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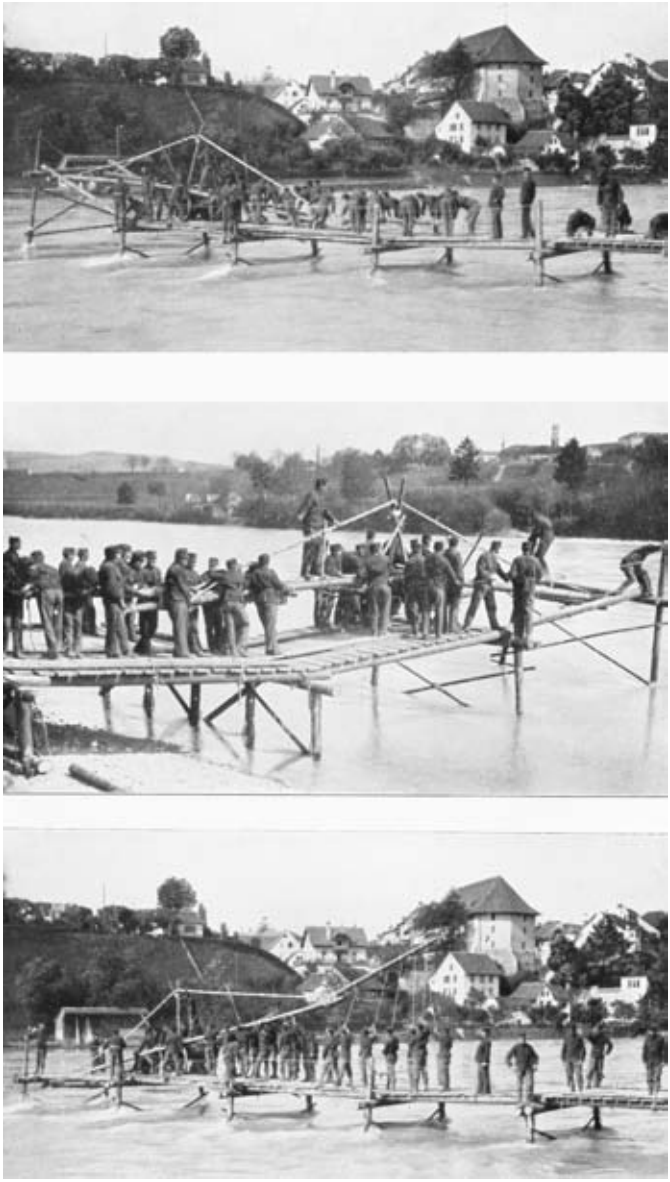

Trestling Bridging

THE PRINCIPLES OF ORGANISATION.

By Capt. J. W. S. Sewell, R.E.

In a recent article in the *R.E. Journal*, a writer called attention to the absence of any literature on the above subject. A great deal however has been written recently on what may be called applied organisation, that is to say organisation as applied to the Army generally or to some branch of the Army. Examinations cover a wide area, and entail an extensive knowledge of the details of this subject. It is moreover the fashion of the day, and doubtless has always been so, to criticise keenly such organisation.

But the principles of pure organisation, on which all applied organisation is or should be based, form no part of the curriculum of any Military School as far as I am aware. And yet these principles are as few, as simple, and as unchangeable as the fundamental laws of strategy. As with the laws of strategy, so the principles of organisation can only be violated with safety when exceptional factors enter into the personal equation. A few great leaders, knowing the personal defects of their opponents, have achieved victory by such violations of strategic principles as division of their force. In the same manner some great organisers achieve great results owing rather to their own personal genius and energy than to slavish adherence to fixed laws. Such cases are, however, the exceptions, and are only mentioned here in order that they may not be quoted as disproving the rules of pure organisation.

The subject is of great importance to the R.E. officer. It frequently occurs that he has to organise some undertaking *ab initio*. The officer who is zealous and energetic, and has good knowledge of detail but not of organisation, frequently starts off without efficient organisation and gets a long way by sheer personal effort. In war, with a short task and no time for organisation, this may sometimes be necessary, and is often very successful up to a certain point; but at the best a one-man concern is very risky. Under more normal circumstances the work has a knack of getting far beyond what the most energetic man can personally control in detail. An officer such as the above will probably find that his output *per caput* is diminishing; and, if he is to avoid chaos, he will have to inaugurate organisation, and produce order from confusion with a staff whose initiative he has successfully paralysed.

The most recent work on pure organisation which I have been able to find in the Chatham library is a French translation of a German pamphlet, dated 1869 and entitled *De la Responsibilité dans la Guerre.* This pamphlet contains a recital of the causes which weakened initiative and responsibility in the armies of the period. These causes are of sufficient interest to reproduce in detail :—

1. Uniformity of tactics in the armies of the 18th century, composed of unreliable soldiers of fortune, foreigners who required iron discipline, brave but untrained officers, and superannuated generals and staff.

