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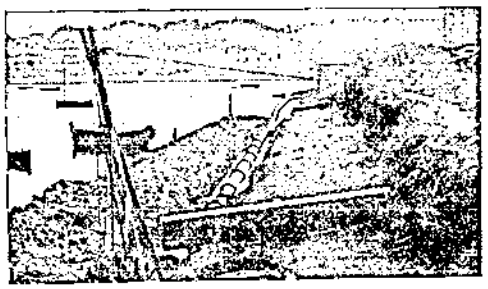

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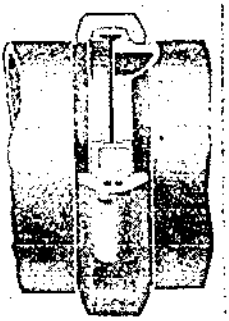

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THE NATIVE PRINCES OF INDIA.

A Lecture delivered by PROFESSOR L. F. RUSHBROOK WILLIAMS, C.B.E., *at the S.M.E., Chatham, on Thursday, 27th March,* 1930.

THE subject with which I propose to detain you for a few moments to-night is one of great political interest at this moment. Last autumn the importance of the Indian States was, perhaps for the first time, officially recognized in the correspondence exchanged between the Prime Minister and Sir John Simon. Sir John Simon said, in practically so many words, that in endeavouring to lay down the line of the future policy of Great Britain towards British India, he found himself at every turn brought up against the problem of the Indian States. That being so, he informed the Prime Minister that he desired to extend his investigations to the relations existing between the Indian States and British India. One of my objects in addressing you to-night is to make you realize why it was that Sir John Simon was brought to that conclusion and why it is now that the problem of the Indian States demands close and fixed attention.

In presenting the subject to an audience of this kind, it is hardly necessary for me to go into elementary details, but generally speaking, few people in this country realize that England does not rule India. The total area of what we call the Indian Empire, leaving Burma aside, is 1,500,000 square miles. Of that, we only rule 900,000 square miles. The remaining 600,000 square miles is not British territory at all. It is the territory of the Indian States. Inside that territory there live people who are not, as the British Indians are, our fellow subjects. Inside that territory the King's Government does not rule. Parliament has no vestige of control over anything that goes on inside that 600,000 square miles, and the people who inhabit it are the subjects of their own sovereigns, who are in subordinate alliance with the King.

A glance at the map of India will show the importance from a strategic point of view of the Indian States. It is possible to go almost from Kashmir to Cape Comorin, and almost from Karachi to Calcutta without touching more than a few miles of British territory. The native States lie in great blocks across the main lines of communication, and that is one of the reasons which, from a military point of view, makes the attitude of those States towards the Empire a matter of very great importance.

In order to enable you to see the picture a little more clearly, I want to take you back some way into the past. I do not mean to emulate the example of an Oxford professor, who may or may not have been a colleague of my own, who announced a course of lectures on the French Revolution. He was a gentleman who was notoriously thorough and at the end of the second term, a colleague asked him how far he had got. He said, "I am doing very nicely. I have just completed the building of the third pyramid." But in order that we may realize what the Indian States mean to us, it is necessary that I should give you briefly some kind of information as to what they have meant to empires in the past, because India has extraordinary continuity of tradition, and if we look back into the history of that country, their recorded history, we sometimes get very useful guidance as to what is likely to happen in the present and in the near future.

We are the latest of a very long series of empires in India and all the empires previous to our own have crumbled. If you will bear with me, I should like to give you, very briefly, a clue to this process. The previous empires of India have been marked by one characteristic; this is to say, they have been founded by the process of invasion from the West and from the North-West. Races and dynasties from the cooler and more temperate regions which lie to the North and West of India have made their way to the plains of Hindustan, have established their military supremacy by force of arms, and have ruled the country. But as time went on, these successive races and dynasties found themselves brought up against the fundamental problem of the climatic influences of India. There always has been in India a tendency to assimilation. The people of the country have tended to assimilate to themselves and to obliterate the characteristic and distinctive marks of any civilization with which they have been brought into contact. Race after race has found itself threatened with virtual extinction by absorption, while the climatic influence has operated to weaken the vigour, both physical, mental and moral, of peoples accustomed to living under more temperate conditions.

The problem with which each empire before ours has been confronted has been simply this. How could the ruling race maintain unbroken the line of communication with the cooler country from which they came, so that they could fill the gaps in their fighting-line, administrative as well as military, and thus repair the ravages of the climate? Every empire before our own failed to solve that problem, for the simple reason that they depended upon land communications. No empire which attempted to rule Hindustan could long be successful, or has ever been successful, after it had lost military control of Afghanistan, and for reasons which will be familiar to many members of my audience it has not been found

physically possible for any empire, even our own, to maintain effective control of Afghanistan for long. Therefore, in the case of previous Indian Empires, they have been confronted always with the dilemma that, if they wished to maintain their position in India, they had to maintain unbroken a long land line of communication; otherwise they could not replace their skilled administrators and generals, of which the climate had taken toll.

I know no more interesting example of that process than the series of Court paintings relating to particular families under the Great Mogul. When Babur came to India in 1526, and conquered the country, he introduced the fashion of Court portrait painting. Some of his noble families can be traced roughly from 1526 to 1710 or 1712, and it is extraordinary to notice the changes which accompany the appearance of the people. When these generals and administrators first came to India, you see them big, ruddy men, with high riding boots, whiskers and beards, carrying enormous swords—altogether very vigorous men. A generation goes by and you will see them turned into slim, elegant people, with heavily embroidered and brocaded coats, and a court rapier by their side. Another generation goes by, and then you see them clad in transparent muslin and holding a rose. That was the kind of alteration effected by the Indian climate on people who were not able to maintain their land communications with the cooler lands from which they came. We are more fortunate because our communication depends on the sea only, and from that point of view we are something new in the history of the Empires of India.

Having given you this brief clue to the history of the rise and fall of Empires in India, I want now to turn to the main subject of the lecture. All these empires have been of the same type; they have been very much of the nature of a loose federation, ruled from the top by a military power. An invader comes down and establishes military supremacy, but he does not rule the country as we understand it. He takes tribute from existing kingdoms and he insists on their rendering military service, and refuses to allow them to combine against himself. Occasionally he finds it necessary to destroy some of them, but the fact remains that the typical Empire in India—and to a large extent even our own—has represented the domination of superior military force over a large number of pre-existing units, semi-independent units. The history of the decaying empires in India before our own time has been simply this: Owing to the climatic influences, which I have sketched so roughly, the ruling power gradually fails to exercise the same kind of control, military and administrative, as it started with; the semi-independent units then raise their heads again, throw off the yoke and become completely independent, and so they remain, with a good deal of bickering and fighting among themselves, until the next invader comes down,

depresses them again, exacts tribute, insists on military service and establishes himself as an empire.

The point, as you will doubtless have seen, to which I am leading is this: What we call the Indian States to-day, are the representatives of a system which is not merely older than our own Empire, but older than the empires of which we have any previous record in Indian history. You may say, if you like to use the simile, that the Indian States, the small semi-autonomous kingdoms, have always been the bricks out of which the fabric of successive empires has been built. Sometimes you get a brick broken, sometimes one is pulverized to dust, sometimes a brick is divided into several fragments, but broadly speaking, throughout the past history of India, you can discern something like the same bricks.

How did we build our Empire in India? Did we build it out of those bricks like our predecessors? To a very large extent, yes, because if from one point of view the creation of our Indian Empire depended upon our supremacy at sea, from the other point of view, it depended very largely upon our creation of an elaborate network of alliances and engagements with the existing Indian States.

When the first employees of the East India Company came to establish their factories on the coasts of India, it was not to the Great Mogul that they looked for permission. It was to the local Indian sovereigns. At first, as you know, they were far from possessing any intention of interfering with the politics of the country, and it was only the combination of disorder in the country and rivalry with the French which finally drove us into it.

It is interesting, and indeed sometimes pathetic, to read some of the early correspondence which was exchanged, let us say, from the middle of the 17th century onwards, between the Company's employees at Madras and Bombay and the Company's directors at home. The Company's directors kept on emphasizing the point that their servants in India were there to trade, and not to mix in politics. Why, it was asked, should they need forts and armaments? Why did they start recruiting Indians, forming them into companies and using them to garrison their small forts? And the answer was always this, although the words may have varied: "We are compelled to adopt this course and policy unless our honourable masters will send to India such as are stick-free and shot-free, and such as can digest poison." In other words, it was the fact that the strength of the Mughal Empire was breaking down at the time when we first came into the political arena, which compelled us to pursue the policy of standing up for ourselves, and we pursued it just exactly as any other Indian State pursued it. That is to say, in the first instance, being weak, we made treaties with the local sovereigns; then, in order to secure the validity of those treaties, we tried to get them ratified by the Mughal. After Clive's adventures in Bengal,

we obtained from the Mughal himself the grant of the revenue collection in Bengal on payment of a heavy annual tribute. Then, as the Mughal Emperor and his administration got weaker and weaker, we did precisely what everybody else had done from time immemorial; we repudiated that tribute and said we proposed to stand on our own rights; and the year 1773, when Warren Hastings declined any longer to pay tribute to the Mogul Empire, marked the real beginning of our terrestrial power in India and put us on the same footing as the other Indian States. Hence it is that, from the historical point of view, our Empire in India is just an example, which might be paralleled in other times, of the gradual advance of one Indian State to a position of dominance and paramount control. We started as the smallest and weakest of all the Indian States. We gradually made our way up, through inferiority and subordination to equality and supremacy; but it is interesting to notice that as recently, comparatively speaking, as the year 1829, it was still customary for our Viceroy to address the Nizam of Hyderabad in the terms used by an inferior person to a superior. That was a relic of the old days, when our power was infinitely weaker than that of any other Indian State.

This process of growth, with which I will not detain you in any detail, affords an extraordinarily interesting study, to which I have no doubt some of you have already devoted attention, but there are two things which stand out. One is the fact that, while we relied to a very large extent upon our sea communications for the establishment and maintenance of our power, we relied to a scarcely less degree on an elaborate structure of treaties and alliances which we built up with the Indian States. In the latter days of the 18th century, we found a number of Indian States who were tired of the system by which they were continually fighting amongst themselves, and we found increasing numbers of them ready to enter into a kind of bargain, which suited them very well. We were afraid at that time of the influence in India of French intrigue. We were also desperately hard-up for money in order to carry on the political and administrative side of the Company's work. Accordingly, we proposed to some Indian States, and some Indian States proposed to us, a bargain something like this. An Indian State said, "I will give you complete control over my foreign policy. Your friends shall be my friends, your enemies shall be my enemies. Further, I will give you a sum of money which will enable you to maintain regiments to protect me." We, in return, said, "We will undertake to guarantee the perpetuation of your existence as a territorial unit and as a government, and so long as you remain faithful to your obligations, we will remain faithful to ours"; and a bargain was struck along those lines.

The result was that, roughly, by the year 1818, British power was

supreme over something a little less than half of India. The larger part was still ruled by Indian States, but those Indian States were being bound to us by closer and closer connections as time went on. It was not, however, until just before the Mutiny that the territorial balance between British India and the Indian States was—owing to Lord Dalhousie's policy of annexation—definitely turned against the States. Up to the middle of the 19th century it was British India which was the smaller half and Indian India which was the larger half, of India. It is only since that time that the proportions have been reversed.

If we examine the opinions held by the Company's officers about the Indian States during the first half of the 19th century, we find that they regarded the fate of these units as being more or less settled. They thought of them as being awkward impediments to our humane, progressive and enlightened rule throughout India. Looking back over the course of the century, it seems pathetic to think that our early British administrators were convinced of the power of British interests, British thought, and British conceptions, to make their way in a triumphant march across the face of an ancient civilization like that in India; for we know now how slight is the impression which even a century of British rule has made upon many of the most fundamental thoughts, beliefs and creeds of the country. But the view which was held by early administrators was unduly optimistic. That being so, they regarded the Indian States as being an anachronism and an obstacle. They were convinced that in any event the day of the States was over, and that they had ceased to count in Indian politics. And yet when the Mutiny broke out, we suddenly found the States counted for a great deal. Indeed, as Lord Canning said, it was these patches of "native rule" which acted as a breakwater to the wave, which otherwise would have swept us away utterly.

After the Mutiny, of course, there was a revulsion of feeling in favour of the Indian States. People began to realize that they did count politically, and that they were not merely museum specimens destined to extinction, and further, that the rulers of these States set their plighted word to Britain above everything. But at the same time the policy we pursued towards these States seems to have been a little short-sighted. From early days, one of the cardinal principles of the dealings of the East India Company with the States had been to keep them rigidly apart, to prevent them having any communication one with the other except through us, and to treat them as isolated units. That, of course, was a tradition of the old days, in which we ourselves were merely one of a number of powers competing for mastery in India. Having obtained that mastery, we then decided that we could not afford to have the same process repeated against ourselves, and this policy—which we may call a

policy of complete isolation—was responsible, during the first half of the 19th century, for a great deal of backwardness on the part of the States. When the rulers and the governments of different States who were, on the one hand, relieved of all responsibility for defending themselves, were also, on the other hand, prevented from getting together to discuss common interests, there was a tendency to sink into isolation and stagnation. After the Mutiny, that policy was not relaxed, because if the history of 1857–58 had shown that the States were loyal, from another point of view it had also shown that they were still formidable politically. Hence the policy of isolation was continued throughout the latter half of the 19th century. Still the rulers of the Indian States were not permitted to meet each other. Still the governments were not allowed to correspond. Still each individual State was kept at the end of a separate string, the other end of which was held by the Government of India. The consequence of this policy was that throughout the second half of the 19th century the States did not progress very much. They certainly did not progress relatively to British India.

The Government of British India, which had been established as a result of the Mutiny, was now trying to centralize, and was able to weld the enormous area of British India into something like an administrative unit. In that process it probably went too far, and the attempt to centralize administration in a country where historically administration has never been centralized may, incidentally, be at the root of some of the trouble at the present time. But the fact remains that while the Government of India was dealing with big schemes of development, railways, irrigation, canals, roads, and the like, throughout the great area of British India, the Indian States still remained comparatively poor and isolated. Nor was there very much chance, on account of their isolation, that their weight would tell politically, for this reason. When the Government of India Act of 1858 was passed, the Government of India, as we call it, which had succeeded the old East India Company, was given a dual task. It became the executive Government of British India, and it became the agent through which the Crown's relations with the Indian States were managed. No real distinction was made between the two tasks and, as you can readily understand, there was a tendency on the part of the Government of India—a very human and very natural tendency—to utilize its position of trust as Crown Agent for these States, to promote the due execution of its duties as the executive Government of British India.

The consequence was that, during the latter part of the 19th century, the Indian States became increasingly conscious that their interests and rights were becoming more and more subordinated to the interests and rights of British India. Our administrators in British India were directly responsible, through the Viceroy, the

Secretary of State and Parliament, for promoting the welfare of British India in every right and just manner. What more natural than that, of the two responsibilities committed to their charge, the more direct should carry the day! The result was that before the new century had dawned, the Indian States were suffering in a variety of directions as compared with British India, and because they were isolated they were not in a position to make their voices felt politically.

During the time of Lord Curzon, that most masterful of Viceroys, the position of the Indian States was extremely depressed, and if at that time anybody had asked whether, in the event of a world war, the Indian States would count for anything, I think the answer would have been, as it was before the Mutiny, "No, naturally! How can they? They are too weak."

Fortunately, during the time of Lord Minto, a policy of greater confidence was adopted towards the Indian States, and they were encouraged by Lord Hardinge to feel that they were really partners in the Empire. I think the change came about through an increasing realization on the part of the administration in India of the growth of what we now call the Indian Nationalist Movement, which made us conscious of the fact that it was fatally easy for an English administrator, no matter how wise or enlightened, to make very dangerous mistakes. There was thus a tendency on the part of both those Viceroys—Lord Minto and Lord Hardinge—to consult the Princes about important matters; to seek their advice and to make them feel that they were no longer to be ignored; while, finally, as a conclusive proof of a changed attitude in regard to them, the Indian Princes were even encouraged to place their own troops into a condition of efficiency greater than that which had previously existed. They were encouraged to aspire to the association of those troops with the British Indian Army, and to earmark their best regiments for what were, until recently, called the Imperial Service Troops.

When the War broke out, as we all remember, the first people to respond in India were the Indian Princes, and the manner in which they placed their resources at the disposal of the Empire was not merely of the utmost value as an encouragement to British India, but also helped to steady the situation throughout many British possessions in the East. For there is this to be remembered about the position of the Indian Princes: In many cases they are the heads of clans which do not all live inside their own territories. You often find an Indian Prince is the hereditary chief of a clan which may people large areas of British India, and there is a tendency on the part of those clansmen, even the British Indian subjects, to look very much to their chief for guidance. A typical example has been the influence which has been exercised by the Maharajah of Patiala

—who is head of the Sikhs—over the Sikhs who live in British India. The British Indian Sikhs have for some time been uneasy, and but for the influence he exercised in his personal capacity, a lot more trouble might have occurred than actually did occur.

This extra-territorial influence of the Indian Princes proved extraordinarily valuable during the War, because not only did they welcome recruiting parties into their territory, but they were able frequently to assist recruiting in British India by their example; and when you remember that within the territories of the Indian States live many of the most important fighting races of India, I think you will realize that the support of the States in the event of any grave imperial crisis is a very valuable one.

As a result of what the States did during the War, this age-old ban, which I call the policy of isolation, was removed, and from the year 1921 the Princes have met together every year at Delhi, in an institution called the Chamber of Princes—which I represent in London at the moment—which is presided over by the Viceroy. This Chamber of Princes has already been found very useful, because it is possible for the various rulers of the Indian States to get together to formulate common policy and speak with a united voice. The formal meetings of the Chamber are only held once a year and they rather approach in character, I fancy, the old Diet of the ancient Roman Empire, because every person who sits there is a sovereign or semi-sovereign in his own right, and the business naturally tends to be stiff and formal. But the Princes have got over that difficulty by the establishment of their own parallel machinery. For about a fortnight in Delhi every year, before the Chamber of Princes meets, the same Princes who, inside the Council Chamber, will constitute the Chamber of Princes, meet informally in a building of their own, and that is where their discussion takes place and the course of action is mapped out for the year, and where the decisions are taken which are subsequently put into formal shape by resolutions in the Chamber of Princes.

Within the last two years, the Chamber of Princes has opened its galleries to the press and the public, and the result of that has been a general recognition throughout India—and, perhaps I may say, an increasing recognition in England—of the fact that the Indian States count very much indeed in Indian politics.

Now, how are they likely to employ their influence? Well, I do not think there is very much room for ambiguity on that point. It is significant that last year, on the first occasion on which the press were admitted to the Chamber, one of the early resolutions dealt with the question of independence for India. The ideal of independence by cutting the painter between India and England had, at that time, already been mooted. The Indian Princes, who are well informed about the problems, particularly the political

problems, of British India, realized the danger, and they passed a resolution to the effect that, whilst they did not desire in any degree to interfere in the political problems of British India, they wanted British India to realize that if British India put forward any proposals to the Indian Princes, with the idea of arranging some kind of quasi-federation, or some arrangement for talking over problems which affected All-India in common, the Indian Princes could not consider any proposals which were not based upon a British connection. Again, when in December, Congress passed its resolution setting forth independence for India as its goal, the Indian Princes, individually and collectively, made their attitude once more perfectly clear. They said again, " So far as the ideal of independence is a matter affecting British India only, it is no concern of ours. That is a matter between Great Britain and British India ; but in so far as independence is an ideal which is likely to affect the whole of India, we regard it as being inconsistent with the treaties which bind us to the Crown, and also contrary to the true interests of the country." The result of that has been that there are some symptoms now of a practical alliance between the Indian Princes and those parties in British India who are prepared to co-operate with Britain in working out a policy of Dominion status ; and the Indian States are likely to supply a much-needed support for the more rational political element in British India.

That, briefly speaking, brings you up to the present moment. I think we have every reason to hope that with the Indian States playing the game, as they always have played it, and with the co-operating element in British India able to rely upon their support, it will be possible to arrange some kind of a working constitution for India. That the Indian States must come into that Constitution, as will be obvious from the sentences with which I started this lecture, has already been realized, and the Indian States are now admitted to be the third element of the Round-Table Conference, the other two being His Majesty's Government and British India.

I think, therefore, there is every reason to hope that, with the assistance of the Indian Princes and with their co-operation, India will still continue to be a real part of the British Commonwealth. One thing is clear and that is that perhaps the strongest of the links between Great Britain and India at the present moment is the Indian States. They take a personal pride in their devotion to the King. They are proud of the British connection still and, as they have shown in the past, so I think they will show in the future that no sacrifice is too great which, in their view, will enable this connection to be maintained.

THE PROBLEM OF THE LAST 800 *YARDS.*

By BRIGADIER J. F. C. FULLER, C.B.E., D.S.O.

THE PROBLEM.

In brief, the problem is this: The offensive power of infantry is on the wane, because the defensive power of infantry is increasing. We cannot scrap our entire army and replace it by something new and more effective. How, then, are we going to modify our army to meet and partially overcome this difficulty?

TO-DAY we are an infantry army, thinking in terms of mechanization, and we are thinking of mechanization in terms of infantry, and as we recognize little or no change in the infantry idea our tactics have become muddled in the extreme.

What, then, is the infantry idea? Is it a constant or a mutable factor? History will show us that it is the latter, and that it is governed by the power of cavalry—the complementary arm.

When no cavalry were used, as amongst the Spartans, the infantry idea was an exceedingly simple one: A line of men advanced against a line of men, and unless it was long enough to overlap the opposing line, the battle was decided by pluck and muscular endurance. Tactics simply consisted in pushing pikes, of command there was little or none, and tactical skill was replaced by grit.

When cavalry is combined with infantry we see a vast change in the infantry idea. The assault is no longer carried out to push the enemy over and destroy him, but to hold him in a clinch, and so gain time for the cavalry to manœuvre round his flanks and towards his rear. From a smashing force infantry becomes a holding force; they pin down the opposing infantry, and the cavalry stick them in the back.

When infantry and cavalry oppose cavalry alone, the battle is frequently undecided, when they oppose infantry alone it is normally won at small cost; but when they are opposed by their like, under the best generals, the infantry hold and the cavalry hit, and battles are won more often by skill than by superiority of numbers. Such was the infantry idea until the advent of gunpowder.

At first, firearms made little difference, because of their crudeness. But as they became more perfect they simultaneously increased the power of infantry to resist infantry and cavalry, and so reduced the power of cavalry to attack infantry. The result was that gradually

the cavalry idea of developing offensive mobility from the infantry holding attack changed; cavalry either sought cavalry to fight with, or they said to the infantry, "If you will give up holding and return to the assault, and break up the enemy's infantry, we will come forward and annihilate the fragments." The infantry agreed to this, and as the fire fight, even as late as the Napoleonic Wars, opened at only 100 paces' distance, a volley or two were fired, and a bayonet charge followed. The whole idea was to get home with the bayonet, the bullet was quite a secondary factor.

Until about 1860, infantry remained purely an assaulting arm, cavalry were impotent until the assault succeeded, and when muzzle-loading rifles replaced smooth-bore muskets the assault entered a rapid decline; not that riflemen could not hold an enemy, but because it was useless to hold him, for cavalry could no longer charge, that is, develop offensive mobility from the holding attack. During the American Civil War, seven out of every eight assaults failed, and so completely had the bullet defeated the bayonet, that infantry on the defence, especially when entrenched, could nearly always beat back a very superior frontal attack. So powerful had become the defensive that, in the 1870–71 War, not one single frontal attack by either Prussians or French succeeded. The assault was dead.

During this period in the history of tactics the central infantry problem was to resuscitate the assault. It was no longer a matter of rushing over a 100 yards, and then charging with the bayonet; but of methodically working forward over many hundreds of yards and then hoping to charge. It was entirely a problem of fire power, depending very largely on holding the enemy by artillery fire, and developing from this operation infantry mobility. In their own way, infantry were attempting what cavalry could no longer do. The rifle, however, soon shattered this imperfect theory. Increasing in range, the bullet forced the attacker to begin deploying at 1,000 yards, further than this it drove the field gun almost off the battlefield, until, at the beginning of the present century, the gunner had to adopt indirect laying and elaborate a complex system of observation and communication. The assault had long been dead, now the rifle attack began to expire. In the Russo-Japanese War, attacks covered days; in the World War, weeks. The attack then died, further the approach died, for, when once fronts were entrenched and wired, it was scarcely safe for the infantryman to raise his head above his parapet, and sheer suicide to move forward. All this is common knowledge. As the cavalryman of the 18th century said to the infantryman: "I can no longer charge until you have assaulted," the infantryman of the 20th century says to the gunner: "I can no longer assault until you have blown the enemy to pieces."

This, then, is the pivot of the present muddle—the assault. The

assault has been dead since 1865, yet infantry will persist in revolving the whole of their battle tactics round this idea. Since 1870, the frontal assault has persistently failed for the simple reason that a rifleman on the defensive can shoot down a dozen or more riflemen sent forward to attack him. The holding power of the defens[illegible] is so strong to-day, and the range of rifle fire so great, that [illegible] distance from the defender the attack is brought to a standstill, and that from this distance it is not possible to do more than hold a fraction of the defender's force, because a few well-placed machine-guns will hold up an attacking brigade.

If the assault is to continue to be the infantry idea, then the problem is a perfectly clear one: infantry must be endowed with the power of advancing over these 800 yards, not in weeks but in minutes. But is this the best thing to do? Should not the tank, a piece of mobile armoured artillery, be contrasted with the infantry idea rather than absorbed by it? Obviously, in one respect the tank resembles cavalry, namely, in cross-country mobility. Less obviously, because we have forgotten the true role of cavalry; being armoured it can charge where cavalry can no longer exist. If equipped with lances it could do so far more effectively than cavalry. But no one would suggest so archaic a weapon, in spite of the fact that the majority of us still adhere to an equally archaic idea, namely, that the ultimate aim of infantry is to close with the bayonet.

Given tanks and infantry and equating their powers, we can, so I hope to prove, get back to the old cavalry-infantry idea, namely, infantry hold, cavalry hit.

The whole of this problem revolves round the last 800 yards. If infantry can be so equipped, or supported, that they can advance over this distance, or anyhow can move several hundred yards nearer to the enemy than they can to-day, they will force him to strengthen his defensive front; to draw on his reserves; to immobilize himself, and consequently they will hold him. They may threaten assault if you like, but their idea is not to disrupt him and risk being disrupted, but to pin him down, so that the tanks, the new cavalry, can gain time to manœuvre round his flanks and strike him in rear, and the rear is and has always been the decisive point.

What is to prevent this? The bullet? In 1914, bullets were mainly fired from rifles, and static warfare was the result. To-day, bullets are mainly fired from machine-guns; is warfare, then, likely to become less static? To-day, four to five times as many bullets would sweep over a battlefield than was the case in 1914, 1915 and 1916. Then we had thousands of guns to destroy rifles and machine-guns, to-day we have about 72 to each division; can it be contended that to defeat the bullet, and it is the bullet which is the whole crux

of the last 800 yards, reliance can be placed on artillery? Obviously the answer is "No." What, then, can we do?

Remember the problem: that the infantry should be able to advance over the last 800 yards, and by constantly threatening the enemy, compel him to increase his defensive power by drawing on his reserves, and so force him to fix himself.

Remember the conditions which surround this problem: money is short in peace time; we can expect no drastic change; the best is enemy of the good; we must work from what we have and know.

How can we resuscitate the mobility of infantry? Strategically by motor transport, tactically by armour. Armour is the enemy of the bullet. A quarter of an inch of steel will keep out the rifle bullet, and half an inch the rifle armour-piercing bullet. Half an inch is what we want, it may not keep out the heavy bullet or the shell, but this is not the immediate problem. Let us first defeat the bullet, and when once this problem is solved, we can turn to the next.

We cannot armour all our infantry, but we know that we can obtain quite a good light tank. We have to-day in the British Army 16 machine-guns and 4 anti-tank weapons in each battalion. For an Oriental war, 20 machines per battalion are probably sufficient, and in a European war gold will flow like water, so an increase in this number need not perturb us. Now as to their use.

An attack is launched, and at 800 yards from the enemy it is halted by rifle and machine-gun fire. In place of calling on artillery, one to two miles in rear, to fire at a target which the infantry themselves can seldom see, out go the mechanized light infantry armoured scouts. All they know is the area from which fire is coming. They make towards it, hunting their enemy. If frontal fire is too strong they swing to a flank, they draw fire and deliver fire, then a novel thing happens. A fraction of the rifle line behind them moves forward from 800 to 700 yards' range, perhaps to 600 yards' range —a most astonishing innovation. The light tanks work up a hedge, round a hill; the enemy is pushing up reserves, but they head them off and climb its slope. Five minutes later a sight is seen which has not been witnessed for fifty years, some riflemen are on the hill and they have moved 800 yards in 20 minutes. They take the hill by assault? No. They merely occupy the hill, and begin enfilading the enemy on their right. They are heavily counter-attacked and driven back. Have they lost the day? No, they have begun to win it. They have forced the enemy to draw on his reserves, those forces which are an assurance against the unexpected and a security to his rear. Two or three more such engagements and the enemy will be fixed. All his troops will be tired, if not actually absorbed in the defence. Without reserves he cannot organize a retirement —he is fixed, anyhow for a time.

Have we solved the problem of the last 800 yards? Yes, we have

solved it against an enemy unprovided with light tanks, and should an enemy possess them, then must the problem be reviewed and modified. But have we completed our task? No. We have only prepared the way. Holding must be followed by hitting, and never hit a man in front if you can hit him in the back.

Once the enemy is fixed, that is, his power to move is reduced from a fluid to a glutinous, if not a solid, state, the grand manœuvre can begin; but not before. To send armoured forces wandering into the blue is to ask for trouble, for the enemy may disperse. What is required is a concentrated target: therefore, he must be induced to put all his eggs into one basket.

What type of force do we want for this manœuvre? Not a cumbersome army of all arms, but a force somewhat like the old independent cavalry—light cavalry to find, heavy cavalry to hit, and a few guns to protect. Above all, we want a mobile force, and simplicity normally assists mobility.

Embussed infantry, accompanied by light tanks and mechanized artillery, would certainly be better than infantry on their feet, machine-guns in limbers and horse-drawn artillery; but to-day we possess far more suitable arms, namely, armoured cars, light tanks and medium tanks. We may sometimes require a mechanized bridging train, but we do not want field guns, or medium guns, or sappers, or infantry, or cavalry, because we want mobility, and because this force is going to strike at weakness and not at strength. This is what the old and rightly renowned cavalry did. They did not bump their heads against unbroken infantry—anti-cavalry forces; they avoided them. Why, then, should we expect their modern counterparts to assault anti-tank localities and weapons? True, they may meet them, but then they will avoid them; they will not assault or charge them, for such action is not at present their task. To-day we hear a great deal about the cavalry spirit, but this spirit will lead us into an excess of folly, unless we understand true cavalry action—to use mobility to develop offensive power against weakness and not against strength.

This force, the force for the grand manœuvre which should be the central idea of every battle plan, we see in embryo to-day in the projected Armoured Brigade; a force which, if we do not focus our tactics, will die in the womb, or be born a monster.

To-day we do not want a mechanized army, we want to solve the problem of the last 800 yards. In the future, we may want a mechanized army, and if we do it must grow out of our existing army, and not out of a fraction of it. We want to make good the problem of the last 800 yards, and to gain full benefit from it once we have solved it. Here, then, is the object of an armoured brigade —to crown our problem and so endow the tactical idea which underlies it with full power to govern our unimaginative army.

Given an armoured brigade of one battalion of armoured cars, two battalions of light tanks, one battalion of medium tanks, and a properly organized supply column, and hinge this force to the existing army only slightly mechanized, then for the time being we have a superb army, because it is organized on a fundamentally sound tactical idea. Further still, it is so organized that it can grow to plan, namely, steadily increasing mechanization.

Before I end this paper, there are two points I should like to discuss, and they are the suitability of the medium tank, and the nature of the supply column in the armoured, or hitting, force.

Is the medium tank what the armoured brigade wants? Examine this brigade tactically. It is not purposely going to bump up against formidable opposition, that is, against anti-tank weapons. Its armoured cars will scour the country, and its light tanks can fall upon the rear of the enemy, and attack his line of communications, and his rear services. They may be met by their like, or by medium tanks, or they may want gun support. They, therefore, want some base to operate from, some supporting force which is more powerful than they are, and which is composed of anti-tank tanks.

The medium tank is too much a general purposes machine to fit this category. It may be an excellent divisional weapon—a weapon to support infantry, but it is not in my opinion a good anti-tank tank. What I suggest in its place is a low, fairly long, powerfully-engined machine, mounting one three-pounder gun, or a ·8-inch machine-gun, protected in a turret or by a roofless circular shield. If the latter, the shield might be so constructed that it can be closed to a semi-circle, and thus double the armour should anti-tank weapons be met with. This weapon would represent the artillery of the armoured brigade, designed as an anti-tank weapon, and not an anti-infantry weapon like the 18-pdr. field gun.

As regards the supply column, adequate and continuous supply is essential to the maintenance of the grand manœuvre. Frequently the armoured brigade will be miles away from its base, namely, the services in rear of the main army. Its line of communications will be an open one, and liable to be attacked by armoured cars and ordinary motor-cars. I suggest that, like the supply organization of the old independent cavalry, it should be equipped with two supply columns. One will go forward full, and the other will go back empty, and each will carry several days' supplies. These columns will require an escort of their own, an escort of armoured cars and light tanks and possibly also a battery of anti-tank tanks. With such an organization the brigade should seldom be in want.

DEFENCE AGAINST GAS.

A Lecture delivered at the S.M.E., Chatham, on 28th November, 1929, *by* CAPT. D. DUNLOP, R.A.

I.—INTRODUCTORY.

IN these days of international agreements not to employ poisonous chemicals as a weapon of war, it is natural for many people to assume that there is little likelihood of encountering this weapon in the future. To anyone holding this view, I would point out two main reasons why we can never afford to relax our preparedness.

(*i*) Some nations are not signatories to these agreements and, in addition, the experience of the late War showed us only too clearly that pacts are liable to be broken by a nation seeking to gain the advantage over her adversaries.

(*ii*) Any nation, with a well-developed chemical industry, is equipped from the very outset of a campaign to use this weapon without sign of preparation, owing to the very close relation between peacetime chemicals and those required for war.

For example, chlorine, the basis of nearly all the more important war "gases," is an essential peacetime chemical. Phosgene, a deadly war gas, is largely used in the dye industry.

Throughout history, all new weapons of war have been regarded as barbarous and inhuman, and such is the attitude of the great majority towards "gas" to-day. In addition, mainly as a result of War propaganda against the Germans, the general public imagine it to be the most horrible weapon imaginable—they picture men permanently blinded, choking for breath and dying in agony; H.E. and bullets have been so long established that these people seem to have forgotten the appalling non-fatal injuries and maiming effects that these latter weapons can cause. If any weapon can be called humane, there can be little doubt as to the greater humanity of "gas," which causes no disfigurement and little or no after-effects to those who survive, and the mortality figure even among troops with poor gas training and discipline, is extremely low, as these figures show:—

American Army Casualty Statistics.

Total casualties (all causes).	*Deaths.*	*Deaths.*
258,338	46,519	25%
Total casualties (gas).	*Deaths.*	*Deaths.*
70,752	1,400	2%

Our own mustard gas statistics are particularly striking :—

British Mustard Gas Casualties.

Mode of attack.	*Total casualties.*	*Total deaths.*	*Deaths per 100 casualties.*
Mustard gas period, July, 1917, to end of War	160,970	4,167	2·6

The corresponding percentage deaths from H.E. and bullets was 22 per cent.

It is owing to this proved superiority of mustard gas over all other war gases that I propose to devote my time this evening mainly to problems connected with it.

II.—Protection Against All Known War Gases Other Than Mustard Gas.

I must necessarily deal with this quite briefly.

The prevention of casualties from their effects is purely one of good training in the use of the respirator, good gas discipline and sound organization. If, on the other hand, these essentials have been neglected, then heavy casualties are bound to occur.

There may be occasions in the field when the weather conditions are such as to allow these gases to hang about in the atmosphere for a considerable time without dispersing. Under such circumstances, a commander may, if the tactical situation permits, move his men out of the area in order to avoid keeping them in their respirators. On the other hand, if the tactical situation does not so permit, then he can remain in the area with respirators adjusted for many hours, if necessary—provided, of course, his men have been accustomed and trained to wearing their respirators for long periods.

III.—Mustard Gas.

That the British Army alone had over 160,000 casualties from this gas during the last 15 months of the War, tends to aid and abet the alarmist views held about it in some quarters. It is a fact, however, that nearly 90 per cent. of these casualties could have been prevented by the wearing of the respirators then carried by all ranks. It was mainly due to a lack of knowledge of, and training in, the peculiarities and insidious nature of this gas that this great wastage of valuable men occurred.

(*a*) *Characteristics.*

Now what are these special characteristics peculiar to mustard gas?

(i) It is very persistent, *i.e.*, at average temperatures the liquid vaporizes slowly.

(ii) Both in liquid and vapour form, it penetrates all ordinary clothing and affects all parts of the body with which it comes into contact.

(iii) The odour of it is not very strong, nor very unpleasant, nor has it any immediate irritant effect.

(iv) It has a delayed action, *i.e.*, it may be many hours before the effects show themselves.

(*b*) *Physiological Effects.*

The physiological effects may be summarized, as follows :—

(i) Inflammation of the eyes.

(ii) Erythema, or burning of the skin, which may be followed by blistering, especially in the moist parts of the body. These blisters normally take several weeks to heal.

(iii) Inflammation of the nose, throat, trachea and bronchi, followed by the development of secondary bronchitis or pneumonia.

The respirator, then, will give full protection to prevent all the above effects except (ii). To become a casualty in this way, a man must either come in contact with the actual liquid (directly on to his skin or through his clothing), or be exposed to the vapour for some considerable time. As regards the latter, it is difficult to lay down any hard and fast rule, but it is considered that an average man would have to be exposed for about half an hour, to the highest concentration of vapour ever likely to be met with in the field, to produce actual blistering in the more moist parts of the body some hours later. Under average conditions and concentrations, an exposure of several hours to vapour might fail to produce any blistering effect, although an erythema might result.

IV.—Possible Methods of Distribution of Mustard Gas in War.

Before dealing with mustard gas problems in the field, it is necessary for me to say a word or two about the possible means of releasing this gas in war.

These are as follows :—

Forward Areas.

(*a*) *Artillery Shell.*

This was the only method employed in the late War. It has the advantage of not requiring any special organization or personnel.

The main disadvantages are (i) the small weight of chemical in each shell in proportion to total weight, *e.g.*, 4·5 in. Howitzer shell weighs 35 lb., only 4 lb. (approx.) of which is mustard gas, and roughly one-third of this is vaporized on the shell bursting, (ii) with the direct action instantaneous type of fuze, the liquid remaining after the shell bursts is largely confined to the crater, especially on soft ground.

(*b*) *" Water-Cart " Spray.*

This may be done from armoured cars or similar vehicles, or from trailers towed by them. It is suggested that 50-gallon tanks would be about the maximum capacity for one armoured car. This method might be employed to contaminate local areas or roads on a retirement.

(*c*) *Local Contamination Bombs.*

These might be bombs of various capacities which could be exploded electrically, or by delay action fuze, to contaminate local points, such as billets, destroyed bridgeheads, cross-roads, etc.

Back Areas.

(*a*) *Air Bomb.* (*b*) *Air Spray.*

Although my time is mainly to be employed in dealing with mustard gas problems in forward areas, the employment of this gas by an air force is so important that I feel bound to spend a few minutes in reviewing the possibilities and advantages peculiar to it.

Supply.

All gases to be used effectively in war must be put down in large quantities.

An air force can situate aerodromes in comparatively close proximity to supply bases, thus enabling them to obtain supplies in bulk far more easily than formations in actual fighting areas, which must necessarily be reached by much longer lines of communication. In mobile situations, this advantage must become very marked and may limit the use of gas to the air arm entirely.

Capacity.

Air bombs containing gas have not to withstand any shock of discharge, as in the case of a shell from a gun; they can thus be

constructed with a very thin wall, and contain a high weight of gas in proportion to total weight of bomb. The following figures speak for themselves :—

	Total weight.	*Weight of mustard gas.*
Air bomb	50 lb.	30 lb.
8-in. howitzer shell ..	200 lb.	28 lb.

As a result of this advantage, it is interesting to note that one squadron (10 machines) of modern twin-engined night-bombers, can carry a total weight of mustard gas equivalent to 3,500 4·5-in. howitzer shell (approx.).

Air Spray.

This method of distribution must be regarded as the most dangerous form in which mustard gas may be met with, as it is the one by which liquid mustard can be placed directly on to targets of personnel, as well as on ground or material. On release the spray is carried downwind, so spraying attacks to be effective under average weather conditions must be carried out from low heights and by pilots who are well practised and trained in the art.

If I may suggest it, these spraying attacks would be most effective on nights when there is no wind and roads are congested with troops on the move. Fast bombers of the "Fairey Fox" type could put down belts of liquid mustard over these columns, and flying at high speed would be difficult to hit before they disappeared into the darkness. Very large zones can be effectively covered in this way by a comparatively small quantity of liquid. It is interesting to note that the present procedure for embussed troops, when attacked with bombs by hostile aircraft, is to leave their conveyances and scatter to the sides of the road. If spraying was carried out, troops behaving in this way would expose themselves to the spray, whereas, if they remained inside, they would be protected from direct contact with the liquid.

Just exactly what is the most practical form of protection against this method of attack is difficult to say at present, but it is a problem that requires careful attention.

V.—Factors to be Considered in Studying Mustard Gas Problems in the Field.

I suggest that, as a general rule, a commander should appreciate mustard gas situations in the field under the following headings :—

(*i*) *Enemy Supply Facilities.*

Supply is the crux of the whole matter, where the employment of gas is concerned, owing to the large quantities required for effect.

To deny an area of ground, 100[x] by 100[x], unless at risk of casualties, would require either 300 18-pdr. shells or 110 4·5-in. shells. An

area, 1,000ˣ by 1,000ˣ, would thus require 30,000 18-pdr. or 11,000 4·5-in. howitzer shells (the equivalent of some 225 30-cwt. lorry loads). Such large areas are, therefore, entirely out of the question, except under stabilized conditions of warfare.

For spray areas, 1 gallon of liquid on an area, 7ˣ by 7ˣ, may be taken as a minimum to be effective: thus some 200 gallons would be required for an area 10,000 sq. yds., *i.e.*, 100ˣ by 100ˣ, or, 2,000ˣ by 5ˣ.

(ii) Method of Release.

With a spray area the liquid is evenly spread over the surface of the ground.

With a shell crater area it is almost entirely soaked up and contained in the crater itself.

Thus, in the former case, owing to the greater surface of liquid exposed to the atmosphere, persistence will be far less; but for a short time, at any rate, after being put down, there will be a greater risk of liquid contamination, which, in the latter case, would only be got by men lying or sitting in the craters.

(iii) Quantity Liberated Per Unit Area.

This explains itself—the more released on an area the greater will be the concentration of vapour. A reconnaissance officer would find it difficult to give a very accurate estimate, but in the case of a crater area, he could give an approximate idea of the number and type of shell per — sq. yds., and in the case of a spray area, whether contamination is heavy, medium or light.

(iv) Time.

It is important to estimate, roughly, how long an area has been contaminated when encountered. From the moment mustard gas is put down, except in frosty weather, it will be evaporating and persistence will be lessening.

(v) Weather Conditions.

The conditions prevailing from the time the gas was put down, and when encountered, govern entirely the effect it is likely to have on troops exposed to it. These conditions should be considered under the following headings:

(a) Temperature.—The length of time mustard gas will persist depends largely on this. Under 8°C. it will freeze, so although not dangerous at the time under these conditions, it will become so again when the temperature rises and melts it again.

On a hot summer's day (European), even a very heavily contaminated area is likely to be sufficiently safe to permit troops to traverse such an area within four hours after being put down. It must be remembered, though, that during that time, a very high concentration of vapour will be given off.

(*b*) *Wind velocity.*—A high wind will quickly disperse any poisonous vapour, so its effect would be negligible under such conditions. On the other hand, until the liquid was all evaporated the vapour would become effective again if the wind dropped.

(*c*) *Wind direction.*—Troops should always be moved to the windward of a contaminated area if the tactical situation permits.

(*d*) *Rain.*—Heavy rain will rapidly wash liquid mustard into the ground, except on hard surfaces, such as tarred roads, in which case it will remove a large percentage of it from the surface into the gutters.

(*vi*) *Nature of Ground.*

(*a*) *Roads.*—On a tarred road, liquid will remain more on the surface and, therefore, give off a higher initial concentration than on an ordinary metalled road, which will absorb it to a greater degree.

(*b*) *Grassland.*—If sprayed, there would be, for a short time, at any rate, a greater risk of liquid contamination. This can, however, be avoided by well-trained troops, unless they are forced to lie down in the area.

(*c*) *Woods, houses, valleys, etc.*—In enclosed spaces, such as these, vapour will, of course, hang about in higher concentration than in the open.

(*vii*) *Duration and Nature of Exposure.*

If casualties are to be avoided this factor will require careful consideration.

Are men to be likely to risk contact with liquid or exposure to vapour? In the former case, in what way? In the latter, for how long?

Excluding air spray, the most common form of contact with liquid will be on the soles of the boots. Provided that these soles are in good condition the danger of penetration to the foot will be eliminated largely, provided that men continue to walk over uncontaminated road or downland after contact with the liquid.

As regards length of exposure to vapour to produce vesicant action on the skin, I have already given some approximate idea under "Physiological Effects." It will be realized from the facts indicated, that under normal weather conditions, men may be exposed for some considerable time to average vapour concentrations likely to be met in the field before risking casualties from blistering. In stabilized conditions, it will be necessary to arrange for frequent reliefs of troops called upon to occupy contaminated areas, in order to avoid casualties. The frequency will be determined by the degree of contamination and the weather conditions prevailing at the time.

(*viii*) *The Delayed Action of Mustard Gas.*

Even if conditions and length of exposure are such as to make casualties likely, a commander will be able to take into account the

fact that his men will remain efficient fighting men for many hours afterwards, owing to this peculiar delayed action.

(ix) Facilities Available for Decontamination.

(a) Of ground.—Local areas can, if necessary, be rendered safe by applying such measures of decontamination as are most suitable. A commander will, therefore, require to know what materials are available to carry this out.

(b) Of men and clothing.—After long exposure to vapour, it is possible that the extent of casualties may be decreased by relieving troops and bringing them back for bathing and treatment of their clothing.

A commander will thus require to know what facilities, if any, are available for these purposes.

We have at present no organization to meet this, but I may mention that the American Army War Establishment provides for mobile bathing and decontamination units, and it is possible that we may have to be equipped with similar formations if occasion arises.

VI.—Practical Employment of Mustard Gas by an Infantry Brigade Retiring to a Prepared Defensive Position.

(Map Scheme in Chatham Area.)

Mustard gas available : 400 gallons and 2 contamination bombs.
Vehicles to put it down : 8 armoured cars with 50-gallon spraying trailers.

Lecturer's Notes.

This scheme was designed to bring out the following points :—

(1) Limited supply in the early stages of a campaign.

(2) Use restricted to employment by the retiring force using "water cart" spray or local contamination bombs. (Air weapons excluded.)

(3) The comparatively small areas that can be covered.

(4) The most effective use possible would be on roads in enclosed country, which enemy would require to use. (400 gallons might cover a maximum of 4,000 yards of road 5 yards wide.)

(5) Mustard should be put down (*a*) at the last possible moment to obtain full effect, (*b*) over 1,000 yards from forward defended localities for safety reasons in order to harass and to try and get casualties among the attacking force by the time their main attack develops.

(6) This gas must be looked on as a harassing agent and not a casualty producer against trained troops, unless it is definitely known that they have been pinned down in the contaminated area under favourable weather conditions.

VII.—How Opposing Force Might Deal with the Situation Created in Foregoing Scheme. (Advance Guard.)

Local Contamination Bombs on Cross-Roads in Village.

Lecturer's Notes.

(1) Although Advance Guard would include Reconnaissance Party R.E., with A.G. Mounted Troops or Vanguard, a special Gas Reconnaissance Party would probably be provided, in addition, in order to relieve R.E. Party for their normal role. If any decontamination of local gas areas is required, however, it is suggested that R.E. Detachment, with the Vanguard (*F.S.R., Vol. II*, p. 65), would be called on to carry this out, as other A.G. units would not carry the necessary tools (shovels, etc.).

(2) On encountering this local contaminated area, officer in charge Gas Reconnaissance Party would send message back to O.C. Advance Guard, giving extent of contamination, post responsible man to warn all troops to adjust respirators in crossing and not to halt on the spot.

(3) Area covered with thick layer of earth or other material available by Detachment R.E. This is done as a precautionary measure and to obviate wearing of respirators in the neighbourhood.

(4) If this area is left untouched, there would be danger in two main ways: (*a*) to troops or units halted or occupying houses for some time immediately downwind of the area; (*b*) by men, whose boot soles had come in contact with liquid, entering shelters or billets shortly afterwards. In this case, the warmth inside may be sufficient to vaporize the small amount of liquid and pass unnoticed so that respirators are not worn—result, eye casualties.

Road in Enclosed Country Contaminated for a Length of 2,000 Yards by "Water Cart" Spray with no Alternative Route.

Points.

(1) Similar Gas Reconnaissance Party as in previous situation.

(2) In this case, there can be no question of decontamination.

(3) Reconnaissance officer should (*a*) send back message to O.C. Advance Guard to the effect that sprayed area on road from —— (map reference) has been encountered, that contamination appears to be gross, moderate or light, that he is reconnoitring the extent of it and will report again as soon as possible; (*b*) post responsible man to warn all troops to wear respirators and, as soon as the information is received, to inform all unit commanders of the extent of the area.

(4) It is not considered that reconnaissance should prove difficult in these circumstances because (*a*) in enclosed country a spraying

vehicle would be confined to the road; (*b*) even if liquid cannot be distinctly seen by R.O., he can "test for gas" at frequent intervals to ascertain the extent of contamination.

(5) O.C. Advance Guard would appreciate situation under the headings previously given.

In this case, he will know that, as long as his troops are not halted or pinned down on the area, men will be exposed for under half an hour, as distance is only 2,000 yards. Thus, even if wind and weather conditions are exceptionally favourable for the use of mustard gas, he will not be likely to have any casualties from blistering effect of vapour; that is, of course, provided gas discipline is good and respirators are worn continuously until clear of the area.

(6) In all cases, other than Advance Guard, units would be responsible for their own gas reconnaissance.

VIII.—Special Problems for Royal Engineers.

(1) *Obstacles Erected Across Roadway and Splashed with Liquid Mustard Gas.*

If these require to be handled, I suggest throwing petrol over them and setting them alight in order to vaporize the liquid. Care should be taken that no one is immediately downwind of the point while this operation is taking place, as a high concentration of vapour will be given off.

(2) *Contaminated Mine Crater Across Road in a Defile.*

I understand that the R.E. procedure in this case would be either (*a*) to try and make a fresh track round, or (*b*) to make a causeway across, or (*c*) in certain situations to bridge the crater.

The main point is, however, that it would mean carrying out work round the crater for some little time. All that need be done in this case is to throw a layer of earth (or any similar material ready to hand) over the sides of the crater, in order to bottle up the liquid and prevent vapour escaping—work can then be carried out without respirators. If the roadway upwind of the crater has been contaminated, a layer of earth put over it for a short distance—say, 25 yards—would make it reasonably safe for work to be carried out for a long time provided respirators were worn.

(3) *Steel Bridge Blown Up and Contaminated with Mustard Gas.*

By what method would the bridge be contaminated by the enemy?

I suggest that it would be done by contamination bombs after the bridge had been blown up. If carried out before demolition, most of the "gas" would, in all probability, be removed or buried, and thus wasted.

In most cases, by the time R.E. were called upon to repair the

bridge, I suggest that the liquid would not be visible on it—it would have partly evaporated and partly been absorbed into the paintwork or other material on which it had fallen. Personnel required for repair work would wear "gloves, anti-gas," and respirators as long as "gas" could be detected by smell.

In an extreme case, where R.E. are called on to carry out repairs immediately after demolition and contamination, a thorough hosing down by force-pumps wherever the liquid mustard can be seen, would improve the situation as it would wash off the gross contamination on the surface. If chloride of lime in sufficient quantity was available, an alternative method would be to scatter it all over the contaminated material. This will set up a violent chemical reaction and destroy all the surface mustard with which it comes in contact. Care must be taken in this case that no one is directly downwind of the spot, owing to the high concentration of vapour set up.

IX.—Conclusion.

To conclude, I wish to make it clear that, although some people hold grossly exaggerated views of the difficulties of encountering mustard gas situations, we can never hope to avoid a large percentage of casualties in the future, unless training in peace is designed to include a thorough instruction of all ranks in the characteristics and peculiar properties of this gas, in the wearing and care of the respirator, and in special measures of protection in the field.

Poisonous chemicals must not be regarded as something apart from other weapons and treated separately. They must be included in the picture as a whole, if our training for war is to be thorough.

Finally, let me take the opportunity of correcting the very common but erroneous impression that any knowledge of chemistry is needed for a thorough study and understanding of this weapon. When under fire from H.E. shell, we do not require to know that the chemical in the shell is tri-nitro-toluene or amatol, we are solely concerned with the effect of it on our bodies. Thus it is with poisonous chemicals—we do not need to know that mustard gas is dichlorethylsulphide: we want an understanding of its effects; and the only difference in the latter case, is that we are fortunate enough to be able, in the majority of cases, to take protective measures to avoid casualties, which is more difficult where high explosive shells are concerned!

Note.—Owing to the fact that the Scheme, referred to in Sections VI and VII, is one in current use at an Instructional Establishment, the map showing dispositions, etc., cannot be reproduced, nor can adequate reference be made to it. In view of this, the main points, which the Scheme was designed to illustrate, have been put down in the form shown, to avoid misunderstanding and for simplicity's sake.

