caravan of Swati traders who use this route to get up to Kashgar and Yarkand. Swatis are looked upon by other Pathans as the buffoons of the frontier. This caravan had 475 mules, which they had loaded up in Peshawar. The S. and M. were at Mastuj, building the new suspension bridge, and as the only crossing was a very *kacha* footbridge of poles in a precarious condition, the Swatis had to unload their mules and halve the loads. Each half was then manhandled over. It took them three days to cross. Their goods were mostly spices, *charas* and trinkets. Each man had a monkey, as they said monkeys were fashionable as pets amongst the ladies of Yarkand. They expected to bring back tea, *numdahs*, skins and ponies.

Some would consider Chitral an ideal station, and some would consider it otherwise. Once there, you are there for two years, though possibilities of leave to India are increasing. Two months' leave can be spent in the country on *shikar*, but the new landing ground just built in Drosh will enable officers to get down to India in a day, though the R.A.F. like nothing less than flying to Drosh. Once they have left Chakdara, they have nowhere to land but Drosh, and if they lose their way a crash is a certainty. But there are other ways. There is a true story of the old minister of the country who

went from Chitral to Srinagar in 48 hours by sheer hard riding and good *bandobast*.

Of sport there is hockey, football and tennis. There may even be squash there now. The chikor shooting is the finest in the world, and there are small ibex and markhor. There is a better chance of snow leopard (always a matter of chance) than anywhere else in the Himalayas. There is no fishing. If enough players can be collected, there is polo in Drosh. Failing that, one can always play Chitrali polo. I saw one game of this while I was there. It lasted 40 minutes without a stop: players cut in or out as they felt inclined, but most ponies played the full time; play is unencumbered by any rules or referee, and is started by the two sides lining up at either end of the ground and charging for the ball. The sides of the ground are conveniently provided with boulder walls two feet high, off which some clever cushion shots are taken. A country band plays throughout the game, and the losers have to dance to it after the game for the regalement of the winners.

Chitral is a fine country, and most people who have spent two years there, though they may have felt their activities somewhat curtailed, look back on the time with pleasure.

Editorial Note:—R.E. Professional Paper VI of 1896 gives a lot of information about the bridging operations during the 1895 Relief Expedition.

ANCIENT LAND MEASURES OF BRITAIN AND MALTA.

By COLONEL J. W. S. SEWELL, C.B., C.M.G.

IN the period 2500 B.C. to 2000 B.C., the western half of Britain was invaded by a maritime race, coming from the South, in search of tin.

Malta also was first occupied by a branch of this Eurafrican race.

We might reasonably then expect common factors in weights and measures indicating a common origin, subsequently diversely affected by the influence of Asiatic culture. It must also be remembered that, in those days, there was little arithmetical science, and that land divisions must perforce have been made with the aid only of geometry and probably standard rods. The original measures in use in Malta appear to have been :

*Linear :** 1 Canna=8 Palmi ; 2 Canne=165″
Surface : 1 Salma=4 Weiba=16 Tumoli
=16×256 square Canne.

It will be observed that the multipliers are all powers of the prime 2. The introduction of the primes 3 and 5 will have been due to Asiatic influence ; and thus we find the tumolo divided into 6 mondelli=60 misure.

The British land measures are convertible as follows into Maltese units :

1 Acre=·9 Weiba.
1 Rood=·9 Tumolo.
1 Rod=1·35 Misure.

There thus appears a suggestion that the Weiba is the original Eurafrican unit of land measure, but it is obviously necessary to seek an explanation of the reduction of this measure by one-tenth, so as to arrive at the acre.

The following explanation is purely speculative, but may be regarded as consistent with what is known of early systems of government, and the limitations imposed in those days by the lack of arithmetical science ; it is also suggested by the curious fact that the Maltese units of land measure given above are actually units of capacity. Thus the Salma is 1 Quarter (of corn), and the area of 1 Salma is the area theoretically required to produce 1 Salma of corn. It is, therefore, suggested that the original taxation took the form of

* In these Tables the modern Italian names are used in lieu of the true Maltese names, owing to the fact that the former are the names officially employed.

a tax on capital values. So that a farmer had to yield to the State, not a proportion of his crop, but a definite number of bushels of corn per Weiba held by him. Under the stable conditions of cultivation in the Nile Valley, for example, this would be a reasonable form of tax, inasmuch as it was simple to assess and gave a fixed revenue to the State. The only difficulty would arise in years when the Nile flood was abnormally low. Thus we find Joseph advising Pharaoh to " take up the fifth part of the land in the seven plenteous years." For " land," we may clearly substitute " crop " ; the advice probably involved two changes in the system of taxation :

(*i*) A substitution of an income tax in lieu of the tax on capital values, so as to obtain the benefit of the richer crop per Weiba.

(*ii*) Doubling the tax, from the normal tenth to one-fifth, to meet the subsequent years in which no revenue could be expected ; owing to the richer crops, this increased assessment would be tolerable.

However that may be, it would appear that neither a tax on capital values, nor an income tax on crops, would be suitable for Britain ; the former on account of the unstable climate, resulting in too wide differences in annual crops ; the latter owing to the openings it gave for cheating the revenue. In consequence, when a State church was established, it was provided with a revenue by means of the third course open, viz : a capital levy, by which every landowner ceded to the church one-tenth (a " tithe ") of his holding. Arithmetically, this meant that from the " Weiba " of 48,400 square feet, the Church took 4,840 square feet, and the landowner retained 4,840 square yards, that is, one acre. Geometrically, division was simple, inasmuch as the " Weiba " contained 100 plots of 22 feet by 22 feet.

Thus 1 Weiba $=2^{16}$ sq. palmi ; or $2^2\times10^2\times11^2\times12^2$ sq. inches.

These land measures, of course, involve the use of standard lengths ; we have then to consider :

(*a*) The British standard inch, and the somewhat anomalous linear rod of $16\frac{1}{2}$ feet. This rod contains 198 inches, and is, therefore, divisible by 11. A rod divided by 16×12 would give a small unit of 1·03125″.

(*b*) The Maltese canna, which contains 8 palmi : 1 palma = 10·3125″ ; this, divided by 10, would give the same, 1·03125″.

(*c*) The long foot of 12·5225″, to which Sir Flinders Petrie has drawn attention ; dividing this by 12 results in a small unit of 1·04354″.

The inter-relation of these three " inches " becomes apparent when we consider the plot referred to above of $22'\times22'$ (=1/90 acre).

Now 22′ equals :

(*i*) 264 British standard inches, or,
(*ii*) $256 \times 1{\cdot}03125''$, or,
(*iii*) $253 \times 1{\cdot}04354''$.

Since $253 = 11 \times 23$, this also introduces into the scale the factor 11. In fact, we may regard (*ii*) as the oldest system of division, since $256 = 2^8$; whilst (*i*) and (*iii*) were possibly alternative methods, in different countries, of introducing the factor 11.

It may reasonably be objected that the similarity between the British and old Maltese units which results in 96 canne = 1 furlong, is suspiciously accurate. It is, indeed, quite possible that the original palmo has been arbitrarily shortened very slightly in recent times, in order to provide this accurate consonance.

If the standard rods were made, as is probable, of bronze, consisting of nine parts of copper to one part of tin, which is known to have been the alloy used in Crete, the coefficient of linear expansion of this alloy is very approximately ·00001 per degree Fahrenheit, so that expansion from 1·03125 to 1·0315 would result from an increase of about 24°F., which approximately represents the difference between summer sun temperatures in Malta and at Greenwich.

It may be of interest to note three consecutive lengths measured by the writer along the axis of a megalithic monument in Malta ; the measurements were between most distinctive points, viz : from step to step ; the conditions were such that the measurements were not closer than 0·25″ in any one case. The measurements noted were :

(*a*) 5′ 1·75″
(*b*) 13′ 9″
(*c*) 25′ 0·5″

It was only subsequently observed that :

(*a*) 6 palmi = 5′ 1·875″
(*b*) 16 palmi = 13′ 9″
(*c*) $24 \times 12{\cdot}5225'' = 25'\ 0{\cdot}5''$

This affords some evidence that both palmi and " long feet " were used as units of length by the original (Eurafrican) builders in Malta.

Brigadier-General G. P. Campbell, C.I.E., C.B.E.

Brigadier-General G P Campbell CIE CBE

MEMOIR.

BRIGADIER-GENERAL G. P. CAMPBELL, C.I.E., C.B.E.

GEORGE POLDING CAMPBELL was born at Wanstead, New South Wales, in 1864, the second son of Edward Campbell, of Grambalang, who had settled in that country some years previously. Educated at Sydney Grammar School and Sydney University, he carried all before him in the mathematical schools, and was accordingly selected by the then Governor, Lord Carrington, for a commission in the Corps. It was offered to Sydney University as a compliment to the colony of New South Wales for the assistance voluntarily offered by its people in the Egyptian troubles of the time.

Having thus obtained a direct commission, Campbell escaped the "Shop," and joined at Chatham in May, 1886. He stayed there the usual two years and was then appointed to Aldershot. There he became engaged to Frances Georgina, daughter of the Rev. C. B. Fendall, of Woodcote House, Windlesham, one whose unfailing courage and cheerful serenity were to be a great source of strength to her husband in the arduous years to come. Matrimony amongst subalterns was not favourably regarded in those days, and he was promptly ordered to Ceylon. His marriage had consequently to be postponed till his first leave, and took place in 1891, after which the young couple returned to Colombo, where they remained for four years.

Transferred to India in 1894, the Campbells went first to Ferozepore, where he designed and carried out the defences to the arsenal, and then to Bannu. For the whole of his service in India, Campbell was employed on Military Works, and in accordance with the then custom, as a P.W.D. officer when on the N.W. frontier. He was promoted to Captain in 1896, and in the following year took part in the Tochi expedition, the outcome of the widespread frontier agitation then prevailing. At that time, he was the father of four children.

An officer who worked under him writes: "I remember G. P. Campbell best in 1897, when I served under him as Assistant Engineer in the Punjab P.W.D., as it was in those days, in the Tochi Valley. He was my Executive Engineer at Bannu, and I reported to him, I think, in March, and we rode up the valley together to Datta Khel, which was to be my headquarters for the building of the posts at Miramshah, Boya, and Datta Khel, and the road to connect them. He was a cheery, bright soul, well known on the frontier for his yarns

and after-Mess stories, one of which, 'The Yellow Light,' gave him his nickname at that time. He was a most engaging chief to be under, and a sound practical frontier engineer from whom I learnt many tips.

"The Maizar outrage in June, 1897, put back our building programme before we had done more than put up the political officers' houses and P.W.D. rest houses, and we then concentrated on cutting out some sort of road up which the Tochi Expedition could advance. He and I designed a crib pier bridge over the Tochi at Boya, which carried the troops over dry-shod, but did not long withstand the summer floods; he used to be frequently up and down over my section of the road, which was from Miramshah to Datta Khel, always cheerful and encouraging. I went down with Tochi fever, and was invalided home in November, and the last I remember of his kindness was when he took me into his bungalow at Bannu and nursed me fit enough to stand the tonga journey on. I looked on him as one of the best to serve under, whose one aim was to get things done by personal interest in the work and never a thought of personal risk or exposure. Red tape was an abomination to him, and he never called on an Assistant Engineer for a report if he could possibly come and see for himself. The result was that we all loved him, and did all we could to carry out his suggestions."

And another officer writes: "I first made Campbell's acquaintance at Bannu in the autumn of 1897. Bannu was then the base of operations for the Tochi Valley Expedition. Dysentery was very prevalent and Campbell was one of the many officers who was invalided home towards the end of it. I remember his arriving at Bannu on his way home. The first thing he did was to interview the Staff Surgeon and to get taken off the sick list. He went to the Mess that evening, and returned home about 2 a.m., which was not a bad effort for a man just recovering from a serious complaint. . . . I do not think I met him again until after the War, in 1920, when he was Brigadier-General and Chief Engineer in Waziristan. He was as cheery and genial as ever, and bursting with amusing stories and reminiscences. . . . There is no doubt that, in spite of his extraordinary light-heartedness, he was a very capable officer and a sound engineer. . ."

The Tochi was certainly no health resort in those days. During the expedition, the force suffered no great loss from the enemy, but terribly from the climate, as the memorials at the little church in Bannu, and the cemeteries at Datta Khel and Miramshah testify.

On Campbell's return to India, there followed ten years of ordinary duty as Garrison Engineer in various stations. Promoted Major in 1904, he served from 1905 to 1908 at Barrackpore, where he built the rifle factory. In April of the latter year he went home for a "wild east" course at the S.M.E., which, with his two years at Aldershot, were the only home service he had. The next twelve

years were passed almost entirely on the N.W. frontier, mainly at Peshawar, where he carried out civil works as a P.W.D. officer, as well as performing the normal duties of an officer of the Military Works Department. During this time, much important work fell to his lot, and he carried it out in a manner which showed that he possessed the qualities of a really fine engineer of taste and ability. The stately buildings of Islamia College and the beautiful official residence of the Chief Commissioner stand as examples of an architectural understanding of no common order, whilst a lasting memorial to him exists in the double roads up the Khyber, which were aligned and constructed under his direction.

Campbell was promoted to Lieut.-Colonel in 1913; the outbreak of the Great War found him still at Peshawar, whence he took part in the operations against the Mohmands and Swatis in 1915. For his services on this occasion he received the brevet rank of Colonel.

In 1916, he was transferred to Quetta, where he was called upon to carry out much important work in connection with the camps for the additional troops who were stationed there during the war. For his work at Quetta he was made a companion of the Order of the British Empire.

An officer under whom he served then and earlier in his service, writes: "G. P. Campbell served under me at two different periods—once from 1895–97 on the Punjab Frontier at Bannu, and again about 1916–18 at Quetta. On both occasions I found him an excellent man to work with—always cheery and full of life, even in the hottest weather, when most men are liable to be depressed. He was well read, had a good memory, fond of a joke even when it was at his own expense, and the best of company—no dinner party of which he was a member suffered from flagging of conversation, and possibly these powers of conversation may not always have been of advantage to him. I remember he told me once shortly after he joined me on the frontier that he had been badly reported on by his C.R.E., and when he expostulated 'But, Colonel, I have only served under you for a short time and you have not, I think, seen any of my work,' he received the reply, 'No, I have not seen your work, but I met you out at dinner once, and you talked too much.' I found him officially a very capable, zealous and efficient officer, who took a keen interest in his work and was ever ready to help; personally a very kind-hearted, hospitable and reliable friend whose loss I deeply deplore."

The following extract from a letter from an officer of the I.M.S., a very old friend of the family, gives a good idea of Campbell's unselfish character: "My first meeting with Campbell was when he discovered me all alone and very ill indeed in the old club at Sheikh Budin. I had just arrived in India and the Derajat for the first time and in May. He carried me off to the bungalow of a friend and sat up several nights looking after me. He must have had an anxious

time of it, as I was the only doctor in the place, but he took my temperature, sponged me down, filled me up with quinine, and wired to D.I.K. for instructions to carry on. And when I got better, he spared no pains to see that I was put up to all the ropes as to how to live in an Indian climate.

"Unselfishness was so ingrained in Campbell's nature that the interest and trouble he took in everyone around him never seemed any effort to him. . . .

"The backbone of Campbell's character was a great faith in life and an unswerving loyalty to high principles. With all the worries of executive work under trying conditions, and with all the anxieties of a large family in an Indian climate, he was always cheery, and his kindly sympathy, which made him so full of thought for others, also enabled him to see humour in everything going on around him.

"His wife was a splendid help to him, and always cheerful in all vicissitudes, and that is saying something, for with his boyishly humorous temperament no one ever knew what Campbell would do next."

In 1919, Campbell was appointed Chief Engineer of the Waziristan Field Force, and went at first to Bannu. He was much interested in the development of the Tochi Valley, in which he had done pioneer work over twenty years before, especially in the motor road up the valley to Miramshah, which for most of its course followed the alignment of his tonga-road of '97.

Later in the year, his headquarters were moved to Dera Ismail Khan, and there a small group of Sappers, with the C.E. at its head, spent a pleasant winter together in the A.C.R.E.'s bungalow, brightened by the presence of Mrs. Campbell and her youngest daughter. As C.E. he was responsible for the alignment of the part of the Waziristan circular road (which included the passage of the ill-omened Himmis Tangi) from Khirgi up the Zam Valley towards Razmak, a work of primary importance in the settlement of that troublous country. For his services in Waziristan he was made a Companion of the Indian Empire.

Long residence in India had undoubtedly told upon his health, and in 1920 he was invalided home and retired as Brigadier-General in August, 1921, with over 35 years' service to his credit. After a few months, he finally settled in Farnham, where he was in touch with old friends, and continued his life of useful service by acting as Chairman of the Aldershot, Farnham and District War Pensions Committee—a position which he resigned only a short time before his death—and as local Secretary of the Soldiers' and Sailors' Association.

He died of pneumonia on September 9th, 1928, after a long illness borne with quiet courage, and is survived by his widow and eight children, of whom his four sons are in the Army.

Campbell was a man of great mental and physical energy. At Aldershot he hunted a good deal. He played golf all his life, and represented the Corps at Sandwich in 1898. He also played polo and cricket, and did some big game shooting in Ceylon. Apart from games of all kinds, his chief recreation was writing. He was well read and had an easy style, and was never at a loss for a word. For several years he contributed to papers in India, acting as a correspondent to the *Statesman*, *Pioneer*, *Civil and Military*, and other publications, as well as contributing articles, reviews and poems.

Perhaps his most salient characteristic was his religious sincerity. He was a devout Catholic, and his devotion was of no theoretical kind, but showed itself in the breadth and kindness of his nature and the conscientious and thorough fulfilment of all his duties. He had a strong sense of humour, which often led him to view things, including official business, from an unaccustomed angle, and perhaps endeared him more to those amongst whom he lived than to those under whom he served. For though entirely loyal and single-minded in his desire to accomplish whatever his task might be, he was utterly intolerant of the petty obstructions which often arise from the unintelligent application of prescribed methods.

To one who knew him well during his time as Chief Engineer in Waziristan, he leaves a memory of unfailing cheerfulness, most pleasant companionship, great personal attraction, and unswerving devotion to his lofty ideals.

A.H.B.

BATTLE HONOURS OF ROYAL ENGINEER UNITS.

(Continued from December, 1928, R.E. Journal.)

SIGNALS.

MEGIDDO. I.—SHARON. 19TH TO 25TH SEPTEMBER, 1918.
II.—NABLUS. " " " " "

Unit.	Formation.		Remarks.
	I.—SHARON.		
U Corps Signal Co.	XXI Corps	E.	
54th Div. Signal Co.	54th Div.	"	
75th "	75th "	"	
3rd Indian "	3rd Ind. Div.	"	
7th Indian "	7th "	"	
60th "	60th Div.	"	
W Corps Signal Co.	Desert Mtd. Cps.	"	
4th Cav. Div. Sig. Sqdrn.	4th Cav. Div.	"	
5th "	5th "	"	
2nd Aust. Signal Sec.	Aust. Mtd. Div.	"	
	II.—NABLUS.		
V Corps Signals Co.	XX Corps	"	
10th Div. Signal Co.	10th Div.	"	
53rd "	53rd "	"	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	"	

DAMASCUS. 1ST OCTOBER, 1918.