2. The idea that it was necessary to keep soldiers always occupied; hence refinement and exaggeration of uniformity and precision in manual and drill. Small minds excelled in this and acquired undeserved reputations; but it rendered the service dull, and checked progress and the promotion of better men.

3. The importance consequently attached to detail by all ranks of the military hierarchy.

4. Numerous (ceremonial) parades; and peace manœuvres worked out to prearranged schedules, regardless of the realities of war.

After the above enumeration the writer proceeds to give sundry precepts with a view to correcting the errors. These precepts form an amplification of the first Rule of Organisation, which may be stated as follows :—

Give to each subordinate a definite responsibility; cultivate his initiative; and do not allow him to shirk responsibility within his sphere of action.

The precepts referred to make the operation of this rule clear, and a brief summary of the principal points is therefore given.

1. Separate and define exactly the sphere of action of each individual.

2. Thus prevent a superior encroaching on the duties of a subordinate, that is doing his work or deciding points which lie in his sphere of duty. Superiors should not only avoid such action themselves, but should see that those under them are not encroaching on the duties of their subordinates.

3. Do not permit work to become mechanical: with this object demand little, but insist on that being good.

4. Deal severely both with the official who, through want of attention to regulations, steps outside his sphere, and with him who "refers for decision" of a superior any matters within his own sphere.

The second Rule of Organisation is a corollary of the first;—

Throw off detail on to subordinates.

To thus let go of detail is by no means easy. It requires self-restraint to judge by results without interference with methods; and still more self-restraint to avoid short-circuiting a subordinate and giving orders direct to his subordinates. In civil organisations this

latter action would never be tolerated; but in military systems the sense of discipline makes it difficult for the subordinate to protest, and thus a bad habit has arisen. We all resent such interference by our own superiors, but are, most of us, somewhat prone to fall into this error ourselves.

But if initiative and responsibility are to be cultivated in our subordinates—if we are to be free to look around, to initiate, and to improve—interference in the sphere of action of our subordinates must be strenuously avoided. Our reward will come in the freedom gained from minor worries, enabling us, with full confidence in the ability of our subordinates, to attend to all current details, to take ourselves a wider and more comprehensive view, and to look ahead. I have heard the head of an important department, employing some 20,000 men and dealing with a turnover of nearly ten millions, complain that he had nothing to do: such men are organisers, who are not content simply to "carry on," but have always time to look ahead.

In the Army, most officers are provided with a "*fidus Achates*": the general has his staff officers, the battalion commander his adjutant, the captain his colour-sergeant, and so on. A good system of organisation may well result in peace time in reducing the work of these officials to a minimum. It will then be necessary to ensure that such assistants are not, in their desire to create work for themselves, regathering into their own hands the details which the superiors have intended to throw into the hands of subordinates. This is somewhat apt to be a weak point in military organisations; and the evil effects only become conspicuous in war, when such officials immediately become overworked, and the paralysis of initiative in subordinates becomes a heavy drag on the enterprise of the superior.

The third Rule of Organisation is:—

Limit the number of subordinates directly responsible to one superior.

With too many subordinates a superior will be tied to his office, and the result will be the same as in the case of a man who is hampered by detail. In considering this question in its application to the Army a most important object to be considered is the timely transmission of orders in the field. Prince Kraft, in his *Letters on Strategy*, says:—"The possibility of rapidly transmitting orders is one of the chief factors in deciding the number of divisions in a corps; and for this reason it is endeavoured to limit the number of subordinate authorities with which the corps headquarters have direct communication."

Though each organisation must be considered separately, and it is undesirable to be too precise when dealing with general principles, it may be suggested that, as a general rule, seven is a good maximum for the number of such subordinates: of these four may be heads of

major departments, and three of minor ones. The minor departments have a way of increasing as new enterprises are undertaken, and it may then become necessary to group some of them under one head subordinate. This principle has been adopted in the new system of organisation of the Army Commands at home by grouping the administrative branches under a Major (or Brigadier) General in charge of Administration.

The organisation of our Field Army Commands shows the embodiment of these principles very clearly. They are so arranged that, with one curious exception, the officer in command has:—(A) four principal subordinates; and (B) a maximum of three minor departments or services, of less urgent consideration in the event of a collision with an opponent.

An Army Corps has:—(A) 3 divisions, corps troops.
(B) supply and transport, parks, and medical.

A Division:—(A) Cavalry, artillery, 2 infantry brigades.
(B) R.E., supply and transport, ambulance.

A Brigade:—(A) 4 battalions.
(B) Transport.

A Company:—(A) 4 sections.