FIELD COMPANY TRAINING WITH OTHER ARMS.

By BT. LIEUT.-COL. G. LE Q. MARTEL, D.S.O., M.C., R.E.

As very few R.E. officers spend more than a short portion of their service with field companies, it naturally follows that most officers find themselves short of experience and ideas when they are sent to command a field unit after perhaps a long spell of other work. If it was possible to collect a list of tips and notes from the officers who have had more experience with field companies and issue these in pamphlet form and keep them up-to-date, it would be of great value to the units and probably to C.R.E.s as well. Failing this, some short articles in the *R.E. Journal* might help and the following notes are written with this in view. They are merely suggestions and only deal with a small part of *Field Company Training*, but they may give rise to discussions and lead to further contributions, which will be of more general assistance to everyone.

These notes deal with the training of field companies with battalions or infantry brigades. It so often happens that field companies march out with brigades and do practically nothing for days on end, that everyone loses interest. This is mainly due, of course, to the difficulty of construction or destruction under peace conditions; now that we are slowly getting some mobile bridging equipment, we can sometimes have a day of practical work in bridging, but there are many other ways in which we can take an active part, if sufficient forethought and imagination are used. Two examples of the type of work that can be arranged are as follows.

DEMOLITIONS.

A reconnaissance is made of the training area where battalions or brigades are training, and some natural obstacle selected over which a bridge can be constructed. The obstacle should, for choice, be a river or stream, but an irrigation cut, or anything of that nature, will suffice if necessary. A site on this obstacle is selected at some point within, say, five miles of the camp, and at this point the ground is dug away if necessary, so as to provide a short length of artificial obstacle, and the remainder of the obstacle must be marked out and considered as impassable to troops. A bridge is then built at this point. Most of the bridge will have to be timber work to avoid

expense, but a small portion should be solidly constructed for demolition purposes, *e.g.*, one pair of trestles might be made of concrete, or a concrete retaining wall can be built as an abutment. The demolition of either of these would provide useful training.

The infantry now work out a scheme in which a rearguard has to withdraw across the obstacle, and when they have done so, the sappers demolish the bridge. The following are the points that are brought out :—

(*a*) The infantry will probably want some additional footbridges across the river, so as to avoid having to converge and cross at one bridge which may be under fire. Will the infantry commander think of this and will the R.E. officer remind him of it ? If possible, the sappers should actually erect these footbridges before the rearguard withdraws over the obstacle.

(*b*) What instructions are given to the R.E. officers ? Is he told what to do in case the enemy suddenly appear at the bridge, and who will instruct him to blow it up ?

(*c*) Is the local defence of the bridge organized so that the sappers are not rushed at the last moment and so fail to demolish the bridge? What will the R.E. officer or N.C.O. do if an A.C. suddenly appears at the bridge, when the whole of the rearguard is still on the far side ?

(*d*) If there is only time for a hasty demolition, the roadway or pier will probably have to be attacked. If there is more time, the abutment can be mined as well. If there is not time to do this during the scheme, it can be demolished later as a demonstration.

Road Blocks.

Most infantry officers put some sappers in the advance guard because the book says so, but they have little idea as to what they would do in war. A very common duty is the removal of road blocks, and the value of sappers for this work can easily be demonstrated. An obstacle which can be imaginary or real is again selected, and a road block placed at the only crossing place over the obstacle. If a bridge or causeway over a river is selected which cannot be blocked because of civilian traffic, it can sometimes be arranged to put the road block down on some ground clear of the bridge, and for the umpires to close the bridge until the block is removed. The block should be a really substantial one, such as a crib or, say, 18" tree trunks dogged together. If possible, the block should be constructed secretly during the previous night by one section of sappers, and the

sappers who will have to remove it should not be allowed to see it. The infantry now make up an advance guard scheme and advance along the road and bump into the block, and the following points are brought out :—

(1) How soon do they get the message back that the road is blocked ?

(2) Is there an R.E. reconnaissance party well forward to send back a report as to what tools are required, and how long it will take to remove the block ?

(3) Were there some sappers well forward to deal with this ?

(4) Did the advance guard commander at once consult his sapper or did he panic and try to get round by some other way ?

It is very instructive to let the infantry have a try at removing the block with their own battalion tools, on the assumption that they had no sappers. If green timber is used and well dogged, they will not remove a single log in an hour. No infantry officer who has been "caught out" like this will ever forget again to ask for sappers with his advanced guard.

It will usually be found that battalion or brigade commanders are quite ready to work in schemes of this nature with their normal training, provided they are consulted well beforehand, and the units are very enthusiastic in carrying them out. There is no better way of instilling the correct method of co-operation between engineers and other arms and in bringing to light the importance of R.E. work, which is apt to be forgotten as we recede further from the War.

Finally, the point often arises in discussions with other arms as to what work the R.E. units should undertake. Whenever the warfare has stabilized for even a short period, there is so much R.E. work required that it is laid down for our protection that it is the duty of the troops themselves to do their own wiring and the simpler work in connection with their defences. In moving warfare, however, there is sometimes little work for the sappers to carry out. Yet under these circumstances, one often finds an R.E. officer refusing to do some work such as wiring, because the book lays down that it is not "his job." It is very unlikely that this was ever intended and there is no doubt that the sappers should do everything they can to help the cause, merely keeping in mind that we must train the infantry in peace, because there will be many occasions when we will be totally unable to help them with such work in war. With this proviso, we should be prepared to do wiring or any other work during the moving warfare in the early stages, if there is no technical work such as bridge-building or demolitions to be carried out.

SHORTCOMINGS OF REINFORCED CONCRETE ROAD DESIGN.

By CAPTAIN A. MINNIS, R.E.

PLAIN and reinforced concrete as materials for road construction have made a rapid advance since the War. Thousands of miles of concrete—principally "reinforced"—have been laid over a sufficient length of time to provide data on which to base an estimate of their success.

The objects of this article are: to summarize briefly the history of this type of construction; to note the defects in modern R.C. roads; and then to present the writer's opinions as to the reasons for those defects.

Comment being practically confined to the shortcomings of R.C. roads and their designers, criticism is necessarily chiefly destructive.

To be complete, the article should go on to show how R.C. roads ought to be designed and built. But to do so would make it inordinately long. It is proposed, if permission be given, to follow up the arguments here put forward by another article in which the principles of good design will be set forth, with a few typical examples of their application in practice.

HISTORY.

This brief historical summary does not attempt to start at the beginnings of concrete roads; it is concerned only with roads built of Portland cement concrete, plain or reinforced.

Portland cement was first produced on a commercial scale by a Yorkshireman named Aspden, rather more than a hundred years ago, but it was not until the 'sixties that it definitely took the lead away from Roman cement.

In 1865, the first P.C.C. road was laid at Inverness; presumably not with conspicuous success, because the material does not appear to have been used again for road-making until twenty years later, when Gillespie Crescent, Edinburgh, was paved with mass concrete, 10 inches thick. From this time and on to the early 'nineties, a mild epidemic of P.C.C. road-making appears to have occurred over most of the "up-to-date" world, but principally amongst the large municipalities of Great Britain and the United States of America.

The reasons are not far to seek.

Tar and bitumen had not then come into use as road binders to any appreciable extent.

Roads were principally made of water-bound macadam (for country roads and in town streets not subject to heavy traffic), or of granite or other hard stone setts (where traffic was heavy and the streets such as were required to last a long time without the inconvenience of renewal).

Traffic was practically all horse-drawn and steel-tyred. The not-too-hard stones which lent themselves best to water-binding wore fairly easily under traffic, so that macadam roads were sludgy in wet, and dusty in dry weather. They were cheap and gave a good foothold to horses, with reasonably quiet running under wheels.

Granite setts were too hard to wear into sludge and dust, but they had to be laid with joints sufficiently coarse to give a good foothold. They were, therefore, very noisy under steel tyres, and they were expensive in first cost.

Portland cement concrete seemed to promise most of the advantages of both types.

Since consolidation by roller and water was replaced by using cement mortar as binder, harder stones could be used than for water-bound macadam; so that the road promised long life and cleanliness, and the absence of joints promised more silent running than granite setts. The results were disappointing—concrete roads had faults in practice which had not been foreseen.

Cracks occurred, due to shrinkage on setting, temperature changes, and subsidence of the foundations, and these cracks made starting points for rapid deterioration; also the surface was disliked by horse-owners, being slippery for horses and harsh under steel tyres.

Concrete, as a running surface, fell into disrepute; though, as soling to be paved with granite setts (for hard use) and wood blocks (when silence was the primary consideration) its use increased.

As rubber-tyred motor traffic increased, the objections to noise and poor foothold began to lose weight, and it is probable that concrete roads would have made a very large advance in the five years before the War, had not circumstances caused another rival to appear. The necessity for finding a palliative for the dust nuisance on water-bound macadam roads brought tar and bitumen into use as top dressing. How the use of these materials as binders for macadam roads instead of water followed their use as top dressings, is familiar to everyone, but that is not for discussion here.

It is mentioned only because it was probably the principal reason why concrete did not receive the attention it deserved at that time from those interested in road development and maintenance.

There being an excellent and easily used makeshift which did not require much thought by the engineer, or skill on the part of the

labourer, there was little incentive to try to overcome the difficulties in the use of a potentially superior material.

(A parallel might be drawn with the killing of the steam motor-car by the internal combustion engine, due largely to timely developments in the production of petrol.)

The use of reinforced concrete in structural engineering, however, developed rapidly, and its success encouraged engineers to try the new *composite material* for road-making.

Just before and during the War a few reinforced concrete roads were made, notably in Melbourne (1914), Tilbury (1917) and Long Island (1917); and immediately after the War, both plain and reinforced concrete roads received a huge boost in the United States, due largely to the enterprise and influence of the cement manufacturers in that country.

The material has now definitely established itself as a first-class road-making medium; but there is room for great improvements in its use before it becomes truly efficient, there being far too great a gap between the performance possible and that which is usually obtained.

A Few General Remarks on the Present State of Design.

Before proceeding further, the reader's indulgence is asked for the rather loose use of the word "foundations."

It is a matter of some importance to use the right word for the particular part meant when writing of roads which are built in successive layers, such as macadam roads, or roads paved with a surface material which is of a nature distinct from material below.

But reinforced concrete roads are peculiar, in that normally they consist of a layer of material which is itself soling, carpet and running surface all in one, sitting directly on the soil.

They may have a thin layer of sand or clinker between soil and concrete for drainage purposes, and on very unstable soil a bed of hardcore may be put down before placing the concrete, but such expedients are in no sense "soling": being used specifically for drainage or to improve the quality of the soil. They are, strictly speaking, precautionary measures used in particular circumstances, though their use is very frequent. The word "foundations," as used in this article, means whatever is immediately underneath the road slab, whether virgin soil, an old road, or a bridge deck.

Care will be taken to guard against ambiguity; and the reader is asked, if he is a stickler for terminology, to substitute whatever his pet expression may be, whether "formation," "sub-grade," or anything else.

In what follows, reinforced concrete is the material discussed, plain concrete being unsuitable for road-making over any but soil

or other bearing giving a very perfect foundation. There is practically no difference between the laying of the two types, but there is a great difference between the efficiency of a plain and a well designed reinforced road, especially over bad ground.

Unfortunately the majority of reinforced concrete roads are not well designed ; if, indeed, they can be said to be *designed* at all.

There have been some roads laid to well-thought-out designs, and some will be illustrated in the article devoted to good road design ; but such are the exception.

The stereotyped "design" (the inverted commas are not accidental), illustrated in Fig. 2 is by far the most common form of construction used, and it is the principal purpose of this article to show where, in the writer's opinion, it fails. There is good reason to believe that the continuance of most of the typical defects of R.C. roads is due to the uncritical acceptance of this "design," for no other reason, apparently, than that it is easier and less risky to follow a precedent than try to think out something better.

This statement may seem to be very sweeping ; and objection to it may be raised by pointing to the manifest improvements of late years in reinforced concrete road construction.

But it does not follow, because some roads are better than others, that they cannot be improved, and in most cases where the stereotyped "design" has proved a success it is probable that the foundation soil is so good that plain concrete would have been equally successful. Some of the successes of this design are accidental ; due to conditions of site, climate, shade, etc., but more to the excellence of modern cements.

Most of the improvements in R.C. road construction are due, not to the designer, but to the enormous strides made in the manufacture of cement ; in the practice of concrete mixing and placing ; and, to a much smaller degree, in the manufacture of reinforcing steel.

That is to say, that most of the credit belongs to the composite material, which has succeeded in producing good roads, although it has not always been used to its best advantage and has frequently been grossly misused.

Before discussing design in detail it will be useful to catalogue the principal defects of R.C. roads, then to discuss the causes of those defects, and finally to summarize such conclusions as are arrived at from this discussion.

Principal Defects.

(1) Difficulty of opening up for service pipes and cables.
(2) Difficulty of repairs.
(3) Length of time a road is out of use during construction.
(4) Weakness of joints—causing cracking and disintegration.
(5) Waviness.

(1) Is a very serious difficulty in the case of roads in districts which are developing. In towns and country districts the trouble is not—or should not be—serious, because in the former the run of pipes and cables is known and provision for access can be given, and in the latter the question seldom arises.

In suburbs of large cities, where building is continually going on, new sewers, water and gas mains and electricity supply cables are sooner or later provided to serve the shops and houses which follow new road construction.

Whatever the type of road, such cutting up and filling in as is required for these service installations spoils the road surface, but R.C. roads present the most difficulty in opening up, and suffer most damage in the process.

Though some ingenious—not to say mad—ideas have been put forward to make easy access everywhere to the foundations, the only practical solution lies in forecasting what mains, etc., will be required, and so placing them (*e.g.*, in tunnels) that they can be got at without disturbing the road surface.

(2) R.C. roads are more difficult to repair than other types, because of the stubbornness of the material. When bad places require patching it entails much more labour to cut out the patching hole to square sides than in the case of, say, tar. macadam. Also, patches must be given time to set, and so require to be guarded from traffic for 24 hours at least. On the other hand, repair patches, once set, are much more effective than similar patches in macadam roads.

(3) This difficulty need not be dwelt upon. It is disappearing with the advance of quick setting and rapid hardening cements.

(4) The principal fault and the real *raison d'être* of this article. Cracking, at joints or at weak places, arises from several causes, though the great majority of people concerned with R.C. road-making lay the whole blame at the door of expansion and contraction, due to temperature changes.

Whilst agreeing that temperature changes probably do cause their share of cracking in roads of indifferent design, they are not, in the writer's opinion, the principal agents of cracking, even of badly designed roads.

Initial cracks are often due to shrinkage on setting, which cracks are made worse by expansion and contraction, due to changes in: (*i*) moisture content, and (*ii*) temperature.

Uneven settlement of foundations is also a principal cause of cracking, linked up with which is the primary cause of nearly all the trouble—careless or unintelligent design.

Warning to the Not-Very-Interested Reader.

Before going further, it is necessary to discuss certain properties of concrete, in order that those who are keenly interested in the

material may follow the writer's main argument, even if they disagree with his conclusions. Others are cheerfully recommended to skip the next page or two.

Shrinkage.

Concrete is subject to two distinct conditions of shrinkage. The first and more important, is that which takes place on setting, and which is due entirely to chemical changes within the material itself.

It is this "setting shrinkage" which causes initial cracking of (say) a slab, the extremities of which are not free to follow up the setting concrete as it contracts towards the centre of its mass. Most of these cracks form very early in the setting, when the concrete has very little tensile strength and cannot pull in its outlying parts against such resistance (usually friction due to a rugged bearing surface) as it may encounter. It does not follow that shrinkage cracks will invariably take place close to the extremities or near the centre. They will occur where the concrete, relatively to effort required to produce local movement, is weakest.

The second condition of shrinkage is that which takes place when concrete, already set, is subjected to some external drying agency.

Concrete is, and remains, porous, and therefore under normal atmospheric conditions never dries out completely.

If it is subjected to a drying agency, such as sun and wind, it will shrink, but this shrinkage is distinct from the initial "setting-shrinkage," in that it is reversible by the application of moisture.

Concrete behaves in exactly the same way as timber, which is shrunk by seasoning to a practically stable condition before it is fit for use as structural material. It will afterwards shrink or swell very slightly according to its use in very dry or wet situations, but no amount of moisture will cause it to swell to its pre-seasoning volume.

Thus, the shrinkage of timber in seasoning is, like that of concrete in setting, not reversible, whereas shrinkage due to subsequent drying, both of timber and concrete, is reversible by the addition of moisture; and both materials, when in use, are subject to fluctuations in volume, due to variation of the water content.

It is the first, or setting shrinkage, which causes initial cracking of concrete; but secondary shrinkage (or swelling), although its effects are neither immediate nor obvious, is also a factor which should be considered in design.

Expansion and Contraction due to Temperature Changes.

There are two schools of thought about the question of the necessity for provision for changes in length of R.C. roads due to temperature variations. One party says that expansion joints at frequent intervals must be provided or the road will crack by contraction, or "blow up" by expansion. The other party prefers to lay the road in one continuous strip, the only intentional "joints" being

where one day's work ends and the next begins. If any movement due to temperature changes takes place, then the road "will crack itself and make its own expansion joints where it wants them."

Opinions vary between the wide extremes of making the same allowance as is made in railway construction, on the grounds that concrete and steel have practically the same coefficient of expansion; and of making no allowance whatever "because there's plenty of room for the road to do all its expanding sideways."

Both of these astonishing propositions have been made in the writer's hearing.

As the coefficients of expansion of concrete and steel are respectively 0·000006 and 0·0000065, there is, on the face of it, some reason for considering R.C. roads to be similar to railway metals in this matter of variation in length due to temperature changes.

But the analogy stops, literally, "on the face of it." Owing to the extremely poor conductivity of concrete, heat from the sun does not penetrate far below the top skin. Exposure for a whole day to hot sun (which would heat a rail through and through as much as 100° above night temperature, with great effect on its length) would have no appreciable effect on the temperature of good concrete below an inch or so from the exposed surface.

At night time, most of the sun's heat taken up during the day is given off again to the air, only a very small amount soaking down further into the mass. Given a very long period of hot weather, a concrete road must absorb in this way sufficient heat to raise the average temperature of the mass a little above "normal," and similarly a long period of hard frost will reduce the average temperature to near freezing point, but the total range of temperature through which the heart of a road slab passes will probably not exceed 35°, *i.e.*, from, say, 30° to 65°. Therefore, on account of the difference in conductivity alone, the alarming possible variation of over 3 feet per mile based on a range of temperature of about 100° in the case of railway metals, can be at once reduced to about a foot. Even this amount is again reduced when one considers the shrinkage caused by drying under hot sun. It is probable that even the surface of an R.C. road expands very little due to hot sun, because the tendency to expand is largely counteracted by shrinkage due to drying out.

It may be pointed out against this that roads laid in continuous strips *do* form their own "expansion joints" themselves, and that where this has not taken place roads have been known to "blow up." The answer to this is that nine out of ten such cracks as appear have nothing to do with temperature changes; and that if the tenth case occurs there are always contributory causes, as well as expansion. An extremely small longitudinal expansion is sufficient to

cause a road to "blow up" into transverse folds of considerable height.

Again, these transverse folds, it will be noticed, invariably occur as "blow-*ups*," not "blow-*downs*," the reason for this being that any tendency to buckle downwards is checked by resistance of the foundation and the steel reinforcement on the underside of the slab. As the slab is not reinforced against tensile stress near its upper surface, that surface tears apart, and the resulting fracture allows of local lifting which eases off the compression due to expansion. See Fig. 1.

Plastic Yield.

Before going on to a conclusion on this matter of "blowing up," it is necessary to make a short digression dealing with "plastic yield," a property of concrete which is known to too few of the users of that material; although the phenomenon has been known for thousands of years to users of timber.

A beam of concrete or unseasoned timber deflects when a load is first applied, due to elastic deflection. If the load is allowed to

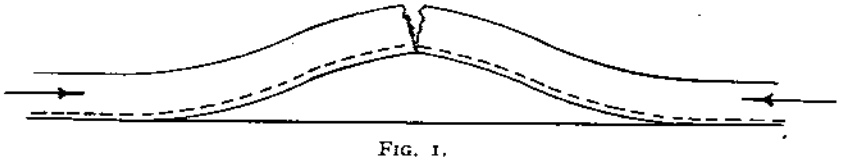

FIG. 1.

remain, deflection increases as time goes on. On the load being removed, the beam recovers to the extent that the initial (or elastic) deflection disappears, leaving as a "permanent set" the additional deformation which occurs after the initial deflection. This "permanent set" is the result of "plastic yield," due to the combined effect of load and time.

It is not proposed to go further into this matter than is necessary for the present purpose. It is mentioned only in order to point out that concrete can, due to this plasticity, yield sufficiently to take up within itself, and without damage, compressive stress due to expansion, which stress is only very gradually applied.

All that is necessary is to stop the concrete buckling by reinforcement designed to prevent such fracture as is shown in Fig. 1.

Further, such reinforcement is necessary to take up the tensile stress which is set up by contraction.

It is the writer's opinion that a road could be laid in one continuous slab without any danger of trouble from *temperature changes* if reinforced top and bottom; such reinforcement serving the double duty of taking up tensile stress on contraction and preventing buckling on expansion.

(Reverting to the parallel case of railway metals, cited by the expansion "fans," it may be noticed in passing that, even in that matter, expansion allowance may be completely omitted provided that firm anchorage against buckling is given. Modern practice in the laying of tram rails in streets, where the top of the rail is flush with the pavement, uses welded joints between rails, making a continuous jointless rail.)

It does not follow that continuous construction of R.C. roads is recommended; cracks from "setting shrinkage" would still occur, and variation due to wetting and drying. The opinion is expressed only with the object of laying the "expansion-by-heat" bogy, which has received far more attention from R.C. road-makers than its unimportance warrants.

Continuous Strip versus Jointed Construction.

The writer has already stated that continuous strip construction is not recommended, in spite of it being, in his opinion, possible so to design such continuous work as to eliminate all danger from temperature changes; and the reason given is that setting shrinkage would cause cracking. Therefore, jointed construction, in the form of short slabs, is necessary. But such jointed construction immediately places us where we were before as regards the danger of "blowing up" on expansion, if the slabs are butted closely together.

It would be useless to leave this question in such an undecided state; some idea of the necessary space to be left between slabs, and the best method of leaving it, must be given.

In this matter the two factors to be provided for are "setting shrinkage" and "expansion" (obviously "contraction" does not matter).

These two factors are mutually opposed in their effect on the road when laid, and the first can be made to allow for the second.

The setting shrinkage of concrete varies in amount due to several causes, the chief one being the quality of the mix; usually the richer the mix the greater the shrinkage.

But for average good concrete, setting shrinkage is about 0·0005 inch per inch, which is the same as the expansion due to a temperature rise of 91°F.

It has already been shown that full allowance for such a range of temperature is unnecessary.

If, therefore, slabs are laid on the "alternate bay" system (which is the most convenient method for practical work), sufficient allowance will be made for expansion if, when laying "even numbers" between the "odd numbers" already set, the edges of the odd numbers are coated with some greasy substance, so as to prevent adhesion of the new concrete. The new concrete of the "even numbers" will then shrink away from the joints, and spaces amounting to ·00025 inch per inch will be left over the whole length of the road.

This shrinkage will thus provide easement equivalent to spaces between 40′ slabs of about $\frac{1}{8}$″. (This, of course, does not mean that there will be gaps $\frac{1}{8}$″ wide between slabs. The actual gaps will usually be about $\frac{1}{16}$″ wide, the remainder of the shrinkage being divided between many minute cracks in the slabs themselves. These cracks must first be closed by expansion before a slab can begin to exert any pressure on its neighbours.)

It is obvious, then, that the normal provision of an expansion joint by inserting a solid bitumen strip or wooden packing of about $\frac{3}{8}$″ thickness—this joint being again widened by shrinkage—is absurd. All that is necessary is to ensure that slabs are not actually joined; leaving the concrete to form its own easement during setting.

If, after the first few "even numbers" have been laid and have set, an inspection shows only a fine gap between their ends and those of the older "odd numbers" (as may well be the case with some qualities of concrete and with various cements), some misgivings may be felt as to the sufficiency of easement.

In such a case it would be as well to use a bitumen strip of (say) $\frac{1}{8}$″ thickness every five or six joints. More provision than that should never be necessary.

Cracks due to Faulty Design.

If one takes the broad view, *all* cracks are due to faulty design, because even those for which such causes as shrinkage, temperature changes, and conditions of site, can be blamed are in the last resort the fault of the designer, who should make his design to meet these dangers.

But there is one extremely common fault in design which is itself the cause of most really serious cracking—that is, the misuse of reinforcing steel by unintelligent placing or from a mistaken attempt at economy.

Makers of reinforced concrete roads may be roughly divided into three classes, those who know their materials well and take thought and care in design; those who don't know much but take meticulous care in execution of work; and those who may or may not know, but don't take the trouble to think out the problems of design, nor to supervise the execution of the work, for themselves.

The first class holds the select few, one of the other two includes the great majority.

The first class has made and is making what are, in the writer's opinion, the best roads of any kind ever built.

The second is making roads of bad design which achieve some measure of success because of the attention paid to details of concrete mixing and laying, whereby the material is enabled to perform duties which it ought never to be called upon to do. This is a large class.

The third class, also a large one, accepts the "designs" of the

second class (because those of the first are usually a little more expensive), and takes very little trouble in the execution of the work. These people make, considering the materials, very bad roads.

Let us now examine the stereotyped " design " referred to earlier. It is illustrated in Fig. 2 and is due to someone of the second class

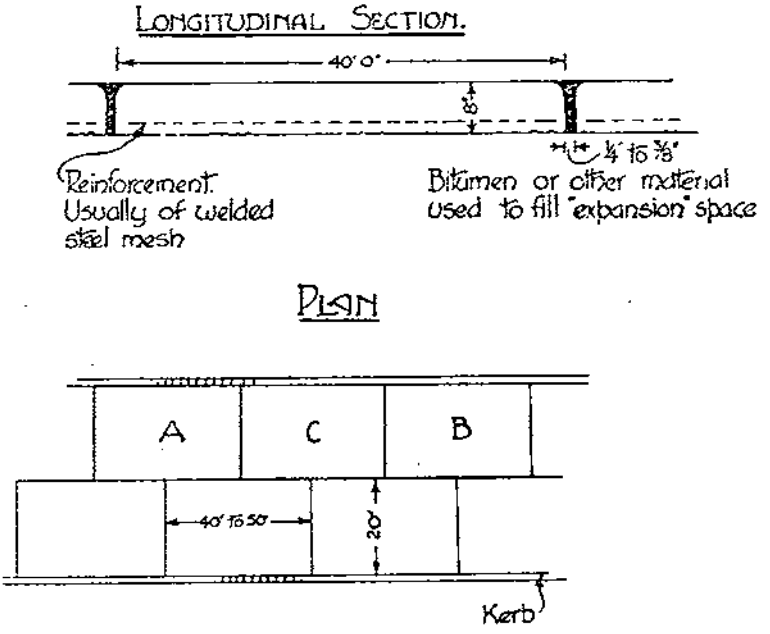

FIG. 2.

and used by the second and third classes to build most of the R.C. roads already finished and in construction.

The slabs are usually laid on the alternate bay system (A first, B second, and then C between A and B). The thickness, of course, varies, but will usually be about 8". It is sometimes made up of a bottom course of 5" to 6" thick of 4–2–1 concrete, using aggregate graded down from 2" to ⅛", and a " wearing " course of 3" to 2"

thick of 3–1½–1 concrete, with aggregate graded down from ¾" to ⅛". The reinforcement used is usually a steel mesh placed 1½" to 2" above the formation. The joints are simple butt joints with a space between the slabs of about ⅜", kept by placing boards on edge against the slabs already set, or by placing and leaving a strip of solid bitumen which forms the "filling" to the "expansion joints." When boards are used they are sometimes left to rot away, and are sometimes removed when the slab is set, the filling between slabs being bitumen run in hot.

This, very briefly, is the specification in most common use to-day, with variations which do not affect the essentials.

There are several minor points which are open to criticism, but for the present we are concerned with the placing of the reinforcement only. The slab is designed in the same way as a floor slab supported at its edges.

The reasoning on which it is based—the writer has heard it reiterated by a great diversity of people in sundry places—is, omitting irrelevancies and repetitions, as follows: "If you load a slab it deflects into a saucer shape. The constant repetition of this deflection compresses the soil under the centre of the slab until it eventually becomes permanently depressed, and the slab is then supported only on its sides. Consequently, the underside of the slab is always in tension in varying degrees of intensity; therefore, tensile reinforcement is necessary near the bottom; the top is in compression, which the concrete can deal with itself."

At the risk of insulting the reader, who will already have noticed that this reasoning exhibits its own weaknesses abundantly, its two principal fallacies will be pointed out.

The first is that the loading is assumed to be always more or less central. It is not. The normal run of traffic on a road puts every part of the surface at one time or another under maximum point loads. The second is the assumption that the slab is supported chiefly at its edges.

Whether such people as use this design agree or don't agree that their reasoning has been fairly presented, a glance at the placing of the reinforcement is sufficient to show that this assumption must have been made.

The reinforcement is placed near the underside of the slab, as it would be in the case of a floor slab carried on four walls without any intermediate supports.

This means, if it means anything, that the designer anticipates sagging bending only; because, if he thought that any useful support could be expected at any point between the edges, he would provide reinforcement against hogging bending, exactly as in the case of a floor slab continuous over several supports.

As he makes no such provision, only one deduction is possible

(assuming that the designer has some knowledge of R.C. design): that is, that he is perfectly satisfied that "saucerwise" deflection only need be expected.

Now even if we assume the most favourable conditions—a perfectly elastic foundation of even consistency—the slab will seldom deflect "saucerwise"—never when two widely separated loads are on the slab at once.

The tendency to deflection will be, for representative conditions, as shown in Fig. 3, which shows a longitudinal section of a road slab under loads in various positions. A cross-section of the slab would show similar tendencies to deflection.

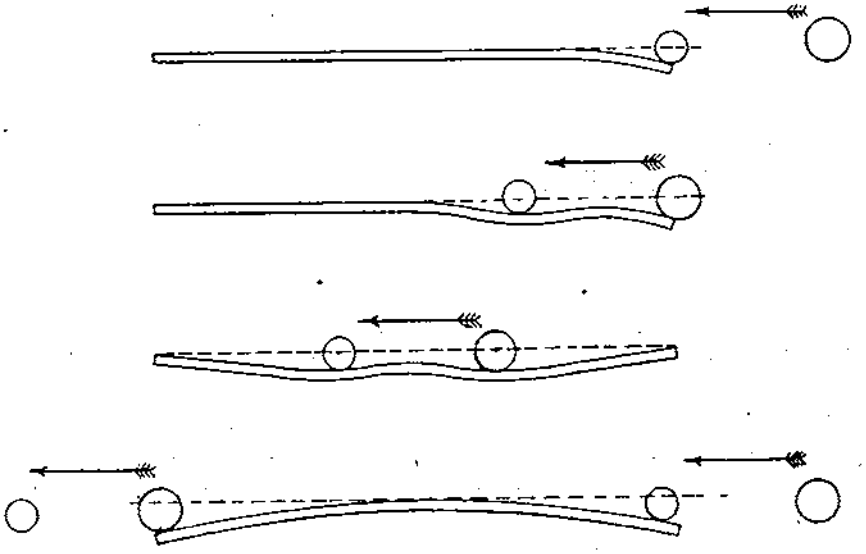

FIG. 3.

Under the ideal conditions assumed it is unlikely that any convexity sufficient to cause serious tension in the upper skin will occur in practice, but it is clear that the easy assumption that tension will occur only in the bottom skin will not do.

When we come to the more practical case of foundations which are not reliably consistent in bearing capacity, and are liable to local settlement due to water or filling of embankments, etc., the "saucerwise deflection" assumption explodes with a bang.

There are very few cases where the soil on which a road is built can be depended upon to settle evenly, and for this reason the condition of uneven settlement is called the "practical" one.

Whether a layer of clinker, or other drainage arrangements underlie the road slab, makes at best only a difference of degree in the effect of uneven settlement of the foundation.

If a singly reinforced slab is to remain sound, local settlement

must take place, if at all, as shown in Fig. 4 (a), when the steel would be in its proper place.

Unfortunately, even the best-intentioned soil has little knowledge of the principles of R.C. design, and is just as likely to sink, as shown in Fig. 4 (b), when the steel would be useless. Even without appreciable settlement, the constant depression and lifting of the edge of the slab as it passes a wheel off itself to the next slab will cause consolidation of the soil locally to a level below the remainder; and the slab will soon lack support at its edges, thus being subjected to a hogging instead of a sagging bending action.

(It should be noticed that local consolidation of the soil, due to alterations of loading, will be much more likely at the edges of the slab than in the centre, because there is no connection between slabs, and, therefore, no support forward of the load point.)

The case of the slab in Fig. 4 (b) is not so bad if the settlement

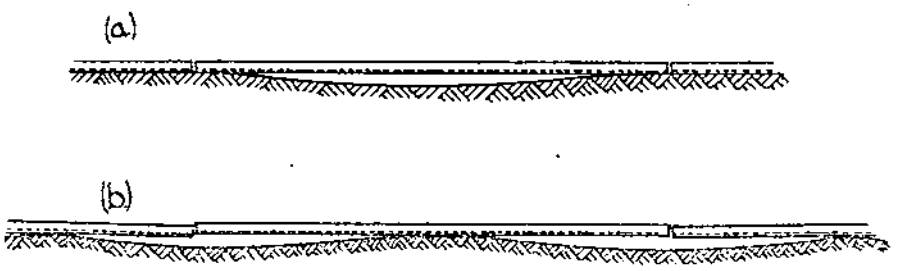

FIG. 4.

takes place in the middle of the transverse edge, as shown in Fig. 5 (a), but even here a crack, due to unforeseen tensile stress, will be very likely to start (as shown X–Y, Fig. 5 (a)).

Further trouble may be avoided by the *transverse* rods of the reinforcing mesh, which will be in their proper place as tensile reinforcement between A and B, the slab acting as a beam from A to B and bridging the depression. The *longitudinal* rods will, of course, be quite useless.

The case of the slabs in Fig. 5 (b) is much worse. Here the settlement has taken place at the corner of the slab, and, there being no chance for a beam such as A–B in Fig. 5 (a) to form itself, the corners become cantilevers projecting from the main slabs. They are, of course, not reinforced as cantilevers, and crack as indicated at XY and XY.

These results of uneven settlement are not a matter of conjecture only; they can be seen on any singly reinforced road; and some young officers may remember (when a certain singly reinforced road, which they saw in course of construction and later, was being laid) that they were told how these corners would crack within a couple of years or so. The prophecy was unnecessarily cautious; a great

many cracks appeared within a month of opening, more are developing, and still more will continue to appear until the bed settles for good, if it ever does.

Sufficient has been said to show that this commonly used " design " fails on the point of most importance—that of the provision and placing of steel reinforcement. Single reinforcement is nearly useless,

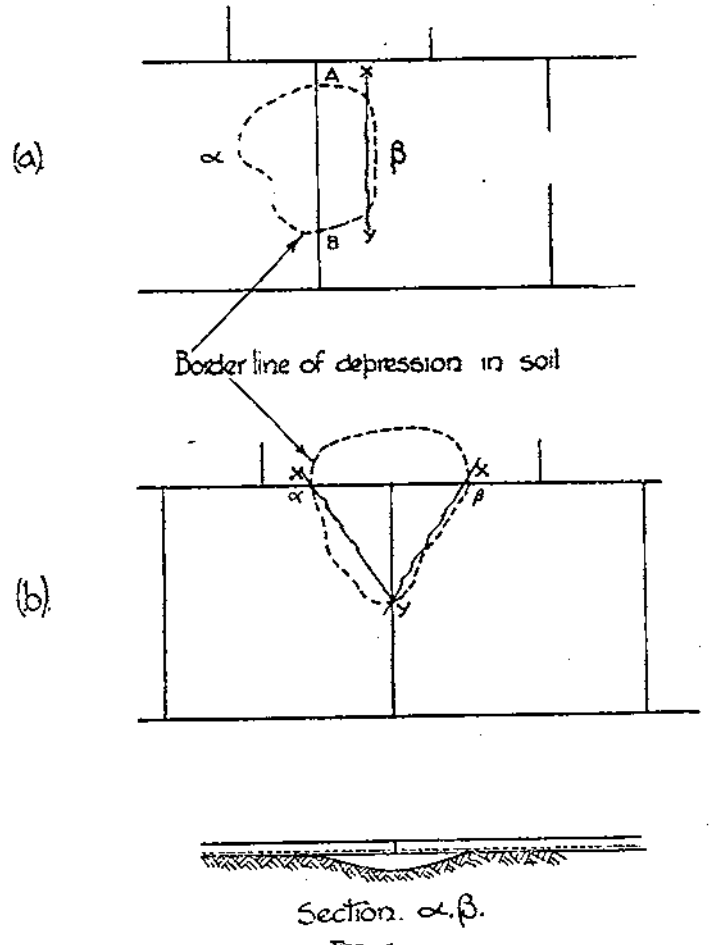

FIG. 5.

wherever placed; but if the extra cost of double reinforcement will not be faced, it is better to place the single layer of mesh near the top of the slab. The corners (which are the weakest places) will then be strengthened and the inevitable cracks where a depression is fully bridged will at any rate be underneath and out of sight.

Another point which has been brought out in the foregoing is that reinforcement across the slab is almost as important as longitudinal steel. (See Fig. 5 (a).) This is practically never provided in the

"design" under discussion, the mesh commonly used having its "main" wires running longitudinally only, the transverse wires being merely spacers, placed at much wider centres than the main wires, and being usually of lighter gauge.

Even double reinforcement, which provides for both hogging and sagging deflections, does not always fill the bill completely. In addition, shear stress should be provided for in some cases.

We have not yet finished with the shortcomings of the "stereotyped design."

Leaving aside minor faults which will be dealt with by implication when a good design is discussed, there is one important failing which is worth special notice. It is bound up with what has already been said about the damage due to uneven settlement, and it refers to the transmission of loads from one slab to the next.

In this respect road slabs are in a similar position to railway metals; when a wheel arrives at the edge of a slab, the slab deflects

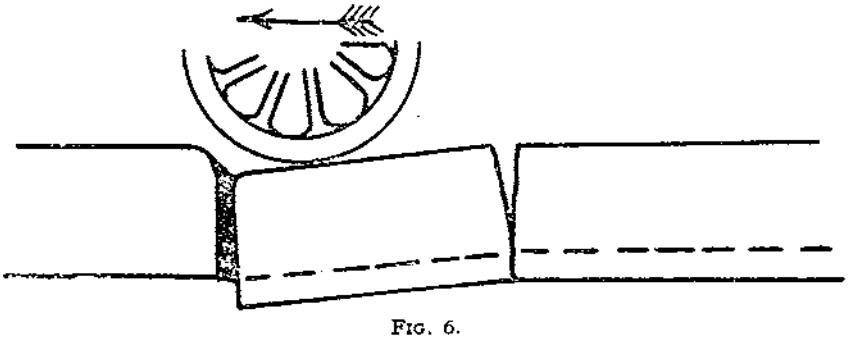

FIG. 6.

below the level of the next, and there is a slight jump when the load actually crosses the joint. Railway metals are fished in order to make one rail relieve the other as much as possible whilst the wheel is on the overhang, and to depress both rails together so as to minimize the jump. It is not possible to fish R.C. road slabs in this way—continuity of reinforcement has been tried, but is not a success; but it is possible to design a joint which will serve the same purpose.

The "design" under discussion makes no such attempt, with the consequence that joints suffer pounding, even if the slabs escape such cracking, as is shown in Fig. 6.

Waviness.

This is the last of the five defects. Waviness of R.C. roads has nothing in common with those corrugations of macadam roads with which every motorist is familiar. The crusts of macadam roads soften and expand at the same time, due to wet in the case of water-bound roads, and heat in the case of roads bound by tar or bitumen.

In their soft and expanded state, which causes folding into waves,

these macadam crusts are subjected to pounding from traffic which exaggerates the waves and makes them permanent.

Concrete, having much greater compression strength, refuses to be kneaded about in this fashion, and, therefore, does not corrugate in the same way.

(It may here be remarked that the bastard type of road sometimes met with—a concrete road with a " waterproof carpet " of bitumen or tar—is for this present purpose, not a " concrete road " at all. It will corrugate, of course ; and for this reason is bad construction, the corrugations causing unpleasant running and needless impact on the concrete bottoming.)

But R.C. roads do develop waves, though the waves are much greater in length and much shallower than those of macadam roads. The effect felt by the motorist is nothing like so unpleasant as that from a corrugated macadam surface ; but there occur occasionally stretches of R.C. road on which waves are so regular in length as to develop a " period " in the springs of a car travelling at the right speed. The writer has never seen or heard of any explanation of this waviness, which is not of frequent occurrence, and is, therefore, not often discussed.

The two suggestions which follow are put forward with diffidence and the writer would welcome criticism or confirmation of them.

They are, that waviness may be caused by warping, or by deflection due to local sinking of foundations ; the former being variable according to atmospheric conditions and the latter being cumulative due to plastic yield.

Warping.

This follows from the same causes as warping of timber.

When one side of an R.C. road slab is exposed to the sun, it dries and shrinks, whilst the underside remains moist, retaining its original length and breadth. There is, therefore, a tendency to warp. The writer has seen cases of warping (of pre-cast concrete structural units).

Deflection.

This requires no explanation.

Assuming either or both of these suggestions to be true explanations of waviness, it will be of interest to notice some of the implications which ensue. In different cases :—

Either warping or deflection may be the sole cause of waving.

If deflection is the original cause, warping will probably exaggerate it.

If warping is the original cause, there will be a tendency for the edges of the slab to leave the foundation, and incidence of loading will tend to flatten it out.

Waviness caused by warping would probably be less noticeable after a period of wet weather, and more noticeable after a spell of hot, dry weather.

In the case of a road laid in slabs of equal length, waving caused by warping would be regular over long stretches of road; whilst that caused by deflection would occur at irregular intervals depending upon variations in quality of the foundation.

CONCLUSIONS.

The writer's conclusions on the defects in most reinforced concrete road construction, with which the reader is invited to agree, are as follows:—

(1) That on most foundations it is impossible to forecast where the hard and soft places will be, and that it is, therefore, wrong to assume that any slab forming part of the road will necessarily have its principal support at its edges.

(2) That hogging bending is just as likely to occur as sagging bending; therefore, tensile stress may occur at either top or bottom of the slabs.

(3) It follows from (1) and (2) that single reinforcement, wherever placed, cannot provide for the varying incidence of stress. It can be in the place where it is wanted only by a fluke.

(4) That the surface cracks which form themselves at more or less regular intervals in singly reinforced roads laid in continuous strips, and which are popularly thought to be self-made "expansion joints," have usually nothing to do with temperature changes. They are due, sometimes to shrinkage cracks, and sometimes to hogging bending over relatively firm places following depression of the foundation between them.

(5) That a road slab requires transverse as well as longitudinal reinforcement.

(6) That temperature changes need not be considered if the road is laid in a manner which makes use of setting shrinkage.

(7) That corners of slabs require special thought in design, and that joints between adjacent slabs must be so designed as to make the slabs mutually supporting.

And, finally, that most of the faults to be found in R.C. roads have their origin in the designer's office.

Some few engineers have already shown that the composite material is the best road-making medium yet produced; and its superiority would be universally proved if a small fraction of the thought and care bestowed on relatively unimportant details of concrete mixing on the job were given to preliminary work on the drawing-board.

THE GERMAN ENGINEER AND PIONEER CORPS.

(INGENIEUR=UND PIONIER=KORPS.)

By COLONEL G. H. ADDISON, C.M.G., D.S.O.

PART I.

INTRODUCTION.

"To enter the war at full strength from the start, Germany needed in peace 100 instead of 35 Pioneer battalions, and the war showed that this would have been feasible if all effectives had been called up. It would have been both cheaper and more businesslike to have carried the burden of this armament, than to lose the World War and be obliged to pay the consequences. If a prudent, calm German people, a far-seeing, wise Government, a vigorous, resolute, supreme power had ensured the necessary increase in time, if only by two-thirds, the outcome of the war would have been very different, and victory won in 1914; it may even be that war would not have come at all. Not by weak-kneed pacificism, but by the doughty man at-arms, by the strongest battalions is peace assured to a nation And so all the self-sacrifice, all the devotion of the 50,000 Pioneer dead could not avert the Fatherland's doom. Once again has Segestes betrayed the people of Hermann."

"This is the end of the story;
The Nibelungs' doom and despair."*

This, freely translated, is the end of Lieut.-Colonel Augustin's story of the development of the German Engineer and Pioneer Corps during the Great War.† It is an interesting and in some ways surprising story. Germany entered the war with a Pioneer organization that provided three field companies to every two divisions, with no Army or General Headquarter reserves, other than a few fortress Pioneer regiments which events might or might not make available for the field army. At the height of the struggle, there were still divisions with only a single field company, and with over 200 divisions in the field only 9 Pioneer battalions (36 companies) remained unallotted to divisions. The story of the war, so far as the Engineer and Pioneer Corps was concerned, is one of a long hopeless struggle to make up for a bad start. Remembering the completeness of German pre-war organization, it seems incredible that the allotment of Pioneers to the field army in 1914 should have been proportionately so little greater, as regards officers even less, than what had proved necessary a century earlier. The long con-

* In A.D. 9, Arminius (the Latin form of Hermann) led the people of South Germany in revolt against the Romans. In spite of the treachery of Segestes, who betrayed the plans to the Roman commander, the revolt was completely successful, and Hermann became the German national hero.

† "Die Entwicklung der Pionier—Waffe im deutschen Heere während des Weltkrieges," Von Oberstleutnant Augustin. Mittler & Sohn: Berlin.

tinued neglect, it might almost be called contempt, of the technical arm offers an interesting study of Prussian military psychology. The following pages are, however, designed as a plain story and not as a critical study. The original intention was to confine the story to the period of the Great War, but it soon became apparent that some knowledge of what had gone before was necessary to an appreciation of how and why things happened during the war. The result is a general history based on a number of German works which are tabulated at the end of Part II ; in addition, reference has been made to various official handbooks and publications in order to check and fill in gaps in the other works. It should be remembered that the original authors are all officers of the Engineer arm, and it is only natural that their views should be coloured by the peculiar conditions attaching to it. This is of some importance when expressions of opinion rather than statements of fact are in question. On all points in connection with the German Army, whether dealing with experiences of the past or lessons for the future, the opinions recorded are those of the original authors and not of the present writer, whose comments are generally confined to footnotes. The translation of the German word "*Pionier*" always presents difficulties. It has quite a different significance from "Pioneer" as understood in the British Army; but, for various reasons, the more usual translation "Engineer" would not be convenient. The plan adopted is to render literally "Engineer" for "*Ingenieur*," and "Pioneer" for "*Pionier*." Readers who are not already acquainted with the organization of the German Corps may find it helpful to glance at page 248 before reading further. Attention was first drawn to Lieut.-Colonel Augustin's work by Sir James Edmonds, to whom acknowledgments are also due for much valuable advice and help in the preparation of this paper.

EARLY HISTORY.

Pre-Napoleonic Period.

We usually begin the history of our own Corps with Waldivus Ingeniator, 1066, or at all events not later than Edward III.'s body of engineers, gunners and other artificers at Calais in 1346. There is no record of military engineers in Prussia until the second half of the 17th century when, under Frederick William of Brandenburg ("The Great Elector"), small parties of "pontoniers" and "miners" were attached to the artillery. The pontoniers were formed in squads of 10 to 15 men under a "bridge-master"; they had no bridging equipment, and it is evident that the artillery had to do most of the work. The greatest bridging exploit of this period occurred in 1689, when Frederick crossed the Rhine with 20,000 Brandenburgers over an improvised bridge. Frederick William I. ("The Soldiers' King") formed the first independent company of pontoniers, but its strength was only 2 non-commissioned officers, 1 master and 20 men. He also introduced an equipment consisting

of copper pontoons, each carried on a light wagon, with anchors, breastlines, boathooks, etc., but no superstructure. This company took part both in the Swedish War of 1718 and the French War of 1735. Like the pontoniers, the miners were at first attached to the artillery, only occasionally being placed under command of a miner officer. Both engineers and miners were employed at the Siege of Stettin in 1677, and this is the first record in Prussian annals of the use of "engineers" in a siege. In 1690, a regular miner company was formed, but of low strength, and with no regular status in the army.

At the end of the second Silesian campaign, Frederick the Great formed both pontoniers and miners into separate corps; they had no fixed establishment, but were recruited as and when required for service. The copper pontoons were, at the same time, replaced by wooden boats, of a type that lasted until 1860, when the first iron pontoon was introduced. Frederick also organized a Pioneer battalion, but the losses of the Seven Years' War led to its conversion into Fusiliers.

At the beginning of the Napoleonic Wars, the Prussian Army, of roughly eight to nine Corps, had only two and a half weak pontoon companies; Austria had one battalion of four companies. Russia was better provided, and in 1812 had 6 pioneer battalions, and 20 pontoon companies with ample equipment, attached to the Artillery. In France, until the Revolution, only artillery personnel seems to have been employed in bridging, but separate units were quickly formed which, by 1801, far outnumbered all the other armies combined, with the exception of the Russian. In 1809, Napoleon demanded two pontoon companies from Bavaria. These were the first technical troops to be formed in that country, and the Bavarian Pioneer Corps is their direct descendant.

Birth of the Prussian Engineer and Pioneer Corps.

In the general break-up of Prussia, both Pontonier and Miner Corps disappeared. When the army was reorganized in 1809–10, pontoniers, miners and engineers were amalgamated by Royal Decree into a single composite Corps. Various dates are given for the actual birthday of the Engineer and Pioneer Corps, which was at first composed of a Corps of Engineers (officers) and three companies of Pioneers, all that was allowed by the Peace of Tilsit. As first constituted, each company comprised in peace miners, sappers and pontoniers in the proportion 1 : 2 : 1. For war, the miners were to be formed into four fortress companies; the remainder into field companies (2 officers, 81 other ranks), consisting of two sapper and one pontonier sections. The distinction between fortress and field companies soon disappeared in the French War, siege operations during 1815 being almost entirely conducted by field companies, not unlike the experiences of a hundred years later. By 1815, the number of companies had risen to 21, roughly one per division, and the strength of each company to 200. An Engineer officer was

attached to each brigade headquarters, and with every Corps there was an Engineer and Pioneer Commander, with at least two other officers. These details are chiefly of interest for purposes of comparison with 1914.

The regulations of 1809 were signed by Scharnhorst, Gneisenau, Pullet, Boyen and Leithold. To Scharnhorst, as head of the reform commission, fell the executive duty of putting the reorganization into operation. He may be regarded as the first chief of the Engineer and Pioneer Corps, and so long as he remained in control the Corps was in close touch with the staff and the rest of the army. The final downfall of Napoleon left Prussia with restored confidence and strong forces. The army had so changed in size and character that drastic reorganization of peace establishments had to be undertaken; in particular, the need for much greater independence in the constitution of the principal arms was recognized. But the effect on the Engineer and Pioneer Corps was disastrous, for it was relegated to a subordinate position which soon developed into a state of complete isolation from the fighting arms. This condition of affairs, introduced in defiance of every lesson of the war, was to have a lasting effect not only on the Corps but on the whole technical service of the German Army.

The period that followed was marked by notable developments of science and progress of civilization in Europe. Population increased rapidly, finance flourished, hundreds of miles of road were built, new industries sprang up, and Germany began to look for her place in the sun. Machine shops, first established in Aix by the Englishman, James Cockerill, were copied in Germany by Von Hummel, Freund and Egells; and in 1826 the younger Krupp took over his father's primitive steel works at Essen, which in the course of a few decades were to outstrip all foreign competitors. But time was still to elapse before their importance to war technique was recognized. The Pioneers, one of whose duties at this time was to take over garrison guards when all other troops were on manœuvres, had little opportunity to interest themselves in scientific development. Their interest was first awakened in connection with railways and telegraphs. The army was slow to take either of them seriously, the general view being expressed in a paper written by the Chief of Staff, to the effect that it was impossible to contemplate the use of such new-fangled contrivances in war, where risk of failure so far outweighed possibility of success. This was in 1836, and some years later the Chief of Engineers, General Aster, becoming alarmed at the growth of railways and their possible influence on the defence of fortresses, put forward a demand that no lines should be permitted to pass through a fortress, and that where they even approached its neighbourhood strict military control should be established and complete preparations for demolition made. The War Minister, Boyen, with more vision, laid emphasis on the strategical advantages to be

gained by the defenders. When it is remembered that the term fortress covered many great towns, such as Cologne, it is not surprising that, in spite of military doubts, railway construction continued to follow the dictates of trade and of topography. Aster apparently took no steps to train technical troops either in construction or destruction.

The history of telegraphs is very similar, arguments of the same kind being advanced as to their possible danger to the army, and the necessity of control by the War Ministry. This led, in 1849, to the appointment of an Artillery Colonel as Director of State Telegraph Services under the Board of Trade, much to the chagrin of this department. The struggle to militarize state telegraphs continued throughout the next fifty years; but in the technical development of the service the Pioneers had no share.

The Corps of Officers.

In the earlier days of its existence, the officer corps went through many trials and tribulations. Starting with 37 trained Engineers in 1810, it had been built up by 1815 to a strength of 175, most of whom had no engineering training or experience except such as they gained in the war. The pre-war regulars went rapidly to the top, where they remained, causing complete stagnation in promotion; for example, the Chief of Engineers became Major-General at the age of 43, while there were under him subalterns of 37 and Captains of 50. To add to the difficulties caused by post-war reductions, fortress construction and maintenance were formally entrusted to the Engineers in 1822. In the course of reorganization, there had been a great opportunity to broaden the scope of military and technical training of officers, but it was not taken; and in 1816, the study of tactics was cut out of the syllabus of the joint artillery and engineer school, as being unnecessary for technical officers. The chief aim of authority at this time was to get cheap fortress construction out of the corps, which became more and more divorced from the rest of the army. This applied equally to the Pioneer companies, and attempts to secure for them a share in field training and manœuvres met with stern condemnation as being a misuse of technical troops.