Unit.	Formation.		Remarks.
XXI CORPS.			
No. 3 Co. 1st K.G.O. S. and M.	7th (Indian) Div.	E.	
No. 4 "	"	"	
522nd (London) Field Co.	"	"	
14th Army Troops Co.	XXI Corps	"	
DESERT MOUNTED CORPS.			
4th Field Sqdrn.	4th Cav. Div.	E.	
5th "	5th "	"	
2nd Aust. Field Sqdrn.	Aust. Mtd. Div.	"	

SIGNALS.

DAMASCUS. 1ST OCTOBER, 1918.

Unit.	Formation.		Remarks.
W Corps Signal Co.	Desert Mtd. Cps.	E.	
4th Cav. Div. Signal Sqdrn.	4th Cav. Div.	"	
5th "	5th "	"	
2nd Aust. Signal Sqdrn.	Aust. Mtd. Div.	"	
U Corps Signal Co.	XXI Corps	D.	
7th (Indian) Div. Sig. Co.	7th Indian Div.	E.	

MESOPOTAMIA.

Unit.	Formation.		Remarks.
BASRA. 15TH TO 17TH NOVEMBER, 1914.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
SHAIBA. 12TH TO 14TH APRIL, 1915.			
17th Co. S. and M.	6th (Indian) Div.	,,	
22nd ,,	,,	,,	
12th ,,	12th (Ind.) Div.	N.E.	
Sirmur Imp. Service Co.	,,	,,	
Bridging Train		,,	
KUT, 1915. 28TH SEPTEMBER, 1915.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
Bridging Train	,,	,,	
12th Co. S. and M.	12th (Ind.) Div.	N.E.	
Sirmur Imp. Service Co.	,,	,,	
CTESIPHON. 22ND TO 24TH NOVEMBER, 1915.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
Bridging Train	,,	,,	
DEFENCE OF KUT. 7TH DECEMBER, 1915, TO 28TH APRIL, 1916.			
17th Co. S. and M.	6th (Indian) Div.	E.	
22nd ,,	,,	,,	
Bridging Train	,,	,,	
Sirmur Imp. Service Co.	12th (Ind.) Div.	,,	

SIGNALS.

Unit.	Formation.		Remarks.
BASRA. 15TH TO 17TH NOVEMBER, 1914.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
SHAIBA. 12TH TO 14TH APRIL, 1915.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	N.E.	
KUT, 1915. 28TH SEPTEMBER, 1915.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	N.E.	
CTESIPHON. 22ND TO 24TH NOVEMBER, 1915.			
A.C. Signal Co.	II Ind. Army Corps	D.	1 Section only in area.
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	D.	1 Section only in area.
Bde. Signal Troop	6th Cav. Bde.	E.	
DEFENCE OF KUT. 7TH DECEMBER, 1915, TO 28TH APRIL, 1916.			
34th Div. Signal Co.	6th (Indian) Div.	E.	
12th ,,	12th (Ind.) Div.	D.	1 Section only in area.
TIGRIS, 1916. 6TH JANUARY TO 22ND APRIL, 1916.			
No. 1 A.C. Signal Co.	Tigris Corps	E.	
3rd Div. Signal Co.	3rd (Indian) Div.	,,	
7th ,,	7th ,,	,,	
13th ,,	13th ,,	,,	

TIGRIS, 1916.
6TH JANUARY TO 22ND APRIL, 1916.

Unit.	Formation.		Remarks.
TIGRIS CORPS.			
20th Co. S. and M.	3rd Div.	E.	
21st ,,	,,	,,	
3rd ,,	7th Div.	,,	
4th ,,	,,	N.E.	
72nd ,,	13th Div.	E.	
88th ,,	,,	,,	
CORPS TROOPS.			
12th Co. S. and M.	Attached 3rd Div.	,,	
13th ,,	Attached 7th Div.	,,	
Bridging Train	1st S. and M.	,,	
Field Troop	2nd S. and M.	N.E.	

KUT, 1917.
9TH JANUARY TO 24TH FEBRUARY, 1917.

Unit.	Formation.		Remarks.
CAVALRY DIVISION.			
No. 2 Fd. Trp. 2nd S. & M.	6th Cav. Bde.	E.	
7th Field Troop R.E.	7th ,,	,,	
I INDIAN ARMY CORPS.			
No. 18 Co. 3rd S. and M.	3rd Ind. Div.	,,	
No. 20 ,,	,,	,,	
No. 21 ,,	,,	,,	
No. 1 Co. 1st S. and M.	7th Ind. Div.	,,	
No. 3 ,,	,,	,,	
No. 4 ,,	,,	,,	
III INDIAN ARMY CORPS.			
71st Field Co.	13th (West.) Div.	,,	
72nd ,,	,,	,,	
88th ,,	,,	,,	
No. 12 Co. 2nd S. and M.	14th Ind. Div.	,,	
No. 13 ,,	,,	,,	
No. 15 ,,	,,	,,	
ARMY TROOPS.			
No. 1 Bridging Train		,,	
No. 2 ,,	1st S. and M.	,,	
No. 3 ,,	3rd ,,	,,	
Searchlight Co.		D.	No diary.
Tehri Garhwal S. and M. (I.S.)		E.	

SIGNALS.
KUT, 1917. 9TH JANUARY TO 24TH FEBRUARY, 1917.

Unit.	Formation.		Remarks.
Army Signal Co.	Tigris Front	E.	
1st (Anzac) Wireless Sig. Sqdrn.	Cavalry Div.	,,	
6th Cav. Bde. Sig. Troop	,,	,,	
7th ,,	,,	,,	
1st Corps Signal Co.	I Ind. Army Cps.	,,	
3rd Div. Sig. Co.	3rd Ind. Div.	,,	
7th ,,	7th ,,	,,	
3rd Corps Sig. Co.	III Ind. Army Corps	,,	
13th Div. Sig. Co.	13th (West.) Div.	,,	
14th ,,	14th Ind. Div.	,,	

BAGHDAD, 1917.

25TH FEBRUARY TO 10TH MARCH, 1917.

Unit.	Formation.		Remarks.
CAVALRY DIVISION.			
No. 2 Fd. Trp. 2nd S. & M.	6th Cav. Bde.	E.	
7th Field Troop R.E.	7th ,,	,,	
I INDIAN ARMY CORPS.			
No. 18 Co. 3rd S. and M.	3rd Ind. Div.	,,	
No. 20 ,,	,,	,,	
No. 21 ,,	,,	,,	
No. 1 Co. 1st S. and M.	7th Ind. Div.	,,	
No. 3 ,,	,,	,,	
No. 4 ,,	,,	,,	
III INDIAN ARMY CORPS.			
71st Field Co.	13th (West.) Div.	,,	
72nd ,,	,,	,,	
88th ,,	,,	,,	
No. 12 Co. 2nd S. and M.	14th Ind. Div.	,,	
No. 13 ,,	,,	,,	
No. 15 ,,	,,	,,	
ARMY TROOPS.			
Tehri Garhwal S. & M. (I.S.)		N.E.	
No. 1 Bridging Train		E.	
No. 2 ,,		,,	
No. 3 ,,		N.E.	

SIGNALS.

BAGHDAD. 25TH FEBRUARY TO 10TH MARCH, 1917.

Unit.	Formation.		Remarks.
Army Signal Co.	Tigris Front	E.	
No. 2 Wireless Sig. Sqdrn.	L. of C.	N.E.	
Cav. Div. Signal Sqdrn.	Cav. Div.	D.	No diary.
1st (Anzac) Wireless Sig. Sqdrn.	,,	E.	
6th Cav. Bde. Sig. Troop	,,	,,	
7th ,,	,,	,,	No diary.
1st Corps Signal Co.	I Ind. Corps	,,	
3rd Div. Sig. Co.	3rd Ind. Div.	,,	
7th ,,	7th ,,	,,	
3rd Corps Sig. Co.	III Ind. Corps	,,	
13th Div. Sig. Co.	13th (West.) Div.	,,	
14th ,,	14th Ind. Div.	,,	

KHAN BAGHDADI, 1918.

26TH TO 27TH MARCH, 1918.

Unit.	Formation.		Remarks.
No. 5 Fd. Trp. 1st S. & M.	11th Cav. Bde.	E.	
448th Field Co.	15th Ind. Div.	,,	No diary.
450th ,,	,,	,,	
451st ,,	,,	,,	
No. 19 Fd. Co. 3rd S. & M.	I Ind. Army Cps.	N.E.	Attached 15th Div.
No. 1 Bridging Train, 1st S. and M.	,,	E.	
No. 2 Bridging Train, 1st S. and M.	,,	,,	

SHARQAT, 1918.

28TH TO 30TH OCTOBER, 1918.

Unit.	Formation.	Remarks.
No. 5 Fd. Trp. 1st S. & M.	11th Cav. Bde.	E.
No. 7 ,,	7th ,,	,,
448th Field Co.	15th Ind. Div.	N.E.
450th ,,	,,	,,
451st ,,	,,	,,
Sirmur Sappers (I.S.)	17th Ind. Div.	,,
Malerkotla Sappers (I.S.)	,,	E.
Tehri Garhwal Sappers (I.S.)	,,	,,
No. 2 Fd. Co. 1st S. & M.	18th Ind. Div.	,,
No. 5 ,,	,,	N.E.
No. 6 ,,	,,	E.
No. 8 ,,	,,	,,
9th Co. 2nd S. and M.	Attd. 15th Div.	N.E.
19th Co. 3rd S. and M.	,,	,,
No. 1 Bridging Train		,,
No. 2 ,,		E.
No. 3 ,,		N.E.

SIGNALS.

Unit.	Formation.	Remarks.
KHAN BAGHDADI. 26TH TO 27TH MARCH, 1918.		
Bde. Signal Troop	11th Cav. Bde.	E.
15th Div. Sig. Co.	15th Ind. Div.	,,
SHARQAT, 28TH TO 30TH OCTOBER, 1918.		
1st Corps Signal Co.	I Ind. Army Cps.	E.
Bde. Signal Troops	7th Cav. Bde.	,,
,,	11th ,,	,,
15th Div. Signal Co.	15th Ind. Div.	N.E.
17th ,,	17th ,,	E.
18th ,,	18th ,,	,,

[EDITOR'S NOTE.—*This completes the list of Battle Honours of Royal Engineer Units. Previous instalments appeared in the R.E. Journals for June, September and December, 1925; March, June, September and December, 1926; March, June, September and December, 1927; September and December, 1928*].

N.=Eligible.
N.E.=Not Eligible.
D.=Doubtful.

PROFESSIONAL NOTES.

REPORT OF THE BRIDGE STRESS COMMITTEE.

(H.M. Stationery Office, 1928. 18s. net).

THE Bridge Stress Committee was appointed in 1923 by the Privy Council Committee of Scientific and Industrial Research to enquire into the nature of stresses caused by moving trains over steel railway girders.

The Bridge Committee included Sir Alfred Ewing and Professor Inglis, and consisted of four scientists and six railway engineers, and they employed a chief engineer and some fourteen engineers for five years making experiments.

CONDEMNATION OF EXISTING PRACTICE.

The report opens on page 8, with a condemnation of impact formulæ hitherto made use of which are described in detail in Appendix "A." The Committee in these paragraphs seem to have demolished a bogey of their own making.

It has been common knowledge for forty years that impact is due to many causes, and that the effect varies with the type of girder. As Mr. Stone wrote on a Government of India file in 1892, "the coefficient, if accurately determined, would not only differ for each member of a bridge, but it would probably differ to some extent with changes of temperature, and it would certainly again differ for different designs of engine and different speeds of train. Hence it is generally admitted that to apportion consistently the working stress to every case which may occur, is quite out of the question. There must be a compromise."

For this reason it has been recognized that to attempt to devise a formula or law for impact analytically is to search for a chimera. This committee have not held that view, and it remains to judge whether they have succeeded in justifying their optimism.

With regard to so-called formulæ now in use, no one has ever suggested that they were a sort of mathematical impact law. In fact, they are no more than a convenient way of expressing what extra allowance must be made for impact for any given span, and as such they differ in no way from the table of equivalent loads which this committee has published on page 133 in its report.

The only value of these expressions is to give the impact allowance in convenient form. Whether it is worth while retaining this kind of formula is another question, but there is no need for the blows which the committee have showered on them, nor indeed any justification.

The original impact formula was :—

$$Y = 2.$$

But no one supposed it to be a law of impact.

The Pencoyd formula improves on this :

$$Y = 1 \text{ plus } 300/300 \text{ plus } L$$

and both these formulæ were generally considered of universal application, whatever other factors of safety were used.

The Indian formula $Y = 1$ plus $65/45$ plus L improves on the Pencoyd in many ways by being restricted

(1) To 5'6" gauge railways.

(2) To modern design girders.

(3) To locomotives with hammer blow restricted by the equation

$$\frac{\text{hammer blow at 1 r.p.s.}}{\text{total load per foot run for which bridge is designed}} = 1/5.$$

(4) To normal working speed. This is implicit in the ratio in item 3.

(5) For working stresses of eight tons per sq. inch of steel.

Mr. Fyson's formula is not one which is generally known, but to print it as is done on the diagram (page 144) is to confuse the reader unnecessarily.

Bridges designed with this impact allowance, and 14,000 lbs. per square inch working stress, for which it was intended, will be almost identical with bridges designed with the new Indian formula for which a working stress of 18,000 lbs. is used.

The Committee go on to say, " There is no proportionality between the impact effect of a live load on a given bridge and the amount of the load ; consequently the idea of an impact coefficient is fundamentally wrong."

I disagree entirely with this sweeping statement. The Committee seem to overlook the fact that bridges are designed for a given load, and that there is a definite proportion between the weight of a bridge, the load for which it is designed, and the effect of the load, always assuming that engines and bridges are normal and not unusual designs.

What the Committee perhaps have in mind is that these formulæ are not capable of solving the problem of the impact effect of any load on any girder. But such a formula is unattainable, and the search for it is as futile as the search for the Philosopher's Stone. Moreover,

it is of no importance in bridge design to know what impact effect may be given by any load except the load for which the bridge is designed.

This leads me to examine what seems to be the

Committee's Fundamental Error.

The Committee appear to have fallen into the error which our Indian Committee avoided, of observing high impact effect on under-loaded bridges, and applying the results to fully loaded bridges.

The methods by which the loading recommended has been reached may be found in Figs. 71–75 and para. 167–171.

From this it appears that the maximum loading which has been arrived at by computation is the result of inserting in the calculations for the weight M of the girder various estimated values, ranging from what they describe as light weight, to heavy weight bridges.

There is no such thing as a light weight or a heavy weight bridge; there is only one economic weight for a railway bridge for a given loading, and the effect of that loading on bridges of other weights designed for other loadings is of no interest.

The whole point of impact investigations is to enable the economic weight to be more accurately determined. The diagrams of mass shown in Fig. 71, show a misconception of the problem before the Committee. The diagram shows three bridges experimented upon in the neighbourhood of 150 ft. span, with weights ranging from 600 tons down to 200 tons. The 600-ton bridge is a four-track structure. All were tested with single engine 15/15 test trains. In the region of 310 ft. two bridges are shown, one of 1,700 tons weight and the other of 1,100 tons weight, and to bring these two bridges together on one diagram is of no practical value. They are two different problems quite independent.

In the diagram in Fig. 72 (2), which is based on computation, it is shown that the impact allowance for light bridge, 150 ft. span, for 15/15 loading, single track, is about 63%, but for a heavy bridge it is 121 %, and adding various allowances for joints and lurching, the Committee recommend an impact allowance of 147 % for all 150 ft. spans on British railways. It is clear that if the light bridge is a correct weight for this loading and 63 % is sufficient for impact, then there is no need to consider what impact effect it has on a heavy bridge, because the heavy bridge is designed for much heavier loads; that is the only reason for its heaviness.

The absurdity of the diagram Fig. 72 (2) is shown by the position of the curves between 160 ft. and 200 ft. span, from which it might be deduced that the more impact allowance is given the lighter becomes the bridge. The same result is shown in diagram 3, span 130 ft. to 170 ft.

It is evident that the excessive impact allowance which the Committee recommend for medium span bridges is based on some fundamental error of observation or conception of the problem, and multiplied in the course of computation beyond the error to which experiment alone would have led.

It is possible that 147 % impact might be obtained experimentally on 150-ft. girders, supposing that two coupled engines could be got to move at 90 miles per hour, on bridges less than a quarter loaded and using engines with an exceptionally large hammer blow, but in any case I feel sure that such impact allowance is unnecessary for fully loaded bridges.

The frequency diagram in Fig. 71 is also rather unnecessary. Weight being governed by loading, frequency varies with depth of girder, and depth is usually governed by considerations of design, such as head room and a need for a certain rigidity to reduce deformation stresses.

OTHER REMARKS ON FIGS. 71 AND 75.

The diagrams in Figs. 71 and 72, even if misleading in other ways, are interesting as showing it is desirable to keep the depths of girders as low as possible in spans from 100 ft. to 200 ft. But, practically, it is not possible to build low girders for these spans, because the overhead bracing interferes, except in England, where headway is very low. English railways would be wise to build their bridges for the future, and provide increased head room. In any case, depth should be sufficient to keep down deformation stresses.

The diagrams and list of bridges are also interesting, as they show that most of the girders are shallow and do not conform to modern practice in other countries. For this reason, it must be supposed that the Committee would recommend for modern design of girders even higher impact allowance than 147 %.

It is generally agreed that half this is more than sufficient, and the verdict of history proves that it is sufficient, for no girders designed by the Pencoyd method have been known to fail from impact. This being so, it seems certain that there are fundamental errors in the assumptions and coefficients on which the computations and recommendations of the Committee are based.

THE EFFECT OF IMPACT ON SHEAR.

The Committee's treatment of shear is very valuable. The effect of impact on shear load is very clearly explained in para. 107 *et seq.* The conclusion is that the allowance for impact in web members may be less than on the booms. This bears out the opinion I gave the Indian Committee, but which the Committee did not find evidence to support. Whether the Indian formula should be modified by

calling L the span instead of the loaded length is worth considering. Practical designers are rather in favour of keeping web members stronger than strict computation shows, for various reasons.

The diagram, Fig. 77, shows that the Committee consider the allowance for impact in web members of 150-ft. span, single track bridge, 15/15 loading, may be 18 % at the centre, 23 % at the ¾ point, and 32 % at the ends.

What the Committee have Accomplished.

The causes of impact have long been known, and there is no need to repeat them here. The Committee do not develop any new theory on the subject.

They have, however, experimentally verified by special apparatus that Professor Inglis' analytical investigations approximate to the effect of moving trains on bridges, provided that a correct appreciation is made of the coefficients and assumptions.