The exception referred to is of course the battalion with 8 companies. Controversy still rages round this anachronism; in fact the problem was given as a subject for an essay in the last promotion examination. It is not proposed to discuss the matter here, but briefly it appears to be a question of sound organisation *versus* regimental tradition.

As an example of bad organisation and its evil results, that of the Austrian Army in the campaign of 1859 is notorious. The fatal results of the paralysis engendered by the detailed orders of the Commander-in-Chief are too well known to need further reference.

To write clear, concise, and (in war) frequently hurried orders is by no means easy; it may be remembered that Goethe once apologised for writing a long letter by saying that he had no time to write a short one. To render a proper system at all possible, it is obviously necessary that it should only be requisite to give orders to a few subordinates, and that these orders should leave to them all questions of method and detail. In a work on tactics in the Chatham library, I find, in an example of the orders of a General commanding an infantry brigade, a cavalry regiment, a battery, and a company R.E., such orders as;—"No firing is to take place without orders from commanders of units"; "Arrangements should be made for providing each man before starting with biscuits and hot coffee." Why should it be necessary to consider that the regimental officers are incompetent fools? Surely it is within the sphere of action of a commanding officer to take such steps as may be necessary to bring his men to the ordered point in good condition.

Such are the conditions to be borne in mind by an officer fortunate

enough to be in a position to start organisation with a clean sheet. The question of the reform of army organisation is hardly germane to this article; but, inasmuch as one of the principal obstacles to be surmounted is the result of bad organisation in the past, it may not be amiss to refer to that unhealthy growth—the tendency to bureaucracy.

In war a number of officers are required for special duties, in excess of the real requirements of the army in peace. The necessity for finding employment for such officers in peace has, in the past, given rise to a system of administration in which such officers create work for themselves by redundant correspondence, refinements of check and audit, and interference with minute details, all tending to immense waste of labour, false economy, and passive resistance to progress. Without enlarging on this subject, I need only point to the extraordinary thirst for statistical information on the part of every administrative branch of the service; and to the intolerable delay in getting even a minor point settled, owing to the number of "post offices" which refer the question backwards, forwards, and sideways. The sister service is fortunately free from bureaucracy, and is correspondingly efficient.

An officer of the Egyptian army once told me that the "Babu" was scotched in that service by the fact that correspondence was conducted in Arabic, which most of the officers could not read. If a file showed signs of becoming too voluminous, it had a way of being "lost" out of a railway carriage window. Whilst not interpreting this narrative too literally, it has sometimes occurred to me that the introduction of Chinese as the medium of official correspondence would not be without certain advantages.

The modern tendency is to improve this bureaucracy out of the service, and undoubtedly great strides have been made of late years. But such reform can only be gradual; the task is Herculean; and to clear this mass of inertia out of the way is an undertaking that may well break the heart of an army reformer.

*OVER-SEA EXPEDITIONS.**

By Bt.-Colonel T. Capper, *p.s.c.*, d.s.o., d.a.a.g. Staff College.

It is impossible to go into all the details of the subject in a short lecture of this description. I propose therefore to give one instance† of a large force landing in the teeth of opposition from a civilised, and equally well-armed and disciplined, foe; and then to point out what a difference steam and modern armaments have made in this respect.

I will deal first with the landing of our troops in Aboukir Bay, in 1801. The French expedition to Egypt, which Napoleon hoped would be his first step towards the founding of a huge Oriental dependency to France, had met with a severe check. The gallant defence of Acre by Sir Sidney Smith had upset all his plans. Egypt right up to Philae (Assouan), where the names of his officers may still be seen carved on the walls of the ruined temples, was fully in his power; but the French forces, bounded on either side by deserts, could achieve nothing more. Furthermore the battle of the Nile, Nelson's famous victory in 1798, had given England command of the Mediterranean Sea.

Napoleon had reconciled it with his conscience to desert his army in Egypt and had returned to France, leaving General Menou (after the assassination of General Kleber) in command of the French army. There was no question of the army itself going back to France, for there were no ships. There was little opportunity of it invading India, as was its original intention; no ships were allowed to leave French ports in the East for any such purpose. Surrounded by hostile Arab tribes, and with a Turkish army assembling in Syria, there was no chance of an escape *viâ* the east coast of the Levant. Nevertheless the British Government deemed the presence of a French force of between 12,000 and 15,000 men in Egypt a menace to our Indian possessions.

* Shorthand report of Lecture delivered at the Royal Engineers Institute on 16th March, 1905.

† The main features of the principal over-sea expeditions since 1850 are recorded in the essay on *The best method for carrying out the Conjoint practice of the Navy and Army in embarkation and disembarkation, illustrated by the experience of the past*, which was awarded the Gold Medal of the Royal United Service Institution for 1904 and published in the April, 1905, number of its *Journal*.—Ed.