General Army Reorganization of 1860–61.

In 1839, each army corps was provided with an organized column of entrenching-tool vehicles, and some years later a pontoon train was formed for every corps. No other developments occurred until 1860, when a general reorganization of the army began. In the course of this, Pioneer companies were grouped in battalions, each composed of one company of pontoniers, two of sappers, and one of miners, thus shifting the principle of unity from the company to the battalion. The total strength of a battalion was 18 officers and 482 other ranks, which was also decreed to be the war establishment. The battalion organization was based on purely peace considerations

of command and administration; it was not adaptable to ordinary war formations, and led ultimately to many of the difficulties encountered during the Great War. However, the general scheme, which was carried out under Count Radziwill, a distinguished infantry general, as Chief of Engineers, seems to have been approved by the majority of Engineer officers at the time. The year's training of the battalion, as then laid down, was to consist of: recruit drills, 3 months; company training, 3 months; battalion exercises, 1 month; section leading and field exercises, 10 weeks; revetments, 3 weeks; trench-digging, 1 week; pontooning, 3 weeks; siege operations, 3 weeks; afternoons throughout the year; in summer, swimming, gymnastics and general Pioneer duties; in winter, classes and schools.

A scheme was also started in 1861, of sending Engineer officers to foreign countries to study developments in fortification; the first to be dispatched went to Antwerp, Lille, Cracow and Lemberg; and two to England to study coast defences, especially the latest designs of steel-armoured casemates.

The Wars of 1864 and 1866.

The inherent weakness of the Pioneer organization became apparent in the campaigns of 1864 and 1866, during which all the heroism and devotion of the troops themselves could not make up for inadequate numbers and lack of co-operation. The need for properly organized technical services was also emphasized, particularly in the Austrian War, for which both railway and telegraph troops had to be improvised. Four telegraph detachments were formed of state telegraphs personnel with a small nucleus of peace-trained Pioneers; three field railway detachments of civil railwaymen with a small Pioneer section attached to each; the whole under the orders of an Engineer officer attached to the Army Staff. After the war, a committee, set up by von Moltke, severely criticized the ignorance displayed by higher commanders in their handling of the Pioneers, and also stressed the need for Engineer officers to have wider knowledge of the principles and conduct of field operations. It recommended that there should always be a senior Engineer officer with the staff of every higher formation to advise the commander and convey his orders to the Pioneer troops.

The Franco-German War.

When the Franco-German War broke out in 1870, the general position had altered very little, although one important administrative change had been introduced. The Austrian War had shown the fallacy of separating pontoniers, sappers and miners, and shortly afterwards the battalion was reorganized in five companies: 3 field, 1 reserve and 1 fortress, all composed solely of "Pioneers." On mobilization, battalions were broken up; the commander joined the Army Corps Staff, single field companies were allotted to various formations, and the fortress companies to fortress garrisons. In all,

49 field and 39 fortress companies were mobilized. At an early stage, nine of the latter were diverted to the field army to reinforce the field companies, and during the advance nine more joined L. of C. for railway and general maintenance work; of the remainder, all but six were engaged in the Siege of Strassburg. Each peace fortress company had to mobilize three units, which were made up of 6% active, 6% reserve and 88% Landwehr personnel; 70% of them being fathers of families. Telegraph and railway detachments were specially formed, as in 1866. Other technical units comprised a field photographic section; a mobile torpedo (submarine mining) detachment, designed to block the Seine at Havre; and two balloon detachments for which the personnel had been hastily trained with balloons obtained from England. The Corps of Engineer Officers was much below establishment all through the war, and was never made up, in spite of various shifts. Numerous examples are quoted of delays in operations and unnecessarily heavy losses on the part of the infantry, owing to lack of technical help. However, on the whole, a rather brighter picture is painted than of the earlier wars; the gallantry of the Pioneer troops was recognized by the other arms with whom they often fought shoulder to shoulder; and legitimate hopes were raised that the future would bring wider recognition and increased opportunities to the technical arm.

Period 1871–1914.

These hopes were not realized. The very completeness of the victory led the German higher command to ignore shortcomings that had seemed so obvious to the Pioneers themselves, and such changes as were made had even a narrowing effect on the role of the Corps. Minor improvements were made in the constitution of a battalion; but railways were completely separated in 1875; and so, to all intents and purposes, were telegraphs, although the Chief of the Engineer and Pioneer Corps continued to exercise powers of inspection until 1899. For administrative purposes a regular chain of Fortress and Pioneer Inspectorates was created under a cabinet order of 1885; each inspectorate was headed by a Major-General, immediately responsible to the "Chief of the Engineer and Pioneer Corps and Inspector-General of Fortifications," who reported direct to the Emperor. All the officers of the inspectorates were Engineers, and the state of isolation of the Corps was thus perpetuated. It was the considered opinion of higher authority that Army Corps or other high commanders should not be saddled with responsibility for inspection or training of troops, with the technical details of whose work they could not be familiar.

The first real signs of improvement followed the appointment, in 1898, of another infantryman to be Chief of the Corps. This was Lieut.-General Baron Colmar von der Goltz, well known to all military students as the author of *The Conduct of War*, *The Nation in Arms* and other standard works. The appointment was made for

the definite purpose of bringing the Pioneers into the army and, under his direction, single Pioneer companies were, at long last, permitted to take part in divisional and corps manœuvres; he also organized special Pioneer exercises on a large scale, which not only afforded valuable experience to the Pioneers, but served to arouse the interest of commanders and staffs. The Emperor became personally interested and drew up a comprehensive scheme for what he considered to be the correct distribution and training of divisional Pioneers; although it met with scant support at the time,* the organization that he proposed was very similar to what was actually approved, although not carried out, in 1918.

The lessons of the Russo–Japanese War led to some improvement in the Pioneer reserve position; and to increased interest in fortress warfare; pioneer battalions in fortress areas were given special training in siege operations, and a scheme was worked out for the formation of Fortress Pioneer regiments in war. Finally, Army Corps commanders were given powers of inspection over the Pioneer troops in their district, though there is little evidence that they were exercised.

Von der Goltz's work was carried on by his successors, von Beseler and von Mudra;† the latter was responsible for the slogan, "*Pionier sein, heisst angreifen*" ("To be a Pioneer means to attack").

On the whole, although the period between 1870 and 1914 produced some improvement in minor details, the position of the Engineer and Pioneer Corps in relation to the rest of the army remained generally much as it had always been, and the chief claim to recognition rested on their ability to take part in the infantry battle. Training in field works and bridging had reached a very high standard, and Lieut.-Colonel Augustin claims that, in spite of all difficulties, "better Pioneers the world never saw."

THE GREAT WAR PERIOD.

General Summary of the Position in 1914.

It will now be convenient to summarize in detail the position of affairs just before the outbreak of the World War.

The Engineer and Pioneer Corps comprised:—

(*i*) A Corps of Engineers; officers only.

(*ii*) A Corps of Fortress constructors, composed of:

- (*a*) Fortress Corps officers.
- (*b*) Fortress Corps officials (wardens).
- (*c*) Foremen of Works.

Both (*b*) and (*c*) being recruited from non-commissioned officers of Pioneers.

(*iii*) A Corps of Pioneers.

* In the orgy of ship-building that was going on at the time, there can have been little money available for army increases.

† Both Engineer officers and Staff College graduates. v. Beseler later commanded at the investment and capture of Antwerp; v. Mudra eventually commanded an Army in 1918, the only Engineer who did so.

All officers started their career in a Pioneer battalion; and, after a minimum of 21 months' service, were sent to the technical school, where they specialized. All remained on one list for promotion and, in theory, were interchangeable; but, in practice, having once specialized they were only changed over in exceptional circumstances. The whole of the men were trained in the Pioneer battalions and only non-commissioned officers were eligible for transfer to the fortress branch. The normal period of service was two years, of which the first was devoted almost entirely to infantry training. No trade standards were laid down but, as far as possible, suitable men were selected from civil life.

The German Empire was divided into 25 Army Corps districts.* Two Pioneer battalions were allotted to each of 10 Corps, one battalion to each of the others, making a total of 35 battalions. With the exception of the III Corps, of which the headquarters was at Berlin, each of those with two Pioneer battalions included an important fortress, where the Pioneers were invariably quartered. The battalion consisted of 4 companies, each organized in 3 sections; in addition, 26 battalions had a searchlight section attached. Peace establishment of the battalion, 24 officers (including attached) and 644 other ranks; of a company, 5 officers and 152 other ranks. Total peace establishment of the Corps, in round numbers, 900 officers and 20,000 other ranks.

As regards other technical services with which the Engineer and Pioneer Corps was not concerned; railway, telegraph, balloon and aviation troops were directly under the Inspector-General of the Military Communication Service; barracks and military buildings, not coming under the head of fortifications, were in charge of the Barrack Construction department, a branch of the Intendance; Survey was a function of the General Staff.

For war, a battalion was expected to form three to five field companies, one or two being permanently attached to each division and one kept at disposal of the Corps commander; one Corps and two divisional bridging trains. Certain battalions had to mobilize detachments, each of 1 officer and 33 other ranks, to accompany cavalry divisions; also field and fortress searchlight sections. Others were to be formed into fortress regiments of two or three battalions, each with a siege train. The battalion staff (2 officers) joined the Army Corps headquarters.

The war establishment of a company was 6 officers (includes 1 medical officer and 1 paymaster) and 262 other ranks, organized as

* The organization of the infantry was:—
1 Corps=2 Divisions.
1 Division=2 Brigades, but 6 Divisions had 3 Brigades each.
1 Brigade=2 Regiments, but 5 Brigades had 3 Regiments each.
1 Regiment=3 Battalions.
1 Battalion=4 Companies.
There were also 18 independent Jaeger Battalions.
Total battalions=669.

for peace in a headquarters and 3 sections. The transport consisted of three 2-horsed and one 4-horsed store wagons, 1 baggage wagon, 1 supply wagon, and 1 field kitchen ; the last three being all 2-horsed and forming the 2nd line transport. There was also 1 pack-horse.

Both in peace and war, all transport of Pioneer units was provided with horses and drivers from the Train ; so the personnel belonged to another branch of the service.

General Mobilization, August, 1914.

When army mobilization actually took place all units were brought up to war establishment, and additional units were raised from surplus men at the depots. These units combined to form Reserve Corps, Landwehr and Ersatz brigades. The majority of the reserve corps went straight into the field ; fresh corps were rapidly formed, and early in 1915 the reorganization of four-regiment divisions on a three-regiment basis was begun, by which means extra divisions were gradually added. A total of 93 divisions were actually put into the field in August, 1914, which had increased by March, 1915, to 135 ; at the end of 1916 there were 200, and the highest point, just over 230, was reached in June, 1917, and maintained for just a year. These details are needed in order to follow the course of the Pioneer development.

Pioneer Mobilization.

Immediately mobilization was ordered, each of the Pioneer battalions was duplicated ; the first battalion consisting of Nos. 1 to 3 regular companies, and the second of No. 4 regular and 2 reserve companies. Nine battalions labelled in peace as " fortress " formed themselves into Pioneer regiments, complete with regimental staff, and were earmarked for employment as army troops ; and nine reserve battalions were detailed to fortress garrisons. In the case of all other battalions, mobilization again spelt disintegration. The commander and headquarters went off to various corps and other staffs, while the companies were allotted, either singly or in pairs, to divisions. Landwehr and Landsturm companies were raised to accompany corresponding formations ; also a number of Ersatz companies on a low establishment. Altogether from the 140 peace companies with a strength of some 20,000, were produced 379 companies of all sorts with a total strength of 80,000. Other units that were immediately formed comprised some 100 fortress and 25 field searchlight sections ; a heavy bridge train for the Rhine ; 25 Corps and 70 divisional bridging trains, with nearly 6,000 m. length of equipment ; 9 siege trains ; and 9 cavalry sections. So it will be seen that half the divisions that took the field only had a single field company, and about the same number had a searchlight section. Several of the reserve divisions and nearly all the reserve corps were short of a bridging train. There were no Pioneer corps troops.

Pioneer regiments on a scale of roughly one per army were available as army troops. The Chief of the Engineer and Pioneer Corps with his Staff joined General Headquarters; and the various inspectors were attached to Army Group and Army Headquarters, all being replaced at home by officers of the reserve. It must be said that their position was in no way improved by mobilization; they still remained outside the normal staff organization and the chief continued to report direct to the Emperor. When mobilization was complete the total Pioneer strength amounted to roughly 120,000.

Results of breaking up Pioneer Battalions on Mobilization.

The process of mobilization proceeded smoothly and punctually in accordance with plans that had been worked out in great detail and revised every year. But the complete break-up of the peace organization could not fail to have serious results. No Pioneer officer or staff was allotted to divisional headquarters and the field company commander, or the senior where there were two companies, had to try to perform the dual role of staff officer and company commander. For the most part, divisional commanders ignored them altogether, with the inevitable result that ill-timed, inadequate, or in some cases no, orders were received by the field companies. Three early examples are quoted, of which the third has a particular interest :—

(*i*) During the advance of the 34th Infantry Brigade group against Liége, 5th to 8th August, a delay of 24 hours occurred at the Meuse before bridging started, although three field companies and two bridge trains were at the disposal of the brigade commander. Failure to keep the Pioneers informed and delay in sending them orders involved the brigade in an unsuccessful attack and heavy casualties, the delay in bridging having removed the element of surprise and left no time for proper reconnaissance.

(*ii*) The advance of the XVI Corps was delayed for a whole day on the Meuse below Verdun, in August, '14, owing to the failure of the divisional generals to give timely orders to their field companies, although the Pioneer commander at Corps Headquarters had made all arrangements for the necessary equipment to be at hand.

(*iii*) On the 8th September, 1914, von Klück ordered the IX Corps to detach a force to hold the line of the Marne against the advance of the British, and to destroy the Marne bridges. Von Quast, Commander of the IX Corps, detailed for this task a mixed brigade under Major-General Kraewel, to which one field company was allotted. The brigade reached Montreuil-Aux-Lions, 5 km. from the river, during the night, but the Pioneers never arrived, and apparently no

orders reached the company.* The brigade was tired out, but there would still have been time during the morning of September 9th to destroy the bridges about La Ferté, which fell into the hands of the British later in the day. There was no senior Pioneer officer with any of the formations concerned, and even if the one field company had turned up, it would have been quite inadequate to deal with the 10 road and 7 railway bridges in the area.

Liaison between the Pioneers and the cavalry seems to have been better, though the Pioneer detachment with a cavalry division was deplorably small. In example (*i*) some cavalry on the right of the 34th Brigade crossed the Meuse on both improvised and equipment bridges without delay. In example (*iii*) the 2nd Cavalry division on Kraewel's right destroyed the two road bridges at La Ferté, though they left the railway bridge east of the town standing.†

Effects of Low Peace Establishments.

Further difficulties were introduced by the low peace establishment, which led to over-dilution with reservists and elderly men, with serious effects upon efficiency. Many of the men were physically unfit for the hardships of war service; they were also insufficiently trained in the more recent developments of Pioneer technique.

Shortage of bridging trains produced more complications, and delays in crossing the numerous French canals and rivers were frequent. The IX Corps is quoted as having lost 12 hours before crossing the Oise and Oise Canal at the end of August, owing to insufficient equipment; the corps bridging train having apparently had to be shared with the IX Reserve Corps.

Much the same state of affairs existed in connection with fortress mobilization. Plans had been worked out in great detail beforehand; but lack of touch between the higher command and the Engineers and Pioneers, and also failure to provide adequate reserves of tools and materials, led to much confusion and delay. In the event, no German fortress came within the sphere of active operations; had events turned out differently, extraordinary crises and breakdowns might have occurred.

* The German official monograph on the Marne says, "for reasons not now for certain discoverable the orders never reached it." See p. 287 of the *Army Quarterly*, January, 1930.

† Cavalry bridging equipment and vehicles actually belonged to cavalry regiments and not to the Pioneers; cavalry regiments also carried a quantity of explosives in their own transport.

(To be continued.)

THE ABOR MILITARY AND POLITICAL MISSION, 1912–13.

Compiled from the Diary of the late Capt. P. G. Huddleston, R.E.

FOREWORD.

THE Abors are one of the savage tribes which inhabit the mountainous country in the extreme N.E. corner of the province of Assam.

In March, 1911, some Minyong Abors treacherously murdered their Political Officer, Mr. Williamson. The Government of India accordingly dispatched a military expedition up the Dihang Valley, in the cold weather of 1911–12, with the objects of punishing the Abors and of surveying as much of the country as possible, with a view to establishing a recognized frontier between Assam and Tibet.

As this military expedition failed to penetrate sufficiently far into the country to survey anything but a trifling part of it, the Government of India sent a Civil Mission back into the country the following year to concentrate on the work of exploration.

One of the few major outstanding geographical problems on our Indian frontiers at that time was that of the Tsang-Po—did this river break through the main Himalayan Range, and become the Dihang and so the Brahmaputra on the plains of Assam? If so, were there big falls in the gorge by which it cut through the Himalayas as stated by the explorer Kinthup, or a series of rapids?

During this season, 1912–13, there were two survey parties in the field. One party was under Captain O. H. B. Trenchard, R.E., and worked in the Dihang Valley; the second was under Captain C. P. Gunter, R.E., and explored the Valley of the Dibang.

The party under Captain Trenchard was divided into two. As stated in an article published in the *R.E. Journal* for May, 1915, reproduced from the *Records of the Survey of India*, Vol. IV, 1914, the programme laid down for the season was as follows:—

(1) *The Dihang Party.*—To explore and fix the Doshung La, and discover as much as possible of the geography north of the main ranges of the Himalayas; ascertain the point where the Tsang-po breaks through the main range; fix this range west of the Dihang in conjunction with the Siyom-Sigong party; fix the main range as far as possible east of the Dihang; discover whether the course of the Nagong Chu

is north or south of the main range and whether it flows into the Tsang-po, the Dihang or the Dibang.

(2) *The Siyom–Sigong Party.*—To fix the main range of the Himalayas in conjunction with the Dihang party; fix the courses of the Siyom and Sigong Rivers and explore the passes said to be at the heads of these valleys; endeavour to discover the course of the Nia Chu, whether it becomes the Subansiri, the Siyom, or the Sigong, whether it flows north of the main range into the Tsang-po, or whether it breaks through the main range.

The writer of this diary, the late Captain P. G. Huddleston, R.E., was in charge of the Siyom–Sigong Party. The diary relates the measure of success that attended the undertaking, and gives a graphic picture of the daily life, sport and difficulties of the surveyor in such a country.

Purefoy Gauntlett Huddleston was born on April 28th, 1886, and was the son of T. F. C. Huddleston, Esq., of King's College, Cambridge. Educated at King's College Choir School and at Clifton, he passed into the Shop in 1904, and obtained his commission in the Corps on 16th January, 1906. He proceeded to India in 1908, and joined the Survey of India in 1909. In the first year of the War he was one of those R.E. officers in civil employ who were sent home.

Huddleston was a man of unusually fine physique, being 6 ft. 4 in. in height. When commanding the 84th R.E. Field Company (20th Division) he was killed near Ypres, on March 25th, 1916.

EDITOR, *R.E. Journal.*

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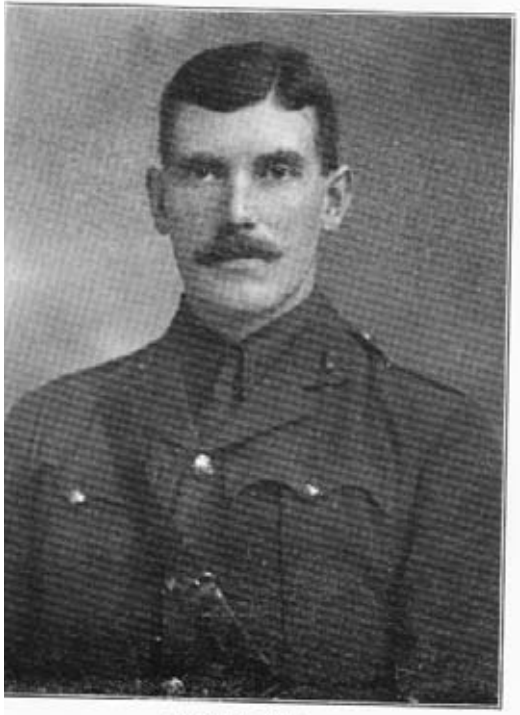
1. PREPARATIONS.

Nov. 16, 1912. On board S.S. *Iris*, tied up beyond Laimekuri on the way from Dibrugarh to Kobo. Party consists of self and 2 surveyors, Hamid Gul and Anwar Ali, and 11 khalasies (2 Gharwali, 8 Gurkha). Orders are to fill in blank between Siemen River westward to the tributaries of the Subansiri and southwards to Dijmur on 4 miles to 1 inch scale as far as possible. Captain Macdonald (I.M.S.) on board. Much talk of prospects of main advance afterwards, for which natives and coolies are being collected. Khalasies allowed 20 lb. of kit so far (10 lb. last year), self 2 coolies = 108 lb. (60 lb. last year) exclusive of office box and food.

Nov. 17. Arrived Kobo 10 a.m. Met Carter, who will command escort of 24 men. Kobo has a very fine stockade and look-out, but is hardly the hub of the universe as it was last year, with 3,000 troops in it. Stocked all unnecessary and extra kit in a *kanal* (godown), with 2 men to look after it. Ready for start to-morrow. Surveying

THE ABOR MILITARY AND POLITICAL MISSION, 1913-14.



P G Huddleston

Surveyor Hamid Gul.

Huddleston & Hamid Gul

Dihang River from Rotung.
(About 10 miles below where Williamson was murdered.)

Distributing quinine.

Dihang River & distributing quinine

plane-tables both complete and ready for work. Porter to take Carter's place as commandant. Cheery dinner and much *bukhing*.

Nov. 18. Pelung, half-way to Pasighat and 12 miles from Kobo. The Abors who went up to murder Williamson were traced to a village near by. What a contrast to last year, where an army was proceeding cautiously along (true most unnecessarily cautiously), and now cartroad with telegraph wire, elephant carts and coolies plying the road at their own pace and without any escort; Abors working in the fields or the roadside. Surveyors and self got off 7 a.m., set up and checked last year's map to here. Large Abor clearings here and there, one 6 miles long, rest of the road through dense jungle. Found Dorward, quartermaster of the Lalchimur Military Police, in charge of the post of 50 men, making bullock and store sheds ready for shoving stores up for the main advance. Dorwood gave us dinner, as, though the 3 elephants arrived early, the carts did not get in till after dark. More *bukhing* about N.E. transfrontier and the numerous little shows that take place and never (thank goodness) get into the papers. Dorwood remarked casually that the other day two Gurkha sepoys who had gone out to *shikar*, not having turned up again after 3 days' continuous rain, were found both dead, lying with their heads on their rifles, out of which the last cartridge had been fired to attract attention. The jungle is so dense and dark that they had dropped in exhaustion quite near the post, after vainly trying to recover their bearings, and they were eaten to death by leeches.

Nov. 19. Decided to grow a beard. Got to Pasighat about 12.30, having left the surveyors to check and add to last year's map. Road 5 miles along a narrow clearing cut through virgin forests last year, and 5 miles through dense jungle with gigantic trees. Pasighat 514 ft. up, right under the Himalayas, where the Tsang-po comes through from Tibet (not much struck by its size). Hills of 6,000–10,000 towering darkly up back on either bank.

Met Furze, a very young Assistant Political Officer, who will administer the portion of the frontier. What a grand job! He has been here 7 months odd, hard at work clearing, stockade already built, getting ready for a bazaar, and building school and hospital. Post consists of 80–100 men. Another post at Balek, half-way up the hill near by. Watched Abors clearing, getting 4d. a day. Took photos. Made *bandobast* for to-morrow's march. Both Furze and Carter realize that this tour is chiefly for survey work, and everything should go well, though we are all very young, self senior by 2 years. When the Abors do not come in to work quietly, Furze sends them out a single match, a hint that their village will be burnt.

Nov. 20. Camped just outside Lalum on a stream where the footpath crosses it, in a space 25 yards square cleared from the jungle. By Jove, life is worth living! Arrived 4 p.m., cleared

space. Built sort of wall of spiked sticks as perimeter, *bashas* (huts) of bamboo and banana leaves and waterproof sheets. The precaution is quite unnecessary, but it is as well to get into the way of doing it every evening, though the Galongs are likely to be most friendly. The Minyong Abors we are among now have learnt their lesson. However, last year, in the Miri mission they got careless up the Subansiri, and were rushed one morning while everyone was doing odd jobs, and if it had not been for Captain Graham, in charge of the escort, bowling over 5 men with his first 6 revolver shots, things might have ended nastily.

Got off with the surveyors about 7.30, leaving Furze and Carter to load up the coolies, 112 loads altogether. Offered an egg by an old lady in the first village, who asked if she might dance for me for a rupee. She also showed me the jungle cotton plants of which they make their cloth. From here magnificent view of the Mishmi snows. Set up again at Balek Post (100 men odd), 2,000 feet up and down and up and down and up to here 900 feet. An Abor runner brought our letters in. Extraordinary how cheerfully they take to becoming members of the British Empire, and yet they have been top dog in these parts for years.

Nov. 21. Camped in river-bed just below Barmin. March of 10 miles odd, 7 a.m. to 4 p.m., along foothills and down and up river-beds all the way. Set up at Yagrung, where Furze had the Abors singing and dancing to him in 5 minutes. Set up also in field below, and for 3rd time below Baring. Saw some ½ to ¾ lb. fish and an Abor (I'm picking up a little of the language) tells me there are big fish in the rivers ahead.

Nov. 22. Camp at Ledum. Could only go 4 miles as different lot of coolies must do next march. Late getting off, as surveyors did not realize the necessity of tying up their kits in the same way every day, so as just to be neither under nor over a coolie's load of 60 lb. Got into the road to Laimakum. Stung twice by small bees, and, on khalasies lighting a fire to drive them off, lit the bamboos by mistake, and we were precipitately driven off the hill. However, the hill burnt itself out in half an hour, and we then got quite a clear view above appalling jungly country with no villages. Ledum Abors very friendly. Drank a sip of their native drink, *apong*, like cider and not at all intoxicating. Glad I spent a few hours over the grammar in Shillong and Dibru, or I should have been held up to-day, as we have only one interpreter.

Nov. 23. Camp Doshing. This is a new village. The old one was burnt last year. March to-day only 8 to 10 miles, but pretty stiff going. Path either through a hole in the jungle, or through high grass or up and across river-beds. Wonderful country. Beats anything I have seen yet. The ascent to this village out of the *nullah* bed was unique, approached by an Abor ladder, a notched tree-

trunk. Last year, the Abors might have made a successful stand here, but they only discharged a few arrows and bolted. The Doshing *gâm* (headman) did not come out to salaam Furze, but the sight of the rifles soon brought him to his senses. It was not worth risking having their new village burnt. Two sepoys down with slight fever. Weather looks doubtful. Raining hard.

Nov. 24. Kaking, the first Galong village, and the reception not as friendly as we had hoped, chiefly because it is the first time they have had to do anything for anyone but themselves. Village on a sort of pinnacle with cliffs all round, approached by one striding edge, across which they had a permanent stockade of spiked bamboos with a spiked door. Quite like ye ancient times. Got a fixing at Doshing, then 4 hours' grind up a bare hill off the path from which we were able to cut in a lot of the hills of the unexplored portion. I was able to suggest plans for the future and discuss them with the village *gâm*. I gave him pencil and paper, and he really made an excellent effort at explaining the position of the villages, and got quite excited when Furze said I had been sent by the English King to fill in the blank places on the map. Difficulty about a pig. They would not sell.

Nov. 25. Koiyu. Same reception. Very friendly. Interested to see our survey things, etc. Gave me a *salami* of two chickens and *apong*. But as for giving our coolies rice and carrying our loads for fair prices and wages, they don't see the point. March similar to yesterday. Camped in bottom of Siemen River. Villagers sent into fits of laughter by looking through my binoculars.

Nov. 26. In camp in mid-jungle up the Gag Pain. To-day disappointing. We had all wanted to do a round, which would have taken us completely through unexplored country, and brought us back on the unexplored portion of the Siemen River two marches below Koiyu. However, Furze had to take 20 sepoys up to the village this morning and insist on their providing rice, and he did not want to ask for coolies and be refused: and since the same friendly but unhelpful attitude might be continued at the villages ahead (all of which we could not burn) it was better to leave this rather ambitious *chukka* out of the programme. When you have 116 coolies with you, savages who last year were fighting against you, who have to be fed by the village of another tribe (Galong Abors), it is best not to be too ambitious. So Hamid Gul and I are off with 5 khalasies and 6 Gurkha sepoys, 12 Minyong coolies for carrying kit and our and their food for 4 days (no villages near), also 2 Galong guides. To-morrow I hope we shall get up the 5,540-ft. hill above and be able to cut in new country. The hill is densely jungle-clad, and we may have difficulty in finding a spot to clear. Anwar Ali with a similar party has gone off equipped for 4 days to try and get some similar hills on the other side. With luck we may between us be able to cut in most of the

unexplored part, and by a similar trip lower down, finish the rest. The Siemen is swarming with fish (? *mahser*), ½ lb. to 3 lb., and I expect bigger. I have never seen such deep green, rocky pools so stocked with fish, and of course I have neither my rod nor the time to pull them out. The scene at the moment is fascinating. A flat space on a hillside of 10 sq. yards cleared out of the jungle alongside a roaring cascading torrent; the sepoys and khalasies singing their weird and very pleasant chanting songs over the fire a few yards in front of my little hut for the night; the savages just outside the perimeter round their fire, and the full moon hardly forcing its way through the trees.

Nov. 27. As I expected to have a hard day or two the khalasies, Hamid Gul, and myself shared with the sepoys one hour's watch each through the night, not from any idea of attack, but in case any of the coolies might take it into his head to steal anything. Though they seem to be the most simple-minded children, and I find no difficulty in making them roar with laughter at the smallest joke and keeping them cheery and happy. Started off at 6 a.m. and the path (to Nomdir) led straight up the hill face, a steady rise of 45° from 1,500 feet to 4,700. The pass, to my chagrin, turned out to be a double one, and broad, with no possibility of clearing it. Hence there was nothing for it but to cut a path along the ridge to the west till we could find a suitable place to clear, and after an hour's hacking through undergrowth and bamboo clumps we found the end of a spur, from which, after 2 hours' clearing, we got as decent a view as I could reasonably have hoped for. Might have been better: might have been much worse. We saw practically the head waters of the Siemen River and Doji village on the Sipu River, which goes into the Siyom. Hamid Gul was able to sketch in approximately the divide between the Subansiri and Siyom tributaries in this corner. If we manage to get up a hill 5980 within the next week, to-day's work will be most useful. Also fixed the village of Sago at the head of the Siemen River, where the Galongs said no village existed. Early dinner and to bed, being the first day that I can say I have been the first white man to see another new piece of this old earth of ours.

Nov. 28. Left Gag Pain camp at 6 a.m. and going very fast reached Koiyu at 9 a.m. Off again with Carter and Furze and all the kit by 11 a.m. Met 10 armed Galong *en route;* it appears they are on the warpath over some dispute about their fields with the neighbouring village. Camped just short of Kadu. Anwar Ali arrived this evening, having failed to get a clear view from his hill.

Nov. 29. Started at 6.30 with Furze. Found road closed by various signs *en route*, which looked suspicious, but turned out to be only a warning not to bring sickness into the village. Villagers came out to meet Furze with chickens and eggs. I have decided to do a *chukka* with light kit from here.

Nov. 30. Daring. Circumstances rather trying, as the *gâm* and villagers insist on sitting round in a circle and gazing at me. Interrupted by giving the children a game of choosing which hand the prize was in, and then Heads and Tails. Now I have finished my tea and most have gone. Considering that no *sahib* has ever been here before, no wonder they are interested.

Left Kadu early with Kaking the *gâm* as guide. Got an excellent fixing for Hamid Gul for the new country. Halted at Tarking (4–6 houses) and saw Jorgi (10 houses), got into Daring about 3 p.m., where, to put it mildly, my reception was most warm. They wrote down my name with much pleasure as being the first *sahib* to visit their village. They gave me eggs and chickens, and I drank rum with the head men. I agree with Furze that no opium should ever be given, but I don't think that a little rum in return for their *apong* does any harm. What with the compass, my binoculars and various other parts of my kit, I had no difficulty in giving them a two hours' pantomime. They contributed by a small boy stark naked dancing a sort of Irish jig. Daring is a thriving village of 60–100 houses. Country less precipitous, jungle less dense and many fields. People doing well. Headmen can talk Assamese, and often go into Dibrugarh, 3–4 days' march, over the hills, not by the Siemen River. Kaking goes back to Furze at Ripon, having got me two guides from this village. My party now consists of self, Hamid Gul, Unwar Hassam (cooking for us both), 4 khalasies, 6 sepoys and 14 Abor coolies.

Dec. 1. Started 7 a.m. with a triumphal procession. The old *gâm*, Kaking, came out of his house with a dirty old *solar topee*, which he proudly said had been given him by the Dibrugarh Deputy Commissioner. He and his brother *gâm* insisted on accompanying me to the Ego River, which to our surprise was as big as the Giri below Solon. Leaving the coolies on the beach we went up a 2,000-ft. hill near by, passing through Lalu village, where I drank their *apong*, and was given more eggs. From the hill we got an excellent view of this unexplored corner. Took heights and selected the hill to be climbed to find out the watershed between the Siemen, Subansiri and Siyom. Showed it to the Abors, and then the difficulties began. "No road, all jungle, etc." "For the map's sake *jubbi luggi* (= *jāka lāge*, must go)," say I. "No, *sahib*, there is a village there which is ill, and all the roads up the Ego River are closed." "*Jubbi-luggi*," say I, and eventually, after many more stern *jubbi-luggis*, we reached the coolies again and started off. At the last moment old Karking, who is rather an old brick, said he must come too, in case we and his nephew (one of the guides) should die. And here we are, 2 miles short of Pading, having come by an excellent path along the Ego River bed and have left the sick village (if it existed) up a side stream. News had been sent by some men we met fishing to

Pading village ahead, and after dark some 8 men with their *gâm* came in with *apong* and chickens and eggs as presents, and seemed very pleased and excited to see me. They repeat there has never been any trouble in their country (referring to Williamson's murder by the Minyong Abors), and they are only too pleased if the Sirkar will send *sahibs* to visit them and see their country. Amused them with my acetylene lamp and, to their immense delight, gave them a candle to go home with. Women and children crowd round at the villages, and I am taking practically no precautions, except my shotgun, which I always carry myself. Shot a small eagle to please them to-day.

Dec. 2. Most successful day as regards more country sketched. Started directly it was light up the river path, very good, passable all the way, except in one or two places, from Taking to Pading. Met by Sissi villagers (16 houses) *en route* and given *apong*. Pading largish village, 20–30 houses, evidently expected, reception very friendly. They suggested best hill to go up. While waiting for guide, noticed an old man abusing Daring *gâm*, who looked frightened. Something wrong. We proceeded towards the hill, but they said "No, no, we must go to another hill." Coolies looked nervous. After some discussion I agreed (as it turned out luckily) to go up the other hill, and we got an excellent view of the head water of the Ego River. Fired off my shotgun at a mark to show them. The old *gâm* got me to write something on a piece of paper, about which he evidently made up some lies while haranguing the villagers, and seemed mightily pleased when we got out of the village. Unfortunately, what with the sepoys talking Gurkhali, the Galongs their own language and a little Assamese, the Minyong Abors their dialect, quite different again, and Hamid Gul Hindustani, it was impossible to find out what the trouble was, if any. It seems that some of the villagers did not want to give the Minyong coolies food, in fact disliked their being there at all. Evidently there is no love lost between the Minyongs and the Galongs, the former having been top dog for years and years. The chief drawback about this pleasant corner is that the Abors here take opium and have the attending greed for money.

Dec. 3. Camp Talu, on the Ego River. Path very bad up and down all the way over a jungle of wooded hills all 1,000–2,000 feet high. The last mile is down an extraordinary fissure which a small tributary of the Ego has cut for itself, breadth at bottom 10–20 feet, and sheer walls of rock 100–200 feet on either side. Side fissures coming in on both sides. Absolutely unique. The Ego is tantalizing. Throw in a stone and both *mahser* and Indian trout 1–5 lb. dash up to see what it is, like throwing bread into the sacred pool at Hardwar.

Dec. 4. Ascended the hill 3,510 feet above, cut a path up the last 1,000 feet almost sheer, and if it had not been for the creeping trees growing in the rocks I doubt if we should have got up. Anxiously

cleared the hill and got quite a decent view, and saw for the first time through a broad gap the 15,700-ft. hill, 100–120 miles off. By Jove, magnificent! A perfect pyramid without a cloud on it. Also got a good view of the Brahmaputra standing out like a long, thin lake with many islands across the plain. Talu village of 20–30 houses seems to thrive, but it is a dead end, impossible either to get up or down the Ego gorge. The only path as far as the villagers will tell me is up the fissure of yesterday. Goodness knows what they do in the rains.

Dec. 5. Camp Ripon with Furze and Carter again.

Path from Talu to Siemen practically up and down stony ravines and gullies and water-courses the whole way, finishing by swimming ford, impassable after rains.

Dec. 6. Camp at Peyang village (burnt last year). Checked Hamid Gul and Unwar Ali's work. Former excellent. Latter needs checking.

Dec. 7. Camp Korang. First-rate morning. Still working at Unwar Ali's board. Country south of Korang and Peyang is a mass of ravines and jungly hillocks. Very intricate surveying, and I think I cleared the contours rather successfully. Korang, also burnt last year, has not come in properly yet. A little durbar to-morrow will no doubt make them understand the British *règime.*

Dec. 8. Furze's little durbar duly impressed Korang villagers, and they now understand that they are citizens of the British Empire.

Dec. 13. Went fishing in the afternoon. Eventually got a 38½ pounder on a *chilva* imitation minnow. Best previous fish 22 lb. 4 years ago. Topping. Took ¾ hour to land. Not a bad christening for my new split cane rod.

Dec. 16. Went down the Dihang to Kobo in dug-out, doing a time prismatic sketch *en route.* In the morning the river was alive with cormorants and fish-eating eagles. An eagle would spot a cormorant which had a fish in its feet under water, and chase it till the cormorant dropped the fish, and off went the eagle with the fish in its beak. Suddenly my boatmen started chasing one of the eagles, and as he couldn't fly fast with a fish in his bill we gained on him, and he in his turn had to drop his prey, but the fish got away before we got there. Then the boatmen spotted a solitary cormorant; it dived; we gave chase; it dived again, we getting nearer every time, till we were within 20 yards. It then flew away, and the boatmen with a triumphant yell seized a dead ½ lb. fish out of the water. What a fascination these big rivers of this corner of India have, with their dense jungles on either bank, their little villages of boatmen, their rapids which are so glorious to shoot, their shoals which you have to punt over like the old Granta up to Byron's Pool, and their superb sunsets over the sandy islands.

In Kobo things are getting a move on. The 2 Macdonald doctors, Pemberton with his ½ company of Sappers and Miners, Musson running the supplies up, and Boyce with his mule corps, 700 strong, which will work between here and Roking; one man per 3 mules. This in itself has cost the Government £6,000 odd, including their food for two months.

Kobo up to last year was a little Miri village in a wee clearing in the dense forest. Now it is all agog. There are the ducks in their pond, the goats, the rows of huge sheds filled with bags piled high with rice, flour and the various foods of the different castes of combatants. Then there are the coolie corps, 850 Gurkhas and 850 Hushauts (the latter a tribe that would compare with the Abors 10 to 20 years ago), putting up more sheds, barracks and officers' bungalows. There is the inevitable Indian *buniya* (merchant), objectionable but most useful, who is starting a little shop for trade, and will cash you a cheque for £10 at sight.

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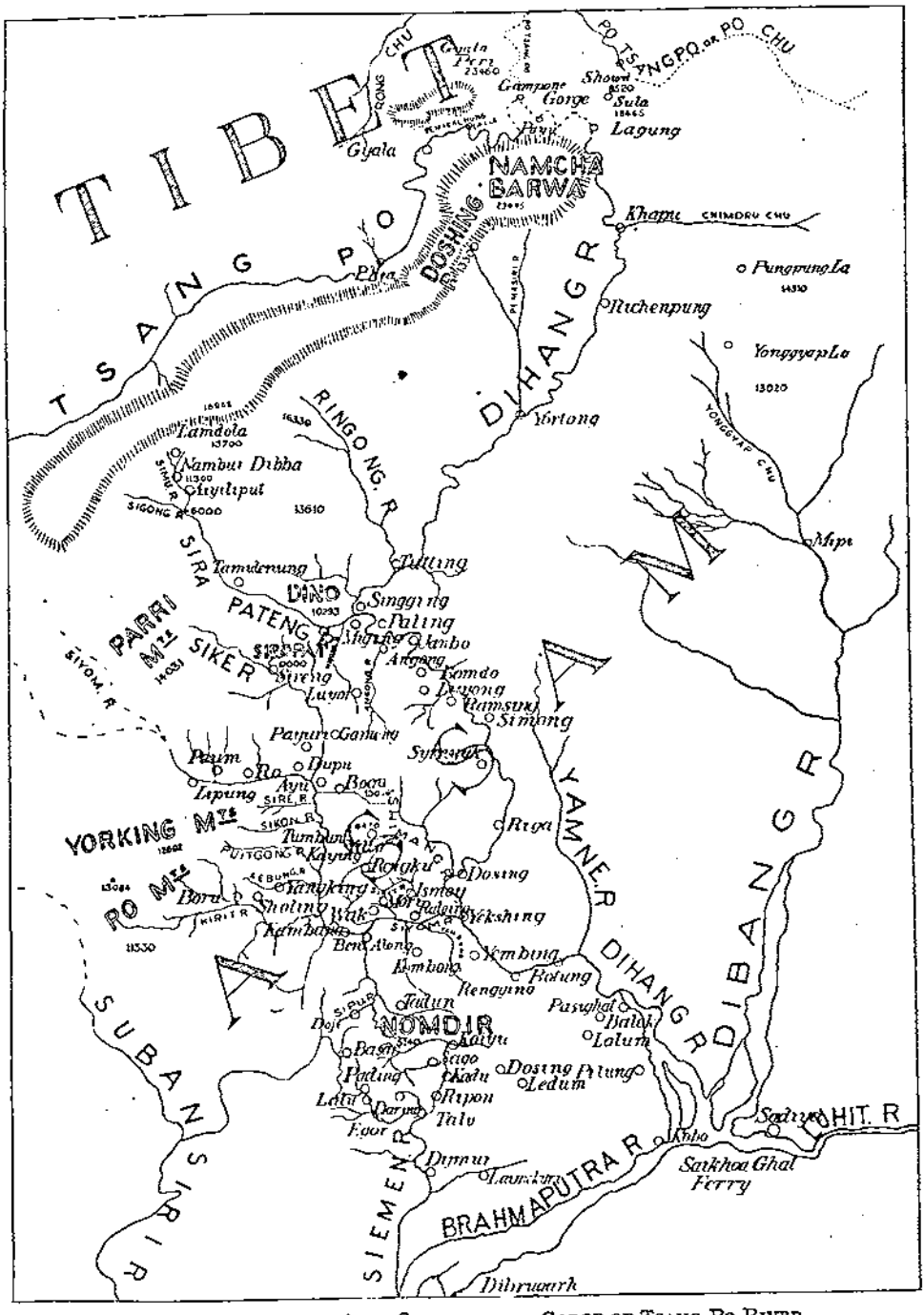
Dec. 24. Took khalasies for constitutional and accompanied Furze 3 miles down the river to where some sawyers were sawing up *horal* trees. About 10 years ago, during the rains, the Dihang distributed these trees, a very fine kind of cedar, all along its banks. Though it is not known exactly, there must have been a big landslip up in Tibet, which made a dam, and when the dam burst, down came these splendid trees, together, the villagers say, with dead Tibetans. And there we saw the trees to-day, lying in dense, damp jungle along the river-bank. Huge trees 6 feet in diameter, beautifully seasoned and smelling like a bottle of sweet turpentine.

Dec. 25. Christmas Day. Pasighat. Worked at computations. Went fishing. One 16, one 10 and one 3½ lb., at any rate enough for my share of the dinner as ordered. Played Association football against the sepoys till the bladder burst. Most cheery and excellent Christmas dinner. Porter did some very clever conjuring and sleight-of-hand tricks after dinner. Others bridge and I to bed.

(*To be continued.*)

THE ABOR MILITARY AND POLITICAL MISSION, 1912-13.



SKETCH MAP SHEWING ABOR COUNTRY, AND GORGE OF TSANG-PO RIVER.

THE ORDNANCE SURVEY IN RELATION TO WAR.

By BRIGADIER E. M. JACK, C.B., C.M.G., D.S.O.

IT is common knowledge that the application of survey to military operations developed during the Great War to an unprecedented extent. This development took place in the actual survey and printing in the field of maps of the front line region and of enemy territory; in the use of air photography as an aid to this survey; in the production and scientific use of large scale gridded maps; and in the utilization of survey as an aid to artillery work. There is no reason to suppose that the hopes that mobility will be greater in the next war than in the last have in any way decreased the importance of maps and surveys. In fact the difference in the pre-war and the present outlook may be gauged by the fact that before the War the bulk of the personnel of the Survey Companies was allotted on mobilization to other units, it being held that there would be little or no call for survey work in war time; whereas now the whole of the Survey Battalion (as it now is) is allotted for survey work on mobilization, and the Director General is made responsible for survey training for war.

The functions of the Ordnance Survey and its relation to war requirements are little known, and the present article is the result of a conversation between the writer and an officer who is keenly interested in the matter, and who suggested that Royal Engineer officers would welcome information on the subject.

As a preliminary, it will be as well to give some account of the employment of Royal Engineers on the Ordnance Survey. The latter is a peculiar institution. It started as a purely military body, with the object of producing a 1-inch to the mile military map of the Kingdom. Very early in its history civilians were engaged to supplement the military, and the production of large scale maps was later added to its duties. With increase in numbers, the civilians came in time to outnumber greatly the military. To-day, the Ordnance Survey is a Civil Department, under the Ministry of Agriculture, but it retains a good many of its original military characteristics. The direction has throughout its existence been in the hands of military officers, and of Royal Engineer officers since 1820, when Colby became Director.

The subordinate staff of the Ordnance Survey consists partly of serving Royal Engineers, partly of civilians, a large proportion of

whom are ex-Royal Engineers. The career of a Royal Engineer who serves on the Ordnance Survey is usually as follows. Lads are engaged, from 15 to 16 years of age, on condition that they will later enlist in the Royal Engineers. (Formerly no condition was made, but at present the Royal Engineers are much below strength, and the civilians above, so that recruitment is now being done only through the Royal Engineers.) They are given instruction in field surveying, drawing, and various Ordnance Survey duties. At 18 they are enlisted and sent to Chatham, where they do the usual recruits' course of one year, and then return to the Ordnance Survey.

There are certain exceptions to the above method of recruiting. Some boys are taken on at an older age, up to about 18, under special provisions; and some recruits are obtained by "direct transfer" from other branches of the Royal Engineers. These are men who apply and show special aptitude for survey work. They are specially selected by Commanding Officers of units, who have been notified by Colonel i/c. R.E. Records of our requirements; they are taken on probation, and if satisfactory after a year's service they are retained.

Once started on their military service on the Ordnance Survey men complete their six years with the Colours, extend to complete twelve, and then re-engage to complete twenty-one years. They then retire with a military pension, are re-engaged as civilians, and serve until the usual retiring age (60) for the Civil Service, when they get a further pension based on their civilian service.

Royal Engineers are employed on the Ordnance Survey on various duties according to their aptitude. At the beginning of their service they usually go to a Field Division and are employed on the revision of the 25-inch map. Those who have a talent for drawing will later be brought into the office. Some pass most of their time in the Levelling Division, and others again, who have previous knowledge or have a leaning that way, go to the lithographic side, and become lithographic draftsmen, provers and machine minders. Lastly some are employed as photographers, or in the allied trades of photo-writer, or workers in the helio and vandyke processes.

Few Royal Engineers however pass their service without some experience outside the Ordnance Survey. There is a constant demand from the War Office and from Colonial Governments for the services of trained surveyors, and it is usual for 50 or 60 men to be absent abroad at any one time on employment in various Colonies and Protectorates. Such tours abroad give very useful and varied experience. They are counted as part of their service, and men return to the Ordnance Survey at the end of them.

The conditions of service enumerated above show that a Royal Engineer, provided he be a good workman and of satisfactory character, has a career for life on the Ordnance Survey, with good pay

and a pension at the end of it. If a man's behaviour is in any way unsatisfactory the Director General, who has very wide powers, can get rid of him at the end of his first period of engagement, or at the end of his 12 years, or he can refuse to re-employ him as a civilian. It is, therefore, difficult for an inefficient man to remain on the Ordnance Survey. In addition, the good prospects and security of employment make competition to get on the Ordnance Survey very keen. A good stamp of boy presents himself: selection is by qualifying examination, enquiry, and personal interview. The result of all this is that the standard of men employed on the Ordnance Survey is very high.

We must next pass to the nature of the work done on the Ordnance Survey. The great bulk of this work is, and has been since the completion of the original survey, the revision of the large scale map (scale 1/2500, or 25 inches to the mile as it is commonly called). This revision is the basic work of the Ordnance Survey, and is the employment of the large majority of the staff. The method of revision in the field is based on the assumption that the original survey was of a high degree of accuracy, an assumption which is justified when it is remembered that it was entirely a chain survey, that is to say carried out by actual measurement on the ground.

The reviser takes with him in the field a portion of the existing 25-inch map, about 12 inches square, carried in a special form of case. It is his business to satisfy himself as to all detail which has not changed since the last revision, and as to all changes and additions. Having verified the old unchanged detail he uses it as the basis for inserting the new, which he does by prolongations, intersections, and measurement by pacing or by tape. He has various methods of checking his work. A trained reviser will carry out a revision by these methods with great accuracy.

In some cases where changes are considerable (as in extensions to towns), and there is little old detail on which to fix the new work, some assistance is necessary in the shape of points fixed by a small triangulation, or by a traverse.

These methods of working have an important bearing on training for war. The idea has been held by some that constant employment on this type of large scale survey is useless as a preparation for the survey duties required for war. If the men were employed on chain survey there might be some truth in this; but that work (the original survey) was finished years ago. The revision work described above is as a matter of fact a peculiarly good foundation for plane-tabling. It trains a man to habits of accuracy; it keeps keenly alive his survey sense, that is, the sense for placing details in their correct relative position on the map; it makes him use methods which are in some cases identical with, and are always akin to, those required for plane-table work. In one respect however it gives him no training, and

that is in the representation of ground forms. The Ordnance Survey reviser is an accurate maker of plans, but of plans only, without relief.

After revision in the field comes the drawing of the revised map in the office. This work gives training in drawing on a large scale; it teaches neat penmanship and accuracy. On the whole it may be said to provide a good foundation for the drawing required in war; and is certainly excellent training for drawing for reproduction—an important point.

But while many men are employed on drawing the large scale 25-inch map, and its product, the 6-inch map (which is drawn on the 12-inch scale and reduced by photography) a considerable staff is engaged on small scale drawing of the 1-inch and smaller scale Ordnance Survey maps, or on the 1/20,000 and similar scales for the War Office. This class of work is practically the same as that required for war.

Of the publication trades (*i.e.*, the trades required for map printing), namely lithographic drawing, proving, printing, the making of negatives and zinc plates, the correction and retouching of negatives, etc., little need be said. This class of work is practically the same as would be carried out in war, the difference being in certain points of equipment, and in the conditions of working which are inseparable from active service.

The above general and rather brief description will it is hoped show that the normal work of the Ordnance Survey provides at any rate a good foundation for the work a surveyor is expected to do in war. But much more is obviously required. Further training in the technical duties required for war is necessary, and, beyond that, training in the team work of a military unit is needed.

The first is provided by classes which are held throughout the summer every year. When it was decided that the men of the Survey Companies (now Survey Battalion) were required for survey duties in war and for no other duties, and when the Director General of the Ordnance Survey was made responsible for training in such duties, the annual field works course was abolished and was replaced by courses in military survey duties. Courses are held, from April to September, in trigonometrical and topographical surveying, both preliminary and advanced. Each course lasts a month, and includes about 30 men. In addition to the technical courses, drill and musketry has to be included in the training season; and a special drill and duties course is always held for young non-commissioned officers.

Courses are held during the winter in topographical drawing, and in air photo work; while training in trigonometrical computing, besides being included in the trigonometrical courses, goes on all the year round in the Ordnance Survey Trigonometrical Division.

The above technical training, during the progress of which the men are paid by the War Office, is based on one-third of the strength of Royal Engineers being trained each year. On the face of it, it would appear that no man can go through a course more often than once in three years, but practically, owing to the fact that men of the publication trades do not have to do annual courses, it works out more frequently than this. Even so, the training is slower than one could wish ; but it is a compromise between what is desirable and what is practicable. The " war trades " are classified, and promotion depends on them to a large extent. That is, apart from other qualifications, no man is recommended for promotion unless he has attained to a specified proficiency in various war trades, according to his rank and the employment for which he is fitted.

A man who has gone through a series of courses in war trades may be described as a trained man ; and if in addition, as is frequently the case, he has done two or three years of practical work in a Colony or Protectorate, he is an experienced surveyor. It was men of this type ; men, many of whom could turn their hand to almost any kind of survey work required—observing, computing, plane-tabling, drawing—and all of whom were expert in at least one branch, who formed the backbone of the Field Survey Companies during the War, and without whom the excellent survey organization that was developed would have been impossible, or at any rate would have been seriously delayed. The same type of men are available now, but the needs have greatly developed. Royal Engineer surveyors have now to take their place with other troops immediately on mobilization, or in peace time on manœuvres or exercises ; they have got to produce results, on which other work will depend, at short notice and often working against time. This brings us to the necessity for team training, or training together as a unit.