It was Professor Inglis' mathematical analysis which was published five years ago which enabled the Indian Committee to arrive at their conclusions.

The Committee have also proved experimentally that the amplitude of oscillation of the bridge is proportional to the hammer blow, if the engine is stationary in the centre of the bridge, and they assume the law applies to moving engines.

They also show experimentally that the greatest vibrations of the bridge occur when the frequency of the vibrations coincides with the frequency of the hammer blow, and that increasing the speed does not increase the amplitude of vibrations.

A valuable section of the Committee's work deals with shear as I have explained.

The Committee's Recommendations.

But it is with the practical results of the Committee's work that most engineers are concerned, and to understand them it is necessary to realize that English railways differ considerably from those of any other country in the world.

Owing to the smallness of the loading gauge it has not been possible to build large engines, and this has prevented the increase of goods train loads. The result is that, on English railways, it is the heavy passenger locomotive of high speed which controls bridge design, rather than a heavy goods engine. Moreover, the cramped space in which the working parts of the locomotive have to be fitted has forced engineers to design peculiar types of engine, and they have been forced to conclude that the largest type of locomotive ever likely to be put on English railway tracks will never exceed eight wheels coupled with 20 tons axle load. Even this can only be achieved with

four cylinders. The British Engineering Standard locomotive is a type which is suited to British railways only, and contemplates the use of four-wheeled coupled engines with axle loads 25 % higher than the goods engine. No railway outside England would be likely to use such a standard.

COMMITTEE RECOMMENDATIONS FOR ENGLISH RAILWAYS.

These considerations have led the Committee to decide that the heaviest locomotive is not likely to develop much hammer blow, the main cause of impact. They have in this way evaded their difficulty to a large extent by removing the cause of impact.

But while other engineers have realized that the hammer blow should be reduced as much as possible, it has hitherto been supposed that the expense of making four-cylinder engines, and the expense of running them, was not justified merely to get rid of impact. These engineers are, therefore, interested mainly in knowing what impact allowance the Committee gives for locomotives which unfortunately still develop a moderate hammer blow.

For these the Committee's report gives not much guidance. They specify the impact allowance for a few spans for certain engines with 15-ton axle loads, and with a rather high hammer blow. It is possible that high hammer blow is an unavoidable characteristic of English locomotives.

The Committee give tables and diagrams of uniform equivalent loads for various speeds, and they assert that with speeds of six revs. per second high impact effects are caused. Six revs. a second means that goods trains are running at 60 m.p.h. I did not know it was possible to run an eight-wheel coupled goods at this speed; it must be like running a Ford at 60 m.p.h., but the Committee did manage to run them at this speed.

Practically, 60 m.p.h. is not a normal working speed for goods trains, and it is not necessary to build bridges to that standard.

Similarly, six r.p.s. means running passenger engines at 90 m.p.h. Here again this is not normal working speed, and there is no need to provide for these speeds.

One could not imagine two such engines coupled running at 90 m.p.h., but that is the load which the Committee adopt for single line bridges. Still less could one imagine eight of this particular type of engine all passing the centre of a four-track bridge simultaneously at 90 m.p.h., and four of them in phase.

In a footnote to page 113 it is admitted that these speeds are abnormal, and have no application to fully loaded bridges, but if so, it is not clear why the Committee publish tables of loading for these speeds.

Application to Other Railways.

For a speed of $4\frac{1}{2}$ r.p.s., which is ample for all practical bridge design, the Committee's recommendations give results which may be compared in a few cases with practice hitherto adopted. The loadings to be allowed are arrived at by calculation, and the method of calculation is shown in Appendix J.

In order to apply the report to the requirements of railways of other gauges and other conditions of loading, these calculations would have to be followed for each case. Whether the percentage would work out the same for other railways, it is not possible to say, but the total allowance for British railways for locomotives of about 15-ton axle load, and 15-ton hammer blow, including lurching, may be compared with the general formulæ hitherto adopted.

The impact allowed for single track bridges, and two 15-ton unit locomotive with 15-ton hammer blow at 4·5 r.p.s., works out from the diagram 63 as follows :—

10 ft. span	70 %
20 ft. span	50 %
30 ft. span	50 %

and from the loadings on page 133, including lurching allowance for 15-unit locomotive

$$40 \text{ ft. span } \frac{164 + 17}{97} = \frac{181}{97} = 86\ \%$$

$$60 \text{ ft. span } \frac{228 + 23}{128} = \frac{251}{128} = 96\ \%$$

$$100 \text{ ft. span } \frac{323 + 35}{194} = \frac{358}{194} = 84\ \%$$

For longer spans the diagrams do not indicate impact load separately, but at 6 r.p.s. the diagram on Fig. 75 shows that 15-unit loading requires the following impact allowance.

$$150 \text{ ft. span } \frac{630 + 71}{284} = 147\ \%$$

I do not think anyone will accept these loadings. No one would care to allow only 50 % on 20 ft. spans, certainly not in India; it is not worth while.

90 % impact for 60 foot span is higher than the old Pencoyd formula, which is universally accepted to be far too high. The 147 % impact is quite unreasonable.

In view of the fact that these results fit in with no known experience, I cannot think that any engineer will trouble to go through the laborious calculations recommended in this report rather than trust to empirical allowances based on observation.

No doubt by shuffling the coefficients it would be possible to obtain

results to fit in with practice, but it would be difficult to have confidence in the answers. The calculations are most laborious, but the Committee consider that the Appendix J will enable bridge engineers to apply the theory put forward.

The assumptions and coefficients on which the calculations are based are numerous. Two engines are supposed to be stationary in the centre of the span with their driving wheels revolving free and in phase; the locomotives are idealized and the chassis weight and body weight are taken separately; coefficients for the frequency of the bridge, of the hammer blow, the engine body, and the damping effect of springs are required. This is for single-line bridge, and the calculations extend to three printed pages and include some graphic analysis.

For double tracks the assumptions are more complicated.

A very gallant attempt has been made to work out mathematically the allowance for impact, but the result tends to confirm what Mr. Stone said in 1892 about the nature of the compromise necessary to solve the problem of impact.

The investigation and explanation of all the detailed phenomena of impact have never before been more carefully examined, and I imagine the last word has been said on the subject from the point of view of the analytical investigator, but I think that, in future, bridge engineers will be content to design girders with the empirical allowance for impact based on experiments which cover all the different causes of impact, including chance, luck, personal error, and the state of the weather in one simple observation.

Whether bridge engineers, even of English railways, will accept the loadings recommended would seem to be doubtful. Rather than allow 147 % impact, it would be better to put a speed restriction on the engines with excessive hammer blow.

For those who have to prepare rules for the design and inspection of girder bridges, the report will provide much valuable guidance, but practical needs call for more simple methods of finding impact allowances than the laborious analytical method.

I may draw attention to the Committee's remarks on the question of relief of stress from floors and so forth. They decline to make any recommendation. They, like the Indian Committee, leave it to designers to allow for such relief, if it seems to be justified in any particular case.

In the result the Committee have advanced our knowledge of the effect of impact on shear members, and have generally carried the theory of impact further than it has hitherto been found possible, but their practical recommendations are likely to be viewed with some scepticism by those who design girder bridges for railways.

L. E. HOPKINS, *Lieut.-Colonel.*

"COLAS" ROADS.

A SECOND edition of this book has just been published by Colas Products Ltd., 38, Parliament Street, Westminster. A short note on the original edition appeared in the *R.E. Journal* of June, 1927.

The new book has been somewhat enlarged and brought up to date, as a result of more recent experience. It gives a very good account of the advantages of using "Colas," and describes clearly the best methods of using it under varying circumstances.

"Colas" is an emulsion of bitumen and water. The water carries the bitumen down through the interstices of the road metal, and on drying out leaves a film of bitumen, which acts as a grouting material and binder between the various pieces of stone. In this way the top portion of the road surface is consolidated and made waterproof.

The grouting can be carried out either as a "full" grout, in which case the emulsion can be made to penetrate to a depth of three inches below the surface, or as a "semi" grout, where the "Colas" only penetrates the top inch or so. It can also be used as surface dressing.

"Colas" is applied cold, and this is one of its main advantages. It can also be used under almost any weather conditions, other than hard frost. It is said to be equally satisfactory in the tropics as in colder climates.

Owing to the fact that no heating apparatus is required, it is specially suitable in those cases where roads have to be patched. The "Colas" is then applied by using ordinary watering cans, which can be filled on the spot from the metal drums in which the "Colas" is supplied.

For extensive work, the company supply "Colas" in 1,000 gallon tanks, fitted on a lorry chassis and equipped with an air-pressure feed and spraying jets.

The book contains useful specifications for the various types of work which can be carried out with "Colas," viz., full-grouting, semi-grouting, surface dressing, and patching, as well as surface dressing on wood paving, stone sets, or new tar macadam. There are also some useful tables of cost and quantities of materials required for various types of work. It should certainly be read by anyone interested in modern roadwork.

C. C. P.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE OFFICIAL HISTORY OF THE WAR—GALLIPOLI, VOL. I.

By BRIGADIER-GENERAL C. F. ASPINALL-OGLANDER, C.B., C.M.G., D.S.O.

(Heinemann, 1929. Price 19s. 6d.)

In this volume the author presents a well written, clear and readable narrative of the initiation of the Dardanelles campaign and of the operations connected with the landing up to the final failure of the attack to secure Achi Baba.

The narrative of events is fair and candid. Failure where it occurred is frankly admitted, and the reasons for failure are not represented as unavoidable.

The book is, however, written with a measure of reserve inevitable in an official history compiled so soon after a war.

The student will get from the book a good general pictur, cbut he will do well to read the Australian official history for a more vivid description of the almost inevitable confusion which has to be dealt with in an opposed landing. He will also have to consult other publications for a fuller grasp of the administrative problems.

In his preface the author discusses the questions whether, in 1915, an attempt to force the Dardanelles was strategically sound in view of the general situation, and if so whether tactically it was a feasible operation. To the former question he is clearly of the opinion that the answer is "Yes," provided that for the time being the British Army in France remained on the defensive and that the Dardanelles campaign became the main British effort.

To the latter question his answer is a more definite affirmative. Even as undertaken, the operations, he considers, were within an ace of success.

His opinion is that the whole story is one of lost opportunities. That cannot be denied, but the extent of the opportunities presented may be questioned. A greater initial measure of success might have caused the collapse of the morale of the Turkish leaders or of the less reliable Turkish troops. On the other hand, it might only have drawn Sir Ian Hamilton's forces into a more dangerous situation.

The book is in three parts, and with the appendixes gives most of the information essential to the strategical and tactical study of the operations.

Part I gives a very full account of the stages by which we drifted into the campaign, bringing out the lack of centralized control, co-ordination of effort, and a clear-cut plan. The facts must already be familiar to most students, and we have every reason to believe that the reconstituted Committee of Imperial Defence and the better understood duties

of the General Staff will safeguard us against a repetition of the mistakes made.

General Aspinall-Oglander corrects the view entertained by the Dardanelles Commission that the delay in the dispatch of the 29th Division had serious results. He points out that weather conditions would have prevented its employment at an earlier date. Incidentally, this brings out how little probable weather conditions appear to have been taken into consideration in the initiation of either the naval or military operations, a point which normally should have been one of the first to be taken into account. Actually, the landing was carried out at the most suitable date, which makes the premature naval operations, themselves handicapped by the weather, all the more regrettable.

When one comes to the military plans for the operations, it is a pity that the full text of the appreciation on which the final selection of the points of landing was based is not given in the Appendix.

The summary of the appreciation included in the text leaves the reader in some doubt as to the exact object of the double landing.

The orders and instructions contained in the Appendixes throw considerably more light on this point, especially the instructions to General Birdwood given in Appendix 5. It was evidently not anticipated that the Anzac landing would materially assist the Helles forces in capturing its initial objective, the Achi Baba ridge, but was designed to affect further operations against Kilid Bahr.

The effect of the double landing on the Turkish morale was no doubt great and with a less determined enemy might well have produced decisive results. At the same time, the risk of the Anzac landing receiving the full blast of a counter-attack by Turkish reserves and reinforcements was a danger.

A danger which would have been even greater had the initial success of the Anzac attack carried it nearer to its objectives. General Aspinall-Oglander considers that G.H.Q. underestimated the fighting value of the Turk, especially in power of manœuvre, and gives reasons why this underestimate, which evidently had a dominating influence on both strategical and tactical plans, was formed.

The great disadvantage which in practice the double landing entailed was that: it led to the simultaneous employment of the whole available force, and left little reserve of power in hand. Moreover, it employed the resources of the Navy to the utmost, and at neither landing was there a floating reserve, not committed to a time programme, available to take advantage of unforeseen opportunities. The lack of such reserves becomes very evident in the narrative.

The chapter in Part I dealing with the Turkish preparations and dispositions for defence repays careful study. It brings out clearly the difficulties which must nearly always present themselves in meeting a threat of overseas invasion; the uncertainty as regards the exact point of landing, and the inducement to dispersion consequent on this uncertainty. The advantage the defence has, if it can bring fire on to landing craft, is so obvious that the temptation to strengthen the "crust" at the expense of depth is very great. On the other hand, to make the whole "crust" strong enough to ensure that every possible landing place is guarded, and that the troops holding it have adequate cover

from concentrated fire of naval guns means great expenditure of personnel and labour. Troops are tied to their positions, and penetration at a single point may bring down the whole edifice of defence. The Turkish dispositions under German advice erred almost to the other extreme, and the forces detailed to the defence of the "crust" were surprisingly weak; to a degree not anticipated by the attack, and not recognized at the time.

The success of the dispositions owed not a little to the wonderful fighting qualities displayed by the Turkish soldier. Had he failed in any way, reserves would have arrived too late, and might well have been beaten in detail as they arrived.

Still, on the whole, the Turkish dispositions may be taken as fairly typical of what a landing force may expect to meet. The increased number of automatic weapons and the probably increased mobility of reserves, present increasing advantage to a policy of defence in depth and reliance on reserves.

The time taken to develop the defensive system should be noted. It is unlikely that a coast line can be permanently protected against landing operations, and it should seldom happen that the defence would have so long or so definite notice as in this case. In this connection, General Aspinall-Oglander brings out in several places the opportunities that may arise in the course of a war to undertake opposed landing operations, which would be quite out of the question as an initial step when the enemy was not committed elsewhere. He points out also the greater chances of preparing an expedition during the course of a war, without the enemy's knowledge, as compared with the difficulty of concealing preparations at the outbreak of war.

A nation that has no other commitment has a comparatively simple task in perfecting its defences from overseas attack. When, however, it has other commitments, the potential invader has power not only to exercise great strategic influence, but is also likely to discover weaknesses in the defensive arrangements should definite action become necessary.

Part II deals with the execution of Sir Ian Hamilton's plan, and is the portion of the book which contains most lessons for the soldier reader. The complexity of the arrangements which had to be made with the Navy for the actual landing stand out. These complexities seem to have diverted attention to some extent from the difficulties which would be encountered both in securing the beaches and in making progress from them inland.

The underestimate of Turkish efficiency and an overestimate in the effectiveness of naval covering fire also must have influenced the tactical plan. The arrangements with the Navy appear to have been based on the desire to get as many troops ashore as was quickly possible at a considerable sacrifice of tactical organization and control. Presumably it was considered that re-organization would be effected after the landing.

The operation of landing in face of opposition is probably best considered in two phases, each of which presents its special difficulties.

The first phase is the actual landing of the leading troops on the beaches and the capture of the enemy posts, which can bring small arms fire to bear on them. Surprise, darkness or naval gun fire may be

exploited to cover the approach to the beach. Once ashore, rapid and determined action by junior leaders must secure the primary footing, guided by clear orders issued beforehand.

There still remains the second phase of a further advance to secure a bridgehead position of sufficient depth to allow of the deployment of the main landing force. This covering position must be captured rapidly and without the assistance of the normal proportion of supporting weapons. The difficulties of this phase have increased immensely with the increased range and power of weapons, and a suitable organization for control is necessary.

The depth of the bridgehead and consequently the frontage to be secured have proportionally increased, while the effectiveness of naval covering fire must decrease rapidly as the advance progresses, owing to difficulty of observation and communication.

At Gallipoli, the first phase was carried through at the price of great losses and considerable delay, the absence of a floating reserve to exploit opportunities being a conspicuous defect. The second phase, at Anzac especially, was never really completed; the main force was expended in the attempt to secure the covering position. It was for the execution of the second phase both at Helles and Anzac that the orders and general plan appear most open to criticism, as they made the maintenance of control very difficult, and gave the O.C. covering forces tremendous tasks.

In the light of present-day doctrine it is interesting to consider whether the organization of the command of troops required to seize and hold the covering position could be improved.

In each case, at Anzac and at Helles, the covering position represented a frontage which either for attack or defence would have entailed the deployment of a whole division on a two-brigade frontage in a normal land operation.

Fighting was expected from the moment of landing, and therefore would it not be natural to deploy the Division on its battle frontage from the start? Was the idea of a special covering force with a single commander a somewhat stereotyped one, following the lines of the old doctrine of a special Outpost or Advanced Guard Commander?

At Anzac, the covering force was one Brigade and it was given an objective 6,000 yards in extent and an advance of at least 2,000 yards. Surely too great a frontage for one Brigade Staff to control without established signal communication and without horses. Moreover, the capture of the objective entailed an eccentric operation with the conflicting objects of flank protection and gaining ground towards the final objective. It is true a second Brigade was to follow and take over the protection of the critical left flank, but that did not relieve the O.C. covering force of the necessity of dispersing his Brigade initially.

A landing on a two-brigade front and the allotment of task accordingly would have given an organization in some depth. The Division Commander would then have been O.C. covering force, exercising his command through his two Brigade Commanders. They in turn would have been in the better position to exercise personal control, and devote their attention to their special task.

At Helles the same course in a more extreme form was taken. The

covering force and its Commander, Brigadier-General Hare, were detailed by G.H.Q.

General Hare was originally made responsible for five widely separated beaches, and in addition to commanding his own 86th Brigade had four other Battalions drawn from three different Brigades under his orders. It was realized that this was an impossible task, and eventually he was relieved of the responsibility for the two flank beaches, the Division taking over direct responsibility for them. Even then General Hare had a heavy task, as his three leading battalions landed at separate beaches, and he had an extra battalion added to his reserve on the *R. Clyde*. This reserve being committed to V beach from the first lost its mobility.

The troops on the " S " and " Y " flank beaches were drawn from the 87th Brigade, and the R. Naval Division, but were not under a Brigade Commander.

It had been intended to land the 88th Brigade, so as to take its place on the right of the 86th Brigade and the 87th Brigade (less two battalions) as divisional reserve, on the left at " X " beach.

Eventually, troops of these two Brigades became superimposed on the 86th Brigade. General Hare became a casualty at an early stage in endeavouring to exercise personal control. General Napier, commanding 88th Brigade, was killed in attempting to land in a situation of which he had no information. The dispersion of the Brigades made it more difficult to replace these Commanders.