This training has been provided hitherto by annual exercises, which have been held every year for the last seven or eight years. These exercises have been carried out mostly in conjunction with the School of Artillery, but some have been done by the Royal Engineers alone. The exercises have been done on the usual lines of a military situation which developed as the scheme advanced, and with definite problems to be solved. The Royal Engineer Sections which took part in these schemes (Topographical and Drawing Sections) were necessarily formed *ad hoc*. The men were assembled usually a few days in advance, and were together during the exercise for about a week or ten days.

However good the material of which these sections was composed, (and it was first-rate material) it will be obvious to any soldier that sections formed under these conditions could not be wholly efficient at first, or indeed within the short time the men were together. It has never yet been possible to assemble a complete war unit, fully

equipped. The machine was made of good stuff, but was bound to work stiffly. It must be remembered that a great deal of Royal Engineer Survey work in war must be done in close conjunction with the Artillery. The Royal Artillery have taken up Artillery Survey very keenly. They maintain a full-sized unit, the Artillery Survey Company, which is at work on its own problems all the year round, and Royal Artillery surveyors are, within the limits required for their own work, highly expert. It can be imagined that it was something of a strain for an R.E. Section, gathered from all parts of the Kingdom, and working together as a unit for something less than a fortnight, to keep its end up. That they have managed as well as they have done is a great tribute to the personal efficiency of both officers and men; but it became increasingly apparent that existing methods of training were not adapted to present requirements, and that to make men efficient as a unit continuous training as a unit was essential.

The same conditions apply in the case of the publication trades, lithography and photography. Though men in these trades are employed the whole of their time on them, and hence are individually expert in the duties required for war, the conditions of working on the Ordnance Survey are very different from those of active service. The transition from peace to war duties is in their case in some respects marked by less change than in the case of the topographical trades, but the need for unit training is no less urgent.

Proposals were accordingly put forward that a portion of the Survey Battalion should be detached in the form of a "Training Unit," which would be continuously employed in war duties throughout the year. Men would pass through the unit, spending a period of say two years in it, and returning to their Ordnance Survey duties at the end of the tour. The unit would consist of Sections organized on the lines of War Establishments, *i.e.*, Topographical, Drawing, Lithographical and Photo Sections, fully equipped; it would be occupied on training and productive work throughout the year, and would be available when required for exercises or manœuvres.

The necessity for some such unit has now been officially recognized, but, for reasons into which it is unnecessary to enter here, it has not yet been possible to bring it into existence.

The proposal is, however, still under consideration, and the interest in this question has increased to a large extent. There seems a possibility that a unit may be authorized that will be far larger than was originally contemplated or thought possible.

That, however, lies in the future, for the formation of this survey unit must take time. The Ordnance Survey is a busy Department, performing important public functions, and it has to carry on the work for which funds are provided by Parliament. It is impossible to detach a large body of men suddenly from it without dislocating its

work seriously. The unit must be built up gradually, and it will take some years for it to reach completion. But that a Royal Engineer Survey Company, or organized and permanent unit of some sort, will be in existence in the course of the next few years is I think certain.

And the need for this, apart from the technical and training reasons which I have given, is urgent. Survey is now a serious and indispensable weapon of war, which being new requires study, practice and research. The Artillery have ever since the War accepted the fact that a knowledge of survey is essential for their work. The adoption of survey methods has already had a profound effect on artillery tactics, and is not yet at the end of its development. The demand for accurate maps is greater than it ever was. Yet the Royal Engineer surveyor who lays the foundation for all this work is hardly seen by the Army, and seems sometimes to be forgotten. When the "Survey Company" is mentioned soldiers think naturally of the Royal Artillery Survey Company. This is hardly surprising when the Royal Engineer Survey Company—or a very small portion of it—materializes only once a year for a few days. It is time that a Field Survey Company R.E. took bodily shape in peace time and was available for other troops to see. It is further important that other troops should learn to use the products of the Field Survey Company efficiently. The tactical use of survey is new, and requires working out, so that each party may know what to do and what to expect of the other. There are numerous practical and technical problems for the solution of which there has been little opportunity up to the present, and for which there can be little until an R.E. Survey unit, working full time, is in being.

I have endeavoured in this article to show how the Ordnance Survey provides for the survey requirements of the nation in war. I have tried to show that employment in peace time on the Ordnance Survey provides good material for making the military surveyor (incidentally at no cost to the Army Vote), and that the special training given goes a long way towards making good military surveyors. Finally, I have pointed out that some further provision for military training is needed, and how it is proposed to provide this.

What I have said refers, however, to the rank and file. The training of officers is a different question. The survey course covering the principles and all the most important methods of survey, which Royal Engineer officers get at the School of Military Engineering, makes it easier to give them the specialized training which is required for survey in war. On the other hand, the fact that junior officers stay only a short time on the Ordnance Survey and have large administrative responsibilities makes it difficult to find much time for war training. The tour of a junior officer on the Ordnance Survey is nominally five years, but that period is frequently cut short by calls from the War Office for officers for Boundary Commissions, and

Colonial and other surveys, with the result that the average period of service on the Ordnance Survey of officers below field rank during my directorate has been three and a half years. Employment on practical survey abroad is the best technical training officers can get, and is always encouraged; but it is not training in war duties. Courses are held periodically, mainly for technical training and refreshing; and officers take part in or are attached to all exercises. But a good deal more is needed, and this it is hoped will be provided by the Field Survey Unit which is contemplated.

Earlier in this article I said that the Ordnance Survey was a peculiar institution, and that statement will bear repetition. The Director General acts in a dual capacity. He is the Director of a civil Department, and responsible to the Minister for Agriculture and Fisheries for its efficiency, and for carrying on its work, which is the maintenance of the survey and maps of Great Britain. He is responsible to the War Office for the efficiency of the troops under his command, and for their training for war duties. Strictly speaking, he is responsible for these also through the Minister for Agriculture, but the Ministry leaves the Director General an absolutely free hand in all purely military matters, and correspondence and all arrangements relating to these are carried on direct with the War Office. As mentioned earlier, the Ordnance Survey started as a military institution, staffed entirely by soldiers; it has always retained a considerable flavouring of its military organization; and to-day, with its total establishment reduced to a little over 1,000, and its establishment of Royal Engineers increased to some 450, it will not be many years before the great bulk of the staff will be either serving Royal Engineers or ex-Royal Engineers.

The information given will I hope show that the Royal Engineers on the Ordnance Survey, though in civilian employ for most of their time, are by no means civilian in spirit. No man can hope for advancement unless he becomes efficient in war duties; no man can hope for the permanent employment which is the immense attraction of the Ordnance Survey unless he is thoroughly efficient at all his duties. As a result, the men of the Survey Battalion are a well disciplined, smart and efficient body, who I believe have no need to fear comparison with any other branch of the Royal Engineers.

THE TRAINING OF THE TERRITORIAL ENGINEER OFFICER.

By CAPTAIN E. V. BOWRA, O.B.E., R.E.

A POLICY.

THE Territorial R.E. Commanding Officer has considerable latitude in the training of his unit. The only instructions which he gets to work on are brief paragraphs in *Engineer Training*, to the effect that the principles of Territorial training will be the same as for the Regular forces. These terms are so general that it is necessary that every unit, in order that progress in training may be continually maintained, should have a considered training policy, strong enough to survive the vagaries of successive commanding officers and adjutants and as the effective counterweight to a complicated administration involving much attention.

What is this policy to be? A policy for training for war must be based on the probable employment of the unit in war. A high authority has pointed out in the military press* that the Territorial Army is likely to be required either (*a*) as the foundation of a National Army, or (*b*) to supplement the Regular Army with composite units. It is evident that no T.A. R.E. field unit is likely to take the field just as it is in peace. In case (*a*) presumably a cadre would be thrown off on mobilization to form at once a second line unit. In case (*b*) selected volunteers would be required and arrangements would have to be made to train reinforcements. In either case the raising of sappers would not present great difficulty, but competent instructors and leaders would be an important essential from the outset. These men need not necessarily have high technical qualifications in civil life, but should be in positions of authority where they are already accustomed to leadership. They can then be made capable of organizing and training sappers in their military and engineering duties in the field. *It is considered, then, that the training of officers and N.C.O.s in their duties in the field is of the first importance and should be the definite training policy.* It should have primary consideration as regards expenditure of training grants. Administration should be simplified to the last degree so as to allow time and energy for its execution.

* *R.U.S.I. Journal*, May, 1928, "Some Territorial Army Problems," by Lieut.-General Sir H. Jeudwine, K.C.B., K.B.E. See also *Army Quarterly*, April, 1929, "The Territorial Problem," by Bt. Lt.-Col. H. E. Franklyn, D.S.O., M.C.

Considerations in Training.

It so happens that the Territorial Army lends itself better to the training of the officers and N.C.O.s than it does to the men. The average man joins for four years, at the end of which time, unless he gets promoted, he usually goes. As there is no T.A. Reserve, he is then (militarily) lost. Even if he is keen and has put in more than his minimum of a hundred drills during this period (say 75 hours' actual instruction), as well as his annual camps and certain week-end trainings, the amount that can be taught is small, especially in a technical corps. On the other hand, if he is promoted, he will probably remain on and show increased keenness.

Senior N.C.O.s are permitted to re-engage up to the age of 55 years. Many do this and it is possible to put in as many as 37 years' service, earning the Territorial Efficiency Medal several times over and having one's sons serving in the unit! This long service system tends to a body of N.C.O.s in a unit too old to absorb or impart up-to-date instruction and blocking promotion, thereby discouraging the younger men. Keen young N.C.O.s are what are wanted in a company. They are malleable material, they can be taught a surprising amount in a short time, and if they can manage to get away on courses at the S.M.E. or with a regular company, soon become useful instructors, still active enough to take the field if required.

It is not intended here to discuss the training of N.C.O.s, but rather the more difficult problem of officers—from the point of view of "individual" training (as opposed to "collective" training at "drills" and camp).

The C.R.E. and his adjutant are confronted with all sorts and ages—some with war experience in the corps, some with war experience in other arms, some with no war experience; a few in the engineering profession, some in the cognate professions, some with little or no technical training. The time that these gentlemen will be prepared to give to soldiering varies, but it may be assumed that the average officer will attend at his drill hall one evening a week, on the average, throughout the year and will be able to give up half a dozen or so week-ends, in addition, of course, to annual camp. The officer has a day's (or a week's) work behind him on arriving for his Territorial activities, so cannot be expected to arrive fresh.

Courses with the Regular Army.

No training within the unit can take the place of attendance at a course, either at the S.M.E. or attached to a regular company. There are now no courses compulsory by regulations, but they can be strongly urged by (*i*) notifying applicants for commissions that they will not be considered unless they guarantee attendance at the six-weeks Junior T.A. Officers' Field Works Course at the S.M.E.,

(*ii*) not recommending promotion to Captain until this course has been completed, (*iii*) not recommending promotion to Major unless the Captain's Course at the S.M.E. has been attended. If an officer positively cannot get away for more than a fortnight in the year, it is considered more important that these courses should be attended than that he should attend annual camp. In addition to the training, they give the young Territorial officer practically his only chance of liaison with the Regular Army and of broadening his military outlook. This is important for newly-joined officers with O.T.C. experience, but it is considered imperative for those joining with no previous military experience whatever.

A System.

The organization of the individual training of officers within the unit resolves itself into :—Practical instruction. Lectures. Week-end courses and exercises.

Practical Instruction.

Newly-joined officers should parade with the recruits and be trained by the permanent staff until they reach at least the standard of the practical portion for Certificate "A." If already in possession of Certificate "A" (All Arms) they need only attend field works parades for Certificate "A" (Engineers).

Riding instruction depends on the facilities available. An officers' class at camp is the simplest to arrange, but takes the officers away from the men during the short period they have of collective training. Recruit officers must be taught the elements of riding before they go to camp, if necessary attending the drivers' drills. For those in possession of their Riding Certificates a Sunday morning "jolly" is popular. If it is not possible to centralize the officers for this, arrangements can be made with the Territorial Association horse contractors to provide an officer a horse on demand. A proportion of the Association horse hire grant for riding drills should be definitely set aside for the training of officers.

Lectures.

These are arranged most conveniently during the winter months and may be divided into (*a*) the "general," (*b*) the "particular." The "general" should be a short course for all officers, not more than one a month for the six winter months but all officers are expected to attend. They should be on interesting subjects and may well be on broad lines, *e.g.*, modern R.E. developments, mechanization, horse management, army organization and administration, Corps history; though it is as well, occasionally, to treat of practical peace-time subjects, such as keeping accounts and stock-taking.

The "particular" embrace the instruction necessary for officers' examinations. That with the most failures (although only a school-boy examination), and the only written one, is Certificate "A" (Engineers), which officers have to take within three years of joining, in addition to Certificate "A" (All Arms), if not already in possession. Proper coaching is essential, more especially for candidates for the All Arms paper. A series of six weekly lectures is considered the minimum, including plenty of time spent on the sand model and on map reading. Training at drills and at camp should largely cater for the Engineers' paper, but a few lectures are necessary to ensure covering the syllabus. The candidates must be taught exactly how to tackle a written paper. They should understand that lectures are not sufficient and be given a syllabus of reading to supplement them—the official syllabus is extensive and the average officer is not able to find time to study the whole of it. Instruction is necessary also for candidates for (*f*), (*a*) and (*c*) examinations for promotion. If units have detachments so dispersed that officers cannot attend for personal instruction, that for examinations has to be carried out by correspondence.

It is useful to type out the "meat" of a lecture, together with the appropriate references to the manuals, and give every officer a copy, which he should put away for reference in his "Territorial File." A lantern is a useful adjunct to brighten lectures; a collection of slides can gradually be made, covering a variety of subjects. A cinematograph machine is an asset; for the full-size kind, reels of various subjects can be obtained from R.A.O.D., Aldershot, but the Cine-Kodak type is more likely to be used in the future.

Week-end Courses and Exercises.

A week-end course of practical instruction can be arranged to take place at drill halls, more especially if these happen to be provided with cooking arrangements and sleeping accommodation, if required. It is not always easy, however, to provide an attractive programme, and a week-end exercise at a selected hotel is more of a draw and gives more scope.

The best time of year for these exercises is in the "quiet" season and when the days are still fairly long for out-door work, *i.e.*, in the autumn or early spring. They have the advantage of getting together all the officers of a unit and opportunity can be taken of holding officers' conferences and general mess meetings. The "autumn meeting" gives an opportunity to discuss the unit's winter training and winter entertainments and sports programmes. The scheme can usefully be made to rub in lessons learnt at camp before they are forgotten, thereby ensuring continuity in training. The "spring meeting" is important in order that all officers may fully understand the proposed summer training programme—the scheme can usefully

introduce subjects in connection with it; dates suitable to the majority may be fixed for week-end activities. A further advantage is that the half-yearly Certificate "A" and promotion examinations are held at these periods and the exercise can act as a "refresher" just before them.

The decisive factor as to how many exercises should be held is the training grant. Considerable economy is effected by officers drawing travelling and detention allowances to cover their expenses, but no pay. Officers are usually willing to use their cars without claiming mileage allowance. This excellent "voluntary" spirit should enable at least two exercises to be held in the year, in addition to an officers' and N.C.O.s' combined exercise.

To make the week-end popular, officers should not be worked after dinner on the Saturday and they should finish early enough on the Sunday to start for home by daylight. If given ample notice, they can usually get off work early enough to travel on the Saturday morning. Those who play games on Saturday afternoons should understand that Territorial duties should have first consideration. The following has been found to be a useful working programme :—

Saturday.	1.0 p.m.	Assemble for lunch.
	2.0 p.m.	Issue scheme.
	5.30 p.m.	Conference on afternoon's work.
	7.0 p.m.	Break off.
Sunday.	8.30 a.m.	Breakfast.
	9.30 a.m.	Carry on with scheme.
	1.30 p.m.	Lunch.
	2.30 p.m.	Conference on day's work.
	3.30 p.m.	Conference on training programme, mess meeting, etc.
	4.30 p.m.	Break off.

The setting of the scheme is no easy matter when dealing with so many varieties of rank and of attainments. The following types have been found to be of some value :—

(*i*) A tactical *allez-allez* (*i.e.*, oral and moving about) scheme. This is useful if there are a number of candidates for Certificate "A" (All Arms), or for promotion examinations. It also serves to bring in the co-operation of R.E. field units with other arms. It is not essential to carry out this type of scheme within a R.E. unit, as arrangements can be made for officers to attend with the nearest infantry battalion.

(*ii*) A R.E. *allez-allez* scheme. This is the most popular and is probably the most useful, as covering the greatest field of

instruction in the time available. It is useful for candidates for (*f*) examination for promotion to Captain and for candidates for Certificate "A" (Engineers). Some written work may be introduced. The scheme may embrace either the employment of a whole company or of sections only. In the latter case, the majors can be employed as directing staff and captains must act as section officers. The more senior officers have nearly all had war service, so it is the junior officers who require the bulk of the training and for whom all schemes should be primarily designed. The schemes become more realistic and will arouse more interest and discussion if they deal with the practical handling of sections on the same lines as an exercise with troops, such as can be carried out at camp. This method introduces a warlike atmosphere and serves to counterbalance what may be termed the "drawing office" attitude which some young T.A. officers acquire as a result of S.M.E. projects.

(*iii*) A R.E. project. The Saturday afternoon is spent on the reconnaissance report, Sunday morning on the main report and the afternoon on a conference. This means all Sunday indoors for people who probably spend the rest of the week indoors and so is not so popular. If attempted, officers should be given a very clear line to go on and work in carefully organized syndicates, so that the young officers get instruction from the more experienced. Written work, in any type of scheme, cannot be corrected properly on the spot; this should be done afterwards and the work returned to officers and gone through with them the next drill night (not later, or interest will fade).

The instructions contained in *Training and Manœuvre Regulations*, as regards the preparation and conduct of an exercise without troops, are important. The lessons to be learnt must be very simple, clearly defined and restricted carefully to the time available. All schemes, even projects, should introduce a tactical situation to portray the employment of engineers in conjunction with other arms. This is important in the T.A., as units seldom do any combined training. The scheme should be carefully explained at the commencement of the exercise so that every officer understands the tactical situation and knows exactly what to do.

A combined officers' and senior N.C.O.s' exercise is useful training to indicate the working of company organization. The scheme should embrace the employment of a whole company, be of the *allez-allez* type, every rank (including C.S.M.s, C.Q.M.S.s and mounted serjeants) being given the opportunity of saying what action he would take under the prescribed circumstances. It should be held

early in the summer season, in April. Held then, it has the advantage of getting all the officers and senior N.C.O.s together, infusing enthusiasm at the beginning of the busy season, and gives an opportunity to discuss the summer's events. All ranks can, in most cases, if necessary, be quartered for the night in their drill hall, but it is a better draw to get elsewhere. If army huts cannot be found, tentage can be arranged. Motor coaches are usually required for transport.

A Command R.E. Officers' Exercise has the advantage that a variety of R.E. units can be brought together, both socially and in the scheme. Officers get the opportunity—rare enough—of meeting those from other R.E. units, discussing difficulties and exchanging views. The scheme must necessarily be on broad lines, so it is considered that it is most useful when designed primarily for the more senior officers. If finance is stringent, these only should attend.

The system thus outlined is based on practical experience and the human factor. It has been found that essential principles in organizing officers' training programmes are : (*i*) the maintenance of interest, (*ii*) not attempting too ambitious a programme (or it will lack support), (*iii*) keeping to essential elementary subjects (or some officers will learn nothing through being out of their depths).

Military Education.

In addition to this organized training, there are other methods of furthering the officer's education. The first is *via* orders. These should be published weekly, throughout the year, on a fixed day of the week, and be posted to officers as a sort of weekly gazette, embracing all the current activities of the unit. The officer's store of knowledge can be kept up-to-date by drawing attention to any A.C.I.s or army orders of interest, to important amendments to manuals and regulations, to any new publications, and to any Territorial articles in the press. In each case, a short summary should be given.

The second is by what the Regular Army calls " talking shop." This phrase does not apply to the Territorial Army any more than discussing golf in a golf club may be termed " talking shop." Discussing military matters in a mess and elsewhere is of definite interest to Territorial officers and educative.

Officers may well supplement their knowledge by reading. The *R.E. Journal* should be taken in by units and circulated. The scale of free issue of training manuals is not very liberal. Extra copies of the *Manuals of Military Engineering* and of *Infantry Training* are necessary ; they can be bought regimentally and lent out from the

unit library. There is a demand for " potted " text-books, but these are disapproved of officially.

Conclusion.

It is realized that any attempt at laying down a system of instruction for Territorials will be criticized, owing to the different geographical considerations of units. What has been written is the outcome of experience with a fairly concentrated unit, but it is considered that the bulk of this may be adapted to the more dispersed type.

The Territorial Army R.E. unit is isolated; it seldom sees any other R.E. unit and so has no standard to go by. Small units without adjutants are even more handicapped. An accumulation of administrative matters presents itself to be dealt with on drill nights and distracts from proper attention to training matters. It is very difficult for the T.A. officers to keep up-to-date and the permanent staff serjeant-major cannot function in the same way as a regular officer can. It is considered most important that small R.E. units should have at any rate the occasional assistance of a regular officer throughout the year, to assist in the preparation and carrying out of training programmes and schemes, more particularly with regard to the officers.

All the instruction which an officer receives will not turn him into an instructor or benefit the unit as a whole, unless he personally instructs men and takes charge of work. This is a simple matter at camp (on which, alone, units are too liable, unfortunately, to be judged); but during the summer drill season and the winter N.C.O.s' courses, it is a good practice to detail officers in advance, in company orders, to give instruction in certain subjects on certain dates. They can then arrive *au fait* with what is required. The officer must have initiative and confidence in command. These qualities can only be acquired by knowledge and experience; they may, however, be assisted by giving every officer a definite responsibility, apart from his company or section duties, in connection with sports, entertainments, bands, institutes or messes. An officer's progress can be sized up annually in his Confidential Report; here is an opportunity for giving him credit for those things which he has done and reference may be made to those things which he has left undone.

The well-being of a T.A. unit depends almost entirely on the tone of the officers and of the initiative they display. The above has been written in the hope that it may serve some practical purpose to those gentlemen who, in spite of these days of " no more war," patriotically give up so much of their valuable time to military matters.

BILBAO—AND SO HOME.

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

ILEX knew nothing of the Careaga Cup until it was brought aboard her at Bilbao, by Señor Careaga himself: scarcely one of her vanquished rivals knows what it is even now. Doubtless they grieve the less on that account. The Careaga Cup is a challenge cup open to yachts of Fastnet Race size, and the race-course lies in the Cantabrian Sea, from Santander to Bilboa. Ocean racers find the distance paltry—it is something under forty miles—but such a race is a delicious change, when it occurs at the finish of the ocean racing season. It gives an excuse for staying in the warm seas a little longer: it is a gentle farewell tussle to offset the fierce battling of the previous three weeks.

During the night watches of the Santander Race—my watch is very garrulous—the scheme for entering *Ilex* in a race from Santander to Bilbao had been examined with care. Our leave was coming to an end, and *Ilex* was without a motor to push her through the calms; but it was clear that we must find time for Bilbao. The Santander Race dinner was to be held on the eve of the coastal regatta. Nothing could be more convenient. Spanish dinners start at 11 p.m., and rival May Week hours when they include a dance as well; so that there would be none of the hasty scrambling, which is usually to be seen on board *Ilex* in the early morning of a race, but just a leisurely change from dinner-jacket to shorts in the bright dawn light, and then all hands working on the racing sails. And that, roughly, is what happened.

The Bilbao Race is sailed under a handicap on form, and does not pretend to be an ocean race. The handicapping is easy, as form is quite visible at that end of the season.

The Santander Race dinner was fixed for September 2nd, the eve of the Bilbao Race. H.M. The Queen of Spain had presented the regatta prizes during the morning, and our enormous cup was safely stowed away in the sail locker before we left *Ilex* for our farewell visit to the shore. The dinner started at 11 p.m. and ended with various welcoming speeches at about 1 a.m. First of all, the President of the Santander Real Yacht Club delivered a masterly quadrilingual greeting to us all. He was then supported by the late General Primo de Rivera himself, who spoke Spanish in an annoyed and querulous manner for about a quarter of an hour with great effect,

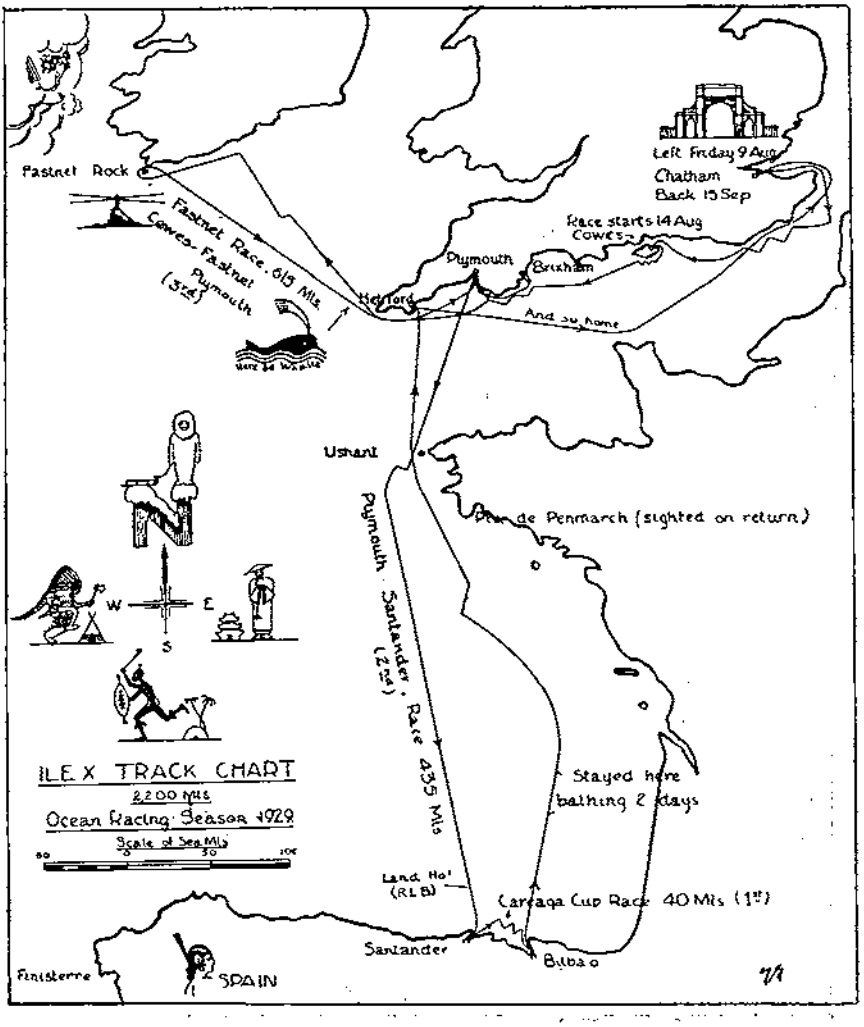
We cheered at the appropriate times. The evening went ahead—a dance, a struggle with a whole queue of taximen, two visits to friendly yachts—and then came dawn. It was time to prepare for the race and we sculled with our solitary oar across the harbour to *Ilex*. "Smokings" were quickly stowed away and the well-salted shorts of ocean racing put on instead. Sail stopping went ahead at great speed; ocean racing trains a crew very quickly. Including the paid hand, there were now only six of us aboard, as Major Armstrong had been lucky enough to find a homeward bound battleship to help him out of his leave troubles. They were D. N. B. Hunt, skipper, Rupert Brown, W. G. Fryer, G. D. McK. Sutherland and M. T. L. Wilkinson. We had arranged to take a local English amateur aboard for the race as interpreter. He was now standing at the Club steps and the dinghy made one last journey to fetch him. "All aboard? Stand by to haul up the dinghy."

Slowly *Ilex* unfolded her white racing wings to the bright early morning of the still harbour. Other butterflies in the harbour, as if encouraged by her, began to try their wings also. Faint voices and the clicking of halliard blocks came from all sides. We had a quick breakfast and weighed anchor with the extra energy it gave us. There was a light air, and we dropped slowly down the anchorage on a gentle ebb tide with little steerage way. *Ilex* came perilously near fouling the 8-metre yachts, which were moored downstream, and they shrank away nervously as we came up to them. Somehow we managed to avoid trouble, and reached the outer anchorage before our rivals.

The start was fixed for 11.15 a.m., across a line about two miles long, between Muros Island and the mainland. The smaller classes were to start first and they now came out in large numbers, towed by every kind of launch. A passing fishing boat gave *Ilex* a short pluck, and we sailed about behind the starting line, watching the metre boats at work. *Hispania V.* (H.M. The King of Spain), and *Osborne* (H.M. The Queen of Spain), were competing in the 8-metre class, and His Majesty gave *Ilex* a *bon voyage* as we crossed tacks. The large yachts—300 tons and over—were gliding about in the background, crowding on sail after sail. There were three of them —*Maria del Carmen Ana*, better known as the ex-*Meteor IV.*, and now Spanish-owned; *Ailée*, owned by Madame Hériot; and *Cetonia*, owned by Lord Stalbridge. It was a hot sunny day with a slight haze on the distant hills: one could not hope for a more charming setting to the large flock of frail white wings, which made up the foreground. A flying boat took off and flew around the men-of-war.

Our wind was dead ahead. We watched the metre classes carefully, and it seemed that those who started on the shore end of the line were the better placed. We discussed race tactics, and Hunt decided to try for a win or nothing. If we sailed the normal course

BILBAO—AND SO HOME.



Sketched by C. J. Godfrey, R.E.

ILEX'S CUPS, 1929 SEASON.

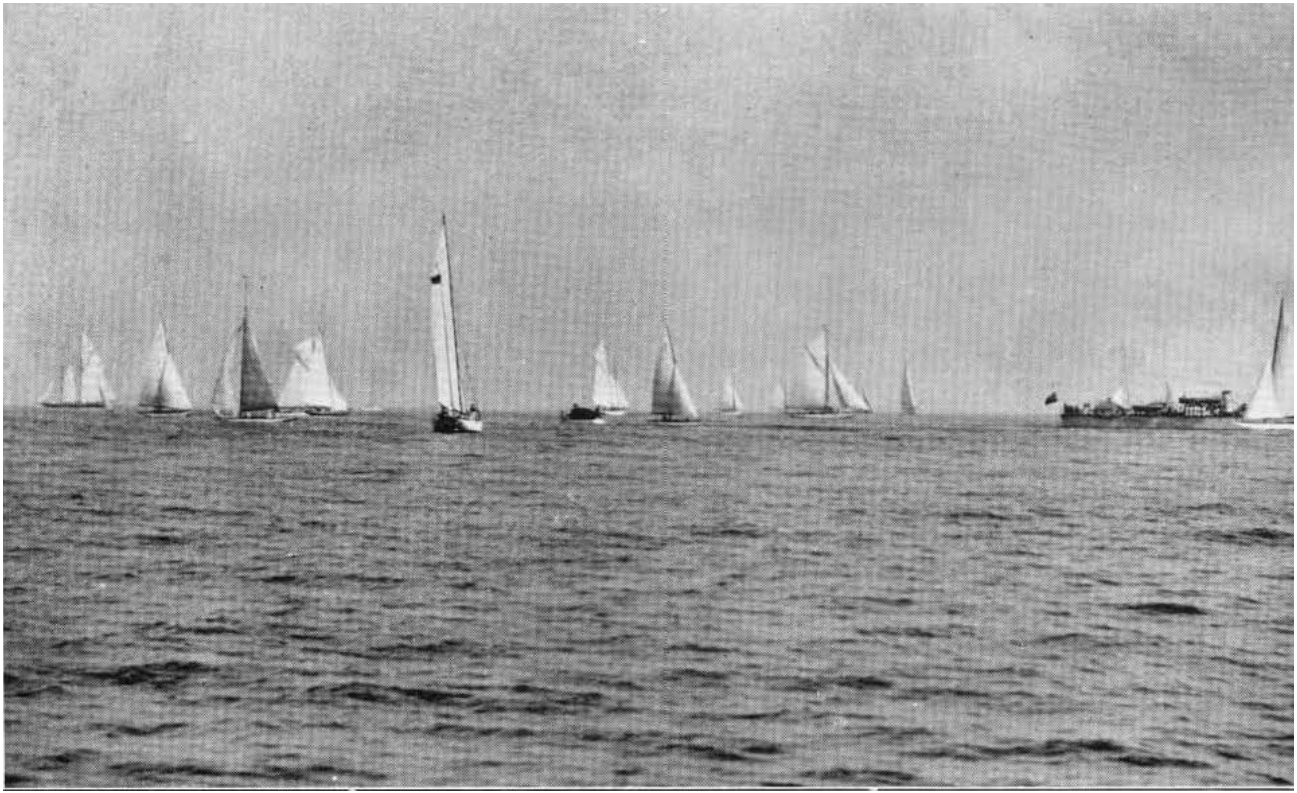
Santander-Bilbao Challenge Cup.

Plymouth-Santander Ocean Race. 2nd prize.

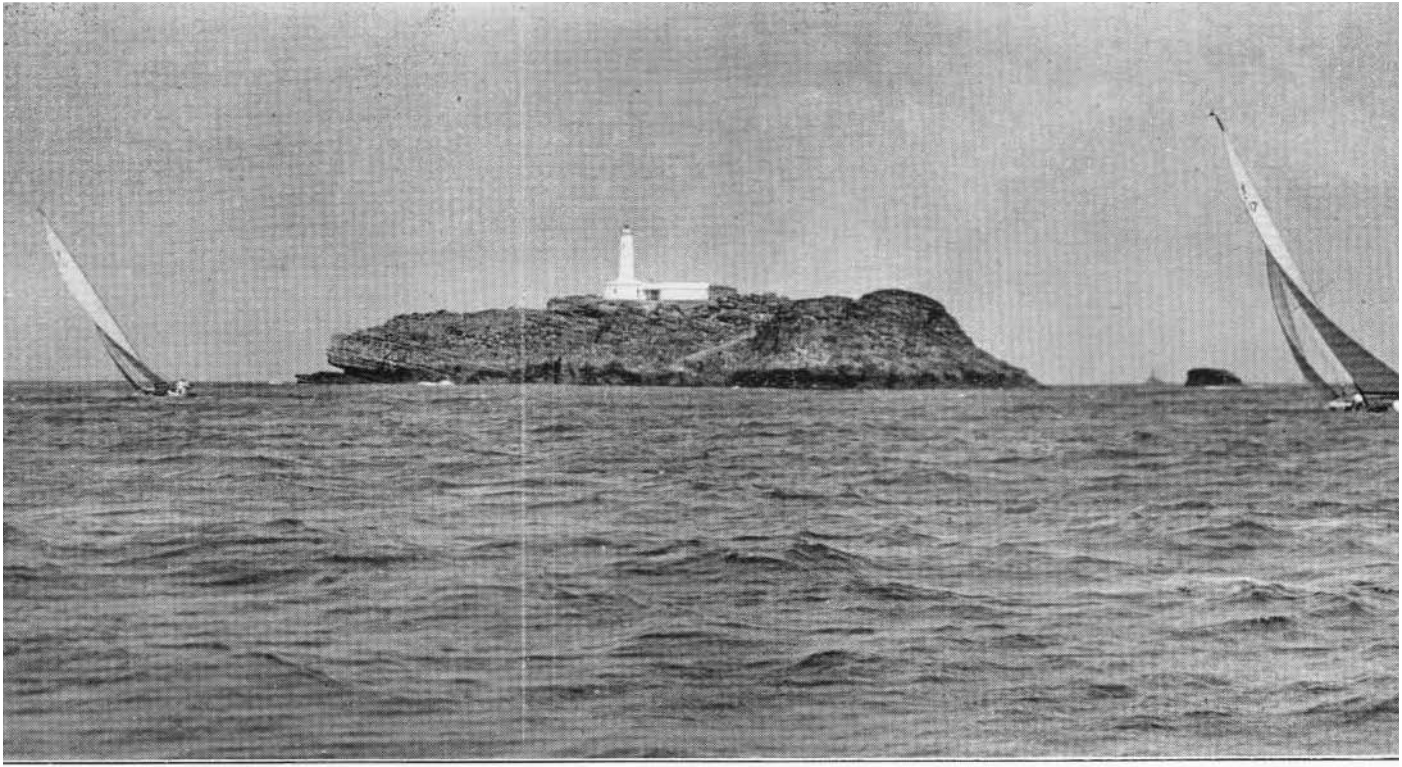
3rd prize. Fastnet Ocean Race.

Santander-Bilbao Race 1st prize.

Ilex cups



Bilbao Race Starters



Muros Island. Santander Harbour.

Muros Island

and kept with our rivals, we had little hope of defeating *Jolie Brise* on handicap, but we had a very good chance of second prize. On the same wind and course, *Jolie Brise* had often shown us that she could slowly pull away from *Ilex* to well beyond handicap range. It was up to us to provide *Ilex* with a better wind and coursé ; our only hope of doing so lay in avoiding *Jolie Brise* as if she were a plague ship, letting our luck bring us a good slant of wind with the change of water. This we did, and it paid us until quite near the end, when it left us far behind, dismal and dispirited ; then, suddenly, it brought a fine fighting breeze to carry us fast through the gloom to a two minutes' win on handicap, after sailing for nearly ten hours. A grand race.

Hunt made a masterly start. Before the gun, *Ilex* was gambolling innocently with the other ten starters about the centre of the line ; suddenly she shot off to the shore end, let draw all sails, and crossed the line an easy first, with a dashing turn of speed. It was to be a dead beat, and the helmsman had an anxious time making *Ilex* show her best paces in such a light breeze. Sheets were checked every few minutes, and halliards set up afresh on the slightest excuse. Slowly *La Volonté* and *Jolie Brise* crept up on us, and finally *La Volonté* went ahead. But we were not greatly concerned about her, as she was giving everyone time. Then *Jolie Brise* came about towards us on an inshore tack, running through our wake close enough for us to see the fair Spaniards who had come aboard her for the race. *Ilex* kept on the seaward tack, and, in the thickening haze, we soon lost sight of the whole fleet. The wind, luckily, was a little stronger out at sea.

We came about on the inshore tack at 4 p.m. and found that we had lost nothing on *Jolie Brise*, while *La Volonté* was only about half a mile ahead, and seemed to be becalmed. *Guerveur* was inshore, holding fourth place about two miles behind. The wind was still light and at 6 p.m. it faded away badly, leaving all three leaders pitching uncomfortably in some malicious little overfalls off Santoña, which is just over the half-way mark. *Jolie Brise* seemed to be taking them far worse than we were, and her bowsprit went under several times, ducking the man on it when she changed her jib topsail.

Jolie Brise now tacked towards us and we thought that the time had come for us to go out to sea once more ; but she went about close ahead, on sighting *Ailée* carrying a fresh breeze on the offing. We let *Jolie Brise* go out to sea alone after her, determined to stand or fall by our tactical scheme ; so that this time it was our much-feared rival who caught the good sea breeze and ran up quickly into first place. It was too late for us to follow her and we continued tacking along the coast line in a close battle with *La Volonté*. We pulled up level with her, but right on the offing a small fleet of yachts

was now bowling merrily along behind *Jolie Brise*—all of them nearer Bilbao than *Ilex*.

It was a very gloomy meal that we ate off Santoña. The crew sat below, while the helmsman, alone on deck, tried hard to fill the sails. Suddenly his shout rang out, "My God, the ship's on fire!" We clattered anxiously up on deck to be met by a hot blast from a furnace. He was evidently right. We looked around for the flames but none could be seen. It grew hotter every moment. Wild looks of apprehension passed among the crew. What *was* wrong with the ship? And then the wind came. Burning hot gusts swept down on *Ilex* from the land and laid her flat, until we thought that *Ilex* had at last forgotten how to deal with a full-blooded breeze o' wind. On the calm sea she made sudden nervous spurts ahead with the water hissing over the rail. To windward the sky had suddenly changed to a brazen yellow, with dark angry clouds shooting out flaming tongues towards us. It thundered: it would.

As always, Carter knew what it was, and in his informative way said, "Yes, this is the sirrock, that's what this is." He burst into some reminiscences about Cape Matapan. The rest of us had heard much at Santander of that sudden tempest which is known locally as the *borrasca*. The *borrasca* occurs in September in the Cantabrian Sea, and is a ferocious wind which blows for about four hours, with little obvious warning. We had heard nothing of its appalling heat; nevertheless, we got ready the topsail halliards and stood about, sweating in our oilies, waiting for the *borrasca* to blow a little harder before we reduced sail. *La Volonté*, just inshore, shook up into the wind and ran down her topsails. A 6-metre beside us put about for the small harbour we had just rounded; whereupon the breeze faded away into a light air from nowhere, and we tore off our oilies before apoplexy claimed us. This freakish wind is known as the *turbión* and seems to be incapable of doing anything, except giving one a Turkish bath and shouting a sudden "bo" to startle one.

At nightfall we could make out *Jolie Brise* well ahead with two other yachts close behind her; it looked as if we could only hope for a fourth, and we sailed on for the finish in a dispirited fashion. It was a black night and odd metre yachts came fluttering across our bows, seeking a faint air. We shifted sails continually, but made little headway. Two yachts behind us gave up and passed us under power; but we kept on, and suddenly our longed-for wind swept down upon us. We trimmed our sails and went hell's bells for the finish, amid the cheerful shouts of the crew. The lights of the mark-boat were soon abeam, and we opened up our usual pyrotechnic display. Carter burnt dangerous-looking paraffin flares all over the foredeck, while the rest of the crew let off Verey lights and flashed torches. Soon the markboat turned the cold stare of her search-light upon us. We waited. "Bang!" "There goes our gun.

Down topsails. Shake her up into the wind." The race was over. It was 10.50 p.m. and we could only guess at the result.

Under reduced sail we bore away for the harbour entrance. An anxious tug came up to us and hovered around with a plaintive message which our interpreter took to be "starboard." We shouted back cheerfully and carried straight on. Later we heard that there is always much nervousness about a rock near the harbour entrance; but as we had missed our sleep the previous night, and were fairly confident of our chart, we were able to raise but little interest in the poor fellow. He steamed away, feeling rather hurt. Inside the harbour, all was still, and we made our way slowly to an anchorage alongside the huge *Ailée*. *Jolie Brise* was stowing sail as we passed by in the blackness. It seemed quite possible that we had saved our time on her after all. Our crew stumbled below, feeling ready to give the seven sleepers ten in a hundred and beat them hands down. A great peace fell upon the vessel.

We were awakened by a messenger from the Real Sporting Club, Bilbao, who brought invitations to keep us amused for the next week. He knew nothing about the race result. With many sleepy halts, we clambered out of our bunks, to find that bright sunlight had long since roused the rest of the harbour. We bathed, breakfasted, and persuaded Hunt and Wilks to go ashore to get news of the race and revictual the ship. They rowed off across the sparkling water, taking our interpreter with them, while we searched the harbour in vain for a winning flag.

There was much to do on board; and we had only half-finished stowing the racing sails, when a smart motor-launch crowded with people darted alongside. The owner of *Maria del Carmen*—Señor Pedro Careaga—was in her, and we invited him on board *Ilex* to look around, though none of us felt that our shorts made a very good reception kit. He came with a friend and they carried two silver cups with them. A curious restraint seized us, and, when we took our visitors below, we talked of any subject except prizes and yacht races. The conversation made nervous little dashes at such well-worn topics as the scarcity of leave, the origin of our whisky: we felt that it was up to them to open the important subject. But Carter is a rough, uncouth fellow, quite lacking in such delicate shades of tact. He had been looking on from the fo'c'sle for some time and at last he burst out with, "What's them cups for?" We were horrified and gave him some jet-black looks. But he had cleared the air, and with much amusement the Spaniards replied, "Didn't we know that *Ilex* had won and that these were her cups? Really? Yes. *Ilex* had managed to snatch first prize from *Jolie Brise* by a scant two minutes. . . ." Our shouts seemed likely to lift the deck timbers. A winning flag was flying within 20 seconds, and our visitors left amid cheering shortly afterwards. One of the

cups was ours for ever; the other was a challenge cup for the same race, which Señor Carcaga had just decided to present. It can be won outright by the yacht club which wins the Santander–Bilbao Race twice. *Ilex* is the first winner, so that the R.E.Y.C. has now a very good start on other clubs.

The end of our leave was close upon us, and we had to start for home that same afternoon. Our interpreter did proxy for us at the race dinner, but we had to promise the Spaniards to stay longer next year. Hunt and Wilks rowed alongside about tea-time with tales of the superb hospitality of the Real Sporting Club. Hurriedly we made sail, and turned up to the harbour entrance against a faint breeze, dipping our ensign as we cleared the breakwater at 5 p.m. *Guerveur*, Baron de Neufville's 48-tonner, followed us out on her way to winter quarters at Bayonne. She had sailed in all the races and we watched her closely as she came up under our lee about a mile away. Her crew could just be made out, lining the weather rail; then down came her ensign to the dip, and, like a distant whip-poor-will in the marshes, we heard the faint sound of cheering. We returned their cheers, hauled our ensign close up, and turned, homeward bound, to give a last look at the vanishing coastline.

The crew had shrunk to five, plus Carter, the paid hand, who does not stand a watch. We kept to the remnants of the former watches and divided up into watches of two. Hunt kept skipper and navigator, Wilks and Rupert Brown took one watch, Fryer and Sutherland the other. Night fell and the wind blew fresher from the nor'-west. We handed all but our plain sail and settled down for a rough passage across the Bay. The southern horizon made great play with lightning flashes, and the rolling thunder made us get out our oilskins. We were heeling well over on the port tack, pushing the lee rail right down to the water. Hunt came on deck to help us and we waited for the wind to harden still more. But it must have been another variety of *turbión*, for the wind faded away to rain and light airs long before dawn.

Dawn broke upon a calm sea. We saw *Jolie Brise* about three miles ahead of us, and the sight set the morning watch to work on the topsails. *Ilex* had now run up into the warm and blue waters of the Bay proper. When the forenoon watch came on deck they found it deserted, and the duty watch splashing about in the water some distance away. Everyone bathed, had breakfast, and then bathed again. There was very little wind for the next two days and we spent them grilling in the terrific heat on deck; night or day, it was scarcely worth while changing out of bathing kit. At this point the mate developed a mania for coconut oil, and went about glistening all over with the beastly stuff. It smelt a good deal and he was an unpopular neighbour at meals in the stuffy cabin; besides, he came off on you.

By the end of the second day he was so dark that he looked to be at least eight annas in the rupee, and was quite satisfied with the result of his hard work.

We tried towing behind *Ilex* in her speedier moments, and thought it great fun, until we realized that we were towing Sutherland under, and that his porpoise jumps were real leaps for breath. At quite slow speeds, a huge bow wave forms in front of one, if the tow rope is fairly long, and then any slight freshening of the wind makes it almost impossible to get back to the ship.

The calm nights were enlivened by lightning displays and busy little wave concerts. These wave concerts would start in a gentle murmur away out to the west, and approach in a crescendo of chatter and lap-lapping. They were too small to move *Ilex*, and after playing around us for a few minutes, they disappeared to the eastward. We scanned them for signs of fish but found none. The tunny line we towed behind did nothing but get rusty and tie itself up with the patent log.

After the second calm day we decided to start single night watches, as there was so little to do on sheets and tiller. Fryer and Sutherland took the early watches and spent their time star-gazing and listening to a couple of whales gambolling round the ship, but during the middle watch, the wind freshened from the east and gave Wilks a strong man's job to do. Somehow he handed the jib-header alone, but, by daylight, *Ilex* was staggering into a steep, breaking sea, and the cry went up for all hands on deck.

We tumbled up to be met by a wet deck and a boisterous wind. The sea was too steep and confused for us to push *Ilex* through it in comfort, and Hunt decided to reef down to double-reefed-main and No. 2 jib. This meant plenty of wet work for everyone, but the sea was so warm that nobody minded getting dipped. The bowsprit-end hand was plunged right in several times, and his only reaction to it was the pleasant thought that he had stolen a march on the others in the matter of the daily bathe. *Ilex* sailed with a far easier motion after reefing, but the irregular waves kept flinging green seas aboard at intervals, in spite of the most careful steering. We were close hauled on the starboard tack all day.

Breakfast was difficult. It was the first rough weather we had met since the Fastnet Race, and the cabin became unpopular in spite of its dryness. Boiled eggs, *in manu* and alfresco, were indicated; by diabolical luck it was Brown, gastronomically our weakest link, who got the bad one. It should not be funny to see a man being hit when he is on the point of going down for the count anyway; but we found it difficult to repress that dry, mirthless cackle, with which, no doubt, an incurable paralytic might view a companion being bitten by a cobra. And so we sailed all morning, going fairly hard, taking in plenty of spindrift and some green seas,

too. The sun came out and began to dry the ship a little. We cheered up and one of us ventured to the cabin to enquire about lunch.

Quite unexpectedly, it was the best lunch of the year. The morning had been long, wet and strenuous, while breakfast had been very little more than another name for 8 a.m. And now, just as we were getting really hungry, the wind and sea slackened down, while the sun beat down quite cheerfully upon the whole scene. Bully beef, bread and red Spanish wine made a meal which put everyone in gorgeous form. Soon we set the staysail, and as the wind continued to fall away, we shook out the reefs and still kept the decks fairly dry.

That night we saw the faint loom of a light on the French coast —probably Penmarch ; later, we also saw a bright masthead light appear on the horizon and shoot swiftly towards us. While Sutherland hunted for the Verey pistol, this turned out to be Venus ; so that perhaps our loom wasn't Penmarch after all. Anyway, it gave the watch below a pleasant little thrill. We still met head winds, but *Ilex* kept up a good six knots most of the time.

During the next day and night we saw many other ships and by dawn on the 9th, we were north-west of Ushant. The log states, "Fix by Jove—7 a.m."—the planet, no doubt, being referred to. Our navigation had by now become quite professional and we were getting some very fine results by all methods. The colder green seas of the Channel made the morning watch less amusing, and discouraged the bathers ; we were undoubtedly well clear of the Bay.

We averaged under four knots all day on the 9th, but towards nightfall the wind freshened enough to send keen look-outs up the mast in search of land. Carter told us once more his story of how his captain's hair had turned grey in a night, but now quite without his usual zest : there is a feeling of uneasiness about a ship about to sight land which affects everyone. Supper and nightfall came, but still we saw no land. After supper, we relieved Carter at the tiller, and as he walked forward, he spotted the Lizard light over a wave top. It was a grand landfall ; so good that we continued on the same course and eventually picked up the Manacles Buoy about 2 a.m. The whole coastline then appeared, and Hunt put *Ilex* about, to make Helford River. We beat slowly up there and anchored just after dawn among the other yachts. We were then five and a half days out from Bilbao, but had grown so used to the sea that we all felt great regret that the sail was over.

Three of the crew left that day after our final dinner. Hunt's father nobly came aboard that night to help us sail *Ilex* round to Chatham, and by 10.30 p.m. we were casting off our tow at Helford River mouth. The sea was fairly calm for much of the way back and we were able to make *Ilex* steer herself for nearly a quarter of the journey. The crew were by now so keen on deep water sailing

that *Ilex* soon lost sight of the coast, and wandered across to within sight of Alderney. Slowly we came round to the Thames, scarcely meeting one favourable wind the whole way; and it was not until five days after leaving Helford that we picked up our moorings at Gillingham. In the calm watches we put in great work with the sextant and Aquino. Previously the navigator's mate had done some very rough work with them. In the Fastnet Race, he had fixed *Ilex* in the Bristol Channel, when Falmouth was clearly to be seen to the northward. Off Folkestone on the way back, he took a sight on the moon, which gave our position to within a mile. All were suitably impressed.

Most of the passage home from Helford was a dead beat. This would have been very tiring with such a small crew had we not tried some single-handed sailing tricks. The most obvious one was to enrol St. Christopher as a helmsman. We balanced the sails carefully and rigged up a simple tiller lock which worked so well that the crew scarcely touched the helm for two days, and yet *Ilex* made some excellent legs to windward during that time. We trusted St. Christopher so much that one of us spent his watch reading below with brief hourly visits to look out for steamers. It was quite calm enough to allow one to hear ocean traffic from the cabin.

Anyone who has sailed much on *Ilex* must have heard several of Carter's salt sea yarns; on this passage home he excelled himself —keel-hauling admirals, captains who always saw a flogging before breakfast, the admiral who was eaten as salt pork—we heard all the old favourites and many new ones. An awful eagerness to see home made him produce them to while away the time. He was the only one who failed to trust the St. Christopher, and when he came on watch his fingers soon strayed to the tiller and upset the accurate setting in case the wind had changed recently without affecting the burgee: never had we seen him so eager to get every knot out of her. Always slow, but never quite stopping night or day, we rounded the Forelands and sailed up the Medway with a light air and the evening flood tide.

Theresa was just stowing sails when we moored in the darkness, and her crew came aboard to view the cups and share our punch. It was nearly midnight when the last dinghy load left *Ilex* to rest in peace at the end of her 2,200-mile cruise. We shot off a Verey light to mark the event, and stepped ashore in time to hear the local picquet telling the police that he didn't think it could be a fire call after all. We left them wondering, and strolled up to the Barracks, glad to stretch our legs after a month of ocean sailing.

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THE INTERPRETATION OF AIR PHOTOGRAPHS.

By CAPT. A. C. DUFF, M.C., R.E.

IN the *Army Quarterly* of January, 1930, there appeared an article entitled "Air Photographs and Their Military Uses," and in it an attempt was made to describe the various uses to which the Army can put the photographs taken for it by the R.A.F. One of these uses is to provide information of enemy locations, enemy movements, and enemy activity generally, for the benefit of the General Staff, and this information is extracted from the photographs by the process known as interpretation.

So little is known about interpretation under conditions of mobile warfare, and the impressions of it that survive from the Great War are in some ways so misleading, that it seems desirable to record in print such data as there are available, and to describe the many uncertain factors which make it difficult to predict what value we may expect from interpretation in the opening stages of warfare against a civilized enemy. The material on which there is to work is so limited in quantity that views can only tentatively be put forward, and such views as are herein expressed are those of the author alone.