It will be seen, therefore, that the normal Divisional chain of Command was abandoned at the start, and could not be re-established for some time.

The Divisional H.Q. became absorbed in the control of the fight on the three main beaches, and appears to have lost touch with the two flank beaches, where successful landings had been made which afforded opportunities of relieving the general situation.

Here again it would seem that if the covering force had been divided into two Brigade sections, the task of the Brigadiers and of the Division H.Q. would have been easier, and its control more effective.

The employment of the *R. Clyde* was an afterthought, and she was expected to perform two functions. One was to provide close covering fire to the landing parties, and this demanded that she should be beached at an early stage. The second and more important was to convey a reserve which should not have been committed till the point when it could best be employed was determined. The *rôles* were, in fact, conflicting.

General Aspinall-Oglander dwells on the opportunity which he considers was lost on " Y " beach. No doubt both there and to a lesser extent at " S " beach opportunities occurred.

It would not appear that the opportunities were deliberately created, as each of the detachments was assigned a protective rather than an offensive *rôle*. They were to serve as a bait to draw off Turkish reinforcements, and offensive action by them was not suggested until they joined in the general advance. As the opportunity that arose had not been anticipated, Sir Ian Hamilton was unable to lay his hand on reserves with which to exploit it.

Without reinforcement by reserves, neither had in reality much power of offensive action, as the force at each place was little greater than was required to secure the narrow footing obtained. It is possible that an advance from " Y " beach on Krithia might have affected the morale of the Turks opposing the main landing, but it appears more likely that it would have resulted only in the force being cut off from its landing place by Turkish reinforcements. Without artillery support, transport, or mounted troops to obtain information, radius of action was limited.

The fact that the 2,000 men landed at " Y " beach were numerically superior to the whole Turkish force south of Achi Baba at the time of landing is perhaps over-stressed.

What proportion of the 2,000 was actually available for offensive action? What degree of mobility did they possess? How far was their Commander tied by his orders, and how far was he handicapped by lack of Staff and responsibility for his own unit? This last factor must have been largely responsible for the ultimate misunderstandings which led to the withdrawal of the detachment.

Part III dealing with the attack subsequent to the first landing is a further record of the wonderful gallantry of the troops, but is of little value to the student.

The task was an impossible one without a degree of artillery support which the Navy could not provide.

The reader can hardly leave the book without speculating how far an opposed landing operation will be feasible in the future.

The increased proportion of automatic weapons and the air arm will increase the power of defence. Surprise will be more difficult. Transports, landing craft and crowded beaches will offer targets to air attack.

Mechanical transport will increase mobility of reserves of the defence.

Where the probable points of landing are well indicated and efficient arrangements have been made for defence by troops of good morale, the prospects of gaining a footing on the beaches must be practically *nil*.

On the other hand, the efficiency of the defence may still be affected by commitments elsewhere, the number of alternative landing-places and the lack of time to complete defensive arrangements, as was the case at Gallipoli.

The attack, too, has gained something. For the actual landing operation much will depend on the amount of naval air support, and whether an air base can be secured from which air support can be provided and local air supremacy obtained.

Naval gunnery against land targets has advanced, though it still must work under great disadvantages in dealing with points of resistance encountered inland and keeping touch with the position of the troops it is supporting.

More efficient landing craft and tanks may play an important part in gaining a footing on the beaches. It is, however, in the problem of securing the bridgehead position that tanks are likely to exercise a great influence. The necessary dispersion of the defence will make the anti-tank problem difficult, while the rapidity of tank action may anticipate arrival of reserves.

This book records how an operation, which had been examined during a period of peace and which had been turned down by military opinion as

too hazardous to undertake, had to be attempted owing to circumstances which had not been envisaged.

We must conclude that the study and practice of landing operations is as much as ever necessary for a maritime nation, and this history must be read at least as an introduction to such study.

It is well to remember the statement made by Mr. Asquith, quoted in a footnote, p. 62: "It is the duty of any Government . . . to rely upon the advice of its naval and military counsellors . . . but . . . sometimes it is not only expedient but necessary to run risks and encounter dangers which pure naval and military policy would warn you against."

C.W.G.

THE VICISSITUDES OF ORGANIZED POWER.

By The Hon. Sir John Fortescue, LL.D., D.Litt.

(Oxford, at the Clarendon Press, 2s. 6d.)

The Romanes Lecture for 1929 was not addressed to soldiers, but it will well repay them to read it. Sir John Fortescue took as his subject the growth and development of the organized forces with which peace and order have been maintained and are still maintained throughout the Empire. He emphasized a trait which seems to be peculiar to these forces of ours, that they are not overbearing nor arrogant in carrying out their work whether in war or peace. This characteristic he derives from the experiences of the British Army. Long years of trial and endeavour have bred in the Army a tradition of service, obedience, and sacrifice. The story of the growth of this tradition through the interplay of character and history is absorbing. The author claims that the chief influences are, firstly, two centuries of national hostility to the Army; then, the existence of the purchase system, which gave full play to the proprietary instinct so strong in the English country gentleman; and finally, the interaction of these influences on the British character. He closes with a tribute to the officers and men who have unconsciously inspired every soldier and constable, of whatever race and creed, with the spirit of the British Army. We should be proud to belong to a service which has inspired such praise, and of which it can be said that "possibly centuries hence historians may agree that through the peculiar schooling and character of the British officer and soldier, *Pax Romana* was eclipsed by *Pax Britannica*."

N.W.N.-C.

MILITARY ENGINEERING.

Vol. VIII.—Railways, 1929.

(War Office, London: H.M. Stationery Office, Adastral House, Kingsway, W.C.2. 8½ in. x 5½ in. 318 pp. and 49 plates. Price 2s. 6d. net.)

(Reprinted by permission from *The Railway Gazette*, dated 7th June, 1929.)

The manuals of military engineering have all been revised in the light of the experience gained in the Great War, and the necessity for this naturally applies with particular force to the volume on railways, since

transportation in all its forms plays a supreme part in modern warfare. It is interesting to have the axiom laid down on the first page of this manual that "Railways have demonstrated their marked superiority over all other means of land transport as a means of moving large forces and material in bulk over long distances in a reasonable time." In spite of mechanized warfare, there seems no danger of motor competition here.

The manual is divided into three sections, dealing respectively with railways in war; operating; and engineering. The first section discusses generally the railway problem in a theatre of war, lines of communication, and repair and demolition of railways. Part II deals with operating principles, locomotives, rolling stock, layouts, signals, operating practice, control and emergencies. The third part covers location, earthwork and drainage, bridges, permanent way, track-laying and maintenance, and fixed equipment. The volume is amply furnished with illustrations, tabular and other data, and with a full index. It will doubtless be studied by engineer and railway reserve officers, and may, indeed, be recommended to railway officers and students generally as presenting a clear and straightforward account of operations which do not differ in principle as between military and civil practice. We note that the description published by *The Railway Gazette* of the construction of the Kassala line in the Sudan is quoted at length in an appendix.

PRACTICAL HORSEMANSHIP.

By Captain J. L. M. Barrett, 13th/18th Hussars.

(H. F. & G. Witherby (1929), Price 12s. 6d.)

This book is written for the novice of all ages, and contains chapters on advanced work and practical hints on horse and pony buying.

The great art of training and riding a horse leads to many various ideas and theories being put in print, and the author rightly says in his preface that "riding" is a very "controversial subject." Captain Barrett starts away right at the beginning of things with his novice, and outlines the course of instruction which should be given to the beginner, and gives his ideas on the various essential attributes which go to make the complete and finished horseman, illustrating his remarks with photographs which are, in most cases, excellent, and any novice who is really imbued with the determination to ride a horse well, will be well advised to adhere to the course laid down for him, and to imbibe the theories explained in these chapters.

Very great stress throughout is laid upon learning to "jump" properly, though insufficient reasons are given for this greatest and foremost essential in learning to ride. The author draws a rather exaggerated picture of our forefathers' horses, every single one of which became "either (1) a confirmed refuser, or (2) that despicable type of animal that would not jump in cold blood, or (3) he put up with it, and was worth a fortune to real bad horsemen with a lot of money." Though these bare statements are believed by many who study the subject in the light of modern teaching, they are not convincing to those who are now learning, and who are surrounded by fathers and mothers of the old school, and which latter local authorities have to be primarily convinced of the

soundness of modern teaching by good sound argument, which is, in this book, somewhat lacking as a foundation for the very sound principles advocated.

The chapter on "hands" is extremely sound in the very limited length to which it goes, insufficient being said about fundamentals, such as the position of these very important portions of the rider, whether they should be kept with the palms upwards or with the palms downwards, and how they should move when brought into action. Merely a few general remarks as to where the hands should be held and in what general manner they should act in relation to the horse's mouth. The real novice requires to know much more than is given here, and further, the general actions so strongly advocated by the author cannot be properly produced by a horseman who holds his hands upside down, even though they are "placed as low as possible, without appearing set or fixed, over the withers, with the wrists slightly rounded." There are no less than three separate and distinct positions in which the hands can be held, which comply with these vague words, and only one of which is the one the author means. In short, Captain Barrett has in this subject fallen deeper into the pit which he describes in the opening sentence of his chapter than most authors.

The chapter on advanced jumping falls necessarily under the heading of "controversial," and it is difficult to follow why one, whose earlier chapters are full of such sound teaching, so obviously the result of good reasoning, should be so easily led into giving the plausible arguments which Captain Barrett sets down in his explanation of what he calls "The 2nd Method—The Foreign Style," or in plain English, the method of "leaving it to the horse."

Singularly unfortunate is the choice of example, as Captain Barrett quotes "Lieut. Bizard, the brilliant French Army horseman," as the best illustration of this particular method, and in doing so, his choice has fallen upon one of the world's greatest artists in "timing." Those of us who were privileged to watch Lieut. Bizard riding his young horse Arcachon to victory in the *Daily Mail* Champion Cup at the International Horse Show at Olympia this year, would find it a hard task to reconcile that consummate display of skill on the rider's part, with the picture drawn of him in this book. The author seems to have fallen into the pitfall of assuming that a very fine horseman is doing nothing, because he is doing a great deal so quietly and so nicely, as to be inaudible to the gallery and invisible to those who are not very closely attentive. It would be interesting to know what Lieut. Bizard would say, did he know that he had been quoted as one who advocated "leaving it all to the horse," even to the extreme of making no effort to keep his horse balanced in the last few important strides of the approach.

In the two chapters on difficult horses and bitting, a great deal of sound advice, only partially supported by reasoning, is to be found by the novice and the author brings a new question into the field of controversy by stating that "it is useless to punish a horse *after* a refusal," a theory put forward and advocated by no other authority on the subject.

Captain Barrett's "Hints on Buying Horses for Beginners" is a first-class chapter, and should be read, and the lessons of it should be learnt by heart, by all novices at this very difficult art.

Practical Horsemanship is full of very sound advice to the novice, as to how he should set out to learn to ride a horse, particularly if discussed with some knowledgable person who can throw light on the more controversial points, and give sound reasons for the methods advocated, but it is a book which should be in the possession of all, novices or those with more experience, who have at times to buy themselves horses. They would be well advised to read through the chapter on buying horses on every occasion before setting out on that fateful expedition.

S.A.H.B.

LES INONDATIONS DU FRONT BELGE (1914–1918).

MAJOR DU GÉNIE R. DEGUENT, Professeur à l'École d'Application de l'Artillerie et du Génie de Bruxelles.

(With photographs and sketches. Paris Edition, Berger-Levrault.)

The substance of this book has already appeared in the form of articles in the *Revue du Génie Militaire*. A précis of these articles appeared in the following numbers of the *R.E Journal*: December, 1928; March, 1929.

MAGAZINES.

REVUE DU GÉNIE MILITAIRE.

(*February.*)—An article entitled "The Economical Employment of Engineers in 1928" describes various works of practical utility on which Engineers were employed in accordance with the standing orders for the training of that branch of the Service, of which the following is an extract: "Chief Engineers will take every opportunity of employing their troops on works of real utility. To this end they will negotiate with landowners, civilian contractors and communes, and will arrange for the units under their command to carry out works of a public or private nature."

For example: in July, the 2nd Regiment was sent to the Alps to widen from three to six metres the formation of the future road from Peille to the Col de Segra. In August, the 17th Regiment, on the application of the autonomous port of Strasbourg, sent a detachment to dismantle the two footbridges over tributaries of the Little Rhine and construct a pile footbridge over the Brunnen-Wasser. The 15th Regiment provided detachments to construct a light railway to the camp of Bitche and to lay 1,400 metres of light railway from Cerisier-Signal to the main line. The 17th Regiment, on behalf of a civilian contractor, blew up a barge loaded with stone which had foundered in the Rhine. The 33rd Battalion (Levant) constructed a post at Zélaf, 80 kilos east of Souéida.

Interesting photographs of many of the works are given, including some of those carried out after the floods and cyclone in Algeria.

There are also articles by General Normand on the systems of fortification practised by Vauban, and a description of a suspension bridge for vehicles of 2½ tons by Captain Pinson.

(*March.*)—Chef de bataillon Tournoux contributes an article called "Ideas on permanent fortification, the importance and object of permanent *points d'appui*." In it he describes the fighting which took place during the recapture by the French of Fort Douaumont. It had been

abandoned by them on Feb. 25th, 1916, after being disarmed, under the mistaken idea that permanent works were no longer of any value. A vivid description is given of its bombardment by the French and its recapture on May 24th.

The successful attack made by the Germans on May 27th, 1918, on the 13-kilo-long position of the Chemin des Dames is cited to show how valuable a system of concrete *points d'appui* would have been.

The defence of Froideterre, situated at the end of the long ridge which stretches from Douaumont to the south-west, is described. It was a small permanent work intended for a garrison of 142 men, with two turrets for machine-guns, and a turret for a 75. Like the other works at Verdun it had been disarmed, but was given a garrison of 134 officers and men and 8 machine-guns. It was heavily bombarded from June 21st, and assaulted on June 23rd, 1916, but put up a successful defence until a counter-attack drove the Germans off.

"The railway from Thiès to the Niger," by Chef de Bataillon L. J. R. Faure. In the November number of the *Revue* there was an account of the construction of the railway from Thiès, near Dakar on the coast of Senegal, to Kayes, on the Senegal River. A line had previously been constructed between Kayes and Koulikoro on the Niger, so that after the completion of the first mentioned line there was through communication between Dakar and the French Soudan at Koulikoro. It was hoped that the rapid economical development of the Soudan and an ever-increasing traffic would follow. This expectation has only been realized in part owing to the inferior construction and indifferent management of the older line, which was begun in 1882 for strategical purposes.

This article describes the measures taken and to be carried out to put the Kayes–Koulikoro line on a proper footing.

This number contains an obituary notice on General Normand, whose death occurred on March 7th as the result of an accident. He was a most distinguished engineer officer, and became *Directeur du Génie* at the Ministry of War in October, 1927.

(*April.*)—"Passage of the breach of Villeneuve, near Soissons," by Colonel Lastours, contains an account of the repair of the railway bridge over the Aisne at Villeneuve, between Soissons and Laon, in April, 1917. The bridge consisted of three masonry skew arches of 21·75 metres span, of which the two southern arches and the southern abutment had been destroyed. The piers were rebuilt in concrete, and the broken abutment replaced by a pier and a short span on to the bank. "Marcille" girders (steel plate) were used to replace the arches. The work was carried out under considerable disadvantages, as the site was at first under machine-gun fire, and for the whole time was liable to bombardment. In May, 1918, the French failed to destroy the bridge in their retreat, but the Germans made no such mistake in September. The "Drainage of an Aerodrome," Lt.-Colonel Grellier, describes how the level of the subsoil water under the aerodrome at Pruniers, near Romorantin, which stood 10 cm. below the surface, was lowered by about half a metre.

This number contains a translation of the article by Lt. J. C. R. Fitzgerald-Lombard on "The Work of a Mechanized Field Company during Divisional Training," which appeared in the December number of the *R.E. Journal*.

A.H.B.

MILITARWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*November–December number, continued.*)—*The Influence of Propaganda amongst Prisoners of War in Russia upon Austro-Hungary's Collapse.* The writer of this article, having been deputy chief to the Austro-Hungarian War-prisoners' Mission in Russia, had special facilities for making enquiries as to the propaganda among the prisoners. He arrives at the conclusion that the immense influence of the Russian revolution upon the subsequent course of internal political events in the states of Central Europe could only in a very slight degree be attributed to those who returned from captivity, since the revolutions in Austria and in Germany originated in those industrial circles which were least in touch with the army, and hence with the returning prisoners. It is curious that he does not mention the fact that very many of the prisoners were unable to get away from Siberia until long after the revolutions had taken place.

The last Battle of the 12th Mounted Rifle Division. The commander of this division (now a Lieut.-General in the Polish Army) writes a short diary of the division's doings from the 26th October, 1918, when, in the final Allied offensive on the Piave, it was attacked in the Sergnalia sector, to the 11th and 12th November, when, after having been the last body of troops of its size to cross the Austrian frontier, under arms and with military discipline, the four brigades entrained at Tarvis for their respective demobilization centres (8,000 strong with 4,000 horses).

The account claims to prove that formations, even when composed of troops of different nationalities (in this case Austro-Germans, Czechs, Poles and Hungarians), if trained on well-established principles, and led by officers imbued with the spirit of arms and keeping themselves apart from politics, will do their duty to the utmost.

Soldiers will find the account interesting as one more example of what military history has taught throughout the ages, viz., that a high enough military spirit can fuse together quite discordant elements.

Railway Services during the Collapse in the autumn of 1918. The railways of the Austro-Hungarian Empire, which had fulfilled all requirements during mobilization and for over four years of war, found their most difficult task with the homewards flooding of troops from all fronts.

Demobilization instructions had indeed been drawn up in 1917, laying down both principles and preparatory measures, but they were based upon the idea that peace would follow an ordered armistice. When the collapse came, the result was chaos on the railways. Only the self-sacrificing work of the railway personnel was able to effect in barely four weeks a mass movement which had been calculated according to plan to take five months. The cost was enormous, both by destruction and loss of army material, much of which fell into the hands of the quickest grabbers and other war-hyenas.

Submarine Warfare, 1914–18. This article is responsible for the statement that Germany lost 763,000 lives in consequence of the hunger-blockade: otherwise it discloses little that is new. It quotes both Lloyd George and Lord Churchill (*sic*) as evidence that Great Britain only just escaped being defeated by the unrestricted use of submarines, started by Germany on February 1st, 1917; and points out that it was the

United States which saved us, by providing the destroyers necessary for the convoy system, which defeated the submarines.

In complaining finally that the cruel words "Too late!" must be written over Germany's last, powerful, and hopeful attempt to finish the War in honour, even if not in victory, the author (a sailor) disregards—he could hardly overlook—the great land offensive of 1918.

The Civil War in China. The narrative by General von Mierka is continued. It covers the entry into the War of the Governor of Shansi (brought about by one of his subordinates starting hostilities against Chang Tso-lin): the events of the winter of 1927-28, from Chiang Kai-Shek's return to the great Customs Conference in March: the quite thrilling campaign of 1928, up to the death of Chang Tso-lin: and the Mongol effort against Khailar. The author knows his East, throws instructive sidelights, and is always clear and entertaining.

The Offensive in Wood-fighting.—Consists of two examples of wood-fighting on the Russian front, from which Lieut.-Colonel Kissling deduces that, while increased weapon-effect has changed tactics elsewhere, the tactics of wood-fighting, in which tanks and aircraft play no part, has remained unchanged.

The Italian 12-in. Howitzer. Major Heigl interrupts the ordered sequence of his series of articles on artillery-material to describe what is both the most powerful gun used against the Austrians during the War and still the best of its kind. The 30·5-cm. Howitzer L/17 was originally designed for coast defence, but the Austrians knew before Italy entered the War that thirty of them had been made mobile for the field. Of this number, at least fifteen fell into Austrian hands during the 1917 advance. The Austrians got out new tables, and took them into use. Since the War, the range has been increased by improved projectile from 14,600 metres to 17 kilometres. L/17's construction in many ways points to its English origin, as a product of the Armstrong-Pozzuoli works in Naples (*e.g.*, wire-winding, enlarged rear end of chamber, method of breech-closing), and Major Heigl feels impelled to suggest that the excellent quick-loading arrangements (which appear again in the new American 16-in. coast defence gun) were purposely neutralized by breech-closing arrangements (three motions), which even in 1912 were out of date, because Italy was at that time Germany's ally.

The photographs show the 12-in. howitzer on the line of march, in the firing position (ordinary mounting), and in the firing position as mounted by the Austrians.

The Motor-lorry as Railway Engine. A demonstration was held at the end of last year at Korneuburg, before the Press and other interested persons. An ordinary four-wheeled motor-lorry has its fore part carried on an eight-wheeled bogey, and the steering becomes automatic. The bogey and the railway trucks run on the rails, while the lorry's driving wheels run on the metal outside the rails. For this system is claimed that it combines the good properties of the wagon which runs economically on rails, and of the motor-tractor on a road, which provides a good tractive performance as a result of the great friction between wheel and road surface.

The disadvantage of the ordinary train, viz., that the tractive-power depends on the weight of the locomotive, and the disadvantage of the

motor-lorry on a road, viz., that on account of steering and braking difficulties it is not able to tow more than one trailer, are both done away with. As no great adhesive-weight of the engine vehicle is necessary, lighter rails can be used, and both rails and general construction of field lines are sufficient for the motor-lorry engine system.

The whole, especially the automatic-steering bogey, has been worked out by Major-General Tlaskal, formerly D.M.T. in the Austro-Hungarian Army. Practical use has been made of it in Uganda, the Transvaal, Rhodesia, Australia, India, and other British colonies and dominions, also in Scotland, in Spain, and in the Spanish theatre of operations in Morocco.

For steep slopes and soft soil the wheels have been replaced by caterpillars, also having automatic steering.

The mounting and dismounting of the lorry takes two men four to five minutes. At the demonstration, automatic steering functioned perfectly on 10 metre radius curves at a speed of 18 m.p.h.

The system is recommended as doing away with the necessity for locomotives on lines where there is little or only periodical traffic, the lorry being available for road work in the meantime, and especially for military purposes for getting lengths of light railway quickly into use.

The French new Medium Tank.—The *Bulletin Belge* announces as under trial in France a 20-ton tank which carries a field-gun as well as four machine-guns. From Poland also, the replacement of the old Tank Mark V* of the War by a 20-tonner has been confirmed.

The appearance of such a tank, especially in France, is sensational, since it appears to be directly in opposition to the views of the French school. The explanation is possibly that the new light tank, which from English sources is reported to travel up to 37½ m.p.h., is too weak to take the field against strong anti-tank defence, except under special protection.

The English new Six-wheelers.—Quotes from a lecture by Major Kuhne at the R. United Service Institution, and shows a photograph of a six-wheeler car carrying 10 men on four transverse seats, the pairs of which face inwards as in railway carriages.

An interesting feature is the provision of a small fourth pair of wheels, near the driver's feet, the object of which is to engage when crossing ditches, and thus prevent the fore-wheels from falling in too deeply.

Tracks are carried on both sides above the four rear driving-wheels, so that the car can be quickly converted to half-track.

As regards the provision of bullet-proof pneumatic tyres, the English are not so advanced as the French or the Czechs.

All these 6-wheel vehicles, with two axles driven, give very satisfactory results across country as long as the country is not altogether too rough.

F.A.I.

COAST ARTILLERY JOURNAL.

Mention was made in the June issue of the *R.E. Journal* of an article on the World Coal Situation contained in the December number of the *Coast Artillery Journal*. On April 9th, *The Times* called attention to Britain's lag in electrical power, and mentioned the World Power Conference which proposes to "establish standard methods and values for

assessing the power resources of the world, to obtain such methods and values through the collaboration of 48 countries, and to carry out as rapidly as possible a survey of the world position on this basis."

The Conference has just published an initial volume—*Power Resources of the World, Potential and Developed*—which gives details of the basic work carried out in those countries, including the British Dominions, United States, Central European States, Germany, Holland, Russia, China and Chile. The opinions, as far as they can be obtained in the early days of the research, vary considerably: the estimates of the world's coal resources vary from $5\frac{3}{4}$ to $10\frac{3}{4}$ million million tons. From the coal output of 1927, it is roughly calculated that the coal reserves of the world will not be exhausted for some 4,000 years, at the present rate of production. This rate of exhaustion varies from about 50 years in some European countries to a very far distant age in the case of the United States.

The exhaustion of the oil fields, on the other hand, is mentioned as being within sight, 40 years being one estimate.

The most accurate estimate, however, seems to have been made with regard to water-power, though a great deal of co-ordination is still required to obtain any working basis. The latest figure given appears to be in the neighbourhood of 500 million H.P.

The world's output of electrical energy is reported to be 190,000 million units, of which the United States control nearly half, while Great Britain's portion is only about 5%. Great Britain's present rate of progress, even, is less than that in the United States, Germany, Canada, Italy or Switzerland, so it is hoped that the proposed national power scheme will soon begin to make up for lost time.

Germany, Russia, France, Spain, Italy, Belgium, Austria, Czecho-Slovakia, Hungary, Greece and the Dominions all propose to carry out ambitious schemes for the complete electrification of their countries with a view to decreasing the cost of production of their industries.

The American Bureau of Mines finds that the percentage of power derived directly from coal, when compared to the power derived from electricity, oil, gas, etc., has fallen from 88·5% in 1913 to 77% in 1927. Electrical power, on the other hand, has increased its ratio from 3·4 % in 1913 to 11 % in 1927. Economic values are rising ever more rapidly.

The March number continues the historical narrative of the origin and gradual growth of the system of coast forts along the South Atlantic.

In the same number there is also an article entitled " Ships on the Battlefield," concerning the use of tanks in land fighting. Last November, the new Christie tank of the U.S. Army Light Tank formation covered 144 miles along a road, " between breakfast and lunch," though the actual time is not stated.

After the description of a manœuvre between a combined, unarmoured, unmechanized Corps of all arms and an up-to-date mechanized force, in which the light tanks irrupted unannounced into the cavalry screen and broke it up, the author deduces two lessons. First, that " cavalry should be the first to recognize, teach and apply the improved methods which fast, cross-country fighting machines will provide," to assist them in their work. It will be remembered that some of our own cavalry regiments have already been transformed into A.C. regiments. And secondly, that

" changes in tactics, far more radical than those caused by aircraft, have come to stay."

The May number contains an article on the rôle of the new 37-mm. AA gun which has been under trial. This weapon fires a shell with a fuse sufficiently sensitive to produce detonation on contact with the fabric of an aeroplane. A hit on any part may therefore disable it and put it out of action. The fuse is provided with a time scale to ensure detonation in the air, so as to preclude eventual danger to ground troops and others from heavy falling missiles. When compared to other AA weapons, its performances are as follows: Max. vert. ranges: 3-in. gun, 16,800 ft.; 37-mm. gun, 10,000 ft.; 50-cal. M.G., 6,000 ft. Max. hor. ranges: 3-in. gun, 5,400 yds.; 37-mm. gun, 3,000 yds.; 50-cal. M.G., 2,000 yds.

For use at minimum ranges, the 37-mm. gun is as easily manipulated as the heavy machine-gun: it is capable of picking up an enemy plane in a few seconds and delivering directly-aimed fire till overhead, and can be used against targets flying under 1,500 ft. It is furnished with tracer ammunition. It could probably deny effective enemy observation under 9,000 ft., and would thus be of use only in the forward areas in place of the machine-gun. And even for this quick work it is hampered by its present mounting on a trailer which has to be towed. It must be placed in position before it can deliver fire, and must be dismantled to return to the road. When in position, its covering power compared to the M.G. is as 12 is to 8. It would, therefore, seem to be useful only as a more efficient machine-gun if made more truly mobile.

There are two detailed articles on the care of seacoast armament when laid up, giving instructions which have been proved in practice and found to give good results: the whole trend of the article is to cut down the numbers of caretakers by centralizing the safe storage of all moveable parts.

In a well written essay on " Imperial versus National Sea Power," the author traces the present " agreement to disagree " in the matter of cruisers, to the announcement in 1920 that Great Britain would be satisfied with a one-power standard as regards her navy. It will take time for the average Englishman to become reconciled to this great departure from his long-standing tradition, for tradition is part of his being. The present difference of their needs is stated lucidly. " It is a fairly accurate generalization to state that, while the British Navy exists to fight, the American Navy exists to avoid fighting." " With reasonable steadiness in Washington, we need have no fear of a *casus belli* from London." " The naval needs of the United States . . . are in some measure fulfilled by a fleet in being, rather than by a fleet in action."

The former articles on Colonial Forts are followed by one on " The Colonial Forts on the Pacific Coast." Vasco Nunez de Balboa discovered the " South Sea " in 1513 and annexed for Spain the whole ocean and all lands washed by it; some gift, even for His Most Catholic Majesty of Spain. Magellan made the South Pacific a Spanish lake, and Cortes strengthened the hold of Spain by the military occupation of Mexico and California. In 1542, Juan Rodriguez Cabrillo confirmed possession by the discovery of San Diego harbour and his expedition reached Cape

Blanco in Oregon. The lure of gold and gems beckoned the Spaniards on to twenty or more voyages along the coast up to the forty-third parallel of latitude or about Cape Blanco, but without permanent occupation; Estevan Jose Martinez in 1788 reached the sixtieth parallel and examined the Russian settlements as far as Prince William Sound.

Meanwhile, other discerning eyes found the same attraction when Francis Drake made his memorable voyage in the *Golden Hind* in 1578. Though it was not till 1778 that England was again upon the scene, when Capt. Cook mapped the far north-west from Norton Sound through Bering Strait to Icy Cape, beyond the seventieth degree of latitude. From that time the Pacific shores were well known to British, French and American navigators.

But all this time the Russians had been creeping in from the north-west. In 1728, Vitus Bering sailed through the strait that bears his name, and found that Asia and America were not united by land. Many others followed, but without lasting success till about 1769, when Levarscheff established Russia's claim to Alaska.

In 1769, Spain made her first real attempt to oust all her rivals by fortifying San Diego and Montery; in 1770, the harbour of San Francisco was discovered by Don Gaspar de Portola, the military governor of California. The settlement consisted generally of a religious mission protected by a small garrison, the frontier being guarded by a line of small forts or "presidios." Later, the defence of each presidio was increased by a battery of eight twelve-pounders. These were in various states of preparedness or decay, according to the spirit of the commander of the occupants. Some of the details of the garrisons in 1773 are illuminating; at Montery, the capital, there were a Commandante, a serjeant, two corporals, twenty-two soldiers, two carpenters, two blacksmiths, four muleteers and a storekeeper: at San Diego, the same garrison, but in the charge of two serjeants; while for each of the five principal missions there were five corporals and twenty-five soldiers.

San Francisco was occupied in 1776 and Santa Barbara in 1782. At the first important inspection of the coast defences, by Governor Jose de Arrilago in 1792, it was found that there was only one small gun of questionable serviceability at San Francisco, while at Montery there were certainly more guns, but no gunners to work them. His successor in 1794 found that San Francisco and Montery had a few guns, but that the rest of the province was quite defenceless: and what must have disturbed him was the fact that his sovereign had just declared war on France. He had less than 300 soldiers in the whole country, and they were scattered in twenties and thirties all along the coast.

The fortifications seem to have still been so neglected in 1803 that a British brig, mounting six three-pounders, put the forts at San Diego out of action in three quarters of an hour. There were but eighteen artillerymen assigned to about the same number of batteries dispersed along the seaboard of California.

In 1812, the Russian governor of Alaska sent a force of about one hundred Russians and a hundred Indians to establish a settlement at what is now known as Bristol Bay, and form a trading post for the Russian-American Fur Company, but in 1841 they abandoned the site.

In 1818, two privateers under a Frenchman named Hippolite Bouchard

stormed and carried the forts at Montery, destroyed the presidios and plundered the inhabitants. After he had put to sea again, the forts and the presidio were rebuilt on up-to-date lines and were put into good condition for the first time. In 1822, Mexico became independent, with California as one of her provinces. In 1824, a Russian explorer, named Kotzebue, entered San Francisco Bay, and, according to his own statement, had to lend the governor of Fort San Joachim the powder with which to fire a salute in his own honour.

In October, 1842, Commodore Thomas Jones, of the U.S. Navy, commanding the frigate *United States*, together with the sloop *Cyane*, entered Montery harbour, thinking that Mexico was at war with the United States. He captured the fort and raised the American flag before he discovered his mistake. The next day he hauled down the flag, apologized to the Californian authorities, and sailed away. The master of the American ship *Alert* did much the same thing at Point Guijarros.

War was actually declared by Mexico against the United States in 1846, and Commodore Sloat, commanding the American Pacific squadron, was ordered to secure possession of Upper California. He landed and seized Montery, Yerba Buena and San Francisco, the Sacramento forts, Bodega and Sonoma without a fight, and California was ceded to the United States by the treaty of 1848.

The forts further north on the Colombia River and Vancouver were merely fortified trading posts to protect the activities of the Pacific Fur Company and the North West Fur Company, which became amalgamated in 1821 into the Hudson Bay Company. In 1856, the treaty between Great Britain and the United States fixed the forty-ninth parallel as the permanent boundary between America and Canada.

In 1741, the first Russians, Chirikoff and Bering, brought back such beautiful furs from an expedition across Siberia to Alaska, that they roused the envy of Russian traders and trappers, so that, in 1784, the strong Shelikoff Trading Co. established its first settlements on Kodiak and Atogniak Islands and in Cook Inlet. Later on, a rival firm, the Lebedeff-Lastochkin Co., fixed its permanent headquarters in Cook Inlet also. The history of these various fortified posts surges backwards and forwards in guerilla warfare between the Russians and the Indians for years, a tale of sanguinary massacre and reprisal. In 1833, the Hudson Bay Co. fitted out an expedition to establish a post on the Stickeen River. Baron Wrangel, the Russian governor of Alaska, got wind of the attempt and dispatched an armed brig to anticipate the British. When the unsuspecting fur traders sailed into the harbour they were greeted with a sudden volley of heavy fire from the Russian ship, as well as from a fort on the shore. The British were forced to withdraw to Vancouver. This attack provoked a diplomatic incident between the two countries, but was settled in 1840 by the payment of an indemnity by the Russians and the lease of the land to Hudson Bay Co.

Finally, after a period of continuous Indian warfare, Alaska was sold in 1867 to the United States for seven million, two hundred thousand dollars.

In an article on the "Activities of Anti-war Societies," the author mentions a list of eighty-seven organizations in the United States, each complete with its board of directors and salaried officials, in well-equipped

offices and with a membership ranging into millions. Their main class of propaganda is religion or communism. Their method is to affiliate with foreign organizations of a like nature and develop an international pacifism, and to use this influence to begin with a reduction of armaments, leading progressively on to the abolition of all armed forces.

The assistance of the sincerely religious pacifist is heartily welcomed by the communist at present; they are both pushing in the same direction to begin with. So were Lenin and Kerensky. But in their final aims they are widely separated, and the honest pacifist will be thrown over, to his own undoing, when the time is ripe for the more deadly work which is, as yet, unseen.

In the April number is an interestingly written historical account of "The First American Offensive," when Washington led his forlorn hope against the hitherto victorious British at Trenton at Christmas, 1776.

The Continental Army was scattered beyond the Delaware, and a bitter winter had set in. Spies were numerous and busy on both sides. Gen. Grant at New Brunswick knew on the 24th December exactly what Washington had said at a very secret conference of the American leaders a few days previously. Washington's scouts, in the guise of loyalists, mixed quite freely with the British High Command.

Washington decided to attack the Hessians on Christmas night, and trust to his staunch allies, supine self-confidence and soothing Christmas fare. The watchword was "Victory or Death." Though the Hessians had been warned of an impending attack, the surprise was complete, and the issue of the engagement was settled within the hour. Of the attacking force it is reported that two were killed; of the defenders, the commander and about a hundred men were killed, about a thousand were taken prisoners, and the rest escaped.

This was the first of the victorious events which culminated at Yorktown. D.M.F.H.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1929. TOME I.—NOS. 1 TO 6 INCLUSIVE.)

Les opérations de l'Armée belge (1914–1918). The account of the Line of Communication services during the trench-warfare period is continued in No. 1. The matters dealt with are those which relate to the medical services; the duties allotted to the "Inspection générale de l'armée" created in September, 1914; and the transport services. When the Lines of Communication of the Belgian Army were extended to the Base formed in France, the main responsibilities of the "Inspection générale de l'armée" were those connected with recruiting boards, training centres and the depots for convalescents. The routes utilized for the supply services, and the measures adopted for the defence of the same, are briefly touched upon, and a short account is given of the part played by the railways and internal waterways in meeting the requirements of the Belgian Army. The Belgian State Railways remained under civilian control and management after the outbreak of war, and the Chief of the Railway Administration made the necessary arrangements for meeting the needs of the Belgian High Command. In 1914, the only military railway unit in Belgium was a company attached to the fortress troops in Antwerp; during the first few weeks of the War, this

company was not employed on duties connected with the transport of troops or supplies. When the Belgian Base was established in France, an International Commission, consisting of representatives of Great Britain, France and Belgium, was created, with Headquarters at Calais, for dealing with the railway requirements of the troops on the Western Front. As the War progressed, developments naturally took place in order to provide for the increased needs of the Belgian Army in relation to railway transport. Eventually, Commissions were created for the management of the railways, and for the control of the traffic arrangements and staff. The railway troops were also increased, and when the Armistice was signed in 1918 the Belgians had an engineer railway battalion (4 companies—total strength 2,000 all ranks) ; a field railway section ; a light railway section ; and a platoon for traffic duties.