Interpretation may be defined as the art of recognizing on a photograph the marks of military activity on the ground. It is desirable to restrict the term to its proper use, and not to apply it to the recognition of ordinary topographical detail; nobody would speak of interpreting a map, and it is equally unnecessary to talk of interpreting on a photograph the natural features of the ground.

There is no need to stress the value of interpretation. It is possible to photograph any part of the area occupied by the enemy; his Base and L.-of-C., his forward defences, his battery positions, his aerodromes and hospitals. If the detail on the photographs is correctly interpreted, the Intelligence Section of the Staff is presented with a mass of information of the greatest value. It may be advanced that the same information can equally well be obtained by the pilot, but this is not so. The pilot endeavouring to reconnoitre country below him labours under many handicaps. His field of vision is limited by the spread of the lower main planes; his attention is distracted by having to fly the machine, and, very possibly, to dodge the fire of "Archies"; his powers of observation may be impaired by discomfort or fatigue, and, finally, his vision is restricted to what he can see with the naked eye.

None of these limitations applies to the camera. The camera is fixed in the bottom of the fuselage, and has a clear field of view; it is insensitive to discomfort, fatigue, or other personal factors; and by an alteration of the lens it may be endowed with any degree of telescopic sight considered desirable. There are two particulars only in which the camera is inferior to the pilot. Its first disadvantage lies in the fact that it is blind to movement, for its period of observation is a minute fraction of a second, while movement quickly attracts the pilot's attention. The second drawback lies in the time factor; before the information obtained by the camera can be made available the machine must return to its aerodrome and land, and the photographs must be developed and printed, a process far slower than the pilot's report of what he sees, sent down at once by R/T. These are the factors that have to be borne in mind when deciding whether any particular reconnaissance will be better carried out by the pilot or by the camera, or by a combination of the two.

To return to the question of interpretation, a photograph of an area in enemy occupation will convey little to a man who is unused to looking at photographs of this kind. Unless the photograph is at an exceptionally large scale it will not show men, horses, wagons, or guns. Columns of troops or transport on the road may appear, but once units are deployed, or scattered among billets, they become invisible, and the only indications of their presence are the marks they make on the ground. The study of these marks is the art of interpretation.

These marks fall into two categories. First are the marks made by digging. As soon as a hole of any kind is dug the texture of the ground is altered; the excavated earth lying round the hole is smoother in texture than the grass or scrub surrounding it, and consequently reflects more light upwards, and shows lighter; while in the hole itself one side is in high light, and shows light, while the other side is in shadow, and shows dark. Even a hole only two or three yards in diameter shows up clearly on a small-scale photograph.

The second series of marks are those made by occupation. A party of men walks across a field. The grass is crushed down under their feet, and again the texture is altered, for the flattened blades of grass reflect more light upwards than the blades standing erect, and consequently appear lighter. If movement continues along that route a track is formed, and when the grass is trodden right out the bare earth appears lighter still.

A track of this kind is of no particular interest, but may be of value by indicating the point to which it leads; and in addition the making of tracks is often incidental to some other occupation. If, for instance, barbed wire is erected at night, in the morning there will appear tracks along the edges of the entanglement, though the entanglement itself may be quite indiscernible. Or again, a trench

or a battery position may be covered over with sods of turf so carefully that it is effectively concealed, but it may yet be easy to pick up the patches from which the turf has been cut and the tracks along which it was carried to its destination.

It is on the correct reading of such marks that interpretation is based, and a moment's reflection will show that it is under conditions of position warfare that interpretation will give the fullest and most accurate results. During the War, certain areas were occupied for weeks, months, even years on end, and throughout the period digging went on continually. The German lines were photographed at frequent intervals, and a comparison of each series of photographs with the series last obtained showed clearly the activities which had taken place in the interval. His tactical methods and his standard designs in field defences were known, and it was soon realized, to take an illustration, that a certain peculiar zig-zag marking indicated the emplacements of a field battery. Other characteristic markings were similarly noted; an air-line was indicated by a fine, straight, white line, with small dots spaced at even distances along it; a buried cable showed as a faint line with a peculiar blurred edge; a light railway was distinguished by the smoothness of its curves. Thus was gradually built up a kind of dictionary, in which one could discover what characteristic markings any particular form of enemy activity was likely to produce on the photographs.

The information thus acquired was of immense value in arriving at an appreciation of the enemy's plan. If on a certain sector of the front the roads and railways were seen to be pushing forward towards his front line; the number of hangars on his aerodromes to be doubled; his battery positions to be largely increasing in number; the traffic round his ammunition dumps to be heavier; and his signal system to be extended and duplicated; then it could be assumed that an attack on that sector was in preparation. The photographs, it is true, gave little evidence of the probable date of the attack, but they indicated with accuracy the frontage over which the attack would extend.

The results obtained during the War tended to give rise to an impression that it was possible to obtain from air photographs very complete indications of an enemy's plans and intentions. Emphasis must, however, be laid on the fact that the quantity of information then obtained was largely due to the extremely favourable conditions —those of position warfare—that then prevailed, and that in the opening stages of a future European war such results could not be expected. The war for which the Army is training is not the position warfare that may prove unavoidable, but the mobile warfare with which a campaign is bound to open; and it is under mobile warfare conditions that we want to know what interpretation has to offer us.

The answer to this problem is highly obscure, but certain tentative views have been reached and may serve at least as a guide. They are based principally on two exercises carried out in 1929 under widely different conditions; one in the United Kingdom, the other in Egypt.

In the former exercise a battalion position was occupied and defences constructed during a period corresponding to five days under war conditions. The troops who carried out the work were at the same time practising the use of natural cover and the construction of camouflage. The ground was hilly and broken, covered with gorse, broom, and heath, with occasional clumps of trees, and as it had been dug over on a previous occasion it was scarred with the lines of filled-in trenches. The work done included a number of section posts, two concrete machine-gun emplacements, two anti-tank gun emplacements, and some short lengths of barbed wire apron fence. The area was photographed before work began, and again at intervals during its progress.

The amount of information that could be obtained by the most careful examination of the photographs was meagre. It proved only to be possible to mark down a certain number of points where digging had taken place. It was not possible to distinguish one kind of digging from another; section posts from machine-gun emplacements, or machine-gun emplacements from dugouts. No trace whatever was visible of the apron fences, for in that tough undergrowth tracks were very slow to form.

It must also be noted that the information obtained, such as it was, was obtained by the aid of a minute comparison of the photographs with the earlier photographs taken before the position was occupied. Had these earlier photographs not been available the value of the interpretation would have been still further decreased.

From the point of view of interpretation the conditions were about as bad as they could be. The topography was entirely unfavourable, and the enemy was making skilled use of natural cover and of simple forms of camouflage.

Under such conditions the value of interpretation may be assessed as follows. It will be possible to ascertain the approximate extent and depth of the enemy position. It will not be possible to locate more than a proportion of his defensive works, or to distinguish their nature, or to detect barbed wire entanglements.

The exercise in Egypt was on a larger scale. A small mixed force took up a defensive position in the evening and entrenched it during the night. The position was photographed on the following morning.

The topography was of course entirely different from that of the former exercise. The desert, though broken and hilly, offered no natural cover of any kind. Although the time of occupation was so much shorter—a matter of hours instead of days—it was possible to

pick out on the photographs practically every point at which digging had taken place. Some simple camouflage had been attempted with varying success, but it was naturally only possible to apply camouflage to a small proportion of the digging zone. It is worth noticing that in such country a series of photographs taken before the position was occupied was not found necessary for the practice of interpretation.

The results that can be expected *under such conditions as obtained in Egypt* may be thus summarized. It should be possible to determine the extent and depth of the enemy position, and the areas in which his resistance is likely to be concentrated; to locate a high proportion of his machine-guns and artillery; and perhaps to make out his organization, *i.e.*, how many main units are present, and how they are disposed upon the ground.

Under two given sets of mobile warfare conditions these are the results that interpretation can give. In trying to decide what results we may expect under other conditions, the following are the factors that must be considered :—

1. *The local topography.* The success or otherwise of interpretation depends mainly upon the type of country occupied by the enemy. The more broken the country, the more difficult interpretation becomes. Thorn, scrub, gorse, broom, heather, are all tough, deeply rooted, and hard to destroy or even crush down. Country of this kind, moreover, appears on a photograph as an intricate patchwork of constantly varying tone, ranging from very dark to very light, thereby making it peculiarly difficult to distinguish those changes of tone, due to military occupation, upon which the successful practice of interpretation depends.

   At the opposite end of the scale is open arable country or pasture land. The bare plough, the stubble or short grass, or the grown corn, all provide a medium on which changes of texture are immediately apparent. A flat desert would offer equally favourable conditions; more so than the Egyptian desert round Mena, which is far from flat and consequently contains many small shadows to distract the eye.

   This factor of the relation of topography to interpretation is one which a commander might profitably consider when taking up a defensive position which has to be held for a period of more than a few hours. If he is able to choose broken ground, such as that described, he is thereby offered a degree of immunity from air reconnaissance that in open country no amount of labour expended upon camouflage would afford him.

2. *The period of occupation.* Generally speaking, the longer a position is occupied the more easy does interpretation become.

A grass field over which troops have deployed will show only small and impermanent traces of their passing; but if they continue to occupy the position the tracks of reliefs, ration parties, patrols, etc., soon become conspicuous, while any digging that they do is at once apparent.

The only exception to this rule is when the period of occupation is so protracted that elaborate measures of camouflage are brought into practice. To take an illustration: when a battery of artillery goes into action it will not, if photographed during the first few hours, appear very conspicuous. As time passes the construction of gun-pits, the movements of ammunition-wagons, the blasts of the discharges, the coming and going of personnel, make markings which become more and more distinct. If, subsequently, effective camouflage is erected and track discipline enforced, the signs of the battery will gradually fade out until they become almost or quite invisible. Such measures of camouflage, however, are hardly practicable under conditions of mobile warfare, both on account of the time required for their execution and the quantity of material necessary.

Under mobile warfare conditions, the possibilities of camouflage are largely limited to what units can do for themselves without assistance from technical troops. They can do a great deal. The intelligent use of natural cover, the screening of newly-turned earth with brushwood or turf, the covering of important points with wire-netting or canvas or any other available material, all help to puzzle and mislead the enemy in his attempts to read the photographs.

3. *The skill of the interpreter.* The best possible results from interpretation clearly cannot be expected unless the man who carries out this duty has certain qualifications. The two qualifications he requires are tactical knowledge and practice.

It is essential that the interpreter shall have a sound and thorough knowledge of the enemy's organization, tactics, and system of administration. Before he begins to examine the photographs he must be able to form a picture of what the enemy's "lay-out" is likely to be. Does the enemy always cover his front with anti-tank obstacles, natural or artificial? Does he dispose his automatic weapons in fours, in pairs, or singly? Does he push up artillery close behind his forward units, or does he hold it well back?

Is his ammunition supply still entirely on wheels, or has he begun to have recourse to dumping? When his batteries occupy a position what kind of emplacements do they build? To these and a score of similar questions the interpreter should know the probable answer before he begins his work.

On the outbreak of war the answers to some of these questions must be problematical, but as the campaign proceeds, and data become available, the Intelligence Section of the General Staff should be able to provide the answers with some degree of certainty.

Given this knowledge, the remainder is a matter of practice; and probably less practice is required than is generally supposed. After a few days an intelligent man should be able to extract most of the information that is to be had.

4. *The photographic factors.* If interpretation is to give good results the R.A.F. must first produce good photographs at a suitable scale.

A "good" photograph for interpretation purposes must be clear and sharp, and should show a well-defined shadow effect. Assuming the efficiency of the technical equipment and the competence of those who have to use it, the other requisite is fine weather. It does not follow that a day which is suitable for photography on the ground is suitable for photography from the air, and in the United Kingdom only one day in three, taken on an average throughout the year, will permit the production of "good" photographs. Thus it is impossible, except in a peculiarly favourable climate, to reckon on photographs for interpretation being obtainable when they are wanted.

The question of scale presents many complications. A photograph intended for the examination of *ground* is better taken at a comparatively small scale; say something round 1/10,000 or smaller. At such a scale each print covers a fairly large area, and yet the features which one wants to see—houses, roads, hedges, trees, etc.,—are sufficiently visible. A photograph intended for *interpretation*, however, cannot show too much detail, and the scale consequently cannot be too large. In country that is at all difficult a scale should be aimed at of not less than 1/5,000.

The R.A.F. will usually have little difficulty in producing the approximate scale required. The scale of a photographic print is dependent on three things. First, on the altitude of the machine; the higher it is flying, the smaller the scale. Second, on the focal length of the lens employed; a long focus lens gives a large scale, a short focus a small

scale. Third, on the degree of enlargement introduced in printing from the negative; this is subject to limitation, for with any given negative there is a degree of enlargement above which the amount of detail shown is not increased. When photographs are to be taken the flying height of the machine is first settled, depending on the height of the clouds below which it must fly, and on the enemy A.A. defence, which may force it to fly high. The scale required is then produced by adjusting the focal length of the lens and the degree of enlargement.

Unfortunately there still remains the factor of time. To take a concrete case, Corps H.Q. requires for interpretation purposes photographs of a certain area. It is worked out that if the photography is done at a scale of 1/10,000 it will require 25 prints to cover the ground.

Now 1/10,000 is too small a scale to be satisfactory for interpretation, and Corps H.Q. may well ask for a scale of 1/5,000. This means, however, that to cover the same area will require not 25 x 2 = 50 prints, but 25 x 4 = 100 prints. And should they ask for a scale of 1/2,500 it means 25 x 16 = 400 prints.

These numbers are unmanageable. While a demand for 25 photographs may take a Squadron, R.A.F, given good weather and barring accidents, about three hours to complete, a demand for 400 photographs may take them fifteen hours or more. (These figures are dependent on many fluctuating factors, but would represent a satisfactory achievement.)

Nor is this all. When the 400 prints have been prepared and delivered by the R.A.F. they have yet to be examined, and the detailed examination of 400 prints would occupy a matter of days.

The answer to the problem appears to be that when time is precious, as in mobile warfare it always is, the interpreter must be content with photographs at a comparatively small scale of the area, extending presumably across the Corps front, with which he has to deal; and though he may and should demand in addition photographs at large scale of certain points of particular interest or importance, he must keep those demands within strict limits. If he does not, but asks for photographs of large areas and at a large scale, congestion and delay are bound to result.

EARTHWORKS.

By MAJOR W. L. WOOD, O.B.E.

DURING the War the following points were impressed upon the writer of this note in his experience with Field Companies R.E. and later with Railway Troops R.E. :—

A. The great importance of rapid digging to secure protection and the inability to dig of (*i*) the average infantryman and (*ii*) the average sapper in the new armies at least.

B. The difficulty of getting a supply of tools up to the forward position during an advance.

C. The unsuitability of the tools provided (*i*) as regards type and (*ii*) as regards condition.

Taking these points in order :—

A. In open warfare, or during movements of advance or retreat in close warfare, the necessity for troops being able to protect themselves by rapidly digging themselves in is obvious, and presumably is not less so to-day than in the late war.

A soldier who has dug himself in quickly and well is better able to resist a counter-attack, quite apart from being protected from the shelling and M.G. fire, which is always directed against newly-gained positions.

In trench warfare the need for good digging is no less important ; during the War, whole brigades were sent up night after night to make communication, drainage or jumping-off trenches, and incurred heavy casualties in doing work which could have been performed by 20 per cent. of the strength, had they known how to dig and been animated by the desire to get their task done and not merely by the desire to get back to hutments. Here a distinction must be made between the outlook of a man digging himself in, and that of a man making a trench which, as far as he knows, he will never be called upon to occupy, but which is turning his "rest" period into a very bad joke.

Many men, of course, knew how to handle a spade, but their work naturally slowed down to the pace of their inexpert comrades, while work at night in strange surroundings, in soil full of roots and other obstructions, reduced all to a common level of incompetence, which only hard training with tools properly conditioned could raise to efficiency.

It must be borne in mind that nearly all the work in the forward area *did* take place at night; it was the writer's experience that working parties were sent up with insufficient officers and N.C.O.s, that those in charge knew nothing and cared less about the work, but were concerned to get their men back safe and sound to their rest with as little delay as possible, and the net result of their labours was only some haphazard turning over of the top soil, which by the following night had made the site a quagmire.

The sappers, who by precept and example should have been the backbone of the work, had not the experience necessary; plumbers, carpenters or bricklayers in civil life, they were all that could be desired when laying pipes or making duckboards, but few of them ever became "sappers."

In this black picture there were bright, though exceptional, patches, and the foregoing observations are of an entirely general character and are certainly not directed against the 9th Division, in which the writer had the honour to serve for a portion of his time in France: for obvious reasons, it was difficult and invidious to formulate complaints against individual units for which, in other respects, one entertained the highest admiration and respect.

It is submitted that the lesson remains; there is need for far more training under practical conditions in digging, and in inculcating in the infantryman an appreciation and care for his spade akin to that which he has for his rifle—"a very present help in trouble."

B. The difficulty of getting a supply of tools up to the forward positions during an advance.

During the month of July, 1916, on the Somme, there were drawn from R.E. Stores for issue to the 9th Division (*inter alia*) so many thousands of picks and "shovels," that an acute shortage existed at the "dumps," although these thousands were strewn on the battlefield, just short of where they were required, to be destroyed, burned, buried or salvaged at a later date.

Only a small proportion of these tools ever reached the front line; the already heavily-burdened soldier let his pick or spade go first of all—quite properly, no doubt, if something had to be jettisoned. Each brigade or battalion going up looked for, and got, a complete equipment—"Q" could hardly tell them to pick them up on the battlefield, although that was really the solution of the problem, for, as it was, they were dropped on deployment after being carried two or three arduous miles.

The result was, for the time being, a grave shortage of tools right back to Base dumps, a waste of transport and most precious road space, and still no tools in the front line.

The writer has no suggestions.

C. The type and condition of the tools supplied.

(*i*) *Type.*—The writer with diffidence suggests the use of the half-round narrow spade, which is in general use for earthworks in railway work abroad.

It does not lift too big a load, it holds its load until thrown, it is a powerful cutter in roots and it is rather more handy to carry; in very soft ground, as in very hard, it is not inferior to the open spade.

It is true that the half-round spade cannot be used as a shovel for moving gravel and ballast, and that "pretty pretty" gardening effects on glacis and parapet (to charm the inspecting eye on Great Days!) cannot so readily be attained, but, on the other hand, it digs a post-hole to perfection.

(*ii*) *Condition.*—It did not seem to be recognized that the condition of a spade to a digger is just as important as that of a chisel to a carpenter or of a rifle to a rifleman. Spades were invariably issued to working parties either as they came from the makers, *i.e.*, quite blunt, or, if "second-hand," rusty or caked with mud as well as blunt.

The writer of this note has had considerable experience with earthwork gangs working on piecework in making railway embankments; these men are able to dig over 20 cubic yards per man per day from a borrow pit and to wheel and tip them to form a low embankment; their spade is their proud care; it is kept knife sharp and silver bright; work with it by comparison becomes a pleasure; each man has a file in his belt with which he maintains the edge.

In France, it was pitiful to see hundreds of men trying to dig with tools with an edge $\frac{1}{8}$" thick, with the blades rusty and caked and made heavy with a pound or two of Flanders mud.

No spade should be issued from store that is not sharp and bright and oiled; to prevent accidents in carrying a guard might be required on the cutting edge; every man should be taught that he can save himself endless toil, and possibly his life, by so maintaining his spade, and that it is as absurd to work with a dirty, blunt spade as for a bank clerk to write his accounts with a walking-stick dipped in ink.

This fault was noticeable in all except perhaps the specialist units such as Tunnellers', Drainage Companies, etc., and the writer ventures to lay stress on it because it was not generally realized; the opinion held was that a spade was a spade and there was nothing more to be said or done.

SOME SIDELIGHTS ON IRAQ'S PROBLEMS.

By "MARCO DOUGLAS."

Note.—The historical statements contained in this article have been obtained mainly from the principal actors in the various scenes.

IRAQ is a subject on which in the past we have heard a great deal, and of which in the future we shall probably hear a great deal more. It is, however, difficult to get a true perspective of Iraq and its problems unless we are clear as to its origin.

The dust of the four years of fighting hung deeply over Europe after the War, and even now the sequence of events in Europe is not too clear in the mind, and the happenings in the East, save in the case of the actual spectators and actors, seem too hazy and complicated to be understood or remembered. It seemed as if, out of a welter of diplomatic intrigue, peace conferences, correspondence, and even rebellion, there emerged the Cairo Conference in 1921, and shortly afterwards the Iraq State was formed.

The country itself is bounded on the north by Turkey, on the east by Persia, to the south and south-east by Nejd, and to the north-west by French Syria. The northern and eastern boundaries are mountainous, the country resembling the Indian Frontier, but inhabited by Kurds who, although good fighters, have nothing like the military skill of the trans-border Afridi and Pathan.

The remainder of the country is flat. From the foothills to the western side of the Euphrates it is fertile, and, where there is water, cultivated. Beyond the Euphrates there is the so-called desert. This is not a desert as the French understand the term in the Sahara. There an officer's patrol is over country three to four hundred miles between water points. In the Iraq desert, in winter, in no place can one get further than twenty miles from water, or in summer more than forty miles. Possibly this does not sound a very great distance, but when it is realized that the maps are very inadequate, and that the desert water points are wells which have no vegetation at their mouths, it is easy to see that if one misses a well, one may have to go a very long way before finding another. So much for the geography.

For some four hundred years before 1914, the Arabs of Arabia had been under Turkish rule. There had always been a feeling of hope

that some day independence would be realized, and this feeling gradually became more intense and there started a movement which became really active in 1876. If 1848 can be described as "the turning point in European history at which Europe failed to turn," then 1876 may be described as the turning point in Turkish history, at which Turkey turned from looking west to looking east.

In the Turkish Empire this was a year of revolt. Bulgaria, Rumania and Serbia were all born from movements begun at this time, and, in this same year, the Arabs began to take active steps to establish, eventually, their independence. Committees were formed throughout the Turkish Army and propaganda was spread among the Arab peoples. The movement began to gain force, and soon found that alongside it another similar movement in the Turkish Empire was being prepared. This was the "Young Turk" Movement. Many members of the Arab Movement were also members of the Young Turk Movement, and eventually the two movements united on the understanding that the Young Turks, should they gain power, would grant the Arabs independence under the Turkish Suzerainty.

In 1908 the Young Turks came into power, and immediately repudiated their agreement with the Arab Nationalists. The Arab Nationalist movement, however, had gained too much momentum to be suppressed, and committees sprang up again in the Army; and was directed from a central committee in Constantinople. Steps were taken by the central committee to get in touch with the British authorities in Egypt, and Lord Kitchener was approached. Though he made no promises, he smiled rather than frowned on a movement which he foresaw would be of inestimable value in the event of war with Turkey.

The movement was gaining impetus rapidly, and in 1913 an Arab Parliament met in Paris. The delegates were from all the Arab peoples subject to the Turks, with a few others from North Africa. This Parliament achieved little except contact between the various members, but it was a gesture and an important one. The Turkish government awoke to the seriousness of the Arab preparations, and early in 1914 arrested as many of the central committee as they could. Several escaped, among whom was a young officer who had been on the staff of one of the Turkish armies near Constantinople.

He fled rapidly, and eventually, after adventures that rival any work of fiction, arrived in Basrah about the beginning of August, 1914—in time to hear of the outbreak of war. No time was lost. He got in touch with Sayied Tayid, the most powerful Arab locally, and a man of whom the Turks stood in awe, and persuaded him to take a message to the British Consul. He said: "Tell the British Government that this war which has just broken out between Germany and Britain is going to include Turkey on the side of the

Germans, and that, if the British Government are prepared to promise the Arabs independence on the conclusion of the war, the Arab Nationalist Party will guarantee that the two Army Corps now in Iraq will come over to the Allies."

He waited; and waited; and waited; and nothing happened. By this time the Turkish authorities had again got on his track, and he fled down the Persian Gulf to Bahrein. There he stayed until he heard news that British forces were assembling in Bombay to occupy Basrah. He again went up the Gulf, this time to Fao, and got into touch with the British Consul at Mohammerah, and sent once again the same message. Again there was no reply.

When the British Troops occupied Basrah, he got into touch with the Chief British Political Officer with the Expeditionary Force, and made the same offer, this time excepting the Northern Army Corps, which had been relieved by a non-Arab Corps from the interior of Turkey. "After all," he said, "it will cost the British Government nothing to make the promise and to allow me to try, and it may be that, instead of having to fight your way to Baghdad, you will be able to send up occupying parties, and in a matter of days the Allies will be provided with a spectacular success; if I fail, you will have lost nothing." Once again there was no reply, and he decided that, since the political policy of the Expeditionary Force was not dealt with by London, no good could come of his remaining in Iraq, and he applied and was sent as a prisoner of war to India.

In March, 1915, the Gallipoli campaign started, and among others who distinguished themselves on the Turkish side was an officer who had, a year before, been the Adjutant at the Turkish Infantry Depot at Aleppo—Jaffar al Askeri—and he was awarded the Iron Cross.

Pre-war German preparations had been thorough and had included propaganda and preparation for revolution among the Senussi in North Africa. In order to contain as great forces in Egypt as possible, the Turkish General Staff decided to use these preparations and to assist the Senussi to revolt. Jaffar was sent across the Mediterranean in a fishing boat under the noses of the British Fleet, and discovered that, before any effective revolt could take place, the Senussi had to have money, arms and ammunition. He therefore returned once again in his fishing boat, and made arrangements for money and the supply of the necessary arms and ammunition, this time returning in a submarine to North Africa. Directed by Jaffar, the Senussi broke into revolt, and after a hard campaign they were finally defeated by a British Force consisting largely of armoured cars and cavalry. Jaffar was wounded and captured by the Dorset Yeomanry, taken to Cairo and put in hospital in the Citadel. After some time he decided to attempt to escape. One night he tied his sheets together and lowered himself out of the window. Unfortunately, Jaffar weighed eighteen stone, and the sheets were ordinary

army quality. As a result, they broke, and Jaffar fell to the ground and broke his leg. He was collected in the morning and taken back to hospital, where, in due course, he recovered.

At the beginning of 1916, the Arab Bureau in Cairo had been investigating the possibility of bringing King Hussein of Mecca into the war on the side of the Allies, and thus threatening the Turkish left flank, which rested on the desert. As his army—such as it was in those days—was very inefficient, it was decided to strengthen it by means of Turkish-trained Arab officers, many of whom had fallen into the hands of the Allies. One of the first to be sent to the Hedjaz was Jaffar, and shortly afterwards Nuri Saiyed followed him from Bombay. The Arab revolt had started. The Palestine campaign continued and, as a result of some very excellent work in the company of Colonel Lawrence, Jaffar was awarded the Cross of St. Michael and St. George. Lord Allenby, who decorated him, arranged a Guard of Honour for the ceremony consisting of the Dorset Yeomanry, who were at that time serving in Palestine. And thus, in one campaign this remarkable soldier, Jaffar al Askeri, won, and won honourably, both the Iron Cross and the Cross of St. Michael and St. George—a unique record.

The Palestine campaign eventually ended, and the Arabs, under the leadership of the Emir Feisal, King Hussein's third son, found themselves in Damascus. There a temporary state was organized, and everybody settled down to await the final decision of the peace conference sitting in Paris.

Time passed, and it seemed that the promises which had been made in the war would never be fulfilled. So, when in 1920 the tribes on the Euphrates who had not seen the might of the British Armies during the War, broke into revolt, the Syrian Government rather countenanced than suppressed what seemed to be merely another movement towards independence. The rebellion was at last put down, and the British authorities then had to face the question of what was going to happen to Iraq, and what was going to be done to redeem their promises to the Arabs.

A conference was called in Cairo in 1921, presided over by Mr. Winston Churchill, and there, very largely owing to the clear and long-sighted views of Miss Gertrude Bell and the courage of Mr. Churchill, it was decided to create an Iraq State under British Mandate, thereby relieving the British taxpayer and at the same time giving the Arabs such independence as British international commitments would allow. The control established by the Mandate was naturally very irksome to the Arabs, but they were, on the whole, pleased to obtain even this measure of independence, the more so as the measure held out the promise of complete independence in the future. From the British side the arrangement was a good one: prestige and war-time promises were re-established, and the British

taxpayer was relieved of the very heavy burden of the defence of Iraq, with no likelihood of those Iraquis who had befriended Britain being returned to the tender mercies of Turkish misrule.

In order to achieve a measure of security for the new State, Jaffar, who attended the Conference, agreed to become First Minister of Defence and to form the army. To help him he had two or three hundred ex-Turkish officers of varying degrees of intelligence and education and about half a dozen British officers, with some of whom he had previously served in Palestine and Syria. And thus he started on a task from which a man without unbounded enthusiasm and energy might reasonably have shrunk. The British forces in Iraq could not be expected to forget, and did not know, as a rule, enough to forgive, the revolt of the previous year, and the Ministry of Defence was met at the outset by a certain amount of understandable suspicion. In most armies the hundred-and-one regulations—clothing regulations, army regulations, field service regulations, army forms, methods of accounting, budgets, handbooks for weapons, law, etc., exist as a result of many years' slow and careful work. The Iraq Army started with none of these things, and from the outset it had to work very hard, not only to compete with present problems, but to make up the lee-way in administrative matters with which it started.

One regulation which Jaffar insisted on was that the Iraq Army, unlike the army of the Hedjaz, should not have all its officers of the rank of Major-General. And in addition he insisted that every officer who joined, no matter what his previous rank had been, should go through a course at a newly-formed Junior Commanders' School in Baghdad, the instructors for which were originally found from British Army N.C.O.s. To make certain that there would be no exceptions, Jaffar himself, though Deputy Commander-in-Chief and Minister for War, went through the course, sloping arms and fixing bayonets under the guidance of a British serjeant. The first few months were unbelievably strenuous. In addition to being instructed himself, he acted as interpreter for a British officer teaching gun drill, worked as Commander-in-Chief and Minister for War, and helped to translate military text-books into Arabic.

At the end of 1921 the army consisted of 2,000 officers and men. Gradually it grew until, in 1928, there were serving some 11,000 all ranks. In these days of "universal peace," it may seem unnecessary for an army, even of this size, to be maintained in a new country, more especially when that country is distinctly poor. But Iraq has very definite military commitments. To begin with, on the north is the Turkish Empire and with no army—or a badly trained army—it would be very easy for Turkish forces, even if not mobilized, to cross the frontier and seize, let us say, Mosul Vilayet. What Europe would do, faced with a *fait accompli* of this sort, is not very

certain, but if the Iraq army is strong enough to make such an incursion by unmobilized troops impossible, then, in order to achieve a military success, Turkey must mobilize. Mobilizations cannot be kept secret and take time, and thus time is allowed in such a case for diplomatic pressure to be brought to bear on the Turkish Government, and for British reinforcements, if necessary, to arrive.

The problem in regard to Persia is not so acute. The Persians, prior to the accession of Riza Khan, undoubtedly cast envious eyes on the Shiah holy places of Nejef and Kerbela. The Persian army, however, is not a very serious matter at present, and the Church party in Persia has declined greatly in influence. To the north of Persia lies Russia, however, and the intentions of the Soviet are by no means clearly pacific. Despite the best wishes of the Persian Government, it is not impossible that, on some future occasion, it might be led into an attack on Iraq.

The solution of the frontier problem with Ibn Saud is a much more difficult matter. The shepherds who occupy the land on the Iraq side of the frontier have relatives, and in some cases the remainder of their tribes, on the Nejd side. Raid and counter-raid have gone on for generations, and many of the raids that have taken place during the last four years have been of a retaliatory nature. A Bedouin raid is a difficult matter to compete with. A party of perhaps 2,000, perhaps 4,000, or perhaps only a few hundred men mounted on camels or horses, decide to raid a definite encampment. They move slowly to within 60 to 100 miles of their destination, and then do this last lap as hard as possible, timing themselves to arrive either just at moon-up at the beginning of the night if there is a full moon, or at dawn. The encampment is rushed and the remainder of the night or of the day is spent in collecting the loot and moving back towards their previous base. In one raid that happened last winter, a party of Bedouin, mounted on camels and horses, did 160 miles in thirty-six hours, including the raid, and the last twelve hours they were driving sheep.

Such raids, though damaging to the prestige of the Iraq Government, are very difficult to suppress. Steps have been taken to make defence posts in Iraq some thirty miles from the Frontier, at which light, rapid-moving forces may be stationed. These posts have given a great sense of security to the desert dwellers, and have, to a certain extent, limited the spheres of action of the raiders.

It will therefore be seen that it is essential for Iraq to have an army. The exact size of the army has not yet been determined, but it is probable that it will not have a peace establishment greatly in excess of its present numbers. In addition to its military functions, its presence is, in another way, proving most important in Iraq's development. The Iraq State is over 99 per cent. illiterate. The number of school teachers is very limited, and so a scheme has been

started in the army for education. The officers in charge of platoons have been made responsible for the education of their platoons, and in the last three years the percentage of literacy in the army has risen from 0·5 to nearly 10. With the development of the scientific arms it has also become necessary to start trade schools, and tradesmen are being turned out greatly superior to their brothers in the bazaar. The army as a school is, perhaps, a new conception, and only in this kingdom of topsy turvy could one find an army with such a justification.

Now, though defence is the most spectacular problem the Iraq Government has to face, the real problem is finance. The country has potential wealth in many directions, even disregarding the oilfields, but without money these potentialities cannot be investigated or developed. The people are ignorant but intelligent—without money they cannot be educated. The yearly toll of disease, due in great measure to bad conditions, is far too high, but without money this cannot be corrected. So the vicious circle exists. Without investigation and development and education and better health, there can be no prosperity and money. Without money, there can be no investigation or development or education or improvement in national health.

In the past, the financial advice has been sound, bureaucratic, unimaginative. Loans have been spoken of vaguely—and always with the idea that a British Treasury guarantee would solve the problem. Such a guarantee, though pleasant and trouble-saving and economical from Iraq's point of view, is improbable and even possibly undesirable; further, it is unnecessary. Iraq can command the necessary capital without either falling into the hands of exploiters, or adopting dangerous financial expedients. How this may be achieved is too long for discussion here, but it may be accepted that a scheme exists which has been approved by bankers as sound.

When the financial problem has been met, then the country will develop and cease to be either a drain or a nuisance to the British Government. Even further, it is easy to imagine circumstances in which a friendly and progressive state of Iraq would be of the utmost value to the British Empire. The Arab's desire for independence is a powerful factor that cannot be omitted from the calculations of statecraft to-day. He is the occupier of the doorstep of Asia, and his co-operation and friendship and true welfare are of the greatest importance.

STRENGTH OF TIMBER STRUTS.

By CAPTAIN O. L. ROBERTS, R.E.

INTRODUCTORY.

THE problem of the strength of timber struts has been very much discussed for many years, but the many varying formulæ devised give results differing by well over 100 per cent.

In October, 1928, the Forest Products Laboratory of the U.S. Department of Agriculture, Forest Service, in co-operation with the University of Wisconsin, published a formula based on both practical and theoretical results.

This formula is, to the best of the writer's knowledge, the most recent attempt to solve the problem and has certainly been produced after very full and careful consideration.

The results appear to clear up the problem to a considerable extent, while the allowable safe loads for short and intermediate struts are in excess of results obtained from most formulæ now in use.

At the same time the formula is too complicated for use in the field.

This article has, therefore, been written with the object of suggesting a simple formula for field use, which is as far as possible in agreement with the most up-to-date ideas.

The solution suggested is only intended for use when accurate calculations cannot be made or are not required. At the same time, it gives results which would appear very much more accurate and more easily obtainable than by the use of Gordon's formula and other similar formulæ.

OBJECT.

In designing struts for military purposes in the field, the two main factors to be kept in view are :—

(1) Sufficient accuracy to ensure reasonable economy combined with safety.

(2) Simplicity of calculations.

The object, then, is to devise a suitable formula, involving only simple arithmetic, which will fulfil the conditions of (1) above.

ANALYSIS OF THE PROBLEM.

Three types of struts are commonly recognized, namely, short, intermediate, and long struts.

Short Struts.

The strength of a short strut depends only on the crushing strength of the timber in the direction of its length. If the safe crushing strength of the timber is known, the strength of the strut can be readily calculated.

Long Struts.

The strength of a long strut depends only on its stiffness. In this case, where small loads produce marked lateral deflection, experimental results agree very closely with values computed from Euler's formula.

Intermediate Struts.

The strength of intermediate struts depends on a combination of stiffness and crushing strength, and is, therefore, not easy to calculate accurately. Moreover, most of the struts commonly employed in engineering practice come under this category.

Many formulæ have been devised, some empirical, others based on theory, but none of them can claim to be generally acknowledged as truly applicable in all cases. It will be seen later what a great difference there is in the results computed from these various formulæ.

Slenderness Ratio.

Struts are classified as long, short or intermediate, according to their slenderness ratio. This ratio is defined alternatively as :—

(*a*) The ratio of length to least dimension.

(*b*) The ratio of length to least radius of gyration.

The latter is the more correct for general application, but is not so simple to determine. Since the radius of gyration varies directly as the least dimension for rectangular, semi-circular and circular sections, the former is quite suitable for timber columns.

The only section likely to occur in timber, for which the radius of gyration does not vary directly with the least dimension, is a hollow rectangular section.

It is, however, considered better to keep the calculations as simple as possible. It is, therefore, proposed that throughout this article the slenderness ratio shall be considered as the ratio of the length to the least dimension.

Summary.

The problem may now be summarized as follows :—

Can one simple formula be evolved which can be applied to all timber struts ?

If not, what and how many formulæ are necessary ? And what are to be the upper and lower limits of the slenderness ratio for these formulæ ?

EXISTING FORMULÆ.

On Plate I, graphs have been drawn comparing some of the formulæ more commonly quoted. These formulæ are discussed in some detail below. In all of them the following notation applies:—

P = safe load in tons.
p = safe load in tons per sq. in.
f = safe compressive stress in tons per sq. in.
A = cross-sectional area in square inches.
l = length of column in inches.
d = least dimension in inches.
r = least radius of gyration in inches.
E = Young's modulus of elasticity in tons per sq. in.

For purposes of comparison, in the graphs, the following assumptions have been made :—

(1) f = ½-ton per sq. in.
(2) E = 220 tons per sq. in.

There is a certain amount of difficulty in comparing formulæ, some of which are based on E and others on f. As far as possible, the values chosen are such as would be in agreement for the same grade and type of timber. If the figures err in any way, the relative value of E is on the low side. This affects Euler's formula only and it thus ensures that the graph of Euler's formula does not give values of p that are too high.

In the graphs, the safe load in tons per square inch is plotted against the slenderness ratio—*i.e.*, p against $\frac{l}{d}$

F.P.L. Formula.

The formula, referred to above, published by the Forest Products Laboratory of the U.S. Department of Agriculture is :—

$$P = fA\left[1 - \tfrac{1}{3}\left(\frac{l}{Kd}\right)^4\right]$$

The notation is the same as given above, while K is a constant, depending on the modulus of elasticity and the crushing strength.

Different values of K, E and f are tabulated according to conditions of weather and usage, and further variations given according to grade and type of timber. The value of K varies from 21 to 32.

Intermediate struts are classed as those which have a slenderness ratio between $\frac{l}{d}$=11 and $\frac{l}{d}$=K.

Thus the upper limit varies according to the timber.

For short struts up to $\frac{l}{d}=11$, strength is calculated by direct crushing only.

For long struts above $\frac{l}{d}=K$, Euler's formula is employed.

The factor of safety for crushing stress is taken as 4, and for the modulus of elasticity as 3.

This method has been described in considerable detail, because it is the most recently published attempt by any official group to tackle the problem, because the method, in itself, appears sound, and because it may not be generally known.

Gordon's Formula.

$$P=\frac{fA}{1+a\left(\frac{l}{d}\right)^2}$$

"a" is a constant which varies with the nature of the strut and the fixing of the ends.

In this case "a" has been taken as $\frac{1}{140}$. This is the constant for square struts with one end fixed and one end free. It will be seen that even this gives low values of p compared to those obtained by other formulæ.

Rankine's Formula.

$$P=\frac{fA}{1+\phi\left(\frac{l}{r}\right)^2}$$

ϕ is a constant similar to "a" in Gordon's formula, and is taken as $\frac{1}{2400}$.

There are very varying opinions as to the correct value of this constant, but as far as possible an average value has been chosen.

Rankine's formula is similar to Gordon's formula, except that the slenderness ratio depends on the least radius of gyration and not on the least dimension. For square struts it gives a larger safe load than Gordon's formula does.

Euler's Formula.

$$P=\pi^2 E\left(\frac{r}{l}\right)^2 A \text{ (for rounded ends).}$$

As stated above, it is generally acknowledged that this formula gives comparatively accurate results for long struts only.

Straight Line Formula.

There are several formulæ of this type, all of which take the form :—

$$P = af + \beta\left(\frac{l}{d}\right)$$

Two such are :—

$$P = \tfrac{3}{4} fA\left[1 - \frac{1}{60}\left(\frac{l}{d}\right)\right] \quad \text{and} \quad P = fA\left[1 - \frac{1}{48}\left(\frac{l}{d}\right)\right].$$

Comparison of Formulæ.

From a consideration of the curves on Plate I, the following facts appear :—

1. Both Gordon's and Rankine's formulæ are very much on the safe side, especially for intermediate struts.
2. For short and intermediate struts the F.P.L. formula gives values very much higher than those obtained by other formulæ. The shape of the curve appears logical and seems to connect up rationally with Euler's formula and with the direct crushing line.
3. The F.P.L. and Euler formulæ combined could very easily, and with a considerable degree of accuracy, be replaced by 2 or 3 straight lines.
4. The straight line formula $p = \tfrac{3}{4} f\left(1 - \frac{1}{60}\frac{l}{d}\right)$ gives high values in some cases and low values in others.

Conclusions.

1. None of the existing formulæ is entirely satisfactory.
2. The F.P.L. formula is the best solution of the problem, but is complicated.
3. The F.P.L. formula could be replaced by straight line formulæ with reasonable accuracy. Calculations would then be simple.

POSSIBLE SOLUTIONS.

Before dealing with the various possible solutions, there are three points to be considered :—

Upper Limit of l/d.

There must be some practical limiting value of the slenderness ratio, which it has been found by experience unwise to exceed. From a study of various authorities, this limiting value seems to lie between 60 and 70.

The solutions considered should bear some relationship to this value.

Short Struts.

The U.S. Department of Agriculture consider that up to $l/d=11$, there is no buckling effect. And, for example, it is quite clear that a 12" x 12" strut, 4' long, would have very little tendency to buckle.

But, if the strut were not initially quite straight, there would be some buckling effect at values of l/d less than 11. And in the field it often happens that struts which are not quite straight will have to be used.

Care should therefore be taken that too high a value of l/d should not be chosen as the limit below which only direct crushing need be considered.

Factor of Safety.

The U.S. Department of Agriculture, when dealing with the strength of struts, have to design struts for permanent or semi-permanent use. In the field it is usually only temporary structures that have to be considered. On the other hand, in civil practice, struts can usually be chosen which are initially straight, whereas in the field this will not always be possible. These two considerations balance each other to some extent.

Therefore the solution to be considered should give values in no case greater than the F.P.L. formula.

Keeping these factors in view, the following solutions appear possible :—

I.—Three straight lines.

$l/d=$ 0 to 9	$p=f.$
$l/d=$ 9 to 35	$p=\frac{5}{4}f\left[1-\frac{1}{44}\left(\frac{l}{d}\right)\right].$
$l/d=35$ to 70	$p=\frac{1}{2}f\left[1-\frac{1}{70}\left(\frac{l}{d}\right)\right].$

This solution gives relatively accurate results, but is rather complicated.

II.—One straight line and Euler.

Up to $l/d=30$	$p=f\left[1-\frac{1}{50}\left(\frac{l}{d}\right)\right].$
Above $l/d=30$	Euler's formula.

This solution is also relatively accurate, but for struts with a value of l/d exceeding 30, calculations would be complicated. Nor does it bear any relationship to the upper limit to the value of l/d.

III.—Two straight lines.

(a)	$l/d=$ 0 to 36	$p=f\left[1-\frac{1}{48}\left(\frac{l}{d}\right)\right].$
	$l/d=36$ to 66	$p=\frac{11}{20}f\left[1-\frac{1}{66}\left(\frac{l}{d}\right)\right].$

or (b) $l/d =$ 0 to 36 $\quad p = f\left[1 - \frac{1}{48}\left(\frac{l}{d}\right)\right]$.

$l/d = 36$ to 60 $\quad p = \frac{3}{5} f\left[1 - \frac{1}{60}\left(\frac{l}{d}\right)\right]$.

Both these alternatives are simpler than *I* or *II*, but not so accurate. Any inaccuracy, however, errs on the side of safety. Alternative (b) is slightly simpler than (a) and errs again on the side of safety for long struts.

IV.—One straight line.

$l/d =$ 0 to 50 $\quad p = f\left[1 - \frac{1}{50}\left(\frac{l}{d}\right)\right]$.

This formula gives very good results up to $l/d = 40$, but above that errs very much on the side of safety. It only allows for the use of struts of $l/d = 50$ or less.

Summary.

Before deciding on the best solution, it is proposed to summarize these considerations.

1. Calculations should be kept simple. This can be done by using straight line formulæ.
2. Suitable straight line formulæ can be found.
3. The use of 3 straight lines is unnecessarily complicated.
4. The use of 1 straight line does not give sufficient accuracy.

For the sake of clearness, the above 4 possible solutions and the F.P.L. solution only have been shown on Plate 2.

Many variations of these straight line solutions can be made, but they cannot vary greatly from one or other of the solutions suggested.

PROPOSALS.

It is, therefore, proposed that 2 straight line formulæ should be used, and that they should be the simpler and safer of the two alternatives suggested in solution *II*, that is to say:—

From $l/d =$ 0 to $l/d = 36$ $\quad p = f\left[1 - \frac{1}{48}\left(\frac{l}{d}\right)\right]$.

From $l/d = 36$ to $l/d = 60$ $\quad p = \frac{3}{5} f\left[1 - \frac{1}{60}\left(\frac{l}{d}\right)\right]$

Struts with slenderness ratios greater than 60 should not be used.

It is admitted that these solutions are purely empirical, and that a sudden change of slope occurs for which there is no justification.

But in favour of these proposals, it is contended that :—

1. They are simple to calculate.
2. The figures obtained from these equations agree fairly well with generally accepted safe loading, and are well inside the figures obtained by the Forest Products Laboratory formula.
3. There is a reasonable degree of accuracy, without sacrificing safety. Hence there is economy of material.

Circular Struts.

It is generally agreed, as a result of both experiment and theory, that a circular strut is not as strong as a square strut of the same least dimension.

Theoretically.

The crushing strength of a strut is directly proportional to its sectional area. Therefore a circular strut is $\frac{\pi a^2}{4}/a^2$ or $\frac{\pi}{4}$ times as strong as a square strut of the same least dimension with regard to crushing only.

The stiffness of a strut is usually taken as being directly proportional to its radius of gyration. The radius of gyration of a circular strut is $\frac{1}{4}$ of its least dimension, and that of a square strut is $\frac{1}{\sqrt{12}}$ times its least dimension. Therefore a circular strut is $\frac{\sqrt{12}}{4}$ $= \frac{\sqrt{3}}{2}$ times as strong as a square strut of the same least dimension, with regard to stiffness only.

Practically.

The Forest Products Laboratory, U.S.A., consider that a circular strut of diameter "d" may be taken as equivalent to a square strut with sides $7/8d$. "d" is measured at a distance of one-third the length from the tip. If the mean diameter were considered, the square would have sides equal to about $6/7d$. Considering the constants for Gordon's formula, a circular strut of mean diameter "d" is considered equivalent to a square strut with sides $6/7d$.

Other considerations.

Generally, and especially in the field, circular struts are more likely to be bent than square struts. The tendency should, therefore, be towards a larger factor of safety.

In any case, the diameter at the tip of the circular strut must be such that the cross-sectional area will be sufficient to withstand crushing. For short struts this will be the deciding factor as to their strength.

If this is always ensured, there is no need to consider crushing further, in deciding the relative sections of circular and square struts of the same strength.

The F.P.L. suggestion is for civil use, and under such conditions it is assumed that the struts will be initially straight or nearly so.

Gordon's formula gives such very safe values for square struts, that the allowance for circular struts may not be sufficient if applied to other formulæ.

Summary of Considerations.

1. The area at the tip of a circular strut must be sufficient to withstand crushing.
2. Apart from this, in considering relative values, only stiffness need be considered.
3. For different reasons, both Gordon's formula and the F.P.L. recommendation are not sufficiently on the safe side for field use.
4. The tendency should be to increase the factor of safety for field use.
5. Summarized the results are :—

Theory—crushing strength	$\pi/4$	=	$0{\cdot}785d$.
Theory—buckling strength	$\sqrt{3}/2$	=	$0{\cdot}866d$.
F.P.L. and Gordon's formula	$6/7d$	=	$0{\cdot}857d$.

Conclusion.

From a study of these considerations, it is thought that the allowance should give a result safer than either the theoretical relative buckling strength or the F.P.L. recommendations.

It is, therefore, suggested that a circular strut of mean diameter "d" should be considered as equivalent to a square strut with sides $5/6d$. The sectional area at the tip must also be sufficient to withstand crushing.

When the circular strut is not reasonably straight, the allowance should be reduced to 4/5 or even 3/4. But in such cases it would be better, if time were available, to consider each strut on its merits as eccentrically loaded. Calculation of the strength of a strut initially bent is comparatively easy.

In measuring the mean diameter, care should be taken to obtain the approximately true mean diameter. Spars are very often wider at the butt for a distance of 2 or 3 feet, before assuming the true taper of the tree.

Illustration.

To illustrate the effect of this suggestion, the following figures are given, using the same value in each case for the safe compressive stress :—

According to Gordon's formula,
safe load on a 20′ – 12″ x 12″ baulk =18·7 tons
,, ,, ,, 20′ – 14″ mean dia. spar =18·7 tons
According to proposed figures,
safe load on a 20′ – 12″ x 12″ baulk =42 tons
,, ,, ,, 20′ – 14″ mean dia. spar =38·8 tons

Rectangular Struts.

The buckling strength of a rectangular strut will be the same as that of a square strut of the same least dimension.

Its crushing strength, however, will be greater.

The proposed straight line formulæ do not allow for any struts being subjected to crushing only.

It is suggested that no extra allowance should be made for rectangular struts, relative to square struts of the same least dimension.

Fixed Ends.

In the figures so far given, struts with " ends rounded " only have been considered.

In several of the formulæ at present in use a strut with " fixed ends " is considered to be able to support an increased load.

This is only true when applied to failure by buckling, as the fixing of the ends cannot, obviously, increase the strength to resist direct crushing.

Under military conditions, occasions will seldom arise when it will be safe to consider either end as completely fixed, and partial fixing has very little effect on the stiffness of the strut.

Gordon's formula makes an allowance for either one or both ends being fixed, but it is considered that these allowances are only justified because in any case the allowable loads err very greatly on the side of safety.

It is, therefore, proposed that, for all general purposes in the field, all struts should be considered as having " ends rounded."

Illustration of Results.

The following figures are given comparing Gordon's formula, the F.P.L. formula and the straight line formulæ now proposed.

It will be seen that the proposed safe allowable loads, though greatly in advance of those obtained by Gordon's formula, are still considerably less than those obtained from the F.P.L. formula.

Results of Euler's formula have not been given as these are embodied in the Forest Products Laboratory method, Euler's formula itself being used for long struts.

The following struts have been considered :—

12″ x 12″ square struts —20′ and 40′ long.
14″ mean dia. circular struts —20′ and 40′ long.

The allowable stress for Gordon's formula and the proposed straight line formulæ has been taken as ½-ton per sq. in. In the case of the Forest Products Laboratory method, 820 lb. per sq. in. only has been taken, since this is the figure given in their table for unselected Douglas fir (dense) and unselected southern yellow pine (dense). This figure is low for temporary structures.

These results are as follows (in tons) :—

12" x 12" square struts.	20'	40'
Gordon's formula, ends rounded	9·7	2·7
" " one end fixed	18·7	5·8
" " both ends fixed	27·2	9·7
Proposed straight line formulæ	42·0	14·4
F.P.L. formula	48·4	17·6
14" mean diameter round struts.	20'	40'
Gordon's formula, ends rounded	10·9	3·0
" " one end fixed	20·8	6·5
" " both ends fixed	30·6	10·8
Proposed straight line formulæ	38·8	12·8
F.P.L. formula	51·0	19·2

SUMMARY.

It is suggested that the following method of ascertaining the strength of timber struts should be employed in the field :—

Square Struts.

For values of l/d from 0 to 36,

$$p = \frac{P}{A} f = \left[1 - \frac{1}{48} \left(\frac{l}{d} \right) \right].$$

For values of l/d from 36 to 60,

$$p = \frac{P}{A} = \tfrac{3}{5} f \left[1 - \frac{1}{60} \left(\frac{l}{d} \right) \right].$$

Above $l/d = 60$, struts should not be used.

No allowance in addition to be made for rectangular struts or fixing of ends.

Circular Struts.

To be considered as square struts of least dimension equal to five-sixths of the mean diameter of the circular strut.

ECCENTRIC LOADING.

In this article, no attempt has been made to discuss the problem of eccentric loading. It is hoped to be able to deal with this in a later article, and more especially with its application to derricks.

NOTE.—Any suggestions, addressed to F.W. & B. School, S.M.E., Chatham, would be welcomed.

Plate 1.