A supplementary account of the Battle of the Yser appears in Nos. 2 and 3. It deals with the struggle in the Tervaete bend on October 22nd, 1914, when the Germans managed to force the passage of the Yser. It has been felt that, in view of the fierceness of the fighting, the critical nature of the situation created by the temporary success of the Germans, and the heavy casualties suffered by the Belgians, a more detailed account of these operations than that already published is desirable ; accordingly, the result of a further study of the events of the day in question is now placed on record in the two numbers of the *Bulletin* referred to above.

Avant-Postes réduit. This article appears in No. 1. Colonel De Haene, its author, points out that the reduction, in given circumstances, of the force employed on outpost duty is by no means a novel idea, the old regulations and instructions of the Belgian Army having tacitly recognized that a reduction in the *normal* strength of an outpost line might occasionally be permissible. What is entirely new is the fact that, in the recently issued Belgian Service Manual and Books of Instruction relating to the tactical training of the troops, definite and explicit rules are laid down on the subject. Colonel De Haene bases his discussion of the matter on the specific articles—which are duly indicated— on the subject contained in the official Belgian publications.

Emploi de la défense terrestre contre aéronefs. This article is contributed by Colonel Molhant, and appears in No. 1 of the *Bulletin*. The general principles of anti-aircraft defence are briefly stated. Colonel Molhant divides the defended area into three zones, viz. (1) *the forward zone* ; this is the area extending along the fighting line, and has a depth of 10 km. ; it is continuously under hostile artillery fire and under constant attack by enemy aircraft. (2) *The rear zone* ; this is the area contiguous to the first named, and reaches back to a depth of 40 km. from the common boundary of the two areas ; it is subject only to intermittent attack by enemy aircraft ; and (3) *The interior zone* ; in this zone, enemy action takes the form of raids at more or less wide intervals of time. Colonel Molhant sets out the nature of the defensive measures, which seem to him to be most suitable for adoption in each of the zones in question ; he further discusses the problem of anti-aircraft defence in relation to Belgian territory, and the Belgian Army. It is pointed out that at present only a very weak and inadequate anti-aircraft defence force exists in Belgium, and it is urged that, in view of the proximity of the

important Belgian industrial and commercial centres to the frontiers of adjacent countries, measures should, without delay, be taken to remedy the deficiency in relation to this branch of the national defence. Colonel Molhant also desires to bring home not only to the civil authorities, but to the whole population, the peculiar nature of the dangers associated with air attacks, so that schemes for providing the necessary protection against this form of attack may be worked out in good time and be ready for instant adoption.

Les armées dans les Alpes occidentales. The second and third parts of the article under this title by Major Delvaux are respectively published in Nos. 1 and 3 of the *Bulletin*. The second part deals with the passage of the Alps by Hannibal. The subject is treated, *inter alia*, under the following heads: the character and manners of the Carthaginians; the military power of Carthage; the causes of Carthage's weakness during the struggle with Rome; the Revolt of the Mercenaries; Livy's character sketch of Hannibal; Hannibal's election, at the age of 26 years, to the command of the Carthaginian Army in Spain on the death of Hasdrubal; his success at Sagunto; the march on Rome; the forcing of the passages across the Pyrenees and over the Rhone; the conflict with hostile tribes, nature and the elements during the march across the Alps. Hannibal's Army, much attenuated, eventually camped in the Valley of the Po, but, in order fully to reap the fruits of the arduous march across Italy's mountain barrier, it was necessary that a decisive military success should be gained; nothing less than that Rome should be occupied. However, this prize proved to be out of Hannibal's reach, and, in consequence, Victor Hugo's paradoxical saying concerning Napoleon—*il était vaincu par sa conquête*—is, Major Delvaux points out, equally applicable to the Carthaginian general.

The third part of the article deals with the passage of the Alps by Napoleon; the subject is discussed, *inter alia*, under the following heads: the creation of the Reserve Army in January, 1800; the principle of the division of powers and ministerial responsibility, whereby it was ruled that the First Consul could not directly command the Army; Marescot's reconnaissance of the Alps in the early spring of 1800; Napoleon's plan of campaign; the final instructions to Berthier; the passage of the Alps by the Reserve Army; the resistance put up by the defenders of the Fort at Bard, and the construction of the improvised route *via* Albaredo in order to turn the enemy's position; and finally, the arrival of the French Army in the plains of Lombardy.

L'offensive. Progression au contact d'une division chargée d'une attaque de flanc. The original article is contributed to No. 2 of the *Bulletin* by Colonel Hans, who discusses therein the question whether, on the outbreak of another important war, the belligerents are likely soon after the commencement of hostilities to be forced to adopt trench-warfare, or, on the other hand, a war of movement will be possible. Colonel Hans brings under review some of the recent foreign literature dealing with this matter, and, at the same time, comments on the doctrines inculcated in the German and Belgian Service Manuals.

Tannenberg. D'après les ouvrages officiels allemands. The second and third parts of the article under this title, by Captain Vandaele, are published respectively in Nos. 2 and 3. In the second part of the article

an account is given of the successful operations carried out by the Germans against the Corps operating on the flanks of the Russian Army of the Narew. The situations of the two Armies are set out, and the steps taken by the German High Command on August 24th and 25th to solve the problem before it are explained. The operations of the German I and XX Corps on August 26th, 1914, which resulted in the victory near Usdau, and those of the German XVII Corps and I Reserve Corps on August 26th and 27th, which resulted in the victory near Gross Bössau, are described.

The third part deals with the operations by which the isolation of the Russian Centre was effected. A description is given of the general attack of the German forces against the various fractions of the Russian Army on August 28th, and the pursuit of the latter on the following day. Maps, which clearly indicate the important situations, are provided.

Les opérations de l'armée belge (1914–1918). The account of the operations of the Belgian Army during the period of the stabilization of the battle fronts is begun in No. 4 of the *Bulletin*. In introductory paragraphs, it is pointed out that, although it was on rare occasions only during this period that attention was publicly called to the operations in progress on the part of the Allied Front held by the Belgians, nevertheless this section of the line was far from being a *secteur de repos*. The many difficulties encountered in the region of the Lower Yser, and the special arrangements which had to be made owing to the waterlogged character of this low-lying area are described in some detail. The casualties suffered by the Belgians at various periods from November, 1914, to September 15th, 1918, are set out; the total loss amounted to 1,220 officers—of whom 319 were killed in action or died of wounds—and 41,793 other ranks—of whom 9,543 were killed in action or died of wounds. The average strength of the Belgian Army during this period was 137,000 all ranks. A table is given showing the length of the front held by the Belgian Army at various dates, and its strength at the same time: on 10.11.14, approximately 11 km. of front were held by 69,000 men (39,000 rifles); by 6.6.16, the Belgian front had been gradually extended to about 32 km., when it was held by 140,000 men (64,000 rifles). The Belgian Army reached its maximum strength, viz., 162,000 men (65,000 rifles) at the beginning of July, 1917; on 7.7.17, the length of front held by this force was about 23 km. The Belgian front was again extended gradually, and on 6.6.18 it stretched from the sea to the Ypres-Zonnebeke road (about 38 km.). A sketch map is provided; on it are marked the positions of the Belgian flanks at certain dates.

The events on the Belgian front during the period November 11th to December 8th, 1914, and the instructions issued to Divisional Commanders on November 18th, 1914, setting out the main lines on which they should organize their defensive arrangements, are also contained in No. 4 of the *Bulletin*.

The events during the period December 9th, 1914, to January 25th, 1915, are dealt with in No. 5. Towards the end of November, 1914, Joffre had decided to take advantage of the withdrawal from the Western Front of German troops, which had been transported to East Prussia in order to take part in the Russian campaign. He now proposed to resume offensive operations. Accordingly, a request was made to the Belgian

High Command to take over a part of the allied line in Flanders held by the French ; this request was acceded to, and the Belgians, in consequence, extended their front southwards from Dixmude to Knocke Fort (9 km.) during the night of December 8th/9th, 1914. A sketch map is provided, and shows the distribution of the Belgian divisions during the period 9.12.14 to 25.1.15. The operations carried out in the neighbourhood of Nieuport by French troops during the latter half of December, 1914, and the part played by the Belgians to divert the enemy's attention, are briefly touched upon.

The events during the period January 26th to March 10th, 1915, are dealt with in No. 6 ; between these dates, the activity on the Belgian front was confined generally to bombardments, and a few actions of minor importance involving enterprises, usually unsuccessful, undertaken by the Germans against the Belgian advanced posts. At one point in the Nieuport sector, however, the enemy succeeded, after a violent bombardment, in driving small detachments of the Belgian 4th Division from their trenches ; a counter-attack for the purpose of regaining possession of them failed, and, in consequence, a new position—300 m. further back—was taken up. Towards the end of January, 1915, the Belgian High Command was requested to take over a further section of the front held by the French ; the texts of a note (dated January 21st) sent to the French Mission agreeing to the proposal, and the orders issued on January 24th to the Belgian Divisional Commanders in relation to this matter are reproduced.

During the winter of 1914–1915, the inundations along the Belgian front caused, at times, considerable inconvenience ; the measures adopted to cope with the situation are briefly described in No. 6.

Les armées dans les Alpes occidentales. The final part of the article on this subject, by Major Delvaux, is published in No. 4 of the *Bulletin*. In it are discussed, *inter alia*, matters connected with the time taken in moving armies over considerable distances ; the military use of railways ; the intervention of Napoleon III in Sardinia's cause ; the railroads of the French Alps ; the military uses of motor transport ; the assistance rendered to Italy by her Allies during the Great War ; and the frontier zone of the Alps.

Major Delvaux points out that the utilization of steam-engines and other forms of self-propelled vehicles has brought about a great revolution in the technique of transport ; both the tonnage of a military convoy and also the speed of its movements have been, for instance, enormously increased. To-day, the solution of strategical problems is more than ever dominated by considerations affecting supply magazines and munition dumps. Hence, we find that large armies are almost rigidly tied to the railroads in the theatre of operations.

Major Delvaux touches upon the American "Dispatching System," which was adopted during the Great War on the French and Belgian railways, and gives an estimate of the economies claimed to be effected thereby.

An outline is given of the measures adopted in 1859 in connection with the transport of the French Army of 140,000 men collected by Napoleon III at Paris, Nancy, Lyons and on the foothills of the Alps for the Italian campaign. The traffic capacity of the roads and railways leading from

France into Italy was found to be insufficient to meet all the requirements of this force, and, in consequence, a part of it had to be conveyed by shipping to Genoa. The steps taken to meet the supply requirements of this force during the campaign are touched upon.

Details are given of the motor routes and railroads which existed in the Western Alps in 1917, and the uses to which they were put in September and October, 1917, when a reinforcement of heavy artillery (with its ammunition) and an allied force of 150,000 men were sent to the Italian front for the purpose of repairing the situation created by the Caporetto disaster. Stress is laid on the fact that whereas in 1859, after being conveyed by rail to the lower slopes of the Alps, the French troops under Napoleon III had to march through the mountain passes on foot, on the other hand, during 1914–1918 the allied infantry was carried to its destination by rail and motor vehicles, and the artillery and cavalry alone made the passage of the Alps by road.

Tannenberg. D'après les ouvrages officiels allemands. The final part of the article by Captain Vandaele is published in No. 4. It deals with the last phase of the Battle of Tannenberg (August 30th and 31st). The Russian North-West Army was superior in numbers to the German Army in East Prussia. Samsonof's force was composed of five corps, a fusilier brigade, and five cavalry divisions; the Germans were in a position to bring into the field only three active corps (two of which had already suffered heavy casualties in the fighting near Gumbinnen and Stallupönen), a reserve corps and a reserve division. The remaining troops under von Hindenburg consisted of Landwehr and Ersatz formations, which were not properly equipped for the purpose of taking part in a war of movement. The opposing forces were constituted as follows:—

	Germans.	*Russians.*
Infantry:	153 bns. ... 144,000	175 bns. 175,000
Cavalry:	58 sqdns. ... 9,000	99 sqdns. 16,000
	153,000	191,000
Machine-guns	 296	384
Field-guns	 728	612

It is claimed that, in these circumstances, the victory of Tannenberg must be attributed to the superiority of the German generalship; it constitutes a record, being the biggest successful encircling movement known to history since the days of Leipzig, Metz and Sedan. Not only was the German attack delivered against a superior force, but at the time both flanks of von Hindenburg's army were also threatened by superior Russian forces. Military history affords no second example of a success obtained in similar circumstances.

Quelques aspects de la campagne des auto-canons mitrailleuses en Russie. The original article appears in No. 6, and is the reprint of a lecture given at Antwerp in February, 1929, by Major-General Semet, of the Belgian Army, who describes therein his experiences whilst serving with the Belgian Expeditionary Corps in Russia during 1916 and 1917.

Remorque-citerne pour char léger Renault. The original article is contributed to No. 6 of the *Bulletin* by Lieutenant de Grave; it contains a description, with illustrations, of a trailer to accompany tanks. The vehicle has been designed to meet the requirements of the *Section Tech-*

nique des Chars d'assaut of the French War Ministry; successful experiments with this type of trailer manufactured by the *Societé anonyme des Usines Renault* were carried out by the French Army during the Morocco Campaign in 1925.

W.A.J.O'M.

REVUE MILITAIRE SUISSE.

(1929. NOS. 1 TO 6 INCLUSIVE.)

L'évolution probable de la guerre. This article is contributed to No. 1 of the *Revue* by Colonel Lecomte; it deals with a theory advanced by Emile Mayer in the last chapter of his book, *Trois maréchaux: Joffre, Galliéni, Foch* (pub. in Dec., 1928, by the Librairie Gallimard, rue de Grenelle, Paris). Mayer has the reputation of being a prophet; many years before 1914 he foretold, in the pages of the *Revue*, that in a war on a large scale on the European continent there would be a stabilization of battle-fronts. He now predicts that land forces will, in the near future, *almost* completely disappear, and the duties of such units as may continue to be retained will then be concerned alone with the maintenance of order and with colonial enterprises. He thinks that "in fact, the orthodox principles of strategy and tactics will cease to have a *raison d'être*. The military art will also disappear. Posterity will no longer have a need for generals of the type of Joffre, Galliéni and Foch."

Colonel Lecomte suggests that if Mayer's latest prophecy should prove to be a correct prediction, then all the civilized powers are at the moment astray in relation to the military policies being pursued by them: France, in her new law relating to national defence, is aiming at the introduction of a military organization which will embrace the whole of her population, men and women; Switzerland is wedded to a mild form of conscription for the purpose of maintaining a land force of the old type; even the League of Nations recognizes that a military force of the Swiss type is a necessity for every self-respecting nation.

Mayer's prediction is based, needless to say, on the assumption that, in the future, the hostile activities of belligerent nations will largely, if not exclusively, take the form of aero-chemical warfare. Colonel Lecomte has made a careful and interesting examination of this question in his article. He admits, of course, that a very considerable development of aero-chemical warfare is inevitable in a future campaign, but he is far from agreeing entirely with Mayer's conclusions. He accepts the view that aviation has reduced the value of cavalry, and also, at least, of heavy artillery, but he points out that, on the other hand, the engineering arm retains all its former importance, and, indeed, he suggests that the more industries progress, the more pressing will be the demand for technical troops, and, at the same time, much more important and varied will necessarily be the duties which they will be called upon to undertake.

Les armes d'accompagnement de l'infanterie. The original article is published in Nos. 1 to 4 inclusive of the *Revue*; it is a translation of a contribution by Captain Däniker to Nos. 9 and 10 (issues for Sept. and Oct., 1928) of the *Allgemeine Schweizerische Militärzeitung*. The evolution of the supplementary weapons of the infantry and the tactical requirements giving rise to their introduction are dealt with in No. 1 of the *Revue*. It was in Germany, Captain Däniker points out, that an

attempt was first made to make practical use of the lessons to be learnt from the Russo-Japanese War; in 1905, a *Minenwerfer* was constructed and handed over to the Pioneers of the German Army for trial. Later, lighter types of this weapon were introduced into the Kaiser's Army; the weapon was intended originally for the purposes of fortress warfare. However, in the early days of the Great War when the battle-fronts became stabilized in the Western Theatre, the importance of this type of weapon as a supplementary armament for the infantry in the field warfare became evident, and it was accordingly issued to it; at the same time, steps were taken to increase the mobility of this weapon. The successive developments which took place during the progress of the Great War in the armament of the infantry of the belligerent armies is traced by Captain Däniker.

Tactical requirements are discussed at some length by Captain Däniker, and his conclusions are then summarized. It is pointed out that the chief *desiderata* in the supplementary infantry armament are simplicity in design; ease of manipulation; facility of maintenance in good order; and robustness, *i.e.*, capability of continuous use without jamming, etc., so as to inspire the utmost confidence in those who have to handle such weapons in action. Captain Däniker recognizes that the number of types of weapon comprising the supplementary armament of the infantry should be as small as possible; the same weapon should be capable of effective use both against hostile tanks as well as aeroplanes when flying low.

The technical considerations affecting the supplementary infantry armament are very fully discussed in Nos. 2, 3 and 4 of the *Revue*. Particulars relating to various types of infantry weapons which have been brought into use, and the requirements of the Swiss Army, are also dealt with in No. 4 of the *Revue*.

La neutralité belge et le plan de campagne allemand. The original article is contributed to No. 2 of the *Revue* by Colonel Lecomte, who deals with the plan of campaign on which the opening phases of the Great War; he calls attention to the views in relation thereto contained in Dr. Bredt's recent work: *Die belgische Neutralität und der Schlieffensche Feldzugsplan* (pub. by Georg Stilke, Berlin, 1929: 10 mk.). Incidentally, Colonel Lecomte mentions that Dr. Bredt has treated the subject with great impartiality, and has avoided special pleading. The question which occupies the greatest prominence is whether the Great General Staff was right in its conclusion that, in a war on two fronts conducted simultaneously, only one plan of campaign could rightly have been considered as affording a promise of success, namely, an offensive, in the first instance, directed against France, involving an invasion of Belgium, coupled with a defensive attitude on the Eastern Front. Colonel Lecomte suggests that up to 1892 the plan outlined was not the one most generally advocated in Germany; in support of his contention, he cites the German plan of campaign prepared in 1891, which is discussed by Reginald Kann in his work, *Le plan de campagne allemand de* 1914 *et son exécution* (pub. by Payot, Paris, 1923, 10 fcs.). In the sketch plan showing the dispositions of the German forces for the execution of the 1891 plan, three armies are shown attacking at the Gap of Charmes, whilst three others are "slipping" along the Belgian frontier for the

purpose of crossing the Meuse just N. of Verdun. The plan put in force in 1914 appears to date from 1905. In the year last mentioned, von Schlieffen carried out a War Game based on the supposition of a war in which the two Central Powers, Germany and Austria, were opposed by a coalition consisting of France, Russia, England, Italy, Rumania and Serbia! It was then that the new doctrine took shape: "defeat the most dangerous enemy, *no matter how*, before the others are ready."

The much discussed question whether Germany's failure to win the War was due to the modifications in von Schlieffen's plan made by von Moltke, the younger, is examined by Colonel Lecomte: his opinion is that the modifications made by von Moltke were not responsible primarily for the German failure, which, he suggests, was due really to the erroneous view taken of the situation as a whole by the Great General Staff. Colonel Lecomte's appreciation of the situation can be summarized as follows: in any case, the major part of the Austro-Hungarian Armies would necessarily have to operate on the Eastern Front; if the Germans, therefore, had decided to support them vigorously on the outbreak of the War, the chances are that the Russians would have been completely beaten in sufficient time to allow the Central Powers to throw their full weight successfully against the Anglo-French Armies on the Western Front. Accordingly, the invasion of Belgium was not only a moral wrong and political blunder, but at the same time a military error of considerable magnitude.

La guerre aéro-chimique et la défense anti-aérienne. The original article, two parts of which are published in Nos. 2 and 5 of the *Revue*, is contributed by M. S. de Stackelberg, an Engineer. A reference is made in No. 2 to the aero-chemical experiments carried out by the American Chemical Warfare Service at the Aberdeen Proving Ground (U.S.A.). Questions relating to the employment of aircraft for bombing and chemical warfare purposes are discussed in the first part of the article, and the considerations affecting anti-aircraft mobile and fixed defences are also examined therein.

A description, with illustrations, of the new Varaud clockwork fuse is given in No. 5, in which the technical considerations relating to anti-aircraft defence weapons are also dealt with.

Un précurseur, le Colonel Julius Meyer. This article appears in No. 6, and is contributed by Colonel Lecomte, who deals with problems of former times and of to-day, relating to frontier defence. Attention is called to the mobile cupola designed by Colonel Schumann, of the Prussian Engineers, and constructed in 1886 by the Gruson Firm, at Buckau, and to the theories relating to the use of the same advanced, some 40 years ago, by Julius Meyer, of the Swiss Army, whose ideas were in advance of his times. The adoption of tanks in the Great War meant the realization, Colonel Lecomte points out, of Meyer's prophetic vision, and it is a matter of considerable interest, now that France has taken steps to fortify her new frontier, and particularly the region of Metz, to learn that Meyer's ideas are to be incorporated in the scheme of frontier defence which has been adopted by the French War Ministry.

W.A.J.O'M.

THE BUILDER.

The Builder of June 21st mentions a way of treating a concrete floor to prevent the formation of dust from hard use. Silicate of soda or water glass (or magnesium silico-fluoride, which is better, though more expensive) should be applied as a wash, so as to form a hard silicate of lime (converted into fluorspar in the second case) in the top layer of the floor.

The method employed is to scrub and cleanse the surface thoroughly with several changes of clean water and to allow it to dry out completely before each operation. The solution should be made fresh immediately before use, by dissolving one gallon of commercial silicate of soda in four gallons of water; the resulting five gallons should not be stretched over more than 1,000 fs. of surface for each coat. Apply the solution with a mop or hair brush over the whole floor in one continuous operation, and brush in well, without stopping, for several minutes to obtain an even penetration. At least 24 hours in dry weather to several days should be allowed for the surface to dry and harden, after which it is scrubbed again with clean water and allowed to dry for the next operation. Three such coats in this manner will produce a very hard surface of uniform appearance.

The softness in a concrete floor may be caused by an excess of cement or overtrowelling of the surface; it is not sufficiently appreciated that the true wearing surface of a concrete floor consists of the portions of the exposed aggregate, and that, for this reason, the aggregate must be itself hard as well as properly proportioned and graded, so that it may form almost the entire area of the surface.

D.M.F.H.

REVUE MILITAIRE FRANÇAISE.

(*April*, 1929.)—The fifth instalment of Lieutenant-Colonel Grasset's "*Montdidier, le 8 août, à la 42e division*" describes the situation after the first rush of the division was over, and before a further advance could be made. The German resistance had begun to stiffen, the barrage was lost by the infantry, and by ten o'clock the whole division had come to a halt. There is little of special interest in this instalment.

"*Après la conférence de Rabat*," by Général Meynier, is a most interesting article on the inter-colonial conferences, now held annually in Northern Africa, and their results. In 1923, M. Millérand made a journey through Northern Africa, and was surprised to find that each colony was separated from the other as if by water-tight compartments. He instituted, therefore, these conferences, and they have been held at Algiers, Rabat (in Morocco), and Tunis. Since 1924, there has been only an interval of one year without a conference, due to the Rif fighting. The writer points out that the time for a governor over the whole of French Northern Africa is not with us yet, but he makes it quite clear how the country has advanced since the conferences started. The most striking development has been the marking out of tracks across the Sahara, combined with an excellent system of wireless telegraphy; and naturally the pacification of the country has progressed accordingly. Northern Africa is now recognized as part of France for defence, and naturally its development adds greatly to the forces which can be produced, should France go to war again.

"*Rôle et instruction des interprètes,*" by Colonel Paquet, is an important article on the training of intelligence personnel for war. He points out that the intelligence officer must understand the staff system, and realize what is the general situation, before he is fit to ask questions as an interpreter. Colonel Paquet, therefore, recommends that a school be formed for the instruction of reserve intelligence officers, the final aim being that the second (or intelligence) bureau will eventually be largely staffed by interpreters. An advance has already been made by an increase in the lectures which interpreters of the reserve must attend; but, as Colonel Paquet points out, more is required for all interpreters to achieve the necessary standard.

"*La structure générale des campagnes offensives de Napoléon,*" by Général Lemoine, is yet another discussion of the Emperor's methods. It is pointed out how he would begin a war on a wide front, contract for battle, and open out again in pursuit. The object of the article is to show how we can still learn from the study of Napoleon's campaigns, in spite of the development of material and man-power since his day.

(*May*, 1929.)—The sixth instalment of Lieutenant-Colonel Grasset's "*Montdidier, le 8 août, à la 42e division,*" describes the capture of Mezières and the Bois du Dé, followed by a temporary calm over the whole battlefield just after mid-day. The calm was due to the disorganization of the enemy and the movement forward of the French guns.

"*Le problème abyssin,*" by Commandant Cornet, describes the present situation in Abyssinia. After considering the country, climate and people, the writer goes on to study the rivalry between France, Italy and Great Britain. The Abyssinian empire, being the sole native survivor of the different states of Africa, is naturally unwilling to give way to the pressure of either of the three European countries, and Commandant Cornet explains clearly how far they have been successful.

In "*Les services de la Xe armée pendant les offensives de 1916 sur la Somme,*" Général Thévenet describes the L. of C. organization used during the great battle. The article is not particularly interesting, but it does show the enormous back organization required to set in motion a force (720,000 men in the army) during trench operations.

Capitaine Marchal begins an interesting article entitled "*La VIIe Armée Allemande en Couverture en août 1914,*" in this number. This Army, under command of General von Heeringen (whose previous career is clearly sketched), had two tasks :—

(*a*) To cover the German concentration by holding Upper Alsace. Any combined hostile attacks were to be met by a withdrawal across the Rhine.

(*b*) The protection of the Grand-Duchy of Baden after the move of the 6th Army (on the right) into Lower Alsace.

In opposition was Dubail's 1st French Army. He had received orders to advance into Alsace, and the first movement was carried out by the 7th French Corps. In this instalment the writer describes the Corps advancing to a position ready to descend into the lower country of Alsace on 7th August.

"*Trois conférences à l'Etat-major de l'armée en 1902,*" by Général Palat, describes three lectures given after the South African War. One was by Captain Fournier, who finally commanded the 8th Corps in the

Great War, the other two by Lieutenant-Colonel Berrot, of the 3rd Bureau (Operations). Although sensible lessons were drawn from the British mistakes in South Africa, it was not realized in these lectures that artillery would not always be far less dangerous than small arms. In South Africa the percentage of small arms casualties was far greater than that due to artillery fire; but we know well now that this by no means held good during the Great War. What was clearly brought out from the lectures, however, was that the form of war to be employed must depend on the training of the soldier and the armament available.

(*June*, 1929.)—The seventh instalment of Lieutenant-Colonel Grasset's "*Montdidier, le 8 août, à la 42e division*," brings us up to the preparations for an attack on Fresnoy, towards the evening of August 8th. The advance of the division, laid down beforehand, had definitely come to an end; but orders were received to push on in spite of the fatigue of the troops. These instalments give so much detail over such short periods, that they are really only of interest to those who actually took part in the battle.

"*La défense antiaérienne des grandes unités*" is an important article by Lieutenant-Colonel Vauthier. He discusses first the methods adopted by other countries, and then turns to what is required in France. It is pointed out that anti-aircraft artillery will either consist of special weapons for this type of work or of ground weapons used for fire in the air. Lieutenant-Colonel Vauthier considers that both types may be employed with advantage in the French Army. This instalment concludes with a specification of what would actually be required in a division and in a Corps.

In the second instalment of Capitaine Marchal's "*La VIIe armée Allemande en couverture en août* 1914," the preparations for the German counter-attack are described. A sketch map indicates the concentration of the German forces and General von Heeringen's orders are given. His final plan was to crush the French left, but, in spite of a considerable German superiority of force, the attack was too late to effect this plan. The instalment closes with the German 14th and 15th Corps just coming into action.

Général Armengaud begins "*La pacification de l'Afrique encore insoumise*" in this number. As he points out, there are three stages to be completed, penetration, occupation and policing of the area. He then shows that General Lyantey's maxim, "With the natives one must always show strength, so as not to have to use it," is more than ever true in these uncivilized countries. The modern method of action is first to combine political methods with the threat of air action. If this is not successful, air action follows, supported by the threat of ground action, which can be brought into force when required. After the penetration has been successful, occupation and policing can be carried out, largely by air action. The writer contrasts the French advance in Northern Africa with the British operations by air since the Great War, in Iraq and on the N.W. Frontier of India; and he makes it quite clear that air forces, provided that they can be supported on the ground, reduce enormously the casualties and difficulties previously experienced in these countries.

"*La Genèse de Neufchâteau*," by Commandant Pugens, describes the

events leading up to the battle of Neufchâteau, where the French were nearly successful in inflicting a serious check on the German 4th Army. This army was commanded by Duke Albrecht von Würtemberg, probably the most efficient of the German royalties who commanded armies at the outbreak of war. The Army had a difficult task from the start, as it had to be in a position either to turn south to support the 5th Army on its left, or to intervene in the more important operations of the 3rd Army on its right. In this instalment the writer deals with the preliminary orders issued by von Moltke, and the early moves of the 4th Army. H.A.J.P.

HEERESTECHNIK.

(*October.*)—*Motorization Questions in Foreign Armies, the Belgian Artillery.* Compiled from an article by Major-General Pierret in the *Bulletin Belge des Sciences Militaires*, from which it appears that the Belgians are inclined to be conservative in this matter. One is prepared for this attitude by an early statement of Belgian conditions, viz., that the rise in the price of petrol, high taxes, and expensive repairs requiring specially skilled workmen, have in many places lately brought about an increase in the amount of horse-traction: that in agriculture the mechanical tractor is now less used: that the total number of horses in Belgium has so much increased lately that the number exported annually is greater than before the War.

The author's answers for Belgium are: for infantry guns, cross-country tractors: for divisional artillery, horses: for artillery with cavalry divisions, horses, or, if howitzers are introduced, cross-country tractors: for corps and army artillery, tractors: for anti-tank guns and anti-aircraft guns, self-propelled carriages: reserve artillery to be carried on lorries.

The Great German Wireless Exhibition, 1928. The chief object of interest this year was something connected with wireless, but not essentially wireless in nature, viz., electrical vision. Two methods of electrical vision, those of Mihaly and of Karolus, were shown, the one among and the other next to the historic and instructive exhibits of the national Post-office.

For electrical vision, as for picture-telegraphy, which has already taken its place alongside music and speech, as a thing broadcast for entertainment purposes, the essentials are that the object to be shown at a distance by electrical means must be capable of being broken up into minute areas, that these areas must be capable of being touched off in rotation, that their differences in shade be electrically transmitted (by wires or wireless), be re-converted at the distant station into light differences, and the corresponding picture re-assembled.

For picture-telegraphy, since the areas are touched off in rotation, only one channel of communication, wire or wireless, is necessary. For electrical vision to be truly simultaneous, as many channels of communication would be necessary as the enormous number of small squares into which the picture is broken up. This, of course, is out of the question; but fortunately it does not matter. Since the inertia of the human eye causes it to receive as simultaneous images occurring as much as ·1 second apart, the simultaneous touching off of all the small picture-

elements, and their simultaneous re-assembly, are unnecessary. The elements need only to be touched off in sufficiently rapid succession. Thus, a picture 1 decimetre square (say 4 in. x 4 in.) contains 10,000 squares of 1 mm. side; ·1 sec. only is available for all parts of the picture to appear simultaneous; therefore picture-elements must be dealt with both at sender and receiver at the rate of 100,000 per second.

Both systems shown at the Exhibition are capable of this speed. Mihaly uses at both ends a disc with holes in it arranged along a spiral. Considering, then, any rectangle past which the disc rotates, light shining through the holes in the disc will fall upon that rectangle in a series of parallel curves. In one rotation of the disc as many lines of light will traverse the rectangle as there are holes in the disc, each line being 1 mm. further from the centre than the preceding one.

Mihaly's cycle is: source of light, lens, transparent picture, rotating disc with holes, light-cell, current-conductor, glow-lamp, lens, rotating disc with holes, screen. Perfect synchronization and the perfect sensitiveness of the glow-lamp are the chief features of this system.

Karolus also uses the light-cell method, *i.e.*, the touching off is done by a light-ray, and not by the metal pencil of the telautographic method (*v. R.E. Journal*, Sept., 1926). Karolus' method differs chiefly in that the source of light at the reception-end is not current-controlled; but a steady light falls upon a Kerr-cell. The principle upon which this cell is built is the Kerr-effect, by which changes in the double refraction phenomenon of certain liquids, like nitro-benzene, follow without inertia changes in the incoming current.

With all due appreciation of what has been achieved, it must be admitted that electrical vision is still deep in the laboratory stages, and a long way short of practical use.

This stricture applies to electrical vision of people and scenes, and not to that of cinema films, which are specially suitable for the purpose, inasmuch that they lend themselves to the use of very bright beams of light passing through photographs prepared with very sharp contrasts. America can already show some success in this direction.

As regards the military uses of electrical vision, the Americans have already foretold the day when the battery-commander will watch the effect of his guns as seen from an aeroplane over the target and transmitted to him on the ground at the battery. The utility of such an arrangement is unquestioned, but it almost appears as if these prophets had overlooked amongst other things the extreme degree of fineness of the image seen in a telescope or field-glasses. In order to deal with such, the elements would have to be of the order of ·01 sq. mm., a minuteness which in the present stage it is impossible even to foresee.

The public was also much interested in picture-telegraphy. Whereas last year's exhibit of the Telefunken-Karolus system was confined to sending pictures over land-lines, the development was clear this year to wireless picture-broadcasting. Various systems were shown. The Telefunken Company, with light-ray at sender and electro-chemical reception, sent pictures 13 x 18 cm. (say, crown octavo size) in about 1 minute; hence to be capable of becoming visible to the eye as an instantaneous image, instead of being reproduced as a permanency, the picture would have to be touched off 600 times as fast.

A Fultograph, the invention of Capt. Fulton, and used for broadcasting pictures from the Vienna station as part of their programme twice daily, was also shown. This is a telautograph, using electro-chemical means at both ends.

Professor Korn's apparatus, as used by the German police, was also shown. It has photo-electric touching off, with photographic reception worked by the ribbon galvanometer (*R.E. Journal*, September, 1926).

The Ministry of Transport (Air Department) showed ground and aeroplane instruments for direction-finding. There is again this year a noticeable decline in the number of types of receivers shown, with a corresponding improvement in quality. For long range reception, neutrodyne and superheterodyne receivers were in abundance. With apparatus for connecting to light-mains the broadcasting short-range receiver has become as simple as the electric-iron, and is becoming increasingly popular.

The electro-magnetic cone loud-speaker holds the field against the electro-static and electro-dynamic, although the superiority of these latter is certain.

To the number of types of valve shown, which is already excessive, must be added Telefunken's exhibit of the Tetrode, which by adding as fourth electrode a grid-screen, eliminates grid to anode capacity. Finally, as regards a matter which is only related to wireless technics, the "Talkies," there is no question that the possibility now exists of combining the ordinary cinema film with speech. A high pitch of excellence was reached by the talking film, "Triergon," at this Exhibition. It is, however, not yet certain whether it is desirable to convert our silent films to talking films, and perhaps the most obvious use of this invention would be for giving people, acoustically as well as pictorially, the news of the week.

The latest Anti-tank Weapons. The latest development of tanks in the contest between mobility and armour is towards the former, hence less weight and less demands on bridges. Tanks under 12 tons are preferred and these would have 20–25 mm. of armour. Even with tanks twice the weight mentioned, armour would not be thicker than 30 mm.; while armoured cars carry only up to 12 mm. of protection.

Defensive weapons have followed this development. The lower limit is the 13 mm. (·5 in.) machine-gun, intended in the first place as an anti-aircraft weapon, but capable of being used against armoured-cars.

As regards anti-tank weapons the chief requirements are good shooting (dependent upon high muzzle-velocity and the utmost handiness in traversing), penetrating power and sufficient explosive effect after penetration to put the tank out of action. The requisite power of penetration is gained with not less than 3·7 cm. (1·5 in.) calibre; but there is also an upper limit. A diagram shows how the smaller calibres with their higher velocities are superior to the larger calibres in penetration, and that the upper limit lies at 5 cm.

The limit of weight beyond which an anti-tank weapon ceases to be sufficiently mobile may be taken as 300 kilos (say 6 cwt.).

The question whether infantry-guns should take over the task of anti-tank defence must be answered in the negative. The matter was tried out thoroughly by the United States in 1920, when a compromise between

the conflicting requirements was found to be impossible. As a result of this decision the U.S.A. have produced two weapons, the 37 mm. infantry-gun and the 75 mm. infantry-mortar.

For mobility, wheels must be as large as possible, consistent with not offering too great a target. A shield is necessary against the fire of the tank's machine-guns.

Other points which are occasionally demanded must not be considered less important, especially the breaking up into separate loads reduces the degree of readiness of coming into action, and involves the danger that an essential part may be missing when required.

As long as the limit of weight of 300 kilos is kept, the limit of penetration is 25 to 40 mm. Hence, heavy tanks armoured up to 30–40 mm. in front can only be penetrated at the shortest range. They must, therefore, either be fired at from the side or from behind, or left to the larger field-guns farther back to deal with.

A tabulated list is then given of the particulars which are available of 21 modern machine-guns of the leading nations in three classes :—

(A) 13 mm. Class, chief task, anti-aircraft.
(B) 20 mm. Class, chief task, anti-tank and anti-aircraft.
(C) 3·7 to 5 cm. Class, chief task, anti-tank.