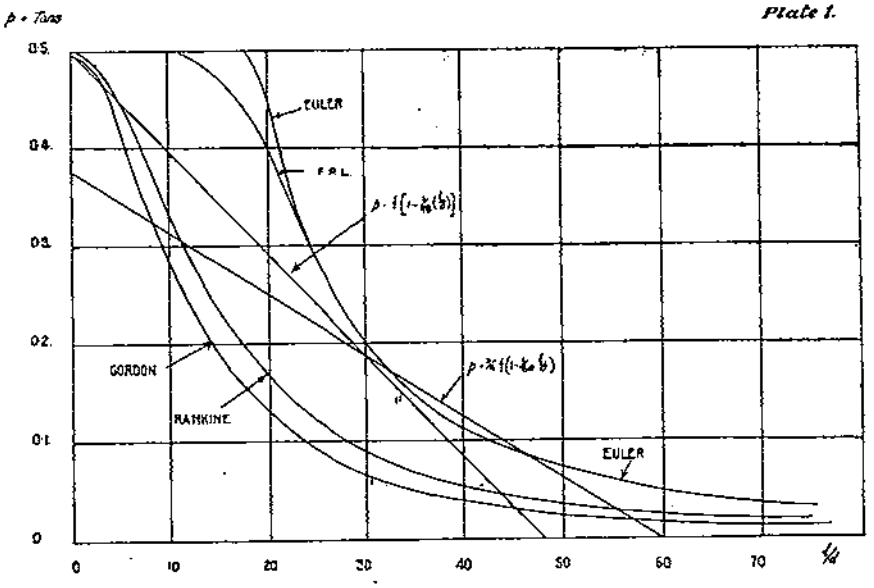
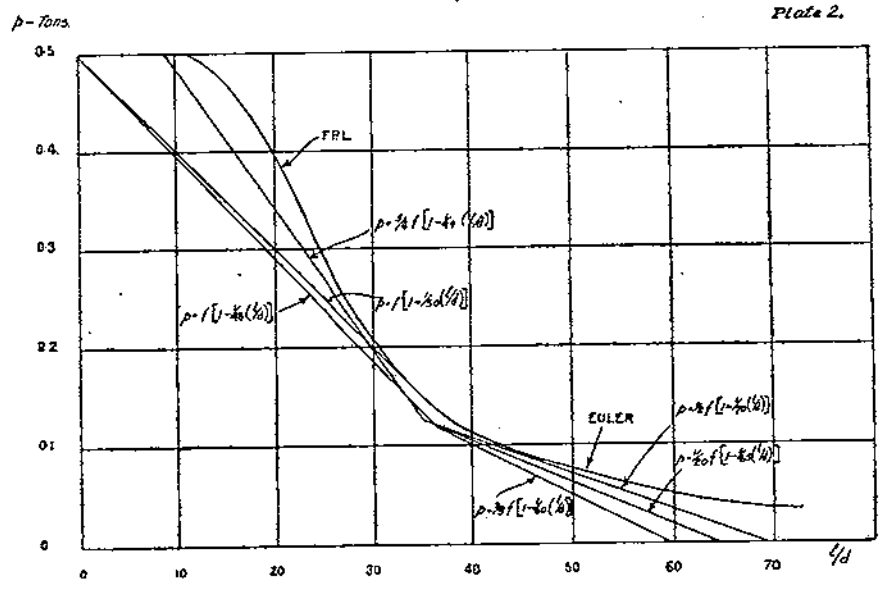


Plate 2.



THE OBERHASLI HYDRO-ELECTRIC SCHEME.

By BT. MAJOR G. MACLEOD ROSS, M.C., M.ENG., A.M.INST.C.E., R.E.

A RECENT visit to Switzerland, and the courtesy of the Kraftwerke Oberhasli A.G., enabled me to look over a hydro-electric scheme, which utilizes the source of the River Aar to obtain a quarter of a million horse-power.

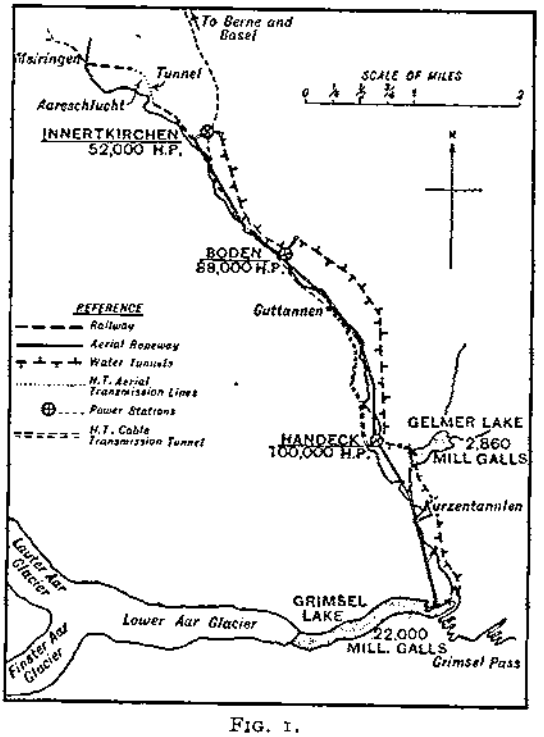


FIG. 1.

The Aar rises in several glaciers which lie below the Finsteraarhorn (14,926 feet) and the Shreckhorn (13,386 feet) and flows down the Haslithal to Lakes Brienz and Thun and thence to Berne. (Fig. 1.) For many years the potentialities of the source of this river have been recognized, and as a result of measurements taken over a period of ten years, ending in 1923, the run-off from the Unteraar glacier measured at Grimsel (6,200 feet) was found to be 52,800 million gallons annually, or sufficient to supply the City of London for 200 days. The difference in level between Grimsel and Lake Brienz is approximately 4,000 feet static, in a distance of 15 miles.

A committee of experts was appointed to discover the best means of utilizing these natural resources, and it was eventually decided that the main reservoir should be formed at the Grimsel, near the Pass, and that it should connect directly with an auxiliary reservoir, to be formed on the site of a natural lake at Gelmer, 3¼ miles away, and 200 feet lower. This second lake is fed from a catchment area, producing 18,700 million gallons annually. Finally, the water so conserved was to be brought down and passed through three successive power stations, Handeck, Boden and Innertkirchen, at levels of 4,280 feet, 2,900 feet and 2,092 feet respectively. It was estimated that these stations would produce 538 million K.W.H. per annum.

The Company interested in the promotion of this scheme is the Forces Motrices Bernoises S.A., which is a public utility company supplying Berne and Basel, and as soon as the company found the demand for power increasing, it decided to implement the works necessary for the fulfilment of the expert committee's plans, and placed a contract with the Bernischen Kraftwerke A.G., which formed the Kraftwerke Oberhasli A.G. to handle the job with a working capital of £1·2 millions.

It was decided to develop the scheme in two portions, the former to comprise the reservoirs at Grimsel and Gelmer, and the Handeck Power Station, whilst the two remaining power stations at Boden and Innertkirchen were left for later development.

The first portion of the scheme will produce 223 million K.W.H. per annum and will cost £3·3 millions, the net cost of current being estimated to amount to 0·352 pence per K.W.H., whilst on completion of the whole scheme it is hoped to reduce this figure to 0·238 pence per K.W.H.

Although the nature of the two schemes is entirely different, it may be worth while to mention that the Shannon Scheme (partial development) is estimated to cost £8 millions, and to produce 147½ million K.W.H. per annum at 1·13 pence per K.W.H. net.

Preparatory Work.

The nearest railhead to the Grimsel was Meiringen, 15½ miles away, and one of the first undertakings was the three-mile extension of this metre-gauge line, through the Aareschlucht to Innertkirchen, involving a mile of tunnelling. At Innertkirchen has been established the main receiving depot for all stores, and here, too, are housed the store and accounting staff.

From Innertkirchen to Grimsel there is a good mountain motor road, but it carries a very large volume of pleasure traffic in the months of the year, May–October, during which the Grimsel Pass is open, and the road would not have supported the added burden

of the continuous stream of cement necessary for the constructional work. It therefore became necessary to erect an aerial ropeway over this stretch, and also from Kurzentannlen to Gelmer. (Fig. 1.)

From Guttannen the valley is narrow and rugged and the ropeway trestles have been placed on the spurs in order to avoid land and snowslides, which are the order of the day at altitudes above 4,500 feet. This ropeway is similar in design to the lately dismantled Khyber Ropeway, and has a capacity of 200 tons per 24 hours, the 12½-mile trip taking 2 hours.

Other preparatory work, in addition to barracks for the labour at all the locations concerned, comprised a funicular railway from Handeck to Gelmer, rising 1,700 feet straight up the face of the cliff, and capable of hauling 4½ tons at a time up a grade which reaches 100 per cent. maximum.

At both Gelmer and Grimsel, much contractor's railway had to be laid; at the latter location, 3½ miles were required (Fig. 5) to enable aggregate to be hauled from the foot of the Unteraarglacier to the headworks. At both these places, buildings and machinery were installed to crush aggregate and mix concrete, and at the Grimsel site an extensive system of cableways was erected to handle the concrete on to the two dams.

This preparatory work occupied three years (1924 to 1926) but in considering this it should be remembered that the working time available was actually half this figure, and that the precipitous nature of the terrain and the severe climatic conditions made the work exceptionally difficult and slow. Completion of the first part of the undertaking is anticipated in 1931.

THE GRIMSEL HEADWORKS.

As can be seen from Fig. 2, the outfall of the River Aar is to be blocked at two points near the old Hospice. All around is bare, homogeneous granite, and although the consulting geologist was satisfied that the rock was free from faults, a trial bore was driven at the site of the larger of the two dams, in the Spitallamm gorge, as a result of which his predictions were confirmed.

The necessity for a first-rate geological opinion, supported by trial bores on the dam site, was exemplified a couple of years ago by the failure of the St. Francis Dam in California, where investigation after the disastrous failure proved the site selected to be geologically unsafe.

The main dam is of the arch type and will be an immense mass of 444,720 cubic yards of reinforced concrete, to be known as the Spitallamm Dam. It will rise 377 feet above the bed of the Aar, at which height the gorge is 590 feet wide. The base, which is keyed into the solid granite, is 223 feet thick, tapering at the top

to 13 feet, the upstream face sloping at 10 to 1, and the downstream face at 2 to 1.

In August, 1929, this dam was about 50 per cent. complete, and Fig. 3 deserves detailed study. On the left can be seen the keyways hacked out of the granite with compressed air and gelignite, whilst up this face runs a wooden ladder which is a good guide to the scale of the illustration. On the dam itself can be seen the shuttering to contain the concrete, whilst above are visible the means whereby the concrete is placed. These consist of a steel chute, suspended

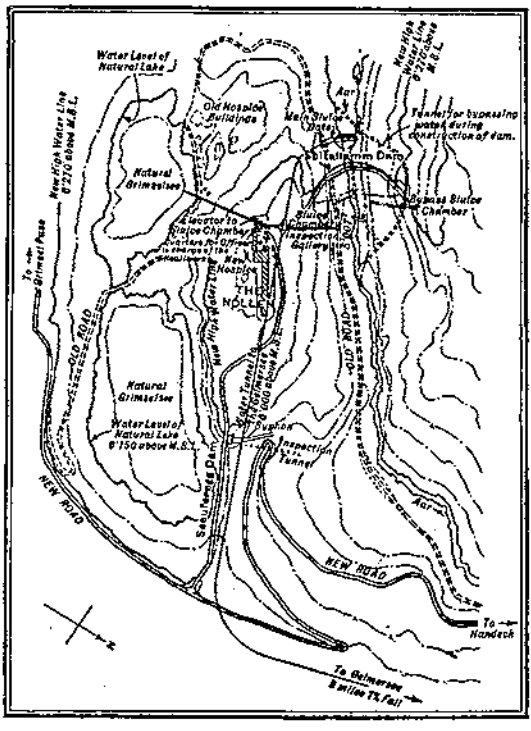


FIG. 2.

from a cable, which delivers from three points along its length through "elephant trunks" to hoppers. In addition, there are six skips of four cubic yard capacity, travelling on cables, to required points on the working floor of the dam. The vertical expansion joints in the dam can be clearly seen, whilst at the bottom at bed level is the emergency sluice for relieving any flood water.

On the Nollen, shown on Fig. 4, is constructed a steel frame and wood-panelled building. The north-east end of this building is the terminal of the aerial ropeway from Innertkirchen, and carries cement which is dumped into two huge silos. The opposite end of the top floor of this building contains the crushing and grading plant for aggregate elevated from the railway terminal shed.

The aggregate having been crushed and graded falls into three wooden bins on the next floor, whence it is measured out in the desired quantities with cement on to an extensive system of belt conveyors which feed into batteries of concrete mixers, situated on a still lower floor of the building. The mixers feed direct into the chute and cable skips mentioned above, and a continuous flow of concrete is hereby assured on to the dam, amounting to some 3,720 cubic yards per 24 hours. This figure will be more readily gauged when it is said that it is equivalent in volume to the Lecture Theatre of the S.M.E. Main Building, Chatham.

Enormous as this figure undoubtedly is, the possibilities of placing concrete can best be gauged from a comparison with the rate obtained on the Diabolo Dam in Washington State, which is of similar design but of somewhat greater size. Here, a belt-conveyor delivery system from mixer to job has been tried out, and it is possible to place no less than 30,850 cubic yards of concrete per day.

The second, and subsidiary dam, is the Seeuferegg, shown in Fig. 4, and is of gravity section, 1,000 feet long, and containing 75,864 cubic yards of reinforced concrete. This dam is complete and will carry the roadway up to the new Hospice on the top of the Nollen, seen in Fig. 4.

By means of these two dams a reservoir will be formed, 3½ miles long, and about half a mile wide, with a high-water level at 6,271 feet above mean sea level, a capacity of 22,000 million gallons or 8,100 acre feet, and having an average depth of 270 feet.

During construction, the water from the glacier is by-passed round the Spitallamm Dam, but in October, 1929, before work ceased for the year, it was decided to impound water up to the finished level of this dam, so that the generation of current at Handeck might commence.

THE GELMER RESERVOIR.

From the Grimsel, a tunnel, 6½ feet diameter, has been driven 3¼ miles through the rock at a level of 6,002 feet above M.S.L. to the Gelmer Lake, which has been formed by damming the western edge of a natural lake fed from a rich catchment area to the north and east.

All work here is completed and the dam is 1,250 feet long, contains 102,000 cubic yards of concrete and impounds water up to a level of 6,074 feet above M.S.L. (Fig. 5), the capacity of the lake being 1,050 acre feet. The illustration shows the steel staging erected to carry the travelling gantry; this will shortly be dismantled.

Theoretically, it would have been preferable that the levels of the reservoirs at Grimsel and Gelmer should be the same, but it was estimated that the cost of raising the high-water level at Gelmer the 200 feet between the levels 6,074 feet and 6,271 feet would be double

the cost of obtaining the higher level at the Grimsel site. This provides an interesting comparison between the development costs of the two sites—the Grimsel having a narrow bottleneck with nearly vertical sides, and consequently almost ideal from the hydro-electric point of view; the Gelmer being a widely-splayed gap, the cost of blocking which increased rapidly for every additional foot rise in height.

The Handeck Power Station.

The working head available at Handeck is 1,796 feet static maximum, and 1,690 feet minimum, depending on the level of Gelmer Lake. The water from Gelmer is led to Handeck through a steel pipe having a maximum gradient of 72 per cent., set in a shaft hewn out of the granite, and nowhere less than 100 feet from the surface. It is thus protected from low temperatures and avalanche.

The Power Station, seen on the left of Fig. 6, will house four Pelton-wheel turbines, each of 30,000 horse-power, set on vertical axles on which are directly mounted the Oerlikon 25,000 K.V.A. alternators. The current is three-phase, 50 cycles periodicity, and the generation voltage is 11,000.

Opposite each alternator is a Brown Boveri transformer, having a ratio of 11,000/50,000. The transformers are of the oil-immersed, water-cooled type, and can be run out of position for inspection on a special motor-driven bogie, it being only necessary to break two connections.

In August, 1929, two power units had been completed, together with all necessary switch gear, and only awaited the impounding of the water at Grimsel to commence generation. The remaining units are well in hand.

The largest single piece of machinery to be transported by motor-lorry and trailer up the hill road to Handeck consisted of a portion of the rotor which weighed 22 tons.

The power house is a steel frame, granite-panelled, and the generator hall is served by a 90-ton travelling crane. The main doors of the building are pressed steel, and slide vertically on counter-weights.

On the right of Fig. 6 can be seen the staff quarters which are connected to the power house by a tunnel for use in the winter.

The switchboard is of the most modern design, and includes, in addition to the electrical instruments, a recording gauge, showing the water level at Gelmer; controls for the sluices at Grimsel and Gelmer, and master temperature gauges, operated by press-buttons, on which can be ascertained the temperatures of the main bearings of the generator sets, and of certain points in the ventilating and heating ducts.

The ventilating and heating system is of considerable importance

in a station subject to such low temperatures, and it has combined with it a fire-extinguishing system, by means of which any alternator can be isolated in case of overheating or fire, and carbon dioxide may be pumped in under pressure.

In the turbine wells, a very interesting feature is the portion of cast steel reinforced pipe which connects to the four turbines. The thrust at the end of this pipe is taken by an immense monolith of concrete, and forms a most impressive bit of work.

The estimated draw-off of water from Gelmer on normal load is 235 cusecs, rising to 425 cusecs maximum, but since the plant installed can utilize 616 cusecs, one of the four units can be regarded as in reserve. The water impinging on to the paddles of the turbines is controlled both as to direction and quantity, the latter control being by means of a needle valve. Safety devices are included whereby, in case of accident to a unit, the water can be by-passed automatically direct to the tail race. From the tail race the water passes to a compensating reservoir before entering the tunnel, which leads to a point above the Boden Station.

INNERTKIRCHEN TRANSFORMER STATION.

Current from Handeck is conducted over the first three miles of the distance to Innertkirchen by means of buried cables, set in the floor of a tunnel, which is large enough to contain a narrow-gauge line and a battery-driven train, which hauls stores and staff between Handeck and Guttannen. The need for this precaution arose owing to the fact that this section of the Haslithal is subject to very bad avalanches in the winter, which would have jeopardized the continuity of an aerial transmission line in this section.

From Guttannen four sets of conductors, set on pairs of pylons, carry the current from each of the four power units, through Boden, to the open air transformer station at Innertkirchen. The four lines come in on the left of the station, next comes the bank of four Brown Boveri transformers, having a capacity of 26,000 K.V.A. and a transformation ratio of 50,000/150,000—only two transformers have been erected so far. The first switch on the line from Handeck comes next, after which the four lines are paralleled, and a double transmission line goes off to Berne and Basel, respectively 40 and 90 miles distant, over the Brunig Pass (3,317 feet above M.S.L.).

SECOND PHASE OF THE SCHEME.

In August, 1929, the Power House at Innertkirchen, which is again a steel frame with granite panels, and is covered by a 120-ton travelling crane, was complete and awaited the generating plant,

THE OBERHASLI HYDRO-ELECTRIC SCHEME.

Fig. 3.—The Spitallam Dam.

Spitallam Dam

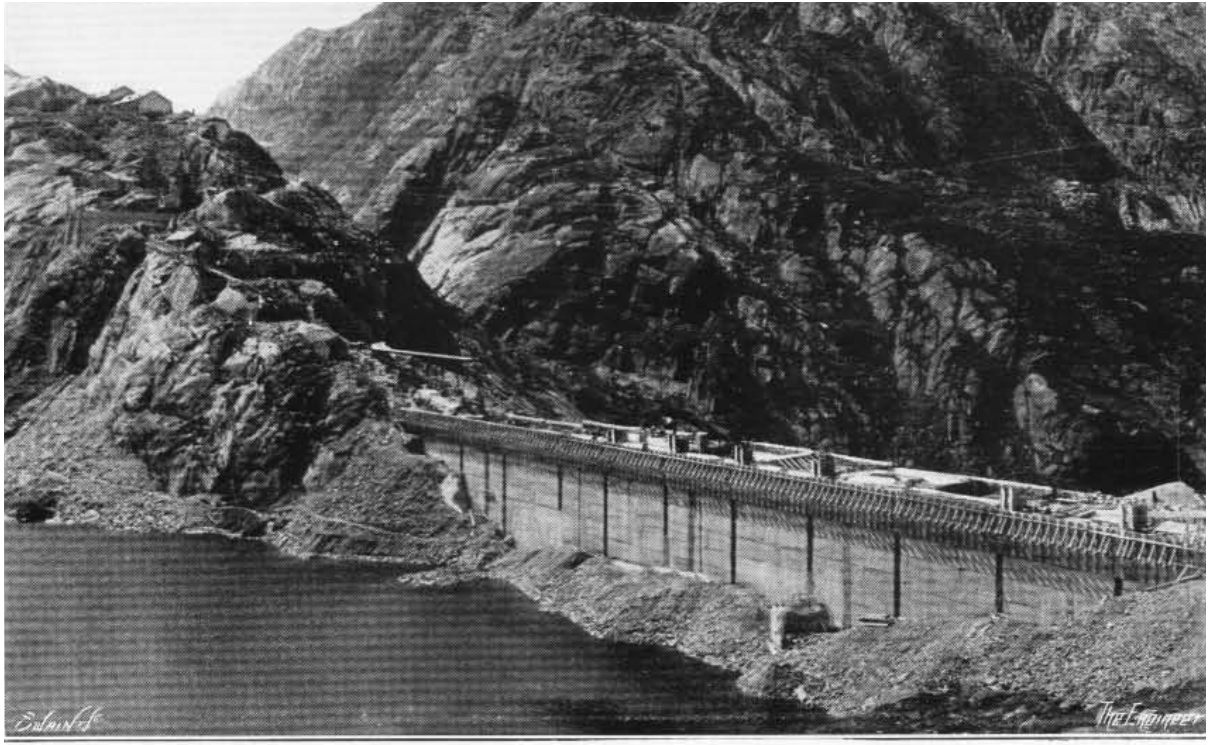


Fig. 4.—The Seeuferegg Dam.

Seeuferegg Dam

Fig. 5.—The Gelmer Dam and Lake.

Gelmer Dam

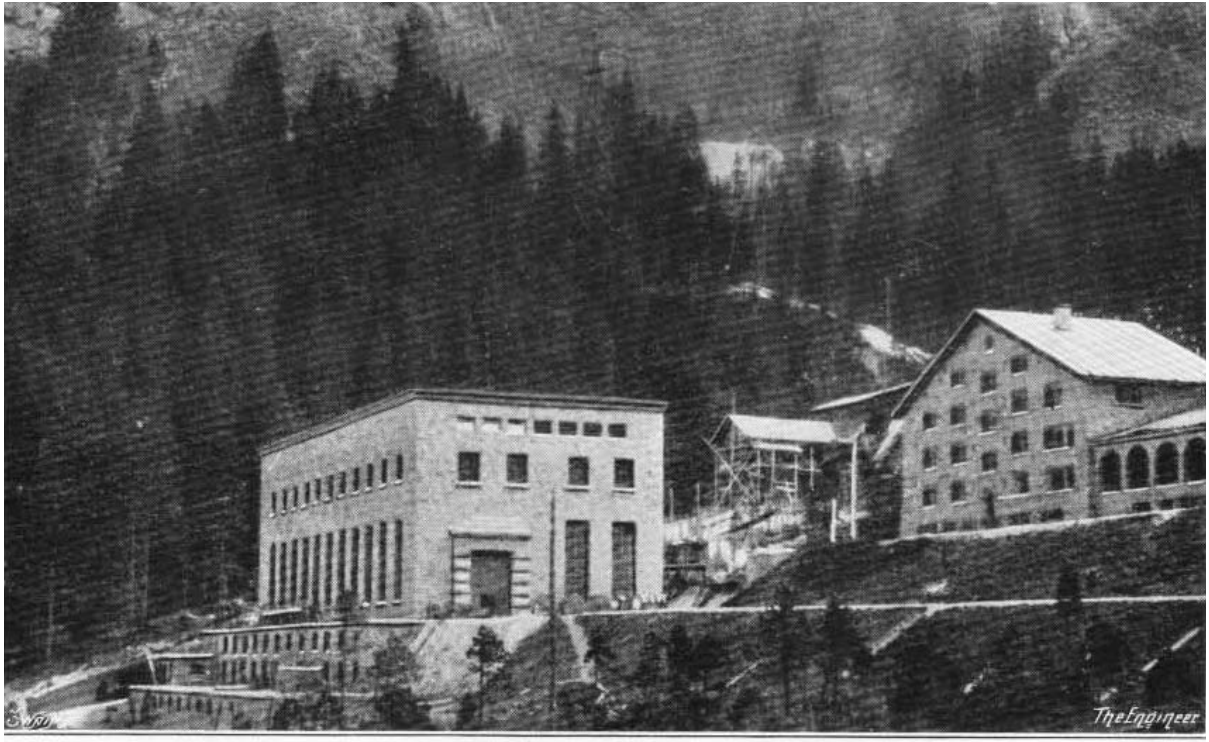


Fig. 6.—The Power Station at Handeck.

Power station at Handeck

which is to consist of four 13,000 K.V.A. alternators, working under a static head of 815 feet, and having an annual output of 125 million K.W.H. (see Fig. 7).

The water is to be led down to the turbines from the compensating tank at Boden, through a 10-foot diameter tunnel, 2·8 miles long, driven through the rock side of the valley, with a gradient of 2·2 per cent., to the pressure shaft, which will be 1,875 feet long.

At Boden, where the third power station will be sited, four 22,000 K.V.A. generators are to be installed, working under a static head

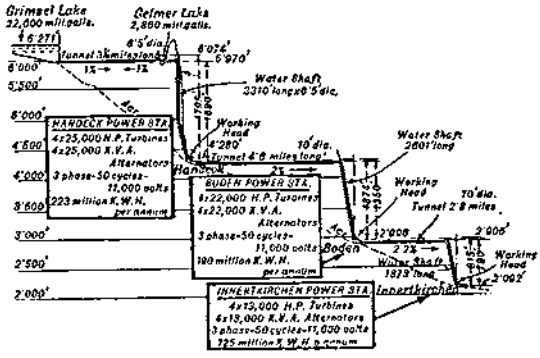


FIG. 7.

of 1,374 feet maximum, and producing 190 million K.W.H. per annum. Both this station and that at Innertkirchen will generate at 11,000 volts, and this pressure will be stepped up to 50,000 before transmission to the central transformer station at Innertkirchen. The Boden Station will be fed from Handeck, through 4·6 miles of 10-foot diameter tunnel, with a 2 per cent. grade to Boden, the pressure shaft being 2,600 feet long.

No date is available for the completion of the whole scheme, and it is probable that progress will depend on the demand for power in the industrial areas to be served.

Acknowledgments are due to Sir William Lister, K.C.M.G., for permission to reproduce Figs. 4 and 5.

MEMOIRS.

COLONEL SIR THOMAS HUNGERFORD HOLDICH, K.C.M.G., K.C.I.E., C.B.

(Reprinted by permission from "The Geographical Journal," March, 1930.)

"THE death of Sir Thomas Holdich at the age of eighty-six has removed one who, at the beginning of the century, had a greater experience and a more profound knowledge of the geography and inhabitants of the North-West Frontier of India than any other living man. That knowledge and experience were founded on personal contact with almost every tribe and race that inhabit Afghanistan, Baluchistan, Turkistan, and Persia, during twenty years of service, crowded with incident military and political, on the borderland of India. When he left India he was the supreme authority on all matters connected with frontier delimitation and demarcation.

Sir Thomas was born at Dingley, Northamptonshire, on 13th February, 1843, the son of the Rev. Thomas Peach Holdich, and was educated at Godolphin Grammar School. Passing high out of the Royal Military Academy at Woolwich, he was commissioned in the Corps of Royal Engineers on 17th December, 1862, and after completing his instructional courses at the School of Military Engineering at Chatham, he came out to India early in 1865. His choice of career in India had probably been made before sailing for the East, for in less than a year he received a temporary appointment in the Survey of India, and accompanied the Bhutan Field Force as assistant surveyor in the cold weather of 1865–66. At the close of that expedition he was made permanent in the Department, and remained in it until his retirement in 1898, at the age of fifty-five.

Holdich was soon on active service again. After little more than a year in Rajputana he was selected as one of the survey officers for the Abyssinian campaign in December, 1867. Eighteen months later he returned to India and joined a survey party in Central India. It was here, I believe, that he had the narrow escape in company with Edward Leach out tiger shooting, the story of which he used to tell right up to his death as one of the most exciting moments of his long career. But this was an incident that did not compensate one

Colonel Sir Thomas Hungerford Holdich, K.C.M.G., K.C.I.E., C.B.

Photograph by Elliott & Fry, 55 Baker Street, W.1.

whose yearning was already for a life of active service on the frontier, and soon after he was given charge of the Vizagapatam Survey in 1877, he took furlough to England, after having been continuously abroad, it appears, for twelve years. From this furlough he was recalled to join the Southern Afghanistan Field Force in December, 1878, thus beginning his long unbroken connection with the frontiers of India, which lasted for twenty years.

When Holdich first set foot in Quetta, in the early days of Robert Sandeman, very little was known of Baluchistan, beyond parts of Kalat and the Pishin plain; even the present line of the railway was unexplored, and, to quote his own words, "only a thin line of information was marked on the maps linking up Jacobabad with Quetta and Kandahar." The Afghan War changed all this, and in many ways changed also the policy of the Army towards geographical and topographical exploration. This change in policy was due mainly to two men, Sir Donald Stewart and Michael Biddulph, the two generals who commanded the South Afghanistan Field Force. For the first time, apparently, trained staffs of sapper surveyors, both triangulators and topographers, with Indian assistants, accompanied the advanced forces in the field to carry out scientific survey, as distinct from rapid military sketches. An accurate system of triangulation was carried up to Kandahar by Maxwell-Campbell, Heaviside, and Rogers, and when that place was taken in January, 1879, Holdich, who had been in charge of the topography, following close on the heels of the triangulators, employed his men in detailed surveys towards the Helmand, Girishk, and Kalat-i-Ghilzai.

On the conclusion of peace in the spring Holdich accompanied the Thal-Chotiali Field Force, which returned to India by the previously unexplored Khojak route. The peace was, however, of very short duration. The fate of Cavagnari's mission at Kabul restarted the war in the autumn, and Holdich was ordered to join the force operating on the Khyber line. The survey officers who had been in the Kurram during the first phase of the war were almost all out of action, Samuells and Charles Strahan were down with typhoid; Edward Leach (who had won the V.C.), Tanner, and Woodthorpe had all been wounded; only Scott, who first surveyed the middle course of the Kabul river, was whole. Woodthorpe, however, was able to join the Kurram column under General Roberts, while Holdich, with Bright's force, carried his triangulation along the Khyber. The junction of the two surveys was made on the hill overlooking Bala Hissar. Surveys and rapid reconnaissances were now carried out in all directions from Kabul, until they were interrupted by the siege of Sherpur, in the defence of which Holdich and his surveyors took an active part. Subsequently he accompanied Roberts on his memorable march to Kandahar, but, as might be expected, the pace was too hot for much survey work. For his

services during the two Afghan campaigns, Holdich was mentioned in dispatches and promoted brevet-major.

Early in 1881 the Wazirs raided Tank, and a force was called into being at Dera Ismail Khan to punish the offenders. It was divided into two columns, to the northern of which, under General John Gordon, Holdich was attached as surveyor and triangulator. While Gerald Martin, with the column under General Kennedy, ascended Pre-Ghal, the highest mountain in Waziristan, and triangulated to the south, Holdich, with an escort from the northern column, was the first white man to ascend Shuidar, the second highest, whence a fine view was obtained as far as the Safed Koh to the north, dividing the Khyber from the Kurram. It is of interest in these days, when Shuidar and Razmak are so easily accessible, to remember that Holdich accompanied the first British force to reach both places.

The results of this little and almost forgotten campaign—so forgotten that it was asserted in 1927 that neither Pre-Ghal nor Shuidar had been climbed—were most important from a survey point of view, and Holdich was quick to seize the opportunity. The policy of sending explorers into forbidden country was revived. Surveyors, both British and Indian, were trained by Holdich as explorers, and, often without the knowledge of our own political officers, were encouraged to cross the border. Their rapid and surreptitious reconnaissances—in these days we rather look on them as " tip-and-run " surveys—based on the points fixed by Martin and Holdich, afterwards proved most valuable. Unfortunately, no history has ever been written of the exploits of these men, and but for scattered references to such as McNair, Abdul Subhan, the Bozdar, and a few others, it is almost impossible to ascertain details.

We find Holdich next in charge of the Kohat survey, but not for long. In 1883 he was placed in charge of the Baluchistan Survey Party, and he was officially, according to the Survey of India records, in command of this party until his retirement.

In the very year he took over charge, an opportunity came for another useful extension of frontier survey and geographical knowledge. The Shiranis had been blockaded for some two years without any effect, and it was decided to send a small " survey promenade " into their country, more with the object of showing them that they were not beyond the reach of punishment than for any other reason. It is, I think, admissible to assume, though there is no official record of the fact, that it was Holdich himself, with his burning desire to turn every faint opportunity of gathering knowledge to full advantage, who proposed and argued this little expedition into being. Only the Khiddarzai clan were recalcitrant: and they lived in the neighbourhood of the Takht-i-Sulaiman. The Takht is a high hill, commanding a fine view to the west and south; the way to it leads through the Dabarrah defile. The combination of circumstances led

the Khiddarzai to shout defiance, and Holdich to accept the challenge. The actual capture of the enemy's position on the Takht-i-Sulaiman was due to Holdich, who, while out with a plane-table, discovered an unguarded but difficult route by which an ascent could be made to the summit. Guided by Holdich in the night, the position was turned and captured without a single casualty.

The highest point of the range was climbed and rapid triangulation executed from it and a neighbouring peak. Forty thousand square miles of new country were within view, and points scattered over this area were fixed by which the " tip-and-run " process could be continued.

By 1884 Holdich was already a very experienced and efficient frontier surveyor, desperately anxious to leave no blank space unfilled upon the map. And like all frontiersmen of the day, he viewed with intense suspicion the steady advance of the Russian across Central Asia. The " Russian Menace " was on everyone's lips. In February of that year, while England was occupied in the Sudan, the way was apparently being prepared for an advance from Merv across Afghanistan. The Amir, jealous of his eastern and southern frontiers, appeared negligent of his Herat border, and it became imperative for the British to call a halt to Russian designs. The outcome of diplomacy at St. Petersburg and London was the formation of the unwieldy Russo-Afghan Boundary Commission, to assemble on 13th October, 1884, at Sarrakhs, the point where Russia, Persia, and Afghanistan met. Holdich was placed in charge of the survey party and marched up from Quetta *via* Kandahar and the Helmand. The old boundary between Turkistan and Afghanistan was extremely vague, and though the Russians had pushed reconnaissances forward and had a good idea of the geography, our own maps were a complete blank. The survey work accomplished by the inadequate staff under Holdich was amazing. By various " technical expedients," as he himself called them, triangulation was taken from the neighbourhood of Kandahar to the Helmand, and thence through Western Afghanistan as far as the Hindu Kush near Herat. It was carried along the frontier, and on it was based not only the British but also the Russian topographical surveys: and from the eastern end it was connected across the Hindu Kush again with the previous work near Kabul. The work of this Commission, undertaken by Holdich, Gore, and Talbot, with only three native assistants, is still reproduced in text-books, as an example of how such survey should be carried out. At the end of it Holdich had some hard words to say about the political organization of the Commission ; but it speaks much for his own tact and capability that, in spite of the scientific rivalry between the two survey camps, the Russian and British surveyors worked throughout in the utmost harmony, even when people at home had begun to rattle their sabres.

The frontier laid down by this Commission has been respected to this day.

For his services on the Commission Holdich was promoted brevet-lieutenant-colonel in 1887, and was awarded the Gold Medal of the Royal Geographical Society "in consideration of the services he has rendered to Geographical Science by his surveys in Afghanistan."

On the conclusion of the Russo-Afghan Boundary Commission, Holdich found himself back in Baluchistan at the time when Sir Robert Sandeman was carrying out his policy of peaceful penetration and settlement. At the end of 1889 he accompanied Sir Robert on the political promenade known as the Zhob-Gomal expedition, which closed the back door to the Sulaiman tribes. The whole of the Zhob valley and much of the Kundar were surveyed and the site of Fort Sandeman was selected. For the next year or two Holdich, now promoted brevet-colonel, was engaged in organizing the surveys of Southern Baluchistan and Makran, the triangulation of which was undertaken by his assistants, Talbot and Wahab. Holdich himself gained an extensive knowledge of Makran and the Persian coast, and surveys were extended as far as Jask and Bandar Abbas.

In 1892 he was appointed Superintendent of Frontier Surveys, and it was in this capacity that he was called upon to organize the various survey parties for delimiting and where necessary demarcating, the line laid down in the Durand Agreement of November, 1893. The actual work in the field in connection with this agreement was not completed till 1896.

Holdich was an opponent of the Durand Line policy from the start. He always maintained that the presence of a surveyor or topographer, who knew the ground from personal observation, among the advisers of Government, would have prevented some of the errors that were made owing to lack of geographical knowledge, and the consequent political troubles on the border, both during and after demarcation. He never agreed with the policy of defining an easily penetrable frontier-line behind the independent tribesmen. As long as there was no boundary west of the tribes, we could, if necessary, follow up raiders and punish them: the boundary line did not prevent intercourse between the Amir and the tribes, but merely formed the frontier of a sanctuary, which we bound ourselves not to violate. Holdich, an ardent admirer of Sandeman's methods, maintained that to do any real good, military posts connected by good communications should be maintained at the "back door" of the tribal tracts, and so prevent the escape of marauders into the Afghan asylum. That was long before the advent of motor cars and aeroplanes, but it is interesting now to see those early ideas of Holdich in force to-day, though modified by modern conditions.

South of the Khyber the work of demarcating the line was divided into three sections. Holdich placed the Kurram party under Captain

Macaulay, the Waziristan party under Major Wahab, and the long Baluchistan section, stretching westwards to the last pillar on Kuh-i-Malik Siah, the tri-junction of Persia, Afghanistan, and Baluchistan, under Captain Ranald Mackenzie, with Tate as his assistant.

Holdich himself, who had been awarded both the C.I.E. and C.B. in the early part of the year, accompanied Mr. Udny on the Kunar Valley Delimitation Commission in December, 1894. Once more he took the Khyber route towards Kabul, and crossing the Kabul river at Jalalabad ascended the Kunar river to Arnawai, the disputed point. It was here that they were to await the arrival of Captain Gurdon, the political officer in Chitral, who was to represent the interests of that state during the demarcation of the frontier between it and Kafiristan. The trouble which broke out in Chitral and the siege of that place hardly concern us here, for in spite of the attitude of the Afghans, Udny and Holdich carried on the work of demarcation and survey and completed it up to the Dorah pass by the following April.

The actual survey work was disappointingly meagre, in spite of the efforts of Holdich himself and his assistant, Lieut. Coldstream, simply for the reason that the Afghans obstinately refused to allow any work to take place that was not absolutely necessary for the delimitation. It is not till 1929 that any error has been found in this frontier, and that error lies in the section of it beyond the Dorah pass which was accepted as correct by both the Afghan and British Commissions.

Hardly was Holdich back from these duties when he found himself appointed as chief survey officer on the Pamir Boundary Commission, with Major Wahab, whose work in Waziristan was finished, once more his assistant. Unlike the other boundary settlements included in the Durand Agreement, the demarcation of a boundary on the Pamirs was necessitated by the principle that at no point on the earth's surface should the land frontiers of England and Russia meet. The Amir was therefore given the small strip of Wakhan, a "long attenuated arm of Afghanistan reaching out to touch China with the tips of its fingers." This narrow springless buffer, a bare eight miles wide at one spot, is all that separates Russia and Britain in the East; and it was the northern edge of this buffer that was demarcated. The work proceeded without a hitch; the Great and the Little Pamirs were surveyed in detail; and the surveys and reconnaissances of Holdich were connected by triangulation carried out by Wahab, based on resection to the distant peaks already fixed from the south. When the geodetic link was forged between India and Russia eighteen years afterwards, the difference between the common points of the two triangulations averaged only five seconds of arc in latitude and three seconds in longitude.

The Russians and British parted on the Pamirs on 12th September, 1895. On his return, Holdich was immediately appointed Chief Commissioner of the Perso-Baluch Boundary Commission, to demar-

cate the frontier west of Baluchistan and Makran, with Colonel Wahab as his chief survey officer. Holdich was now able to put into practice the lessons he had learnt during the many boundary commissions he had been on. He already knew much of the ground, surveys had already been carried up to and along much of the frontier, and he had himself studied the characters of the men with whom he had to negotiate. These factors were of enormous advantage to him and enabled him to complete the demarcation most expeditiously before the hot weather set in. For his services to India on this commission Holdich was made a K.C.I.E.

The year 1897 saw the frontier ablaze from Waziristan in the south to Swat on the north. Once more Holdich had to find officers and surveyors to accompany each column that penetrated to the tribal areas. With his intimate knowledge, he was able to direct the efforts of his best assistants to the regions where the maps were "blankest"; and in 1898, while he was personally engaged on the Tirah campaign and reached the fatal age of fifty-five, decreed by the Government of India to be the age of inutility for Survey officers, he handed over his command in the field to his old friend Colonel Wahab.

When Holdich left the frontier there was hardly a corner of accessible ground on it that he had not seen. His strict scientific training, his capacity to endure the extremes of heat of baking deserts and the cold of Himalayan heights, his adventurous enjoyment of tight corners, all combined to make him an example to his successors on the frontier. His many frontier experiences rendered him most valuable at headquarters, where his push and tact and influence ensured that no opportunity of acquiring topographical information was missed. His view was that, when not actually required in the field, it was his job to see that his subordinates had every chance to do their job efficiently. The fact that surveys still continue on the frontier is due to the ever-increasing needs of peaceful development. Maps of larger scale, of greater exactness and detail, contoured for the alignment of roads and railways, and not merely for the punishment of marauding tribes, are required to-day, and our frontier surveyors are still hard at work. We find little blunders, necessitated by the "tip-and-run" circumstances of Holdich's time. To-day the frontier is at peace, and the back doors are connected by roads. The motor, the aeroplane, and the survey camera are there to assist us. The tribesman, at any rate in bulk, rarely scampers to his *bast* behind the Durand Line.

It must not be supposed that Holdich at the age of fifty-five closed his interest in frontier matters. Though his talents were employed in various fields for many years to come, those of us in the Survey of India who had the honour of meeting him long after he had left us always found him well up in all that concerned the Indian frontiers.

It was not till then that he had time to put his experiences in print for the benefit of his successors. *The Indian Borderland* appeared in 1901; *India* and *Tibet* in 1904 and 1906; *The Gates of India* in 1909; and *Political Frontiers and Boundary Making*, a summary of all his accumulated wisdom on the subject, in 1918. Many of these are delightfully illustrated by his own sketches. That his interest never waned till the very end may be instanced by the fact that on 5th October last, less than a month before he died, he wrote me a letter asking me to find out what had become of a certain explorer, and of the report that he had taken down from the explorer's lips in 1884. A nephew of the man was traced and the manuscript found a few days after November 2nd. Sir Thomas Holdich was a Founder Member of the recently formed Himalayan Club and a generous donor to its foundation fund and library. The last words in his letter expressed a wish for the prosperity of the Club."

KENNETH MASON.

"Perhaps the most important of all Holdich's work was his connection, after retirement, with the Chile–Argentine Boundary. The protracted dispute between these two countries over their common frontier in Patagonia, which on more than one occasion nearly led to war, arose from the ambiguity of their Boundary Treaty of 1881, which defined the frontier as following the highest crests of the Andes along the line that divides the waters which flow into the Atlantic from the waters which flow into the Pacific.

For a distance of some 900 miles in the northern portion of the boundary, a lofty unbroken mountain chain also traces the continental water-divide, but this unbroken ridge ends at Mount Lanin (about lat. 40° S.), and from that point southward, for another 900 miles, the mountain system is a jumble of detached massifs, often separated by great lakes lying transversely to the main axis, and sometimes cut through by deep gorges, through which flow westward to the Pacific considerable rivers which have their sources far out in the Patagonia pampas to the east. It will be seen, therefore, that the actual geographical conditions did not by any means conform with the terms of the Treaty, so far as the southern half of the frontier was concerned.

The Chileans claimed as a frontier the continental water-parting in its entirety, in accordance with their interpretation of the Treaty of 1881. The Argentine case, on the other hand, was a closely reasoned argument in favour of a boundary following a series of high detached peaks as constituting the main range and equivalent to the line of the highest crests mentioned in the Treaty.

After many years of discussion, which at times nearly led to open rupture between the two countries, the governments concerned, with

great good sense, decided to submit the whole matter to arbitration, and invited the British Government to undertake the task. This led to the appointment of an Arbitration Tribunal, in 1900, composed of Lord Macnaghten, a Lord of Appeal, as President, Major-General Sir John Ardagh, the distinguished head of the Military Intelligence Department, and Col. Sir Thomas Holdich, as members, with Major E. H. Hills, R.E., as secretary. In view of the divergence of the claims, and the conflicting and often contradictory evidence adduced, the Tribunal felt that an examination *in situ* of the region in dispute was the only means of arriving at a decision on the numerous points submitted to it. This mission fell to Holdich. He embarked for Buenos Aires with four officers as assistants on 31st January, 1902.

The examination of various portions of the frontier which the Tribunal had found difficult to decide upon was carried out by the different officers of the mission, while Sir Thomas himself crossed to Valparaiso, where he embarked on a Chilean cruiser. Eventually he arrived at Puerto Montt and, in company with the Chilean Boundary Commissioner, Dr. Hans Steffen, crossed the Andes by the low pass at Perez Rosales to Lake Mahuel Huapi, where he met the Argentine Commissioner, Dr. Francisco P. Moreno, the well-known Patagonian explorer. Thence he started southwards, making long marches by the easiest available routes, eager to get into touch with his southern parties before the winter set in. He soon established cordial relations with his mixed following, his impartiality, his friendly demeanour, his keen interest in the work of the surveyors, his determination to complete his task in spite of natural obstacles and vile weather, all combining to make an unqualified success of the journey. He concerned himself with the physical aspects of the line of the continental water-divide as an international boundary, which he found, as he expected, to be an absolute negation, in many parts, of the principle that such a frontier should be easy to see and difficult to cross. Thus it remained for him to select for the consideration of the Tribunal a line that should possess, as far as possible, the requisite physical characteristics and one that should not create any inaccessible enclave, mere occupation, in his opinion, offering no basis for arbitral consideration. The parties then assembled in the neighbourhood of Lake Buenos Aires and marched across the Pampas to Comodoro Rivadavia, where the mission embarked for Buenos Aires, just escaping the oncoming winter, which in these latitudes is very severe.

On Sir Thomas's return to England his recommendations were considered by the Tribunal and their definition of an agreed boundary line was embodied in an award signed by H.M. King Edward VII. in November, 1902.

The frontier as awarded followed a series of lofty mountain ranges, crossed rivers at gorges and avoided giving to either country any useless, because inaccessible, area. The award was received with the

greatest satisfaction by both governments concerned, who have observed it scrupulously ever since. The immediate result was a Treaty of Peace and Disarmament between Chile and Argentine which still exerts a beneficent influence over their mutual relations.

The award met with but little criticism in the popular press, for both countries very soon realized that each had received all it could reasonably hope to make use of. Their appreciation has greatly increased with the passage of time.

On the successful conclusion of the arbitration Sir Thomas was awarded the K.C.M.G. For him, however, the conclusion of the matter had not yet been reached. There still remained the actual demarcation on the ground of the boundary so awarded. Here and there, especially in the south, in the otherwise unmistakable line there were a few points, certain mountain passes, and river and lake crossings, and the portion of the line at the southern extremity, where the governments of Chile and Argentine felt that friction might arise if the boundary marks were not set up by independent authority. They accordingly invited Sir Thomas to return to South America for this purpose in the ensuing summer. This he did, again accompanied by a party of officers.

For purposes of demarcation the frontier, where it did not actually follow the crest of the Andes, was divided up into sections and allotted to the various officers of the Commission who actually superintended the erection of the boundary pillars in the presence of representatives of the two governments.

The writer, who was present with Sir Thomas in South America, can testify to the fact that the success of this undertaking was very largely due to the power he possessed of conciliating divergent elements where difficulties had to be smoothed over. He was endowed with a personal magnetism not often met with.

It is not too much to say that at the present date, twenty-seven years after the arbitration, the name of Holdich is held in high esteem in both Chile and Argentine, while certainly few things gave him more pleasure in his later years than the thought of the enduring peace that has prevailed ever since, due, in no small measure, to his labours."

H. L. CROSTHWAIT.

Sir Thomas Holdich was closely connected for many years with the activities of the Royal Geographical Society. He had completed 25 years of continuous service on the Council when he retired from it in 1923, and he was President from 1917 to 1919.

He died at Merrow, near Guildford, on 2nd November, 1929.

LIEUT.-GENERAL SIR HERBERT CHARLES CHERMSIDE, G.C.M.G., C.B., COLONEL COMMANDANT, R.E.

HERBERT CHERMSIDE was the second son of the Rev. R. S. C. Chermside, Rector of Wilton, Salisbury. He was born on July 31st, 1850, went to Eton as a colleger in 1860 and acquired a high standard of classical knowledge. Going thence to Frost's and Wren's—everybody used to go to a crammer in those days before confronting the examiners—he picked up a good grounding in mathematics, so that he passed easily at the head of the competitors in the examination for the R.M.A.

There is no record as to whether he specialized as a " dry-bob " or " wet-bob " at Eton ; but probably as the latter, for he told the writer, in after years, that he had emulated Byron and Leander in swimming the Hellespont ; and it has since transpired that he won many prizes as a swimmer and oarsman.

The result of the examination for R.M.A. revealed that the number of admissions was unprecedented, some 56 in all, with Chermside, then aged 17, a thousand marks ahead.

The batch included many whose names are household words to us ; but during the course at the R.M.A., which in those days extended over two and a half years, there were periodical examinations that eliminated a large number, so that the batch on passing out was reduced to about 30, out of whom about 24 got R.E. commissions, with Chermside easily at the top.

One of his contemporaries remarks that Chermside, besides being a brilliant scholar in almost every subject he took up, without in any way being characterized as a bookworm, was endowed with a marvellous memory that enabled him to recapitulate almost page by page any book he had read. For examination purposes this undoubtedly confers immense power and Chermside was able to apply it to the study of Hindustani, although he had not touched the subject in the entrance examination, and succeeded in outstripping those who had. It may be readily believed, then, that in after years, when Chermside had spent a great deal of his service in the Middle East and had acquired Arabic and Turkish, that, as was related by the late Sir Lintorn Simmons, he was enabled to correct the interpreter in the middle of a proclamation in Crete. But this is anticipating.

The principal incident of note, when the subject of this memoir was at the S.M.E., arose when certain adventurous ones received permission in 1871 to visit Paris during the disturbances generally

Lieut.-General Sir Herbert C. Chermside, G.C.M.C., C.B.,
Colonel Commandant, R.E.

Lieut-Gen Sir Herbert C Chemside GCMC CB

known as the "Commune," when the Communists, then known as "Communards," were holding Paris against the regular French troops. They found their way to Versailles with some difficulty while the bombardment was in progress, and sneaked in after the French regulars had entered Paris and were busy street fighting. Some slunk back the same night, but Chermside and Noel elected to remain, were taken prisoner, treated as English R.E. officers assisting the insurgents, and were to be led out to be shot next day. Luckily, they managed to get in touch with Lord Lyons, our Ambassador, and eventually only succeeded in getting out of Paris in the guise of Queen's messengers, with letters to the British Government.

A less exciting form of activity was the practice of walking tours, when he and two others of his batch, accompanied by a number of dogs, would set out on Fridays, after lecture, and cover about 80 miles by Sunday evening, with no other impedimenta than light knapsacks. They thus became acquainted with the old posting houses in Kent and Sussex. Noticeable amongst the dogs was a magnificent mastiff, which had been given to Chermside on condition that it was not "shown."

After a spell of ordinary duty in Ireland he disappeared, according to his record of service, on the unprecedented period of home leave of 155 days in the spring of 1873. In reality, to take part as a photographer in an expedition to the Arctic Regions (in the ship *Pittsburg*), organized by Mr. Leigh Smith. One incident is that some Swedish explorers got astray from their ice-bound ship and there was fear of their starving. So Chermside and a companion set out and located the party. It is possible that some of the photographs, which were developed by Capt. Abney at the S.M.E. Photo School, may be still in existence.

Then a further spell at Chatham on H.M.S. *Hood*, the home of the Submarine Miners, and then to Portsmouth and Devonport for practical application of the then budding science of coast defence by submarine mines. It was in this last-mentioned station that, brought into contact with the sister branch of the Service, the characteristic trait in his character was brought to the test.

It had been remarked by his fellow subalterns that in general conversation—no matter what the subject broached—Chermside had always something to say, not in a dogmatic way, but indicative that he knew what he was talking about.

One day he was away otter hunting on the moors, when *The Times*, which arrived late in the day, appeared with an important speech by Lord Goschen on "Indian Currency." It was quite impossible for Chermside to have read the publication, and all in the mess agreed to read it up and broach the subject when he appeared in the evening, to see whether he would be able to participate in the conversation.

They were defeated, for Chermside not only showed himself well acquainted with the subject but even elucidated some points that had appeared obscure to his messmates. This characteristic remained with him throughout his life and we have further evidence from a quondam staff officer of his, who says :

> " His mind was a perfect encyclopædia of knowledge, which to me was very attractive. I doubt whether you ever knew, on talking to him, what he really thought himself. He never laid down the law, but would present a subject in all its aspects and leave you, in the end, wondering what view he himself thought the right one. It was the same in his correspondence."

His real career began when he was ordered on foreign service in 1876, never to return to home service till he was a Major-General, after a lapse of 23 years.

With many other British officers he was selected for duty in Turkey. What that duty was can only be revealed by searching the intimate history of the Middle East at that time. Clouds were brooding over the Balkans and Russia declared war on Turkey. Our old ally was in danger and Constantinople appeared to " All Europe " to be the objective.

Heated debates took place in the Mother of Parliaments, and such expressions as " The Unspeakable Turk " and " Bulgarian Atrocities " found their way into the papers. Names like the Shipka Pass, Valentine Baker, Plevna and Osman Pasha became familiar to British ears.

The Prime Minister, Lord Beaconsfield, was all against abandoning our old ally. Lord Salisbury demurred at an alliance with Turkey, and so the debate went on. But what could statesmen do to unravel the tangle when the man in the street, wending his homeward way from the debate of amateur politicians in the local " pub.," proclaimed in no uncertain tones that :

> . . . And while we're Britons true-u-u
> The Rooshians shall not have Constantino-o-o-o-pul !

So Northcote voted a credit of six millions, early in 1878, and the writer, who was then at a remote small garrison in India, remembers a sudden concentration of rolling-stock in the local railway station marked in chalk " Lahore," or " Bombay."

In a few days' time orders arrived. An infantry regiment was entrained and whisked off to Bombay, and we who remained began to furbish up our camp equipment and prepare ourselves for action somewhere. The next we heard of our infantry comrades was that they were at Cyprus and other troops had landed in Malta. The Fleet was at Besika Bay.

Then the Powers intervened. The Russians were arrested in their march on Constantinople. There was a conference at Berlin and Beaconsfield crossed the Channel on his homeward way on the *Calais Douvre*, and was received by enthusiastic crowds who vainly demanded a speech. It is said that he popped his head out of the window of his railway carriage just as it was moving off and announced: "I bring you peace with honour."

So Chermside remained on in Turkey, sheathed his sword and set about demarcating boundaries. This carried him on till June, 1879, when he joined Sir Charles Wilson, R.E., as Military Vice-Consul in Anatolia.

Egypt.—It may be remembered that in the XVth century, Sultan Selim of Turkey wrested the control of Egypt from the Arabs, and it became vested in a Viceroy under the suzerainty of The Porte. The Treaty of London, in 1841, while recognizing the suzerainty of The Porte in principle, secured the virtual independence of the Khedive and made his dignity hereditary. But the enterprises of Mehemet Ali so embarrassed the finances of the country that the English and French had to intervene and establish a joint control.

In 1869, the Suez Canal was opened for traffic, due to the enterprise of Ferdinand de Lesseps, a French Engineer, who conceived and carried out the project which had hitherto baffled previous undertakers. Thus was opened for the British and French an all-water route to Bombay and eliminated the tedious overland journey from Alexandria to Suez.

The finances of Egypt always appear to have been in a precarious state and in the winter of 1875–6 Lord Beaconsfield, then British Prime Minister, seized on the opportunity of securing for the British Government the preponderating number of shares in the Canal.

When, in 1881–2, Colonel Arabi Pasha raised the standard of revolt, joint fleets of Britain and France lay off Alexandria to protect their respective interests. The French diplomatists, after some discussion, declined to go on with the job, and left the British a free hand to occupy the Valley of the Nile and to protect the Khedive. It was at this juncture that our forces, under command of Lord Wolseley, overran and occupied Egypt, as they do more or less to this day.

To take his share in these operations, Chermside was hailed with his Chief to take up a post on the Staff of the Expeditionary Force as Military Attaché to Her Majesty's Agency in Egypt, though, according to the *Quarterly Army List*, he is shown as D.A.A. and Q.M.G., Egypt. Possibly designed as a basis for regulating the pay of the appointment. Whatever his position may have been, he came under the notice of Sir Evelyn Wood, the first English Sirdar, who

selected him to command the first battalion of the reconstituted Egyptian Army.

It is outside the scope of this memoir to deal with the Mahdi's* revolt in the Soudan, beyond reminding those unacquainted with this phase of developments in Egypt that the mission of General Gordon to Khartoum was to evacuate the Soudan and withdraw the garrisons left behind by the Egyptian Government, with their wives and families.

This eventuated in Gordon being shut up in Khartoum and the abortive expeditions up the Nile and to Suakin dispatched by the British Government, in hopes of rescuing him and saving the garrisons.

When the expedition, under Sir Gerald Graham, V.C., landed near Suakin in 1884, Chermside was one of the British officers engaged in the force and after withdrawal of the British troops he remained with his battalion, in command at Suakin, May 10th, 1884, and was appointed Governor-General of the Red Sea Littoral in October.

Apart from incessant minor engagements with the surrounding Arabs, he undertook the difficult and delicate task of negotiating with King John of Abyssinia for the relief and withdrawal of the Egyptian garrisons scattered in outstations adjoining the Abyssinian border. This was in pursuance of the Treaty,† signed at Adua, on 3rd June, 1884, by which King John was to receive considerable accessions of territory and other material advantages after he had facilitated the withdrawal of the beleaguered garrisons.

The negotiations were long drawn out and involved the dispatch of many messengers and display of much patience and tact. Rifles and dollars were lavished on King John, but it was not till Chermside had dispatched Saad Effendi Rifaat as Egyptian Commissioner in Abyssinia to assist in the movement, that a force was got ready. It left Adua on January 27th, 1885, defeated the Arabs surrounding Galabat and released some 3,000 souls, who reached Massawa at the end of May, there to meet, also, the troops of Amadib and the garrison of Senhit.

Meanwhile, Graham's second expedition arrived at Suakin, March to May, 1885, and though three battles were fought, nothing further was accomplished towards stopping the progress of the revolt; Kassala still remained unrelieved and finally had to surrender on June 30th, 1885.

The garrison of Gera, which had been besieged for some months, was, however, extricated by the Abyssinians on July 22nd, 1885, the Egyptian soldiers, moreover, being clothed and fed by King John. In fact, of the posts on the Abyssinian frontier, the only one which

* Mohammed Ahmed Ibn Sayid, boat builder, born at Dongola, 1848.

† This treaty became known as the Hewett-Mason Treaty and had been negotiated by Admiral Hewett and Mason Bey (the latter an American officer in the Egyptian Service) with King John of Abyssinia.

fell into the hands of the Dervishes was Gedaref, which was surrendered in April, 1884, *i.e.*, before the Hewett Treaty had been concluded.

On the whole, therefore, the results of the Treaty and of Chermside's efforts were satisfactory. The heroic Gordon had met his fate in the fall of Khartoum on 26th January, 1885. The Mahdi died on 22nd June of that year and was succeeded by the Khalifa.* The British Government had ordered the withdrawal of all its expeditionary forces from the Soudan, and it became the task of the Egyptian forces to hold the frontier posts.

Chermside was transferred to command the troops at Wadi Halfa on the Nile, on October 20th, 1886. The Dervishes advanced to Gemai, 22 miles south of Wadi Halfa, on 13th October, and established themselves there under command of Nur-El-Kanzi.

Chermside countered this movement by a display of cavalry and camel corps, supported by an armoured train, and finally drove the invaders back, pushing into Sarras, some 32 miles from Wadi Halfa. Nur-El-Kanzi put in an appearance again on 27th April, 1887, and pushed on an advanced guard as before to Gemai.

Four hours after the news of this reached Chermside, he had pushed out a force directed on Sarras, and marching in the night, occupied the old railway station buildings and positions on the surrounding rocky hills with his mounted troops.

The infantry arrived by an early hour next morning and by 7.45 a.m. the enemy was routed all along the line, leaving some 200 dead on the ground and ten standards. This was a small action, doubtless, but the distance marched and the rapidity of the concentration which defeated the enemy within 14 hours of receipt of intelligence of his presence, call for especially favourable comment in view of this being the first occasion on which Egyptian troops confronted the Dervishes entirely independent of British or other support. The troops returned to Wadi Halfa and a period of tranquility ensued.

Chermside quitted Wadi Halfa some time in the summer of 1887, and terminated his service with the Egyptian Army in May, 1888, resuming his interrupted Consular duties: this time in Kurdistan, and thence returning in November, 1889, to Constantinople as Military Attaché. Here he spent nearly seven years. His activities during this period, of which no record is available, are doubtless locked up in the archives of the Foreign Office.

He was then transferred to Crete on the Commission for reorganization of the Cretan Gendarmerie, till March, 1897, and then British Military Commissioner in Crete and commanded the British troops on the island as Colonel on the Staff.

Expedition to Crete, September 24th to November 24th, 1898.—In order to realize the situation in Crete, the idea that the Cretan

* Abdulla Taashi.

Mussulmans, or Bashi Bazooks as they are generally called, are Turks, must be abandoned. They do not understand either Turkish or Arabic. They, as well as the Christians, are Cretans and speak Greek only. Neither of them likes the Turk, nor does the Turk care for them. But in cases of dispute the Turk, naturally, sides with the Mussulman. The proportions are about one-third Mussulmans to two-thirds Christians: the former, therefore, depend on the Turk for protection.

The Mussulmans were farmers, while the Christians were traders. They had been assassinating one another since time immemorial and were about equal in savagery. On the whole, the pluck was on the side of the Bashis, but both preferred to murder without danger to themselves. The outbreak of about two or three years back, which led to the intervention of the Powers, was caused by Christians surrounding some 900 Mussulmans in a mosque and murdering the lot, after persuading them to surrender their arms on promises of their lives being spared. After this, in Kandia, the Christians were kept in the hills by a cordon of British troops, and the Mussulmans confined to within a few miles of the town by Turkish troops.

At the time mentioned, an outbreak had just occurred, resulting in the massacre by Bashi Bazooks of 600 Christians, including our Vice-Consul, the burning and sacking of the Christian quarter, and the killing and wounding of some British soldiers. The cause of this outbreak would appear to have been :—

(1) The Powers started interfering without making up their minds as to what result they wished to arrive at.

(2) When about to force on a town a tax, which they knew would be resented, they left on duty only one ship, the *Hazard*, which carried no weight of metal, while the remainder went off to coal, so that the weak British garrison of some 250 H.L.I. had to cope unassisted with some 20,000 well-armed Bashi Bazooks, in addition to some 4,000 Turkish troops.

Moreover, no measures were taken for entrenching under the specious plea that they would betray a lack of confidence.

When fire was opened from the loopholed houses, some of our unprotected troops were killed in the hospital tents and when playing football.

The International Council of Admirals at Canea had ordered all arms and ringleaders to be surrendered to the Turkish Governor, who was to hand them over to the British authorities. This was an order easy to issue but somewhat less easy to execute, and Sir Herbert Chermside, Major-General in Command of the troops in Kandia, which formed part of the Malta Command under General Sir Arthur Freemantle, Governor and C.-in-C., had a delicate task in hand to

temporize until his Command had been reinforced by the arrival of some artillery and brought up to a strength of some four and a half battalions of British infantry.

In the end, the population was disarmed and the Turkish Governor and garrison coaxed by a judicious show of tact and force to embark in the transports sent to fetch them, and the incident closed for the while.

A Cretan police force was raised in various districts under British officers, and when Prince George of Greece arrived to assume command, Kandia was the only place in Crete where his safe conduct was entirely entrusted to Cretans.

It should be added that, when the massacre of the 600 Christians took place, Sir Herbert Chermside had just landed in England on leave. He was immediately sent for by Lord Salisbury and told to return and restore order. On arrival at Kandia, alone and unarmed, he walked up the Main Street, which was thickly lined on both sides by silent people, who only a few days before had been engaged in this outrage. The officer in local command greeted him with "Bey! If you had been here this would not have happened."

It may readily be grasped that Sir Herbert had a wonderful influence, by reason of an iron will regulated by a sense of justice and sympathy. This characteristic has, as is well known, a powerful effect on Orientals.

Crete to South Africa.—Proceeding home from Crete, he immediately assumed command of the troops at The Curragh. But he was moved in three months to take command at Aldershot of the 14th Brigade, 7th Division, in which he again spent only three months, during which time he took it out to South Africa, handed it over to General Tucker and succeeded Sir William Gatacre as the Lieutenant-General in Command of the 3rd Division. With this he served till early in 1901, resuming his old command at The Curragh.

His services in South Africa were not marked by any particularly prominent actions. He was not altogether fortunate in taking over a division that had borne the brunt of strenuous marching and harassing engagements of no decisive character. The units were constantly shifting, the Division frequently split up into separate detachments or strung out along the railway, holding the line.

He took part in the operations in 1900, in the Orange Free State, including those at Paardeberg, Poplar Grove, Karee Siding, and later, those in the Transvaal to east and west of Pretoria and in the Cape Colony.

On 3rd February, 1902, he was appointed Governor of Queensland and assumed office in March. Just before embarking for South Africa, Chermside had married Geraldine, daughter of Mr. W. Frederick Webb, of Newstead Abbey, who accompanied him to

Queensland. Both Sir Herbert and Lady Chermside met with much cordial hospitality from the residents, and in their wide tours through the remoter parts of Queensland made warm friends all over the State.

He was not a man to stand on his dignity and he was approachable by all, regardless of station in life, and the fact that he was a good, all-round sportsman increased his popularity. He was not only a sportsman in the usual sense of the word, but he studied and knew the subjects of his sport, was a keen naturalist and a student of forestry and agriculture.

Above all things he abhorred unnecessary cruelty, and it is recorded that when invited to a grand pigeon-shooting match, organized in the Governor's honour, he declined to attend on discovering that the quarry were to be captive birds instead of clay pigeons.

He spoke his mind freely and yet did not detract from his own popularity thereby. In fact, the Colonists had an admiration for him as a man, as apart from his abilities as an able administrator.

It is to be regretted that he found it desirable to resign in September, 1904.

The Australian Parliament, in the interests of economy, had taken action with a view to reducing the emoluments and status of the State Governors. Chermside was desirous of resigning in June, but consented to remain on: but, recognizing the financial exigencies of the State, surrendered part of his emoluments.

Sir Herbert and Lady Chermside left Queensland, as he wrote to the Premier, Mr. Morgan, " with a very high interest and belief in its future and with the warmest appreciation of the kindness, friendliness and hospitality, nowhere to be surpassed, which we have invariably met with at the hands of all its citizens throughout our residence in the State."

More than once he received further offers of high posts from Lord Salisbury, who had a high appreciation of Sir Herbert's qualities: but he preferred to stick to the military profession which he loved.

Sir Herbert Chermside retired from the army in February, 1907, with the rank of Lieutenant-General, G.C.M.G. and C.B., and he was appointed Colonel Commandant R.E., in 1916. Lady Chermside died in 1910 and Sir Herbert spent the remaining years of his life in travelling and in developing his property.

He was greatly interested in forestry and fish culture and travelled much on the Continent, acquiring a great knowledge of these subjects, which he put to practical use in England. Farming also was his hobby and he was an authority on the making of pastures.

On 4th August, 1920, he married Clementina Maria, second daughter of the first Baron de Reuter, and widow of Count Otto Stenback.

The writer was fortunate in renewing acquaintance with Sir Herbert and meeting Lady Chermside in the South of France. They were then travelling in search of new scenes, and rivers where Lady Chermside could display her prowess as an enthusiastic trout fisher. Failing health had for some years forbidden any form of such sport to Sir Herbert, but he was untiring in accompanying his companion to the waterside and participating as an onlooker in her sport.

There is little more to tell. Suffice to say he passed away at a nursing home in London on 24th September, 1929. Many details of rewards and decorations to be found in the usual books of reference have been left out.

The writer does not claim to present more than an outline of the remarkable career of a singularly unassuming man, whose association with the Corps was necessarily restricted by the nature of his service. And yet he may be deemed to have fulfilled the spirit of our motto.

Those who have had the patience to read so far and are desirous of probing more deeply into a fascinating subject, may find collateral evidence scattered in many publications, notable amongst which are :—

Mahdism and the Egyptian Soudan and *The Soudan Past and Present*, by General Sir F. Reginald Wingate, Bart., G.C.B., G.C.V.O., G.B.E., K.C.M.G., D.S.O.

Modern Egypt, by Lord Cromer.

Histories of the South African War. ("Official" and *The Times* editions.)

The Life of Major-General Sir Charles Wilson (late R.E.), by the late Sir Chas. M. Watson, R.E.

Apart from information contributed by our brother officers of the Corps we are indebted to others of the army at large and especially to :—

General Sir Reginald Wingate, Bart., G.C.B., etc.
General Sir H. M. Leslie Rundle, G.C.B., etc.
Colonel Lionel Fawkes } Late R.A.
Mr. R. C. Corbett
Major-General Sir Francis Howard, K.C.B., late Rifle Brigade,

who have put their notes and memoirs unreservedly at our disposal.

J.A.F.

MAJOR-GENERAL SIR S. ROBERT RICE, K.C.M.G., C.B

SPRING ROBERT RICE, the second son of Spring Rice, Esq., of Marlhill, Co. Tipperary, was born in July, 1858. He went to the "Shop" in 1875 and was appointed S.U.O., or as it was called then R.U.O. (Responsible U.O.) for his last term. He was one of the best riders in his term, and, passing out high (second or third), he was awarded the Sword of Honour, an appreciation of his military characteristics which was justified by his subsequent career. Even as a cadet he was a striking personality, strongly built, well set up, and extremely smart, with a courageous and rather masterful manner combined with excellent brains and much common sense. He was commissioned on the 9th of October, 1877.

While at Chatham he maintained his reputation for soldierly smartness and efficiency, while he entered with zest into all the recreations then available, became one of our best cricketers and footballers, and was frequently a member of the crew of the old *Dotterel*.

From Chatham he went to the 6th Company at the Curragh, and in 1881 was moved to Gibraltar, where he remained for about two years. He was a prominent rider to hounds at both these stations. In 1883, he went on to India.

On arrival there he was posted to the Bengal Sappers and Miners at Roorkee, and after three months was sent to Karachi as Assistant Engineer, Submarine Mining. It may seem strange that an officer with so strong a bent for soldiering should have gone "to the sea," especially from Roorkee, the great military centre of the R.E., but in the early days Submarine Mining was looked upon as the coming service, in which both scientific and practical training for war was to be obtained.

Rice threw himself wholeheartedly into this new work, and without any previous training in it became so efficient that in three years he was in sole charge of S.M. Defences at Karachi, and later on, on the death of Major C. C. Carter, the Inspector of S.M. Defence, India, he officiated in that capacity. To his keen disappointment, the vacancy was filled by an officer sent out from home, and Rice decided to leave India on the expiration of his first period of service.

He arrived home in 1889, and was posted as adjutant, S.M. Battalion, St. Mary's Barracks, where he resumed the military side of his R.E. duties with his customary energy.

The Mess was a cheery place, and Rice's humour and quick repartee, though caustic at times, kept things amusing. He now represented the Corps at football and cricket, and captained the latter team about 1890.

Having established his reputation as an adjutant, in 1892 he was

Major-General Sir Robert Rice

selected to fill the appointment of Adjutant, S.M.E., recently created by the reorganization of the Staff of the S.M.E.

In November, 1895, he took over the command of the 37th Field Company from Major A. H. Kenney, and in October, 1898, was transferred to the command of the 23rd Field Company *vice* Major A. C. Foley. One of the officers who served under him describes Rice's character in a nutshell. " He was a very good C.O. for a Y.O. to have. No excuse was ever taken " !

The Company was sent to Salisbury Plain in 1898, to prepare camps and arrange water supply for approximately sixty thousand troops. By Rice's directions, a separate project was prepared for each camp, in which every detail was meticulously included, and consequently everything went according to plan. This work was typical of the man. Given a job to do he would see it through to success, no matter what amount of labour was required from himself or his subordinates. When the manœuvres commenced, and water supply stores had to be taken up and moved on to successive camps, his orders on the subject were inflexible and no relaxation was made in favour of anyone, however high his rank, not excepting the I.G.F. himself ! At this period among his contemporaries who did not know him well he had the reputation of being idle. This, however, was due to a species of vanity with Rice. He affected to do nothing, but his subalterns knew that the projects for work and schemes for training, which were produced mainly by the pen of the Major, had involved the burning of many hours of midnight oil.

In June, 1899, the 23rd Company, which had moved from Aldershot to Chatham, was detailed to proceed to South Africa as one of the units included in reinforcements sent out as a precautionary measure. Rice proceeded with his company to Ladysmith, and was there throughout the siege.

It is a singular fact, but the Staff of that day did not consider that a C.R.E. was necessary for a besieged town. Rice, although the senior R.E. officer doing regimental work, was never regarded as more than the O.C. of the Field Company, and he was rarely consulted on the all-important subject of defence works.

The defences of Ladysmith were designed and made by the Commander of each section of defence, as seemed best to him. On one occasion, the holding of Wagon Hill was a matter of discussion at a conference at which Rice happened to be present. Ian Hamilton, the commander of the section, recommended holding the rear crest. Rice pressed very strongly that the forward crest should be held, and Sir A. Hunter, the Chief of Staff, agreed with him. Sir George White, however, decided that the commander of the section who was responsible for the defence should hold it as he thought best. The sequel showed that Rice was right. On the morning of the battle, he had gone out to Wagon Hill early to find out what was going on, and was on his way back to make arrangements for further help for

the R.E. when he met Ian Hamilton, who asked him what had happened. Rice told him and gave the reason.

An officer of the Staff of Sir George White says that the only time he saw Rice otherwise than calm and unrattled during the whole of the siege was when he came in to H.Q. on the evening of the Battle of Wagon Hill to report the gallant services rendered by the R.E., and announced with tears in his eyes that his two subalterns, Digby Jones and Denniss, had been killed.

Another episode of the siege in which the 23rd Company were involved was the raid on Surprise Hill. This was suddenly arranged by the H.Q. Staff. About 6 p.m. Captain Fowke, 23rd Field Company, R.E., was called to H.Q. and informed that he was to go with the raiding party and blow up the Boer guns. He, of course, went to Rice and told him what had happened. Rice, who had every right to be annoyed at this cavalier treatment, was, however, quite unruffled, and made everything as easy as he could for his Captain by selecting the best N.C.O.s and men for the job and arranging the issue of the necessary equipment from the Company stores.

On the relief of Ladysmith and the subsequent advance by Buller's Army into the Transvaal, Rice became C.R.E., 4th (Lyttleton's) Division, and eventually the Company settled down at Middelberg, Transvaal, where Rice was C.R.E. and the Company did the ordinary Field Company job of defences, water supply, quarters and provision of parties of R.E. to accompany mobile columns.

Early in 1901, Fowke had been asked to provide a raised platform, so that some signallers should be able to cover some dead ground. This was done, and, soon after, another request was received to put some protection round the platform, for the signallers were being sniped. Fowke then put up some sheets of corrugated iron with stones between, and this was found to give complete protection.

As time went on, the Boers turned their attention to the railway communications, and this necessitated the multiplication of defence posts along them: from this developed the system of blockhouse defence, for it was quickly found that defence by means of open works was only asking for trouble.

To meet the case at certain important river crossings, the Engineer-in-Chief had had designs prepared of blockhouses, of the nature of miniature Norman castles, for distribution to the various C.R.E.s. Rice, as C.R.E., Middelberg, received these designs, but saw at once that they were not of general application, as they cost about £600 each, and took about six weeks to build. While Rice and Fowke were thinking over the subject, Rice suddenly said, "Why not try your defence for signallers?" and then they both sat down to work out details. From this moment the corrugated iron blockhouse had come to stay. It was at first octagonal in shape, but gradually it assumed the design which is now familiar in our text-book—the circular shield, roofed, and resting on a parapet of earth or stone.

The H.Q. of the 23rd Company under Rice's direction now became a standardized blockhouse factory, the materials passing through successive stages to completion with astonishing rapidity and absolute accuracy.

The development was reported to Lord Kitchener, who immediately grasped the supreme importance of this new weapon now ready to his hand. He at once gave the order for the construction of the first cross-country blockhouse line; this was followed by orders for others in quick succession, until the Transvaal and Orange River Colony were divided up into defined areas. The mobility of the Boer Commandos was severely hampered, for even if the blockhouse lines did not always stop them, the break-through invariably gave valuable information as to their movements, and probable direction, and the drives by our mobile columns became the irresistible realities which ended the war.

The invention, in itself so simple, was exactly what the situation required for a country like South Africa, with its wide open spaces of rolling veldt. The made-up material was easily portable on the transport wagon of the country; the material required locally, earth or stone, was nearly always available on the site, and the protection afforded against bullets, rain, and sun was complete.

If unbiased evidence is required as to the part the blockhouse played in ending the war, it will be found in books written by Christian de Wet* and Reitz.†

It had been suggested that the blockhouse in South Africa, though stationary, played a part in ending that war comparable to the part played by the tanks in the Great War. That may be so, but the reward obtained was very different. For his services in South Africa Rice was mentioned four times, and received a brevet lieut.-colonelcy, which gave him a bare six months' seniority as lieut.-colonel.

His brother officers and personal friends, who knew what he had done and how much had resulted from it, thought that he had been hardly treated, but he himself, though grievously disappointed, never grumbled or even spoke about it.

Almost his final act before leaving South Africa was to put forward a design for the benefit of the Transvaal Government, showing how two blockhouses could be combined into one residence named "Peaceful Villa."

He came home in August, 1902, and shortly after married Mary Dalrymple, widow of Henry Scaunell, late Inspector General of Police in Bombay, and daughter of the late Major George Dancer, R.A. With the greater happiness which came into his life he lost much of his official austerity.

He was posted first to Cork as D.O., then to Fermoy as C.R.E., then to Portsea, where he completed five years as Lieut.-Colonel.

* *Three Years' War*, by C. R. de Wet. † *Commandos*, by Denys Reitz.

He was promoted Brevet Colonel in February, 1906, but this did not save him from a year of half-pay.

In September, 1909, he was appointed Chief Engineer, South Coast Defences, and was there able to carry out many schemes he had in mind for strengthening the fortress defence of a place by supplementary earthworks.

After two years, he was posted to Aldershot in succession to Scott-Moncrieff, who went to the War Office as D.F.W. Here Rice came under an old South African friend as C.-in-C., Sir Douglas Haig, who knew him well, and who left, with complete and well-deserved confidence, all engineering matters entirely in his hands. He took great interest in the fieldwork schemes of the Field Companies, and by his help they were enabled to carry out exercises in making full-sized defence posts, *points d'appui*, as they were termed in the text-book, teaching which was to have far-reaching effect in the Great War.

On the outbreak of war in 1914, he went to France as C.E., 1st Corps. During the first hundred days there was little scope for a Chief Engineer where work was all of a temporary nature, and troops moved so rapidly that it was impossible to organize any system for the supply of engineer stores, or tools. He was used by Sir Douglas Haig as an extra Staff Officer for liaison, reconnaisance, and reports when these were of special urgency or importance. These missions he performed with such good judgment, and the information he obtained was generally so essential that Haig soon learnt to regard him as one of his best agents.

On one occasion an amusing incident happened, which he was fond of telling. He had to visit a French reserve battalion, who were making a defensive post at the bridge of Guise, and not being satisfied with the design he summoned up his best French and suggested some improvements to the French officer in charge. Rice was not a good French scholar. Much to his amazement the officer replied in perfect English, " I entirely agree with you, sir, but what the devil can I do with these blighters ? " After some further conversation he discovered that the officer was the French master at a well-known English public school.

As an instance of his ability to appreciate a situation, it is on record that in September, 1914, he stated in the Mess to which he belonged that in his opinion the war would shortly develop into trench warfare and that there would be a condition of stalemate for at least a year. This statement was accepted by no other member of the Mess at the time, but events proved that he was perfectly correct.

During the first Ypres, he was sent to a divisional headquarters with certain orders on which depended the fortunes of the day. His ability to appreciate the true facts of the situation enabled him to make a vital decision on the course of action to be followed, which was completely successful, and of which Haig entirely approved.

During the early days of the first Ypres, he was instrumental in

putting into practice the construction of strong points (*points d'appui*) in the support lines. Several of these were on the front attacked by the Prussian Guard on the 11th of November, and by their agency the assault was broken up and smashed.

This system of strong points interposed amid the trench system always formed part of any scheme of defence for which Rice was responsible. On the creation of the First Army he became C.E., First Army, and was gazetted Major-General as a reward for services in the Field.

Later, it was decided to form a Field Force at Salonika, and he was sent there to take over the duties of Chief Engineer, but when General Fowke was made Adjutant-General in France in March, 1916, Rice was ordered back to France to replace him as Engineer-in-Chief, where he remained till November, 1917.

On his arrival in France, the preparations for the Battle of the Somme were in full swing. He found that his functions as E.-in-C. touched nearly every branch of engineering; the growth of the armies in France, together with the experience gained in the changing form of warfare, resulted in demands for greater numbers of engineer units of an ever-increasing variety, and it was in Rice's time that these additions were fully developed. This brood of new units has been immortalized in the well-known cartoon "War-Babies."

The scrutiny of these demands and their final recommendation rested with the E.-in-C., and his old friendly relations with Haig, to whom he had frequent direct access, did much to secure his favourable consideration and final approval. It was this same old friendship which enabled him to press on Haig the eligibility of C.R.E.s of divisions for the appointments of the command of infantry battalions and brigades, which was eventually approved.

The distribution of all kinds of engineering stores was to a large extent controlled in his office, especially those it was necessary to ration. Until the creation of a Directorate of Roads after the Somme, all roadwork in the Army areas was administered by the French *Commission d'Armée du réseau routier*, on which Rice's Staff was represented.

Plank roads, which were first adopted during the Somme, and then became of universal application, involved the supply of enormous quantities of timber.

The design and provision of road bridges of various types were worked out and organized for the general advance which was always confidently anticipated in his office, and, when Rice left France in 1917, no less than three and a half miles of bridging were already in the engineer parks.

In 1916, a school of instruction was opened at Aire, at which classes of selected officers were practised in handling each type of bridge, and this teaching contributed largely to the marked rapidity which was an outstanding feature of all bridging operations of 1918. Special equipment for water supply was also designed and provided.

The success of the mining organization, which culminated at the battle of Messines, was built up during Rice's regime.

Camouflage, a new science, was developed from its original type of individual observation posts, machine-gun nests, etc., disguised as trees, kilometre stones, or heaps of road metal, etc., to the wholesale screening of roads, battery positions, camps and dumps, against aerial observation and was provided with its own factories for supplying its special material.

Geology, an old science, but one hitherto somewhat neglected as far as field operations were concerned, now found a wider scope in the E.-in-C.'s office. Hutting for placing enormous numbers of men under suitable cover was provided from designs evolved under the direction of his staff. Besides these, there were many other forms of engineering problems dealt with under him, which can only be mentioned generally.

As Engineer-in-Chief, one of his Staff says: "His ability and common sense were undoubted. He had a deep antipathy to any personality tinged with self-advertisement, jumpiness or fuss. He expected a high standard of efficiency from all his officers, and was not disposed to bestow praise for what he considered should be the natural maintenance of that standard; nor did he think that such would be due to himself. His natural reserve and personal detachment, blended with a peculiar form of shyness, prevented intimate relations either with his own Staff or with that of the Armies; but when he had gained confidence in any of his officers, he left them an absolutely free hand, contenting himself with general supervision and advice, and unfailing support of their efforts. He was a very good judge of men."

In November, 1917, the C.-in-C. decided that Rice, with other senior and distinguished R.E. officers, whose average age was naturally somewhat higher than that of the remainder of the officers on the Staff, had been sufficiently tried by the storm and stress of three years' war, and was now entitled to a tour of home service, where the conditions might be less trying. This enforced rest was none of Rice's seeking, as may be imagined. He was appointed to the command of the Forth Garrison at Edinburgh, and held that post until he retired in 1919.

For his services during the War, he was mentioned in dispatches six times, promoted Major-General, K.C.M.G., C.B., and received from our Allies the Cross of a Commander of the Order of Leopold (Belgium) and the Croix de Guerre (France).

Like so many of our older officers, the strain of war had affected him more than was realized, and he did not live long to enjoy the peace he had helped to bring about, for death suddenly claimed him at his residence in Brighton on the 11th August, 1929.

R.N.H.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

CHANGING CONDITIONS OF IMPERIAL DEFENCE.

By CAPTAIN D. H. COLE, M.B.E.

(Sifton Praed. Price 6s. 6d.)

This admirable little book, by the author of the standard work on imperial military geography, will appeal strongly not only to those whose calling necessitates a study of the problems of imperial defence, but will also be welcomed by the many others who still regard the British Empire as a living reality in spite of necessary changes in its nomenclature, composition and inter-relationships, and unnecessary attempts to prove that Empire and domination by Great Britain are synonymous.

On the other hand, whole-hogging pacifists will find little encouragement in the following comments on recent attempts to abolish war by covenant :—

" In fact, the advice, ' Don't think of war and don't prepare for war, " and there will be no war,' is highly idealistic. ' Don't think of burglary, " don't prepare for burglary, and there will be no burglary ; have " lawyers, well codified laws, commodious and well-appointed courts, " but no policemen,' is not an unfair parallel.

" The British Commonwealth of Nations is perhaps the greatest " peace-making force in the world to-day, because its interests are so " widely dispersed that it is liable to lose either as a combatant or a " neutral. But it can only exercise its capacity for peace to the full by " being strong in war if necessity should arise."

As explained in the preface, the book does not pretend to contain full discussions of the important subjects and controversies to which its pages refer. The writer's aim has been to present briefly and clearly some of the more important of the changing conditions which affect imperial defence and imperial solidarity, and as far as possible to give an unprejudiced account of those problems of the other great naval powers which may have reactions on our own position.

In view of the recent London Naval Conference, the book is of particular interest at the present time, and sheds considerable light on the difficulties to be faced in any attempt by the great naval powers to reduce their armaments.

The author starts from the basis that national defence is dependent on man-power in association with material resources and power of

movement, and analyses the present and possible future situations regarding these factors. In connection with man-power, he points out that since two-thirds of the white population of the Empire, which is the foundation of the structure of imperial defence, is now situated in Great Britain, the necessity for organization to achieve unity of thought and action throughout the whole Commonwealth has not yet reached a vital phase. In another half-century, however, the population of each of the Dominions is likely to have doubled, while that of Great Britain, he estimates, will never exceed 60 millions. In 60 years the bulk of the white man-power may well be outside Great Britain. Is the minority then to bear the larger part of the burden of defence? If not, how must our defence organization be modified?

The chapter on the material resources of the Empire shows clearly the dependence of Great Britain for food, and for most of the raw materials used in industry, on overseas supplies, and the dependence of the Empire as a whole on foreign sources for a number of vital commodities, the chief of which are cotton and petroleum.

These weaknesses are, as the author points out, shared in varying and increasing degrees by all the industrial powers, who do not, however, possess to any corresponding degree the strength accruing to the British Empire from our control of a number of essential commodities, our ownership of 35 per cent. of the steam and motor ship tonnage of the world, our financial situation, and our predominance in the coal bunkering trade.

Our general material situation necessitates sea power and control of shipping, and "A nation with a world-wide sea trade and a great tonnage "of shipping, but without a navy capable of defending it would be "living in a condition of dependence on the goodwill of others, a "dangerous habit, even when guaranteed by pacts and treaties."

The chapter devoted to the "United States and Sea Power," bristles with interesting information and conclusions. The author demonstrates the growing dependence of the United States, owing to rapid industrialization and the growth of population, on markets abroad, and on imported raw materials for her factories. "This dependence, as it "increases, will be accompanied by a corresponding necessity for the "security of her lines of sea communication to every part of the world. "In this respect her interests will be similar to those of the British Empire—the absolute security of her sea-borne trade."

The respective attitudes of Great Britain and the United States with regard to "the freedom of the seas" are well summed up in the words of an American. "When the British Government is neutral it tends "to act the way the Americans talk: when the American Government "is a belligerent it acts the way the British talk."

France and Italy in the Mediterranean, Great Britain and the Indian Ocean, and Japan and the Pacific, are in turn dealt with by Captain Cole, whose aim is to show that "we must remain a great sea power or perish."

Finally, he comes to one of the greatest problems of the future: How is the world's growing demand for food to be met?

"The population of the world increased from about 500 millions in "the year A.D. 1700 to 600 millions in the year 1800 . . . by 1850 the

" population had reached 1,000 millions. To-day it is over 1,800 " millions, and it is increasing at the rate of over 15,000,000 a year. " Needless to say, the acreage available for food production cannot be " extended indefinitely. The best lands are already under cultivation " —the remainder of the potentially arable land is mostly poor and " unlikely to produce crops comparable with those now produced. . . . " Where are the lands which can be developed to meet the world's " growing demand for food? . . . Much of the available area is British " and much of it belongs to British Dominions weak at present in " population. These areas must become increasingly desirable to other " countries with much larger and denser populations."

" Does the British Empire present a united front towards these " dangers which may not be so very remote? "

The author's conclusion is that while peace pacts and covenants have undoubted value, they must inevitably contain loopholes, and that the British Commonwealth of Nations can only exercise its great capacity for peace to the full " by being strong in war if the necessity should " arise."

The shrinking of the world due to improved communications, while it helps, does not necessarily solve our difficult problems arising from dispersion. The real foundation of imperial defence must, in the author's words, be " the maintenance of a proper team spirit " which might well, he suggests, be based on (1) the development of common interests in trade, (2) the development of constitutional machinery for maintaining a continuous common policy in foreign affairs, which would be able to function without delay in a crisis, (3) the assurance that the governments of the Empire would be prepared to enforce this common policy, and (4) a sharing of the burden of naval and air defence based on the amount of overseas trade which each country possesses.

The continued existence or, alternatively, the disruption of the Empire may well depend on the manner in which this " team spirit " is fostered.

It is to be hoped that this book will be widely read both in Great Britain and in the Dominions, not only by the military student but by budding statesmen and the " man in the street," whose collective vote in these democratic days is, in the last resort, the determining factor in the constitutional evolution of the Empire.

G.N.M.

SHERMAN—THE GENIUS OF THE CIVIL WAR.

By B. H. Liddell Hart.

(Benn. Price 21s. net.)

Captain Liddell Hart is back from another lion hunt in the obscure fastnesses of military history. Recently he produced a fine specimen, Scipio Africanus, " a greater than Napoleon." Now it is Sherman —" the genius of the Civil War." The hunter has measured his kill with the elastic tape of the " indirect approach " and the result is here announced to the military world.

This is very confusing to the simple soul of the orthodox soldier who has heard a lot about Jackson, something about Lee and vaguely of Grant. To find the truth, we must read and re-read the great masters. General Sir Frederick Maurice has but recently proved Lee to be the genius of the Civil War. Brigadier Fuller is about to prove that Grant was the genius of the Civil War. Captain Liddell Hart will have to fall-in his genius alongside the others. To the orthodox observer, it would appear that it took the combined efforts of Genius Grant and Genius Sherman to put it across Genius Lee, and of the three, Lee had been registering authentic genius for some two years before Grant and Sherman became serious challengers.

Still, it is no use quarrelling with the wrapper or the title page. The rest of the book is excellent. The writer sets out to produce a picture of Sherman, the human being, and he does so—" not merely of a man's " limbs and muscles encased in uniform clothing." Sometimes the portrait is a little blurred as the shadow of the photographer falls across the photographed. Occasionally the writer's image obscures Sherman's. But Sherman always reappears, and the writer is at his best when he quotes Sherman's actual words, as he does frequently and appositely.

We first see Sherman, somewhat submerged under " demerits," at West Point. The writer disapproves of military academies and makes an unfair use of passing-out lists from such places in deducing the military characters of general officers. We see Sherman as a young officer—keen, observant, impetuous. We see Sherman in the hopeless 'thirties, that period of military doldrums in which the best of soldiers, Lord Haig among others, become morally becalmed before reviving to fresh activities in the roaring 'forties. Then Sherman the civilian—an indifferently successful business man—perhaps hindered by his early overscrupulous upbringing at West Point—and lastly, Sherman back to the army—or as near as he can get to it—conducting an embryo military academy in the South. There the war finds him.

Sherman's reaction to the War is interestingly told, though the author, in the chapter heading, perpetrates a ghastly pun, when he writes of a " Realist in Wonderland " (this is not the sole offence, elsewhere we read that " the Tocsin of War was a toxin in the blood "). There is Sherman at Bull's Run—Sherman holding Kentucky for the Union, half-crazed by the incompetence at Washington and very close to psycho-neurosis. Sherman baited by and baiting war correspondents (orthodox soldiers, take heed how you treat the journalist and note that nothing is better for an army in the field than paternal criticism of its commanders by an enlightened press) and Sherman as a divisional and Corps Commander settling down to warfare in the Mississippi Valley.

We are shown the beginning of the Sherman-Grant friendship during Grant's bowler-hatted obscurity after Shiloh, and we see the fateful combination maturing during Grant's all-round-my-hat cast after the Confederate fox at Vicksburg.

Then there is Chattanooga and at last, in 1864, Sherman commands in the South the Right Wing of the Federal Armies, at the age of 44.

When Sherman assumed independent command, the War had taught him three things of which the writer approves. Firstly, the value of

mobility and the measure of "Q"; secondly, the advantages to be gained by operating on the widest possible front compatible with control and mutual support of the separated parts of his force; thirdly, the futility of direct attacks against an entrenched enemy unless that enemy is off his balance, and the wastefulness of holding ground gained for ground's sake. These added to his restless energy—which in less exacting times was damned as impetuosity—are sufficient, in a theatre of war where all is flank, to carry him 130 miles from Chattanooga to Atlanta in a dignified gavotte with the Confederate Army. There, the dance over, he somewhat puckishly pulls the stool from under his partner, the Confederate General Johnston, who comes ungummed in every sense.

Finally, during a further military Paul Jones, Sherman, more ungallantly unorthodox than ever, leaves the Chattanooga–Atlanta Ball Room and his Confederate partners and enemies, and Charlestons off to the sea *via* the Confederate Supper Room, where he takes what he needs and destroys what he leaves. This rudeness ends the dance. It is, however, questionable whether Sherman could have pulled it off had not Grant been somewhat importunately buttonholing Lee, the Confederate Chucker-Out. In any case, the responsibility was Grant's —Grant created the opportunity—the truth is Grant and Sherman understood each other and Lincoln had learned to trust the combination. In addition, the South was losing hope—Federal combination produced Confederate collapse.

The last two chapters and the epilogue are exceptionally good reading. Whatever be Sherman's merits in comparison with other American commanders of that War, one is left with the memory of a broad-minded, far-seeing professional soldier—hard yet merciful—a great enemy to misplaced sentiment and to humbug. His outstanding military qualities are his loyalty to his subordinates and his power of getting the maximum out of his administrative organization, his topographical staff and his engineers, and by so doing conserving the energy of his fighting men.

On some occasions in the text, and always with the maps, the author has let his penchant for the "indirect approach" overstep its proper application. Too many sentences start from an "If" and vanish into a fog of parentheses before they emerge with the real meaning, and the maps are always placed at the beginning of the period to which they refer and are not available when wanted.

These, however, are minor defects in a work which embodies much research and which is a valuable contribution to military knowledge of the Civil War, and is equally valuable as a stereoscope through which the Great War may be examined in clear relief.

Moreover, peace, too, comes in for inspection—"War is a symptom of a diseased peace," is one of the writer's many good sayings. He might have added that we have no X-Ray apparatus with which to inspect how far gone in disease our peace may be. Indirectly, this book is a reflection on disarmament and Kellogg Pacts. Nothing was ever less likely than the Civil War. Nothing was ever more inevitable once the politician had really begun to prevent it. That war having been, any war is possible.

It is claimed that Sherman was the typical American. The writer records a youthful statement of that typical American: "For my part, there is no nation that I would prefer being at variance with than the British."

How unthinkable!

E.D.-S.

INDIA UNDER WELLESLEY.

By P. E. ROBERTS.

(G. Bell & Sons. 15s. net.)

The Marquis Wellesley was Governor-General of India between 1798 and 1805. At that time, control of our Indian interests at home was divided between two authorities, the Court of Directors and the Board of Control. The responsibility of the two and their position as regards the Governor-General were ill-defined and overlapped to a certain extent, and their orders were sometimes conflicting. Wellesley, therefore, like a wise man, did what he thought to be right.

When he reached India, the British Empire there was very much in extent as Warren Hastings had left it thirteen years before, for Pitt's India Act committed us to a policy of non-intervention. He left it after Mysore, our most serious rival in the South, had been crushed, the Mahratta Confederacy defeated, and the British unquestionably acknowledged as the paramount power in India.

The causes which led Wellesley to embark on this scheme of aggrandizement were two-fold: firstly, as a counterfoil to French intrigue; and secondly, a genuine feeling that the *pax Britannica* was preferable to native misrule.

As regards the first, the author is careful to point out that the seven years of Wellesley's administration coincided with the darkest period of the French wars; when our naval supremacy was not yet undisputed, and there was a certain danger of invasion at home; when our military expeditions were of the "tip-and-run" order, and our Continental allies were, one after the other, collapsing before the French armies. The French were at Mauritius and the Seychelles, and, by their conquest of Holland, dominant at Java. They were in correspondence with Tippu of Mysore; French officers were training the armies of the Nizam at Hyderabad and of the Peshwa at Poona; and French adventurers were carving out kingdoms for themselves in Hindustan. The memory of Dupleix was still alive, and although Napoleon's scheme of marching a French army overland to India is generally dismissed as chimerical, a Perso-Afghan force, with French backing, might have caused us considerable trouble: it was only sixty years since Nadir Shah of Persia had sacked Delhi. Small wonder, therefore, that Wellesley considered attack to be the best defence.

As regards the second point, it is unquestioned that there was misrule under native rulers, such as amply justified British intervention; but we would prefer, from such an able pen as that of Mr. Roberts, something more than mere reiteration of Wellesley's statements to that effect. He does, it is true, give us a few hints as to how things were managed in

Indian states; for instance, that the Mahrattas collected revenue from subjugated districts by levying *chauth*, a word meaning a quarter. But something more vigorous is required in the way of propaganda if educated Indians are to realize "the rock whence they were hewn and the hole of the pit whence they were digged." Holkar, for instance, on capturing Poona in 1802, had his unfortunate rival tied to the leg of an elephant, and dragged through the streets of Poona till he was dead; nor was this regarded at the time as anything out of the ordinary in the way of disposing of political prisoners.

The wars waged during Wellesley's administration, that with Mysore, in 1799, and that with the Mahratta Confederacy, in 1803–05, were admirable examples of the co-ordination of forces acting from widely separated bases, for the success of which Wellesley himself, though he did not take the field, must receive a great deal of the credit. In both, Wellesley's brother Arthur, the future Duke of Wellington, took an important part. Nor must we forget the dispatch of a British–Indian force to Egypt, which, says the author, proved that the far-off Indian Empire was able to react on the European situation. The Mahratta War was marred in its later stages by two regrettable incidents, Monson's retreat and Lake's failure to storm Bhartpur, mishaps which drew the censure of the authorities at home, and so caused Wellesley to resign.

Wellesley's policy, where Indian states were concerned, was undoubtedly high-handed, judged even by the standard of 130 years ago; while his custom of acting first and reporting afterwards was not always justified by the distance between him and his superiors at home. But, in spite of faults, he was one of the greatest of Indian rulers, and a later generation, fortunately during his lifetime, was able to see things in a truer perspective and to know that, "in his own peculiar sphere and in his destined hour, a great ruler of men had walked in their midst."

Considered as a biography, the book may quite fairly be described as a model; for the author neither magnifies the virtues nor minimizes the faults of his hero. Throughout, we have the feeling that Wellesley's failings are being tried by an absolutely impartial judge; and that his merits are receiving their perfectly just appraisement. And not only so, but previous writers on India and Wellesley receive what we cannot fail to feel is perfectly fair treatment. May we hope that Mr. Roberts will use his remarkable talents in further work of the same kind?

F.C.M.

RACKETS IN INDIA.

By Colonel A. R. Winsloe, C.M.G., D.S.O., with a Foreword by Major-General S. H. Sheppard, C.B., C.M.G., D.S.O.

(Bennett Coleman & Co., Ltd. Price 7s. 6d.)

The author, in his Preface, says the object of his book is to show the rackets player where he may get his game in India, and how to get it cheaply, and he has certainly succeeded. After a short history of the game in India, and a note as to the chief players, come the laws with some apt comments on them. Two very useful chapters follow on how

to get and keep balls and rackets. A list of the courts in India is then given. The final chapter gives a short account of the formation and objects of the Indian Rackets Association, which owes its inception to the author and which has already done much to cheapen the game in India.

Lists of all competitions held, with the previous winners, specifications for coverings of walls and floor and for a door to rackets courts and hints on stringing and repairs to rackets are contained in appendixes.

All officers ordered to India would do well to buy a copy of the book, even if they do not play rackets, as the hints on the keeping of rackets apply also to tennis and squash.

B.L.E.

THE CAVALRY WENT THROUGH.

By BERNARD NEWMAN.

(Gollancz. 7s. 6d. net.)

This is a war novel; not an account of unsavoury personal experience but a pure flight of imagination. It portrays "the War as it might have been," had the "Napoleon" arisen whose appearance we gave up expecting. In France arrives Colonel Duncan with his ragged battalion of supermen, with which he had beaten the Germans in German N.E. Africa, in a brilliant campaign. In spite of the unconventionality of the whole outfit, their fighting qualities are soon recognized, and the Iron Battalion grows to the Iron Brigade, and the Iron Brigade to the Iron Division, commanded by Duncan. The exploits of the Free Companies behind the German lines, the pinching-out of the St. Mihiel Salient, the capture of the Gallipoli Peninsula and the consequent fall of Constantinople are all told in capital style. Duncan, of course, becomes British Commander-in-Chief and Generalissimo of the Allied Forces, and the War ends in 1917. As the wrapper has it, "Here, we take leave to say, is a perfectly gorgeous 'stunt.'"

P.H.K.

NOTES ON AIR SURVEY IN INDIA.

(*Professional Paper No. 24.*)

By MAJOR W. J. NORMAN, M.C., R.E.

(Published by order of Brigadier R. H. Thomas, D.S.O., Surveyor-General of India. 1929. Price 2s. 6d.)

These notes are a review of past and present methods, and of work carried out in India during the period 1924–28. They have been written, as stated in the Foreword, for the use of officers of the Survey of India, who have had little practical experience of air survey and have not had time to study the literature on the subject. We think that the

author has, on the whole, well carried out the task which he has set himself.

A very good summary is given of the points which have to be attended to in considering an air survey project.

A section is devoted to the theory and geometry of air survey in which the various conditions under which the air photograph may be taken are treated, such as distortion due to ground relief and to tilt of the camera.

Another section is devoted to an account of the method of plotting and compilation from photographs. A short description is also given of the instruments employed in aerial survey.

The last section of the notes gives a summarized account of the work done in India during the last five years. This work appears to have varied from 3-inch scale for forest maps to 16 inches to the mile for settlement purposes.

Numerous references are given to various publications which have appeared during the last few years, where full details can be found of the different methods touched on in these notes. There are a set of very clear diagrams illustrating the text; they are printed so as to open clear of the text, a practice which is always appreciated by the reader.

H.L.C.

THE SEREOGRAPHIC SURVEY OF THE SHAKSGAM.

By MAJOR K. MASON, M.C., R.E., Survey of India.

AN ATTEMPT TO DESCRIBE MR. WILD'S SEREO-PLOTTING MACHINE—THE AUTOGRAPH.

By ARTHUR HINKS, C.B.E., F.R.S., (Secretary, R.G.S.)

(*Technical Paper No. 272.*)

(Issued by the Railway Board, Simla. Price 2s. 3d.)

This appears to be a reprint from the *Geographical Journal* of a paper read by Major Mason before the Royal Geographical Society, in May, 1927. To this has been added an account of the geometry of the Wild autograph, which is not at all easy to understand, unless taken in hand by such a lucid exponent as Mr. Hinks.

He who desires to master the details of this complicated instrument is recommended to read this attempt to explain it. He will have to assist him numerous photographs and diagrams, as well as a mathematical disquisition.

Since this paper is published by the Indian Railway Board, we presume they are of opinion that the method could be applied to railway survey, which, we think, it could in certain classes of country, and we believe it is being used in connection with a Turkish railway project in Asia Minor. It is, therefore, worthy of the attention of railway engineers.

The apparatus, however, is very expensive, running into several thousands of pounds, and we fancy would require a very skilled operator to work it.

H.L.C.

CONCRETE CONSTRUCTION MADE EASY.

By TURNER and LAKEMAN.

(Published by Concrete Publications, Ltd., 20, Dartmouth Street, Westminster, S.W.1. Price 3s. 6d.)

The authors have written this book, primarily, for the use of engineers, architects, contractors and builders who have concrete building work to carry out for which no plans are available.

Secondly, to help young engineering students who are starting to learn the methods by which reinforced concrete structures are designed and constructed.

Chapter XI (General Specification and Notes), which the authors recommend should be read first and yet have placed at the end of the book, contains a great deal of information, very useful to anyone who has to make out specifications for a reinforced concrete job, which is not easily found in text-books on the subject.

It also contains data which every young engineering student should know before he takes part in the design or construction of any job in the field.

In the chapters on design and construction, the authors have dealt with footings, columns, beams, lintels, floor and roof slabs, panel walls, staircases, saw-tooth roofs, water tanks and retaining walls.

The designs given are sound for the conditions of loading assumed, but are inclined to be wasteful in the use of material.

The figures and diagrams given show the methods of placing the reinforcement in the various structures dealt with, and are designed according to the recommendations of the recognized text-books on the subject. They are clear and would be useful to anyone with a reinforced concrete job to design.

The examples given, which show how shuttering should be designed and fixed, are good, and emphasize the importance of economy in the use of materials.

To sum up, the book would be of value to anyone who has a sound knowledge of concrete design and construction and who is required to build a structure to carry the loadings, etc., as assumed by the authors.

In the hands of a young engineering or other student, it is thought that the book might have a dangerous tendency to make him believe that he could treat a complicated subject lightly.

B.C.T.F.

MODERN FRAMED STRUCTURES.

PART II.

STATICALLY INDETERMINATE STRUCTURES AND SECONDARY STRESSES. By the late J. B. JOHNSON, C.E., C. W. BRYAN, C.E., M.A., and F. E. TURNEAURE, DR.ENG.

(Chapman & Hall, Ltd. Price 25s.)

This part, of which the first edition appeared in 1910, has been re-written and consists of eight chapters, of which the contents of only the last three are adequately covered by the title.

Four chapters (Chapters II to V) are devoted to the calculations involved in the design of bridges of the swing, cantilever, arch and suspension types, a number of which are statically determinate.

The remaining chapter (Chapter I) is of an introductory nature and has apparently been considerably amplified in this edition.

It is unfortunate that the Macaulay method is not included in this chapter for comparison with algebraic, graphical and semi-graphical methods of analysis applicable to the many constructional problems involving the deflection of beams.