Unfortunately, with the exception of two American weapons, the list is confined to machine-guns of private construction : also it has not been possible to produce a table to show comparative penetrations. Photographs are given of the 12·7 mm. Beardmore-Farquhar, of the 13·2 mm. Hotchkiss on light field carriage, and of the Dutch m.g. of the Holl. Ind. en H. Matsch.—(*To be continued.*)

Modern Road-making Methods and their Applicability to Military Purposes (*concluded*). The author continues his description of modern methods of road-repair—surface-dressing, carpeting and tar-macadam. As regards new roads he laments that, although concrete-roads had a start in Germany of nineteen years (1891) against tar-roads (1910), in spite of the enormously increased use of concrete in all sorts of building, and in spite of much experience on the subject gained abroad, concrete roads in Germany are still in the nursery stage. While in the U.S.A. 60,000 km. of concrete roads had been built up to the end of 1925, the total length of such in Germany up to date is only 70 km. The reasons for this backwardness, he says, lie in no doubt as to the suitability of this material for road-construction, but in the facts that before the War lorry-traffic had not reached such dimensions as to cause undue wear upon the roads, that during and since the War Germany has had more serious cares to attend to, and is still too poor to undertake new road construction on a large scale.

For such construction concrete, as forming an excellent material, would be considered in the first place. The chief military considerations Lt.-Colonel Wabnitz defines as follows :—" Simplicity, rapidity, as little transport as possible, ease in handling the materials, and small amount of labour required." There should surely be in this list a place for the earliest possible resumption of full traffic on the road under repair. Summing up :—

1. Surface tarring is a suitable method of protecting metalled roads, which are still in a good state of repair, against the destructive effect of heavy lorry traffic.

2. Tar concrete carpeting offers a simple means of preserving from further decay roads which are worn, by means of a resisting covering. The Cold Process is to be preferred on account of its independence of the weather.

3. For new roads to be quickly made, concrete comes first of all (record performance, 800 running metres, 5·5 metres broad, in 13 hours !) Next, tarred metal laid cold (*e.g.*, Tarmac process) ; and last (Deidesheimer), large metal with fine metal binding and saturated with tar-emulsion (Kiton or Magnon) before final rolling.

Automatic Ciphering, by Lt.-General Schwarte. The elimination of the human element in enciphering and deciphering is a matter of great interest to the General Staff and to all connected with operations. Their clamour has always been for a cipher-machine to relieve them of what the author, doubtless speaking from experience, calls " one of the most tedious and unpleasant tasks."

In last month's description of the Press Exhibition at Cologne, Lt.-Colonel Pleger calls attention to the " Cryha " Automatic Cipher-machine and this instrument is now described by Lt.-General Schwarte.

The principle upon which it works is that of the well-known figure cipher (*v.* Jules Verne). Before Playfair was invented, the simplest way of avoiding mere substitution was to substitute according to numerical plan. A key number was chosen of, say, five figures, and repeatedly applied to the letters composing the message, showing how far in the alphabet each letter was to be carried forward to obtain its cipher equivalent.

Once the " Cryha " is set, each letter is enciphered by being carried forward a certain number of places, determined by the position of a wheel with 15 holes and 15 different sets of projections on the periphery corresponding to those holes. This gives a key number of 15 figures, so makes discovery enormously more difficult than it would be with the normal five figures. At the same time the alphabets used are jumbled alphabets.

The " Cryha " would thus appear to guarantee absolute secrecy. As, however, the almost uncanny skill of cipher-experts is known, and as the " Cryha," although sold by Marconi's, is manufactured entirely in Germany, it would be wise for anyone, who wants to defeat all attempts at discovery, to do some judicious file-work on the periphery projections of the two sets used, in order to make sure that no other similar machines are in existence to assist in betraying one's secrets to the enemy's Intelligence Branch.

Mediæval Artillery, by F. Sonnenberg. A clever and amusing review of " *Das Geschütz im Mittelalter*," by Bernhard Ratgen, in which the reviewer starts by addressing the patron-saint of all artillerymen, Saint Barbara, and complaining that, after all his efforts in keeping himself abreast of the developments of her black art, she now turns back the hands of the world-clock half a century and orders him to deal with artillery as it then was.

The book itself, which took an artillery officer 25 years of research to write, is praised with such phrases as " with increasing astonishment one perceives that one is falling more and more under the ban of this book," " its great instructional value lies in its putting Why in the foreground and not How," " thrilling from end to end."

The new Explosive, " Radium Atomite." On the authority of " Army Ordnance " some wonderful things are claimed for this new substance—that it contains neither nitroglycerine nor guncotton ; that its detonation-velocity is 3,270 metres per second ; velocity can be regulated, so that radium atomite has been used in the Springfield rifle ; explosive-effect compared with TNT 100 : 60, compared with Blasting Gelatine 100 : 78·5 ; catches fire at 148° C. ; does not freeze ; no poisonous gases on detonation, except 21 % Carbon Monoxide (!) ; no headaches caused when used in mines ; can be prepared from raw material in eight hours ; no danger in manufacture ; neither detonated by friction nor by a blow. When it is further stated that the inventor has produced this explosive " after being occupied with radium for 25 years (!) " scepticism is fairly thrust upon one.

(*November.*)—*The latest Anti-tank Weapons* (*concluded*). The following are described, with photographs : In the B Class, the Danish 20-mm. Madsen m.g., which is only a larger edition of the well-known Madsen light machine-gun. In the C Class, the 3·7-cm. Bofors Infantry-gun, the United States Infantry-gun M1 of the same calibre, the 4-cm. Beardmore (with mention of a new infantry-gun by the same firm of 4·7-cm. calibre), the Polish 4·7-cm. Pocisk, and the heaviest of the three, the 4·7-cm. Bofors, with splayed carriage, which pierces 40 mm. of good armour at 900 metres.

The m.gs. in the C Class are then compared as far as data are available, and criticized. Their future development is foretold in an increase of muzzle-velocity and in an increase in the width of aiming arc, which is at present 40° at the outside.

The Qualities of a Good Vehicle, by Major Gieseke. The author takes the three different types of horsed vehicle found in the German Army, viz., the wagon with perch, the wagon with limber-bolt and the limbered wagon, and considers each of them in turn as regards the three qualities, flexibility or the ability to follow a tortuous course and to adapt itself to surface-irregularities, stability and axle-freedom. The wagon with perch was long in disfavour with military wagon constructors because of its relatively low flexibility, and it was looked upon as too stiff for uneven country. Strong emphasis being laid upon increased flexibility, with universal wheels, led to the limber-bolt system, which had the further advantage that the load was carried not on four points, but on three ; hence greater stability, the load being taken off the front axle. During the War, the Austrian Army had quite another experience of the wagon with perch, and German reports on it were also not unfavourable. The wagon with perch has thus come to be looked upon with a more friendly eye. If loosely fitted together, it gets over rough ground just as well as the wagon with limber-bolt : and has the great advantage of being much cheaper, both in provision and maintenance.

The limber system, by reason of the limber-hook and eye, has the greatest flexibility and axle-freedom, but on account of its small loading

space, complicated construction and great cost, it must be confined to those special cases of wagons which have to traverse rough ground at all costs, viz., artillery and trench-mortars. For ordinary transport both the other systems are suitable.

The International Aircraft Exhibition, Berlin, 1928. This was the second exhibition of its kind to be held in Germany, the first having taken place at Frankfort in 1909. There was, however, a National Aircraft Exhibition in Berlin in 1912. It is not possible to avoid comparing this show with the Paris Aero-Salon which is held nearly every year, but is hardly more than nominally international, whereas in the Berlin Exhibition of last year foreign countries were well represented, especially Great Britain, France, Italy, Czecho-Slovakia, Belgium and Russia. The United States were unfortunately only represented by pictures. Another great point is that at the Paris Aero-Salon the military 'planes dominate the yearly show, while in Germany, where military aviation is forbidden, the exhibition takes on an entirely new character, viz., one of civil aviation in all countries.

As regards aircraft lighter than air, the exhibition has little to offer.

The report is under three heads: (*a*) Machines, (*b*) engines and (*c*) accessories.

(*a*) The machines at the exhibition can be classified as traffic and sporting aeroplanes. Training and sporting 'planes can nowadays be hardly distinguished, since almost all instructional machines can be made to serve sporting purposes. A good distinction can, however, be made between ordinary sporting 'planes of at least 80 H.P. and light aeroplanes. Traffic machines can be classed as those with a single engine, with more than one engine, as well as into aeroplanes and hydroplanes.

Light aeroplanes, *i.e.*, those of from 20 to 70 H.P., were strongly represented. They fall into two very different types, the British type of braced biplane (*e.g.*, de Havilland Moth and Avro-Avian) and the aerodynamically superior type of German, Russian, and Czecho-Slovakian monoplanes. If the Klemm-Daimler with 40 H.P. Salmon-engine can put up the same performance as the well-known de Havilland Moth with its 60-80 H.P., there is still a great deal to be said, from the standpoint of the private owner, for the English style of construction, with " simple and cheap " as its underlying principle. Thus, the comparatively robust and primitively-built English light aeroplanes are thoroughly suitable for the hard wear and knocking about that they get in instructional work. Any village carpenter and any shoeing-smith can repair English light aeroplanes. When one adds to this that, with the best materials and workmanship, they are not expensive, it is evident that German light 'plane construction will have to struggle hard against foreign competition.

The 80–200 H.P. class was scanty in numbers, and, at that, the 'planes were all of well-approved types: Albatross, Raab-Katzenstein " Swallow " and " Pelican," and the Bavarian Aircraft Works " Flamingo."

A main centre of attraction was the Italian single-seater Macchi M 52, a Schneider Cup winner, a graceful machine with 1,000 H.P. Fiat engine and weighing only 400 kilos empty. The well-thought-out shape of this

classical racing 'plane evoked universal admiration. The Czech machines show likewise the high technical position of aviation in Czecho-Slovakia.

Short descriptions are then given of many of the more interesting aeroplanes in the Exhibition, amongst which the following are illustrated with photographs :—

The Czech Smolik-S of the Letov Aircraft Works at Prag (for distant reconnaissance and bombing).

The German H.E. 10 High Seas Hydroplane.

The Junkers W 33 " Bremen," which made the first Atlantic flight from East to West.

The Dornier Super-Whale passenger hydroplane, with two engines built above the wing.

The Dornier Delphin II passenger hydroplane, leaving the water.—(*To be continued.*)

Engineer and Soldier, by O. Schwab, reviewed by Major Kaiser. The attractive title of this book is not true to the usual German practice, as regards titles, of leaving nothing to the imagination. It might mean so many things. The dedication, however, clears matters up, " To the German Army, and to Germany's young Engineers, upon whose shoulders the future of our Artillery rests."

The book deals with the war-service of a civil engineer as an artillery officer, and his activities, especially in sound-ranging and the preparation of shooting-tables. Major Kaiser says that Lieut. Schwab's greatest achievement was the most successful method of breaking the " row of pearls of the hostile kite-balloons." He wishes the title " Engineer and Soldier " to be looked upon as the ideal to which every young artillery officer should strive, even though he may often, and not without a certain amount of justification, " prefer riding to reckoning."

(*December.*)—*Seeing from Tanks*, by Capt. Pirner. Although the technical perfecting of the tanks has made great progress, especially in the last few years, it appears that one of the most important problems—that of seeing from the interior—has found no solution. The author then reviews the whole development, and the present technical position of this problem.

1. Direct observation through slits. This method was exclusively used in the War, the slits being generally conical interruptions of the armour, about 5 mm. high and about 120 mm. broad. These slits were the cause of many very unpleasant wounds in the face and eyes. They had also the disadvantage of a very small vertical angle of view, since in order to avoid injury to the head due to the jolting of the tank, it was necessary to keep the head back a certain distance from the wall. The advantage of direct observation through slits stands in no sort of relationship to the disadvantages named. It is because of such observation that tanks have been called " blind and short-sighted."

2. Observation with mechanical aids. To reduce the number of splinters reaching the observer a rotating disc was introduced, provided with radial slits and driven by a motor. This allowed of an increase in the size of the observation-slit in the tank, *i.e.*, of an increase of field,

but the chief disadvantage of the small angle of sight remained, and further, the brightness or intensity of the picture was considerably diminished. It is this drawback which caused the method to be abandoned.

More valuable was the Stroboscope, which appeared at about the same time in French and in American military literature. This instrument is about 20 in. in diameter, and is fixed on the top of the tank. It consists of an inner fixed cylinder, in the wall of which are eight equally-spaced rectangular windows, giving an all-round view, and covered with non-splintering glass; and an external cylinder, having 30 vertical slits equally spaced around it, fastened to and revolving with the dome, which is electrically driven at 400 r.p.m.

It is easy to show that this great speed of revolution is so small in comparison with the velocity of an incoming bullet as to have no averting effect worth mentioning.

The motor-drive (¼ H.P.) is either direct on the spindle, or indirect by tooth-wheel on the circumference. The former method has the advantage of allowing Stroboscope and motor to be turned back together on a hinge allowing free observation or even egress from the tank.

The Stroboscope has also, below the rotating cylinder, ordinary observation slits, normally blinded, for use in case the motor fails.

3. Observation with optical aids. The simplest instrument for this purpose is the periscope without lenses. The field of sight is, however, quite insufficient, unless one is prepared to use large reflectors with the corresponding drawback of large openings in the tank. These periscopes leave over 20 yards of dead ground immediately surrounding the tank. There is no likelihood of their being generally introduced.

To give periscopes a larger field the eye must be brought artificially close to the outside opening. This is done by replacing the top inclined mirror by a rectangular prism, with a short focal-length object-glass below it. A reversing lens in the middle of the periscope, and a rectangular prism with eyepiece at the bottom, complete the system; or, which is greatly preferable, the lower prism and eyepiece are replaced by a mirror and dull glass, so that the observer can move his head and observe with both eyes.

This periscope has been used by Goerz in making a cylindrical observation tower for tanks with all-round view. Magnification is provided up to 1·5 to counteract the opposite effect, due to the eye being no longer free, but having its view of an object circumscribed by a narrow opening. Distances are thus not over-estimated, and most people think that they are seeing things their natural size. The brightness of the picture depends in general on the size of the openings, and these must be kept small. The picture also suffers by losses in reflection and absorption, so that details are hard to see, and the quick recognition of distant objects is difficult.

It must therefore be stated that the important question of observation from tanks has not yet been solved. The main requirements are:—

1. Horizontal field, 360°: vertical field — 15°, + 100°.
2. Observer to be safe from bullets and splinters.
3. Both eyes to be used for observation, with free movement of head.

4. Picture to be as clear as possible, *i.e.*, the greatest possible elimination of light-losses.
5. Easy change to unrestricted view for travelling and when not engaged with the enemy.

The International Aircraft Exhibition 1928 (*concluded*). (*b*) Engines. There was very much worth seeing. While the machines themselves were already known to the experts, amongst the engines there were many constructional surprises, even amongst those which had already been tried out in the air. France and Italy were best represented. The absence of the highly-developed American engine industry was to be lamented. The English show was incomplete, thus Beardmore showed none of his interesting engines, while Rolls Royce were content to show a single one. The interesting Bristol Mercury engine could not be shown, owing to prohibition by the British Air Ministry. Likewise missing were the 700 H.P. Armstrong-Siddeley Leopard, the latest Napier engines, and many more. The triumphal progress of the Bristol Jupiter of 400–500 H.P. is well known. They are now manufactured by licence in no less than fourteen different countries. Among the many descriptions given, the following are also illustrated :—English A.D.C.—Cirrus 4-cylinder, 85–95 H.P. (*cf.* de Havilland Gipsy) ; B.M.W.'s V 6-cylinder up to 410 H.P. ; Mercedes-Benz engine up to 1,000 H.P. ; B.M.W.'s VIa 12-cylinder up to 750 H.P. ; new 850 H.P. Junkers " L 88 " engine ; new 700 H.P. Argus VIa engine with hanging cylinders ; new 600 H.P. Siemens-Sh 20 9-cylinder (*cf.* Armstrong-Siddeley Lynd, Salmson, etc.).

(*c*) Accessories. These, owing to the civil character of the exhibition, did not include armament. Propellers (metal *v.* wood), carburettors, magnetos, petrol pumps, crash-proof tanks, Farman gears, and instruments are all shortly dealt with. As regards the latter, England and America were best represented. The author considers that German instruments are so far superior that there should be possibilities in the way of export, especially since the universal support afforded by Governments to aircraft and engine-production is not extended to accessories.

It is precisely in the matter of accessories that Germany stood much worse after the War than, for example, in aeroplane construction. The Exhibition shows that the leeway has been made up. This applies more to equipment than to engine accessories. The Exhibition proved a real success, of which evidence should be found in increased trade.

F.A.I.

CORRESPONDENCE.

MOTHER SHIPTON'S PROPHECY.

To the Editor, *R.E. Journal.*

SIR,

In the March number of the *R.E. Journal* was published over my initials a copy of Mother Shipton's prophecy. Shortly afterwards my attention was called by a reader to an opinion that Mother Shipton was a legendary personage, and that the whole doggerel was a fabrication. It has taken some time to find the opportunity for a search in the books on the subject at the British Museum, but the result may be of interest.

There appears to be no doubt that Mother Shipton was not only a reality, but that she was also looked upon as a "wise woman" about the year 1530, and that she lived near Knaresboro', in Yorkshire. As early as 1645, W. Lilley published a collection of prophecies including some of those of Mother Shipton, and it was then considered that some of them had been fulfilled. In Stuart times, there was a general belief in her predictions, of which the two most famous were that Cardinal Wolsey would not enter York on his last journey, and that London would be destroyed.

In the *Life and Death of Mother Shipton*, written by Richard Head and published by W. Harris in 1687, the writer says "A stone was erected near Clifton, about a mile from the city of York, from which the following epitaph is taken :—

> "Here lyes she who never ly'd,
> Whose skill often has been try'd,
> Her prophecies shall still survive
> And ever keep her name alive."

But about 1862 a Prophecy in rude verse under her name was put into circulation by a Charles Hindley, who confessed to the fraud ten years later (*Notes and Queries*, April 26th, 1873).

In his *Mother Shipton Investigated*, in 1881, W. H. Harrison thinks that more than half, possibly the latter two-thirds, of the doggerel given on pp. 183-4 of the *Journal*, were written by Hindley at a time when lampoons were rife and political hopes and desires were being published in the popular form of prophecy. I also find that, in its original form, Hindley wrote the last line as :—

> "In Eighteen Hundred and Eighty One."

I would therefore like to apologize for having inadvertently asked you to publish a fabrication, and to thank my critic for his information. I have heard the verses as published from many sources from my youth, and have never heard a doubt as to their authenticity before. It gives more point to the laconic advice of a celebrated personage to a young friend who asked for counsel and wise instruction before entering upon a new field of activity ; his sole message was : "verify your references."

D.M.F.H.