The use of the area moment method is, however, particularly clearly demonstrated, and the importance in truss design of the consideration of deflection, due to shear stresses in the members, is emphasized.

The treatment of the various types of bridges in the ensuing chapters is logical and relatively complete, although the space allotted to cantilever bridges is comparatively small, while that referring to suspension bridges has been considerably reduced in this volume, major attention being paid to those of the stiffened types.

The recapitulation in Chapter VI of matter already detailed in Part I is, perhaps, over-condensed, but the sections on trussed beams and beams on multiple elastic supports are really good.

An interesting comparison is afforded in Chapters VII and VIII between Winkler's and Mohr's methods of secondary stress analysis as applied to a Platt truss. The example is fully worked out by both methods and it is shown that in the formulation and solution of the equations of equilibrium of the joints, the advantage lies with Mohr, as permitting a more practical use of rapid approximation.

The subsequent process of solution for moments is, however, more readily carried out by Professor Winkler's method.

There seems, therefore, to be little to choose between them, although the authors appear to be of the opinion that, for beginners, the use of the Mohr method is more advantageous.

It cannot be said that the book is one which every sapper officer should possess, but it would undoubtedly be of value for reference purposes to officers involved in precise design work.

Attractively produced and profusely illustrated, the book is eminently readable and relatively self-contained; it is, however, regrettable that there are so many misprints, those on pp. 202, 367 and 393 being particularly unfortunate.

A.D.C.

(1) THE PHYSICAL PRINCIPLES OF WIRELESS.
By J. A. RATCLIFFE. (Price 2s. 6d.)

(2) THE ELEMENTS OF RADIO COMMUNICATION.
By O. F. BROWN. (Price 15s.)

(3) WIRELESS PRINCIPLES AND PRACTICE.
By L. S. PALMER. (Price 8s.)

(4) THE PRINCIPLES OF RADIO COMMUNICATION.
By J. H. MORECROFT. (Price 37s. 6d.))

The soldier, who has realized that "wireless" will have an increasing influence on military tactics, and who therefore wants to learn something of the principles on which it works, is at present faced with curiously

serious difficulties. There are many popular explanations intended to enable broadcatching "fans" to receive programmes from incredibly distant transmitters; and in the proceedings of learned societies there is an all-too-copious supply of literature for the expert. But very little provision has been made for the educated reader who wants a scientific account of wireless principles in reasonably compact form.

Unfortunately, too, the official *Army Manual* is out of date; and its terms of reference were so restricted that it was never very helpful from this point of view. Military students are, therefore, compelled to rely on civilian resources.

The first book of the batch under review is one of the best to fill this need. It is very brief; it is up-to-date; and it is sound. The reader is assumed to have the general scientific knowledge of an undergraduate embarking on the natural sciences tripos physics course at Cambridge; but to be quite new to the subject of wireless. Only one brief warning is necessary about this book. In Chapter I, the author uses, as the definition of the "decrement" of a circuit, an expression which is $1/\pi$ times the value used in almost all other text-books. There is much to be said for the new definition, but students should be warned that it is as yet unusual.

Brown's *Elements of Radio Communication* can also be recommended. It is intended for readers, of no greater educational attainments, who are prepared to do a little reading every night for a fortnight, instead of wanting to get a general view of the subject at one sitting. Since the book as a whole is definitely commended, it may be worth while to record some criticisms of detail. In graphs, such as those on pages 50, 51 and 87, to illustrate the "beat" effect which occurs when two signals of different frequencies are added together, we wish the author had refrained from drawing in the dotted line "through the maximum value of the successive oscillations," and from writing such statements as ". . . we see that the effect . . . is to produce a slow oscillation in the circuit, represented by the dotted line." It is this sort of thing which encourages the heretical and far too widespread belief that the resultant current has a component of the "slow" frequency, even before the rectification which is an essential part of the heterodyne process. Other minor criticisms are that none of the amplifier diagrams on pages 107–118 indicate the need for a grid bias battery, and that there is an obvious error in Fig. 70, where the plates of all three valves of an amplifier are connected directly together.

L. S. Palmer's *Wireless Principles and Practice* is a considerably more advanced text-book. It is a useful volume in which to "look things up," but it is much more mathematical and would be indigestible fare for anyone without a previous knowledge of the subject. So many details have been included, too, that even an advanced reader is apt to lose sight of the principles. To take just one example: valve transmitters are now so definitely superior to other types, that almost the whole Chapter VI, on spark, arc and high-frequency alternator sets, would have been better left to books on the *history* of wireless.

Morecroft's *Principles of Radio Communication* is the American equivalent of Palmer's book—only more so. It is a mine of useful

information, and the reproductions of oscillograph records which are given as practical illustrations of the theoretical equations are a most commendable feature. But woe betide any ordinary mortal who hopes to read straight through the 1,000 odd pages of this massive volume! In fairness to the author, it should, however, be added that he has published a shorter book for the benefit of those whose time is limited. It was reviewed in the *R.E. Journal* of March, 1930.

F.C.C.

MAGAZINES.

REVUE MILITAIRE FRANÇAISE.

(*January*, 1930.)—The second instalment of Général Lemoine's "*En relisant Clausewitz*" appears in this number. The writer continues to compare the present-day principles of war with those laid down by Clausewitz and finds that, in general, there is little difference in spite of modern inventions. The instalment deals first with the relations between policy, strategy and tactics; then with strategic objectives; then with forces available; and finally gives a comparison between the two forces concerned. It is not, however, particularly interesting except to a reader who is interested specially in Clausewitz's own writings.

Lieutenant-Colonel Vauthier begins "*La défense du pays contre le danger aérien*" in this number. The whole subject of protection of the country against hostile air attack is considered in detail, reference being made to the experiences of Great Britain and Italy, as well as France. Before discussing air and ground defences, Colonel Vauthier devotes considerable attention to the air intelligence necessary for air defence. As readers of General Ashmore's book, which incidentally is summarized by Colonel Vauthier, will know, a most complicated and rapid system of intelligence is essential if hostile aircraft is to be intercepted. Both the system of observation posts and the method of utilizing the intelligence gained are described. The writer then turns to the counter-attack by aircraft, first on the enemy's air bases, then against hostile aircraft in mid-flight, and finally by "defensive" aircraft near the enemy's objectives. Although the prevention of a hostile bombing expedition is obviously the ideal, Colonel Vauthier points out that attack by fighting aircraft near the objectives is probably the most effective. The instalment is completed by the realization that defence must be from the ground as well as from the air.

"*Les combats de la côte* 304 *en mai* 1916," by Capitaine Laxague, is a study of the immediate counter-attack during the Verdun battle of 1916. The actual description of the fighting is not specially interesting, but the lesson of the immediate counter-attack does stand out. The German method of attack was that of using a terrific artillery preparation on a

narrow front, and which the French, according to Marshal Pétain, found great difficulty in countering. The French success at Hill 304 was due to the rapid counter-attack of small units far more than to counter-offensives ordered by divisional commanders. We may realize with satisfaction that the principle of the immediate counter-attack by small units is fully realized by our present-day soldiers.

"*Le gouvernement national de Nankin*," by Commandant Cornet, is an interesting sketch of the development of the Chinese revolution. He gives briefly, without an excess of Chinese names, a description of the progress of the revolution since 1911 and of the rise of the Kuomintang. As readers of newspapers know, Chiang-kai-shek is now the leader of the Kuomintang government, and is attempting to produce an orderly government out of chaos, generally on the lines laid down by Sun-yat-Sen, the great southern reformer. Commandant Cornet points out with justice that, while one cannot help admiring the ideas underlying Chiang's development of the government, it is impossible to forecast future events in a country such as China. At any rate, representatives of European powers at least treat with the Nanking government as representing China, and it is to be hoped that the country will gradually become more settled as time goes on.

"*A propos du Salon de l'automobile*," by Colonel Doumenc, is an entertaining description of the French motor show. He describes the modern car as a "singular marriage between a boudoir and a locomotive," a really apt description. After a few remarks about present-day tendencies in cars and the enormous crowd of motor-cycles, he goes on to the more serious part of the show, namely, the heavy vehicles. The modern tendency for pneumatic tyres on heavy lorries is evidently very marked. Colonel Doumenc completes his article with a description of the effect of science on locomotion, and how fresh details of the action of lubricating oil and grease can be found by the application of X-rays. It is evident, from the discoveries made, that we have still some way to go in mechanical inventions for transport.

(*February*, 1930.)—Général Lemoine continues "*En relisant Clausewitz*," dealing with a fresh series of the factors affecting modern war and showing how Clausewitz's principles still apply in general. Although the writer has obviously studied Clausewitz with great care, one cannot help feeling that so careful an analysis of his writings becomes rather tedious for the average reader.

In the second instalment of Lieutenant-Colonel Vauthier's "*La défense du pays contre le danger aérien*," ground methods of defence are discussed. The writer first deals with anti-aircraft artillery, both technically and with regard to its organization. Considerable attention is paid to the technical aspect, and the Vickers "predictor" is mentioned. The need for organization, particularly with regard to good communications, has special stress laid on it. The article then turns to searchlights, which are, of course, necessary to help the guns, and to methods of aerial barrages, which were extensively employed during the Great War. Colonel Vauthier then deals with camouflage on a large scale, including the production of false industrial areas, to deceive the enemy, and he considers that considerable advantages may be attained by these

methods. He finally, as in the previous instalment, compares the methods of other countries with those employed by the French. It will be seen that, although concentration is wanted to absorb the article, it does give a full picture of the enormous organization required to protect a country, or a portion of it, from modern air attack.

Capitaine Albord describes the causes of the Russian disaster of 1914 in "*Le revers russe en Prusse Orientale (Août-Septembre* 1914)." Owing largely to General Ironside's book on these operations, the British officer is now well acquainted with the pathetically inadequate condition of the Russian Army of 1914. The writer brings out clearly the reasons for the Russian failure, and shows that the lessons of the Russo-Japanese war were lost on Russia. Although we can think of the almost legendary figure of the Grand Duke Nicholas of 1914, together with the "Russian steam roller," and now see how incapable the Russian Army was of fighting an up-to-date enemy, it is still difficult to realize what a mistake was made by Great Britain and France in trusting to Russia in the expected war with Germany. Capitaine Albord completes his article with a quotation from the French *Infantry Training:* "The only mistakes of commanders which should always be blamed are: forgetfulness of the mission allotted, inaction and fear of responsibility." It was exactly in these respects that Jilinsky, Rennenkampf and Samsonoff failed in 1914.

"*L'organisation du terrain et ses conséquences,*" by Colonel Chauvineau, discusses the natural tendency of the defender to dig himself in as compared with the provision of field fortifications under the orders of the higher command. Colonel Chauvineau points out that the reduction of infantry during the Great War, compared to the other arms, had really overstepped the mark, and that infantry are definitely required in defence as well as more mobile weapons. He therefore appeals for better training of the infantryman in fortification, as it is impossible for all, or anywhere near all, fortification to be controlled by the engineers. If the infantryman is going to dig himself in, he should be better taught, so that a great deal of his work is not wasted.

(*March*, 1930.) Général Lemoine continues "*En relisant Clausewitz*" with a discussion of the attack. He considers objectives and direction of attack on a large scale, together with the different forms of attack, *i.e.*, turning movements, etc. Throughout the instalment Clausewitz's writings are largely quoted in support of the arguments used.

In the third instalment of "*La défense du pays contre le danger aérien,*" Lieutenant-Colonel Vauthier describes the measures which can be taken in what he calls "passive defence." He regards the partial evacuation of cities as difficult, but not impracticable. From our own point of view it is hard to see how any appreciable part of London could possibly be evacuated, particularly at the outbreak of war. He then considers anti-gas measures and explains how collective protection must be better than just the issue of respirators. The difficulty in the future will be the enormous weight of bombs and the consequent depth to which dug-outs must be sunk; while the problems of ventilation and protection against gas are naturally conflicting. Colonel Vauthier then points out how the efficient use of these measures of defence depends on

the education of the people. He concludes with descriptions of defensive measures proposed by other nations, and gives a diagram of an "ideal" dug-out proposed by an Italian colonel. One cannot help feeling that, good though Colonel Vauthier's descriptions are, it will be quite impossible to educate people to the necessary standard, at least during peace time.

"*Une manœuvre en retraite*," by Lieutenant-Colonel De Charry, describes the operations carried out by the 43rd Division between the Aisne and the Marne at the end of May and beginning of June, 1918. This division succeeded, after a week's strenuous fighting, in re-establishing the front near Chateau-Thierry. The actual operations are rather difficult to follow, but the conclusions are of interest. Colonel De Charry points out the respective roles of the different arms in the retreat and shows clearly how difficult it is for the commander to direct his troops as they are being driven back.

Colonel Revol begins "*Initiation au voyage militaire des Alpes*" in this number. He points out that the French Alps have always offered a splendid field for training in mountain warfare, but that many officers have never had time or opportunity to study the past history of this region. This history teems with famous names, from Caesar and Augustus to Napoleon. In this instalment, after explaining the importance of the theatre of operations, Colonel Revol describes the frontiers and nationalities, followed by the routes across the Alps.

"*Rossignol*," by Lieutenant-Colonel Pugens, is a description of a disaster which befel the 3rd Colonial Division on 22nd August, 1914. This magnificent division was surprised in the Ardennes, and in spite of the most heroic fighting, was almost wiped out. It redounds to the credit of the division that five days later, with terribly depleted numbers, it was able to inflict a heavy check on the Germans. In this instalment Colonel Pugens describes the first contact with the Germans, during which signs were not lacking of an absence of information, which was the chief reason of the French defeat.

———— H.A.J.P.

THE SOCIETY FOR ARMY HISTORICAL RESEARCH.

The *Journal* for January, 1930, fully maintains the high standard of production and interest that we are accustomed to in the case of this publication. Nearly half the number of pages devoted to original articles is occupied by the first instalment of *The Diary and Letters of Arthur Moffatt Lang, 1st Lieutenant, Bengal Engineers, India, 1857 to 1859, with explanatory notes, maps, portraits, illustrations, etc.* The period of main interest covered by these papers runs from the outbreak of the Mutiny till its final suppression, and will be dealt with in four clearly defined sections:—

1. 1857. Meean Meer. March to July. Outbreak of Mutiny.
2. 1857. Delhi. July to September. Siege and capture of Delhi.
3. 1857. Relief of Lucknow. September to November.
4. 1857–8. Final capture of Lucknow. November, 1857, to March, 1858.

Lang thus took part in all the most stirring events in the Mutiny, and his share in the daring reconnaissances of the breach in the Kashmir Bastion by daylight and on the night before the assault of Delhi will be well known to all students of the Mutiny. The memoir published in the *R.E. Journal* on his death states that he was recommended for the V.C. twice during the Mutiny campaign, and mentioned four times in dispatches. The photo published with the memoir shows him as a Major with *one* ribbon, a strange contrast to modern conditions. This first section of the papers is very fully annotated by Lt.-Col. J. H. Leslie, the editor, and there are many illustrations. The second section will be edited by Col. F. C. Molesworth, late R.E.

The remaining articles are "General Sir William Howe's operations in Pennsylvania, 1777," "The Colours of the British Marching Regiments of Foot in 1751" (a continuation), and "Canadian Sketches in 1805-6." Reviews, Notes, Questions and Replies complete a very interesting number. It only remains to add that the Society, which is doing so much for the Army in its own particular line, is always glad to welcome new members.

P.H.K.

MILITAERWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*May–June, 1929, continued*).—*The Crossing of the Danube at Krems, 1927.* The crossing of large rivers in mobile warfare makes extraordinarily high demands on officer and man, and presupposes the existence of a sufficiency of well-trained technical troops and of ample equipment.

If such a crossing is carried out as a peace exercise the most essential war-factor, disturbance by hostile action, is absent; but against this there occurs a host of other difficulties, peculiar to peace, which can with difficulty be overcome or circumvented.

Amongst these peace difficulties are—as in the present instance—lack of labour and lack of materials. Design and execution of this crossing of the Danube must be judged with these limitations in mind.

As owing to the great increase of traffic-loads, as compared with pre-war loads, heavy bridges will be the rule in future, and as a medium bridge had been built in 1925, a heavy bridge was chosen for this year's exercise; width of crossing, 315 metres, maximum rise and fall, 16 feet. In deciding on a heavy bridge, the military authorities had not allowed sufficiently for the restrictions of the local river authorities. The total length of bridge to be carried on piles was cut down to 80 metres, and only six hours could be granted on one day for the total suspension of river-traffic. Three 25-metre spans of iron road-bridge, system Herbert, were put in on three single pile-trestles with adjustable transoms, and two spans of 25-metre Herbert girders, carried on rafts, each consisting of two 45-ton iron boats. With, thus, only 145 metres, or less than half-way, covered by heavy bridge, peace limitations began to weigh heavily, and it became necessary to assume that

the completed portion of heavy bridge was all that remained of a heavy bridge after enemy bombardment, and the remainder of the exercise became the completion of the crossing by medium bridge. This was done accordingly by means of three spans of 15-metre Herbert girders carried on rafts of large pontoons (7 partitions), covering 53 metres, and 116 metres of heavy Birago pontoon equipment, including a 38-metre cut.

The report, which was drawn up under the orders of the General Staff, is accompanied by four plans and twelve good photographs. It claims finally that the crossing at Krems proves that the pioneers of the new Austrian army, if inferior to their predecessors in numbers and equipment, are not so as regards their powers of work and keenness.

Technical Progress of Aircraft Construction and its Influence upon a Future War, by Captain Ritter, of the General Staff. In the Great War the stage of development of aircraft did not allow of air-forces being more than auxiliary to land-forces and sea-forces. It did not open up an entirely new field of activity for the political by acts of violence to overcome the enemy nation's will to war; but there were the beginnings of such opening in the bombing attacks on London and Paris in 1917. The author then works out that at that time it took 24 bombers to produce half a ton of effect. Further, he states that approximately 112 tons of bombs were dropped on London in 27 attacks, covering a period of twelve months. The number of persons killed was 836, and wounded 1,965. It is clear that material effect on this scale could not extinguish a nation's will to war. It had, in fact, an exactly contrary effect in exciting bitterness and the desire for revenge.

The object of the article is then to consider how far the technical progress of the past ten years justifies the opinion that, in a future war, the role of the air-arm will be both more important and more independent.

The author considers at some length the factors and developments, and leads logically to the following conclusion:—An air-fleet could not be used worse or more ineffectively than by being called upon to perform the almost impossible task of seeking battle with the hostile air-forces, and to devote its strength chiefly to this task. Objects against which the activities of the air-fleet may be directed with some prospect of success must be either fixed targets, like towns, industrial establishments, communications, aerodromes, etc., or targets which, although capable of moving, are relatively so slow compared with aircraft, that with anything approaching good reconnaissance and intelligence work they can certainly be brought to book, *i.e.*, land- and sea-forces.—(*To be continued.*)

Austrian and German Military Laws. A lecture by the Austrian Judge-Advocate-General, Dr. Hecht, which compares the present military laws prevailing in the two countries. This subject owes such interest as it may awaken in Austria and Germany to the present general tendency to bring laws, policy, administration, organization, etc., into line in order to facilitate a possible future union; a tendency of which another expression is the interchange of officials for periods

of attachment. For foreigners the chief interest lies, not in the comparison, but in the spirit which breathes from such an utterance as that the armies of Austria and Germany "are the firm foundation upon which will be built up the conscript armies of the future."

The Austrian Army of To-day, by Colonel Schubert. At the Armistice a large proportion of the German-Austrian troops, who during over four years of warfare had always had more than their share of "sticky" places, were on the Italian front and there fell into "After-the-war-prisonership." All those who returned home were immediately discharged, owing to the new republic having no army.

The politicians, however, started creating a People's Defence Force, which by the end of December, 1918, had reached a strength of 1,700 officers and 58,000 men. This force was run on social lines, the Soldiers' Council and the Commanding Officers forming a dualism. The conditions in Vienna when this army commenced its career were so unpromising that the prophecy regarding it made by a General of the old army, is recalled:—"Produced by poor parents in domestic discord, it has a hard youth ahead." The hard youth anticipated is now past, and the army, which was wisely bound on to the traditions of the old army, has made good in every way. It is probable that this success is in great measure due to certain concessions forced at the outset upon the Social-Democrats by their more conservative opponents, the Christian Socialist party; which included the removal of the army entirely outside politics, the limitation of the powers of the political agents, especially as regards commanding officers, and facilities in the matter of taking over officers of the old army.

The article contains many interesting photographs of the army's varied activities, including two of emergency engineering operations, and others of mountain-guides on skis, and of training in ice-technics on a formidable glacier. For further information one is referred to *Oesterreich's Bundesheer*, published by M. u. T. Mitteilungen, Vienna; price sch. 5/-.

The Crossing of the Piave by the British in October, 1918. A translation of Major Kerrich's article in the *R.E. Journal*, December, 1927. The translator makes a few comments at the end. He cannot pass the claim as to greatest length of bridge, and mentions other bridges varying in length from 550 metres to 966 metres and over. His principal comment is:—At nearly every opposed river-crossing two crises can be observed. The first occurs after the landing of the first party to be shipped across, when, through hostile action or lack of engineers and means of crossing, the transhipment of the following parties is either delayed or becomes impossible. When the crossing proper has been gained and the forces established in the bridgehead, small or large as the case may be, have to keep off systematic hostile counter-attacks and to preserve communication between the banks from interruption, then begins the second or more critical stage of the river-crossing. This crisis lasts nowadays longer than formerly owing to the exposure of the bridge to destruction by aircraft, as well as owing to increased ranges, and remains even when the line has been pushed far beyond the point of crossing.

Lieut.-Colonel Kubitzka, who was in the Papadopoli sector in August and September, 1918, doubts from his own experience whether the crossing described would have survived these two critical stages, if it had struck against a firm defensive front. He points out that at the end of October, when divisions were already marching home, no counter-attack was possible. Of which fact cognizance was taken in the *R.E. Journal*, March, 1928, p. 175.

The Development of Artillery Material since 1914 (*continued*). Comparatively little is known about modern British artillery material, and almost nothing about the heaviest of the land-army. This is for the greater part due to British reticence, everything above 9·2″ being kept secret; and partly also because only in a few cases have British firms supplied foreign armies. The description of British heavies on movable mountings is hence confined to the 9·2″ Howitzer Marks I and II, and the 12″ Howitzer, also by Vickers, built for the Russians. The performances of the first and last named Major Heigl considers "weak," and of the 9·2″ Mark II "not great." At that, like all British guns, they are heavy. He would say "much too heavy," but for recognizing that being designed for use in flat country there has been a costly preference for the lower angles, whereas the Austrians, with their mountain frontiers, prefer the upper group. The Austrians never having built such guns can hardly look upon the enormous weights of the English guns as constructional faults. It is quite another story when we come to judge the English guns from a constructional point of view. "We are giving no secret away when we say that by those best qualified to judge among their allies, *i.e.*, among the French and the Americans, the English constructions are generally looked at with an indulgent smile, sometimes with a shake of the head; and that the Italians, whose technical judgment is extraordinarily clever and impartial, while acknowledging the precision and robustness of these English guns, adopt the same attitude."

Major Heigl dissociates himself from these judges. The heaviest British mortars were built literally for rapid fire. He recalls Cambrai and the 8th August, the "black day" of Amiens, and reminds his comrades who were opposite to the British in the Montello sector, and in the Sieben Gemeinden, of the deluge-like inundation of a hostile battery by large-calibre projectiles which was the British method. The advantage of his experience has helped Major Heigl to a better understanding.

Technical Progress of Aircraft Construction and its Influence upon a Future War (*concluded*). Having decided so clearly against what objects the attacks of aircraft can and cannot be directed, the author proceeds to the problem of the tasks to be imposed upon aircraft in a future war. The state of technical development now reached gives air-forces, in addition to their original role as auxiliary to land and sea-forces, another and independent role as a third weapon to the army and navy for the political furtherance of war. The author confines himself to a consideration of this independent role.

The object of war is the destruction of the enemy's will to war. This will to war has three chief supports, which are in the order named,

(1) the will to war of the hostile nation, (2) the country of the enemy as the material source of his power to conduct war, and (3) the enemy war-forces.

Sea- and land-forces can generally only affect (1), the most important of these supports, indirectly by successful action against (2) and (3), *e.g.*, by blockade or occupation, and by battle respectively.

Air-forces can, however, attack directly the first and chief support. Whether they will do so or not must depend upon circumstances, which determine their likelihood of success. Even gas and incendiary bombs may not add sufficiently to the horrors inflicted upon civil populations by hostile aircraft attacks, to destroy their will to war, where the people are willing, patriotic, disciplined and protected, or the scale of such operations is too small. When direct action against civil populations is not of sufficient promise, the independent air-forces will co-operate with sea and land-forces upon the only lines possible to these latter arms.

Having settled the methods of employment of air-forces, Capt. Ritter devotes the remainder of his article to the means at their disposal for attacking the chief support to the enemy's will to war, *i.e.*, the will of the people, or its support of next greatest importance, the material sources of its war-power.

The Official Austrian History of the War. A review by Major-General Kerchnawe of the second of six parts of Vol. I, which dealt with 1914.

Vol. I, price sch. 45/-, was issued complete in December, 1929—publishers, M. u. T. Mitteilungen, Wien I, Stubenring 1.

The Advance of the Soviet Power in Asia. A review by Colonel Paschek of Cleinow's *Zum Aufmarsch der Sowjetmacht in Asien*, published by Reimar Hobbing, Berlin: large 8vo, 426 pp., 12 maps and 47 pictures.

The object of the book is to fill a special gap in the literature of Asiatic problems. Cleinow travelled from Kusnetzk to the Altai Mountains making studies on behalf of a German scientific society. He deals principally with the valuable portion of Central Asia, to so-called New Siberia, or Sibkrai, that is the territory along the railway from the R. Irtish to Lake Baikal, and southwards to include the Altai Mountains. It thus appears to include the greater portion of Mongolia, all except the Gobi Desert. Cleinow estimates that there is room here for 80 million inhabitants, subsisting on agriculture, cattle, forestry, mining and allied industries. He considers the opening up of this country of enormous importance to Russia, as the key to her military position in Asia, and he looks forward to Germans being given a hand in the process.

The Mobilization of Industry. A description of the measures to this end taken in the United States, starting with the National Defence Act of June, 1920, the officials concerned, their duties and activities. The Assistant Secretary of War is said for this purpose to have secured the co-operation of over 600 leading representatives of technics and industry, and to be in touch with over 10,000 factories and other undertakings in various districts.

F.A.I.

HEERESTECHNIK.

(*July*, 1929.)—*The Influence of the Technical Development of the Fire-arm on Infantry Tactics* (*concluded*). In a series of articles with the above title the author does not consider himself called upon to take up any direct attitude towards the actual unsolved problem of rifle and machine-gun, of which he has given us the extreme opinions, viz., on the one side, that the rifle must remain the infantry's chief weapon, with all other infantry weapons auxiliary to it: and on the other side, that the role of the rifle is played out, and the machine-gun must take its place. He has, however, to consider and judge upon the capabilities of all the infantry weapons. Of the rifle itself he says that it came up to all expectations at the commencement of the War. That its effect was ranked so low at the end of the War was due to the infantryman, who had been highly trained in its use, having almost entirely disappeared. The rifle remains the same, a weapon of good precision at short ranges, but also a long-range weapon. The heavy machine-gun likewise remained technically the same as when the War began. It is an excellent long-range weapon, irreplaceable by even a comparatively large number of rifles. It is also unsurpassable at even the shortest ranges, *e.g.*, against infantry assault. In addition, it possesses the possibility of tackling effectively an invisible opponent by means of indirect fire, where rifle-fire would under the most favourable circumstances be inadequate.

The light machine-gun, born of the necessities of trench-warfare and of fighting in the air, is a short-range weapon, and hence only an auxiliary. If the automatic pistol had come earlier and in sufficient numbers it might, at any rate partly, have taken the light machine-gun's place. All other infantry-weapons, the automatic pistol, the hand-grenade, the rifle-grenade, the trench-mortar, are dismissed shortly as auxiliaries. Upon the comprehension of all these different weapons to a combined effect the principles of fighting-formations must be built up. It is the task of tactics so to shape the latter that the capability and particular nature of each kind of weapon is fully utilized in this co-operation.

If it was attempted in the present state of affairs to earmark the rifle again as the principal infantry-weapon, it would show an incorrect appreciation of its powers. The fire of m.g.s is, as things stand, far superior to that of rifles. But the rifle is entirely capable at all ranges of furnishing a supplementary to m.g. fire, which must by no means be undervalued. To use it as a short-range weapon of precision would be to waste its capabilities. As much could be done with a less perfect weapon and with less powerful ammunition. Moreover, the technical development of the rifle is as yet incomplete. Automatic rifles exist already, and there is no reason for believing that the difficulties cannot be overcome of producing an automatic rifle, suitable as an infantry-weapon, and firing its whole magazine without removal from the shoulder. Such a weapon might well make the ligh: m.g. unnecessary: it is very doubtful whether it would essentially diminish the importance of the heavy machine-gun.

Fresh forms of tactics would, of course, follow the introduction of so great an improvement in the existing rifle, and the wishes of the exponents of the rifle as principal infantry-weapon would gain in importance; but even then it is doubtful whether the rifle will ever regain the prominent position of, say, the flintlock with bayonet.

In our technical age the machine, and that the simplest fire-arm has always been, can always do without the man more and more, only never entirely so; while the man can always less and less do without the machine.

It will be noticed that in the foregoing no attempt has been made to go into the effect which the artillery has always had upon the forms of infantry tactics. This has been done on purpose to emphasize the influence of the infantry-weapon, even at the risk of somewhat distorting the picture.

The Advantages of the Diesel Engine for Aircraft. Taken from an article in *Automotive Industries*, December, 1928, and of interest because the conclusions arrived at are based upon extensive trials in the United States.

The two most important requisites of an aircraft engine are safety and reliability; and these are both the Diesel engine's strong points. A flash-point of 70°C for heavy oil, compared with 7·5°C for aeroplane petrol, means the diminution, if not complete removal, of that danger of fire which exists with all aircraft using petrol. In working in the laboratory on new types of petrol engines for aircraft, fires are more or less a daily occurrence. During the time, nearly a year, in which work was going on in the laboratory on the new Packard-Diesel aircraft engine, no single case of fire has occurred, owing to a stream of oil running over the hot engine. All experiences justify the statement that fire on a Diesel-engined aeroplane after crashing is almost impossible. As regards reliability the Diesel engine has a great advantage over the petrol engine, owing to there being no magneto and no carburettor. Comparing the ignition system of a 9-cylinder Star-engine petrol-driven with a 9-cylinder Star Diesel engine, the former needs two independent sources of ignition-current, batteries or magnetos, two feeding-systems for the same, 18 high-tension leads, 18 sparking plugs, etc., perhaps a grand total of one thousand separate parts: the latter firing by compression requires no further parts, and ignition is secured as long as the engine works. Further, the ignition of each separate cylinder is entirely independent of the others, so that it has as many ignitions as cylinders, while the petrol engine of similar type depends on the functioning of two separate systems each of which consists of a number of parts, each of which is liable to failure.

The greatest advantage of the Diesel engine for aircraft is not mentioned in the article, since it does not apply to the United States, the world's greatest oil producer. It is, that a country like Great Britain, possessing coal, but no oil, could, since the heavy oil on which the Diesel engine runs is obtainable from coal, regain that supremacy based upon coal which is jeopardized by our dependence upon other countries for the petrol we need in war.

The Camouflage of Sound. A plea for the extension of camouflage

to include sound. The sphere of observation having been extended by aircraft, movements take place more and more under cover of darkness, or mist, natural or artificial. Increased importance is therefore to be attached to an absence of all betraying noise, to its avoidance, diminution, or concealment by other sounds. Above all, owing to the success of sound-ranging it is necessary to suppress the noise of gun-discharge; and much has already been achieved to this end by mechanical means, by chemical means, or by both combined.

The head-wave (*onde de choc*), which precedes the report of the gun, whenever the muzzle-velocity exceeds the speed of travel of sound, requires also to be dealt with, and appears as yet to have defied all efforts at treatment.

The German Air-map. Taken from *Nachrichten für Luftfahrer*, 1929, No. 25. Apart from provisional maps for airmen produced during the War, the first steps towards a German air-map were taken in 1926. First, a sheet of 1 in 200,000 was drawn up according to requirements laid down by the Aviation authorities. A recognition, however, that the increasing speed of aircraft would make a map on so large a scale unlikely to last, led to the first proposal being abandoned, and an attempt was made at 1 in 300,000 to satisfy the requirements of the aviation authorities, with corresponding modifications. The result was not satisfactory. A solution was then sought on quite fresh lines. Aviation was using exclusively the Government Survey Office General Map $\frac{1}{300,000}$, originally made as a military route-map, and by no means ideal for use as an air map. It was decided to use this map as the basis of a new map. An ideal air map can indeed not be obtained by the alteration of an existing map; but financial considerations rule. As it is, it will take ten years, with the existing personnel, to convert the 51 existing sheets of this map into an air map, preserving rivers, woods and ground-form, and all important names, and omitting all superfluous detail. This will cost one-quarter of what an entirely new map would cost, and take one-quarter of the time to produce. The new air map will be both more distinct and more legible than the present $\frac{1}{300,000}$. It will fulfil the two main requirements of an air map, viz., enable the airman to locate himself, whatever his height; and call his attention to things he ought to see, like wet meadows, power-lines, etc. Rivers and railways, being important for orientation, will be sufficiently emphasized. The same with large woods; but the reproduction of all details of the shape of woods, and the existence of small plantations, afford difficulties which are unavoidable as they arise from the scale. As 300 metres is represented by 1 mm., a wood smaller than 300 m. × 300 m. cannot be shown. The representing of villages also provides difficulties. Towns are shown in their outlines, but villages by means of a circle, or if there is a church, by a circle with a cross in it. These circles are only correct in that the centre of the circle coincides with the centre of the village: they give neither extent nor relative size. The showing of village shapes can only be done to the prejudice of other things more important for orientation.

Roads are taken from the General Central Europe map 1 in 300,000. It is seriously to be considered whether considerable simplification might not be introduced, *e.g.*, retain only the main roads. The chief difficulties are that only the man in the air can decide which are the roads he wants to see on the map, and that it is much easier to leave out a road than it is to put it in again. The greatest difficulty of all will be showing the heights. Levels shown by different colours would certainly be best; but the colour-plates for the height-levels will have to be cartographically entirely redone. Names will be much reduced: the qualification for a village to have a name will be the possession of a railway station.

Admitting that an ideal air map cannot be obtained in this way, a real improvement on the present state of affairs is aimed at.

The Detection of Mustard Gas. The Red Cross convened at Brussels a committee of experts, at the instigation of which it offers now a prize of 10,000 Swiss francs for international competition for the best re-agent for recognizing mustard gas. Considering the ready reaction of mustard gas with all oxidizers, even furious reaction with bleaching-powder, and the ready and widely distributed response to it of the human body —*experto crede*—one suspects a snag. Here it is: the committee demand a recognition of ·7 milligramme per litre of air. The competition closes on 31st December, 1930, and the prize may be distributed to two or more competitors.

(*August* 1929.)—*Accumulators.* Compares the two types of accumulator used in the German Army in the wireless service. They are a 2-cell lead accumulator, and the Edison accumulator, in which the electrodes of each cell are four nickel and two cadmium plates, and the electrolyte is KHO. Regulations for the charging, use and care of both sorts are laid down in H.Dv 493 (50). The lead accumulators are superior electrically; the Edison, mechanically, and are used where weight and space are considerations; also where they are liable to be shaken or misplaced. A weak point in the latter is the means of closing, but a new valve-like stopper has been devised with very small holes, which allows the accumulator, once it has stood for three hours after charging, to be turned upside-down without loss of electrolyte. This device has passed satisfactory trials and is now being tried out by the troops.

The Advantages of the Diesel Aircraft Engine (continued). What is always looked upon as the chief advantage of the Diesel engine, viz., the saving by running on heavy oil instead of on petrol, is relegated by the author to third place, after safety and reliability. This is done because he considers the two factors last named as of much greater importance for the growth of the industry on sound lines. When the superiority of the Diesel engine for aircraft regarding safety and reliability is established in people's minds, then the decisive factor in favour of its introduction will be the economic one. The saving compared with petrol divides into (*a*) 20% decrease in fuel-consumption, (*b*) 70 to 80% decrease in cost of fuel, (*c*) owing to greater reliability a reduction in the number of engines of larger aircraft, less running costs, and less maintenance.

The crux of the whole matter would, however, appear to lie, not in any one of the three advantages claimed, nor in robustness, nor in weatherproofness, nor in all of these combined, but in whether the Diesel engine can replace the petrol engine in its suitability for aircraft from the airman's point of view. This has certainly not been the case during the twenty-five years in which it has been known and used for stationary and marine engines. Slow speed and lack of elasticity have stood in the way of its introduction, even for automobiles. The solution which has enabled the Diesel engine to become a competitor in the air lies in the production of the high-speed Diesel engine (1,400 to 1,500 revs. per min.). Since a Diesel aircraft engine has to run five or six times as fast as a stationary or marine Diesel engine, the ignition-point being approximately the same, the h.s. Diesel engine demands entirely different combustion from the low-speed. Oil injection with the h.s. Diesel must start 50° before the upper dead centre, if complete and smokeless combustion is to take place, whereas in the l.s. Diesel engine oil injection starts about 10° before the upper dead-centre and lasts to about 32° beyond it. Thus with the h.s. Diesel the work-cycle does not differ much from that of the petrol engine. The chief difference is that with the petrol engine at the moment of ignition the whole charge is in the cylinder, while with the h.s. Diesel at this moment only a small percentage of the charge has been injected. This circumstance enables the designer to keep the rise of pressure in the cylinder within defined limits.

It is instructive that this assault upon the petrol engine's position should come from the United States, the country above all others which is least interested in fuel for aircraft being derived from coal instead of from oil.

Military Technical Problems in the Most Recent Literature. Kaiser and Army, by Lieut.-Colonel Niemann, is a book about William II., which does full justice to the Kaiser's interest in the army in peace-time, and the many technical improvements he helped to bring about. "His practical aptitude for science enabled him to keep pace with the feverish development of his times." Amongst the activities mentioned are, the inclusion of heavy artillery in the field army, the timely creation of technical troops, the provision of co-ordinated systems of frontier-fortresses, the development of the railway network, up-to-date equipment of the medical services, etc. It was no fault of the Kaiser's that Germany had made insufficient material preparation for war. Here he found the political situation against him, an attitude which the author says was "due to an erroneous impression that war would be short and would quickly lead to a decision."

"Thoughts of a Soldier," by General von Seeckt. The late Chief of the General Staff sketches the war of the future, discusses the means to mobility, the impossibility of keeping national armies abreast of the rapid progress in technics, co-operation with industry, modern cavalry, the place of the tank, etc. Almost all that he writes is interesting and much of it is worthy of study. Some thought-splinters are, "The modern Cavalry Division will need to be entrusted to a modern Seydlitz"; "Against technical means of attack equal technics has always found a

defence"; "It is quite wrong to speak of the victory of material over man. Material has conquered man in the mass, but not man himself, and never will do so, since it only gains life in man's hand."

"Armament and Disarmament," by Colonel von Oertzen, reviews in a capable manner modern armies and armaments. It might have been written in response to a remark of the Minister of Defence at the manœuvres in Schelsia, when he recommended, owing to Germany's restrictions in this respect, the necessity for German officers to study the efforts, experiences and successes in technics in foreign armies.

F.A.I.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1930. TOME I.—NOS. 1 TO 3 INCLUSIVE.)

Les opérations de l'Armée belge, 1914–1918. The events of the period June 6th, 1916—July 7th, 1917, are dealt with in No. 1 of the *Bulletin;* the general situation at this time is briefly reviewed. At a Conference held at Chantilly on November 15th and 16th, 1916, it was decided that plans should be prepared for a new offensive to be launched in February, 1917. A plan of operations was accordingly worked out; it was approved by Joffre, who, however, handed over command of the French Army on December 16th, 1916, to Nivelle. The latter introduced some modifications in the plan, and the date for launching the offensive had for various reasons to be postponed from February to April, 1917. In March, 1917, the Germans fell back to the Hindenburg Line; this move necessitated new dispositions on the Anglo-French front.

The British offensive in Artois was launched on April 9th; the operations continued until May 4th (Battle of Arras, 1917): the effort met with success, but no decisive result was obtained.

The French main attack was delivered in the region of the Aisne on April 16th (Second Battle of the Aisne), but was unsuccessful. In consequence, Nivelle was superseded, and Petain took command of the French Armies on May 17th, 1917.

The Italians did not launch their offensive until the middle of May; they obtained a substantial initial success in the region of the Isonzo, and desultory fighting continued for some weeks.

A revolution having broken out in Russia in March, 1917, the Russian Army, which was then under the influence of the Bolshevists, remained inactive. Fortunately, the United States of America now decided definitely to support the Entente Powers, and declared war against Germany on April 17th, 1917.

The Belgian Army was during this period engaged in minor operations on a front extending along the Yser Canal; its right rested at Boesinghe. A scheme was prepared for landing a portion of the British Army on the Belgian coast behind the German right flank, and it had been intended that the Belgians should take part in the proposed operations. The scheme was not carried out, but an outline is given in No. 1 of the *Bulletin* of the role assigned to the Belgian Army therein.

Particulars are also given of the preparatory work in connection with the scheme and the raids which were carried out by the Belgians.

The events of July 7th—November 13th, 1917, are dealt with in Nos. 2 and 3 of the *Bulletin*; the Second Battle of Flanders occupies the chief place in this part of the narrative. Although the operations in question did not free the Belgian coast, important tactical successes were gained and heavy losses inflicted on the German Army.

The French gained successes in minor operations carried out at Verdun (August 20th/26th) and at Malmaison (October 23rd/26th); in the latter case, the Germans were obliged to withdraw their troops from the Chemin des Dames.

In the other principal theatres, affairs took a most unfavourable turn, so far as the fortunes of the Entente Powers were concerned. On the Eastern Front, Brousiloff met with a temporary success in E. Galicia, but his troops were permeated with Bolshevism, and, in mid-July, when the enemy struck his first serious blow, the Russians gave way and a panic ensued. It was only when the confines of Bessarabia were reached was Korniloff, Brousiloff's successor, able to stem the invaders' advance. In the midst of these disasters, the Roumanians put up a stubborn fight on the Sereth.

At the beginning of September, just when the situation had been restored on the Russian Front, the Germans seized Riga by a surprise attack, and, in October, occupied the islands in the Gulf of Riga without any great effort. On November 8th, Lenin and Trotsky took over the reins of government in Russia, and two weeks later opened negotiations with Germany for an armistice. Freed from anxiety as regards Russia, the enemy launched a powerful offensive against the Italians on October 24th in the Frioul region; the Italian Second Army met with a serious defeat at Caporetto. The whole Italian Army now fell back; it was able, however, to take up positions on the Piave, and the enemy's advance was definitely checked on November 10th, although fighting continued up to the end of December. Supports were at once rushed from the Western to the Italian Front; the transfer of reinforcements (six French and five British divisions) began on October 28th, and continued for some weeks. French units took their place in the Italian line on December 4th.

An Inter-allied Conference met on November 17th, 1917, in view of the seriousness of the situation; its labours resulted in the preparation of a scheme for the creation of a Superior Inter-allied Council of War.

A brief outline is given of the Battles of Ypres, 1917. Further particulars are also given of the scheme relating to the proposal to land a British force in the neighbourhood of Ostend. It was proposed that a Franco-Belgian Army of the North, consisting of six French and six Belgian divisions, should be constituted and placed under the Belgian King; it was intended that this Army should cover the left flank of the British force detailed to operate against Ostend.

The text of a memorandum from the Chief of the Belgian General Staff to the C.-in-C. of the French Northern and North-Eastern Armies is published in No. 2 of the *Bulletin*; therein, it is pointed out that

constitutional reasons made it impossible for King Albert to accept the command of French troops. It is also stated that, in the opinion of the Belgian General Staff, the chances in favour of the success of the proposed landing operations were small and, in consequence, the Belgian Army could not participate in the scheme.

The text of the Convention dated June 17th, 1917, which was entered into by Petain, Haig and Ruquoy (Chief of the Belgian General Staff) in relation to the operations to be undertaken by the three British Armies, the French First Army and the Belgian Army during the summer of that year, is published in No. 2, and the preparations which were made to give effect to the scheme are briefly described.

The operations of the Belgian Army, known as the Battle of Flanders, 1917, are described in No. 3; a tabular statement shows the minor operations carried out between October 20th and November 12th, 1917, by the Belgian Army.

L'attaque des objectifs au sol par l'aviation allemande. The original article is contributed to No. 1 by Capt. Commandant Van Derr Donckt, who points out that during the first weeks of the Battle of the Somme, 1916, the pilots of the Entente formations acquired a dominating position in the air warfare; their unchallenged supremacy produced a demoralizing effect on the German troops. References to this subject in German publications are mentioned in the original article, and extracts from some of them are quoted. The German High Command felt that the only satisfactory way to meet the situation would be by carrying out vigorous counter-thrusts. Accordingly, during the winter of 1917/1918, in preparation for the offensive of the following spring, von Hoeppner, the C.-in-C. of the German Air Force, assembled selected officers of the air arm at G.H.Q. with a view to studying their battle problems at a Kriegspiel. An account of the conclusions arrived at on that occasion has recently been published by Colonel Jochim. The present-day German air tactics are based on the lessons of 1918, and as this subject is of equal interest to the Air Force and the Army at large, a brief review of the salient features of the German practice has been compiled for the *Bulletin*.

L'organisation militaire de la Pologne. An outline of the military organization of Poland is contained in No. 1 of the *Bulletin*. Military service is compulsory; obligation to serve begins, in peace time, as soon as a young man is 21 years of age, and, in war time, as soon as he reaches his nineteenth birthday. Young men may also enrol voluntarily as soon as they are 17 years of age. Service in the Active Army lasts two years, except in the cavalry, and in the marines—in the former the recruit serves for 30 months and in the latter for 27 months. Service in the Reserve continues until officers reach their fiftieth birthday and those in the ranks reach their fortieth birthday. Finally, ten years have to be spent in the Landsturm.

A Committee of National Defence exists for studying all problems relating to the defence of the country. The President of the Republic is the Chairman of this Committee, the members thereof being the Prime Minister, the Ministers of War, of Foreign Affairs, of Finance, of the Interior and the Inspector General of the Forces.

In peace time, the Minister of War is C.-in-C. of the Polish Army, the Inspector General and General Staff being directly under him. The Inspector General is the officer who has been selected for the position of C.-in-C. in the event of an outbreak of hostilities.

Poland is divided into ten military regions, an army corps being located in each of them. The peace establishment consists of 28 infantry divisions, two divisions of chasseurs, four cavalry divisions and six independent cavalry brigades. Each infantry division comprises three infantry (or chasseur) regiments and a field artillery regiment. Each cavalry division comprises three brigades (each of two cavalry regiments), two horse artillery brigades, one pioneer squadron and one machine-gun squadron. Each independent cavalry brigade comprises three cavalry regiments, one horse artillery brigade and one pioneer squadron.

The distribution of engineer units among the various formations is not stated; the Corps consists of ten sapper regiments; two railway regiments; two signal regiments and three independent signal battalions; one radio-telegraph regiment; one electro-technical battalion; one heavy bridging battalion.

The estimates for 1928/9 provided for a peace establishment of 17,100 officers, 37,000 N.C.O.s, 198,000 men and 1,724 cadets; a grand total of 253,824 all ranks. The population of the country was 30,212,900 at the end of 1927.

Un épisode de la défense de Liége. The original article is contributed to No. 2 of the *Bulletin* by Capt. F. Vandaele, who points out that few incidents of the Great War excited greater alarm than the commotion which occurred at daybreak of August 6th, 1914, in front of General Leman's headquarters at Liege. It was supposed at the time that an attempt to seize the person of the Governor of Liege had been made by German soldiers who had entered the town before the declaration of war and had remained in hiding until the opportune moment should arrive for them to carry out their special mission as a part of the plan for the *attaque brusquée* against the Belgian fortress. The truth in relation to this episode has been made public in many German narratives dealing with the War. The history of the 7th Bn. Prussian Chasseurs, one of the companies of which was involved in this incident, has recently been published, and provides material for dealing with exactitude with the whole of the facts leading up to the episode in question. Capt. Vandaele's article is based on this document, and he describes in some detail the adventures of No. 1 Company of the above-mentioned battalion; it became separated from the main body and passed through the Belgian defences at an undefended point. The inhabitants, thinking that the little band was the advance guard of British reinforcements which had suddenly arrived among them in the northern outskirts of Liege, not only gave the Germans a rousing welcome, but actually acted as guides to them and led them direct to the Governor's headquarters. The cheering of the crowd outside the building attracted the curiosity of a staff officer; he went to a window and, recognizing the German uniform at once gave the alarm. Fire was opened on the Germans, who replied.

It is evident that on this occasion the Germans did not pay heed to the lessons inculcated in military text-books. The story that is told shows brigade and company commanders pushing forward with their troops, without having taken the trouble to obtain intelligence of the enemy's whereabouts, and without any arrangements for maintaining liaison between the several portions of their commands; and, what is perhaps the most serious fault of all, without adopting the usual elementary measures for the protection of troops on the march.

L'organisation de la Défense Nationale en Italie. The original article appears in No. 2 of the *Bulletin*. The subject dealt with is treated under the following main heads: (1) General review of the problem of National Defence in Italy; (2) The Supreme Control; (3) The Army; (4) The Air Force; (5) The Navy; (6) Miscellaneous matters; (7) The Mobilization of the civil resources of the country; and (8) Remarks.

The original article contains much matter of considerable interest; only a few of the subjects dealt with can be touched upon here. The information contained in it is based partly upon contributions by Commandant Conquet to the *Revue Militaire Française* for November and December, 1929 ("L'Armée italienne en 1929") and by Capt. Touret to *La Revue d'infanterie* for June and July, 1928 ("L'infanterie italienne).

Comdt. Conquet considers that the Italian military system is particularly well adapted to meet the conditions imposed by the geographical considerations and the economical situation. Italy, he points out, consists of three distinct regions, which he names, "l'Italie continentale," "l'Italie péninsulaire" and "l'Italie insulaire"; each of them possesses a distinctive characteristic of its own. Northern Italy—*l'Italie continentale*—is by far the most important region; it is the most densely populated, richest and the most highly industrialized part of the kingdom, containing as it does three-fifths of the whole population, 90% of the metallurgical and 75% of the hydro-electric enterprises of the country. It is essential therefore that the measures adopted for the protection of this region should be adequate.

Important economic and political centres, such as Genoa, Rome and Naples, are situated in *l'Italie péninsulaire;* this region is by reason of its configuration extremely vulnerable.

L'Italie insulaire comprises Sardinia and Sicily, which constitute advanced bastions jutting out into the sea; this region provides a strategic position of incomparable value, a part of it situated, as it is, in the zone where the two Mediterranean basins meet.

Italy possesses a kind of Super-Ministry for the purposes of the supreme control of National Defence. Signor Mussolini, as Head of the Government, has for some time personally controlled the Italian Ministry of War, the Admiralty and the Air Ministry and is assisted in this task by a Chief of the General Staff, who, in peace time, issues "general directives" to the Chiefs of the Staff of the Army, of the Navy and of the Air Force respectively; he would, in war time, be a kind of generalissimo of National Defence. In no other country is there an officer with responsibilities and duties exactly similar to those of the Chief of the General Staff here mentioned.

The framework of the military hierarchy in Italy is constituted as follows:—

1. *The Supreme Command.*
   The King.
   The Prime Minister.
2. *Organ of co-ordination and preparation.*
   The Chief of the General Staff.
3. *The Executive Organs.*

	Army.	*Navy.*	*Air Force.*
Technical duties ...	General, Chief of Staff.	Admiral, Chief of Staff.	General, Chief of Staff.
Administrative duties ...	Under-Secretary of State, Ministry of War.	Under-Secretary of State, Admiralty.	Under-Secretary, Air Ministry.

The above organization has been designed with the object not only of ensuring unity of direction and continuity in matters affecting national defence, but also so as to provide for the co-ordination under the best possible conditions of the roles assigned to the several groups forming the national defence force.

The Italian Land Forces are permanently organized in armies (of which there are four); army corps (of which there are 12); and infantry divisions (of which there are 30). There are 111 infantry regiments, one tank regiment, 67 artillery regiments, 12 cavalry regiments and 17 engineer regiments in the above formations.

In 1918, the Italian Air Force possessed 2,600 machines; it was subsequently much neglected and almost ceased to exist. Signor Mussolini, recognizing the important part this arm will be called upon to play in the future, created an Air Ministry in 1925, and personally took charge of it; he has done much to foster the growth of this arm and to promote its efficiency.

The part of the original article which deals with the mobilization of the civil resources of the country merits particular attention, treating, as it does, with a subject in relation to which the literature at present available for military students is small.

Une page de l'histoire militaire belge. Le Siège d'Anvers. The original article is contributed by Capt. Wanty to No. 3 of the *Bulletin;* it contains an interesting account of the blockading operations carried out against Antwerp in 1584–5, by Farnese, the Governor of the Spanish Netherlands; the city was captured by him in August, 1585.

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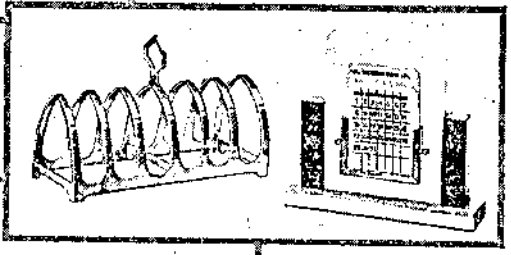

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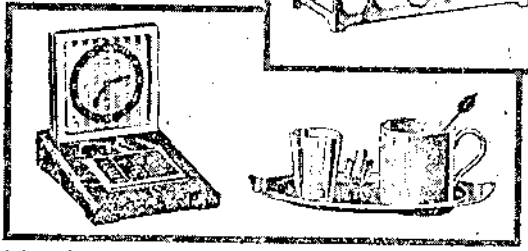

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