There was at this time at Gibraltar a British military expeditionary force. It was a picked force, and consisted of the flower of the British army. Its *rôle* was to act as required, using Gibraltar as a jumping off place.

This force made several false starts. It first attempted an attack on the harbour of Ferrol, near Corunna on the north-west point of Spain, where at the time lay six Spanish men-of-war. The landing was successful; but the General in command, being alarmed at the strength of the Spanish defences and the news he heard of the force the enemy were bringing up, re-embarked on his transports and returned to Gibraltar. Two months later the force attempted to attack Cadiz, but here again indecision and feebleness of command prevented success.

People now began to ask of what use was this splendid force, kept at Gibraltar; why continue the expense of its upkeep when it did nothing? Expeditions to Italy and to Spanish America were discussed. These very diverse objectives show us how wide the field of employment may be which lies before an expeditionary force having free use of the sea and situated in some central position; and the conditions will no doubt repeat themselves some time or the other in the future.

Under the then existing circumstances the Government decided on a descent on Egypt. The command of the Mediterranean was, by Nelson's splendid victory of the Nile in 1798, indisputably in the hands of the British. French despatch vessels could only with difficulty get in and out of Alexandria. A comprehensive plan was formed.

The special service force, amounting to 12,000 men, was to be despatched from Gibraltar under Sir Ralph Abercrombie, who had previous experience of this sort of work. The idea was that this force should proceed to Asia Minor, and there arrange for co-operation with the Turkish forces in Syria against the French in Egypt. Meanwhile an expedition was to be despatched from India to invade Egypt from the Red Sea side. That was the general plan of the campaign. We will see how it worked out.

The time of year was most unfavourable. The orders for the expedition were received at Gibraltar on the 25th October, 1800. Everyone knows that the Mediterranean is liable to severe storms in the winter; and to manage a large fleet of transports and battleships, all dependent on sails, in bad weather was a severe task. Nevertheless there was no hesitation in starting. All ranks were feeling the effect of their inaction and previous feeble attempts, and Sir Ralph Abercrombie was determined to satisfy their legitimate aspirations to show what they could really do. Like Sir John Jervis before the battle of St. Vincent, he felt that the country badly wanted a victory.

Malta was made the first rendezvous; and here the troops were partially disembarked and the vessels thoroughly put into good order. The next point made for was Marmorice Bay in Asia Minor, not far from Rhodes and about 150 miles in a straight line from Alexandria. To Marmorice Bay the expedition proceeded in two portions, and after a very rough voyage was finally established in the harbour by the 11th of January, 1901.

The Turks had promised material assistance in gunboats, cavalry horses, and troops; and a great deal of importance was attached also to the moral advantage to be derived from their support. The Turks are of the same religion as the majority of Egyptians; it was therefore fair to expect that the Egyptians would gladly side with the Allies against the French invaders. As results turned out the material assistance derived from the Turks was practically *nil*. They showed the worst traits of an Oriental nation. Even the horses they had promised were so poor that only 200 for the cavalry and 50 for the artillery could be utilised.

Nevertheless the delay at Marmorice Bay was profitably employed. The sick were landed and encamped; the ships were thoroughly overhauled and cleaned; and above all, the troops were constantly practised in the method of disembarking from the ships to the shore. This matter of practice was perhaps the secret of the ultimate success of the expedition. Marmorice Bay itself was a most suitable place for such practice; the water was calm, and there was plenty of room.

However it soon became evident to Sir Ralph Abercrombie that the Turks were absolutely useless. Their army, assembled at Jaffa, was found on inspection by General (afterwards Sir John) Moore to be incapable of action through sickness and lack of discipline. The Turkish gunboats, always faithfully promised, never turned up.

Meanwhile Sir Ralph Abercrombie became anxious. It was always possible that the French would get to know of the Turkish impotence and march to destroy them. It must also be recollected that communication with India was difficult, and the exact co-operation of the Indian expedition, or indeed even news of it, could not be depended on; there were no such things as telegraphs or quick despatch steamers by which news could be obtained. Sir R. Abercrombie's position was difficult; there was no information about Egypt at all, except what Sir S. Smith could give from his own experience which did not embrace the interior; there were no maps, and the best that could be made out and distributed to the Generals was most inaccurate; there was also no really exact information as to the French strength. Added to all this the time of year was most unfavourable; the Equinox was approaching, and the weather was consistently bad. Nevertheless, in spite of all the difficulties, the British commander determined to carry out the enterprise single handed.

The local pilots declared a landing on the Egyptian coast impossible until the stormy season was over; but on the 25th of February the expedition left Marmorice Bay in 175 vessels. The effective British force in the field can be reckoned at 12,000; it was formed into six infantry brigades, one cavalry brigade of two regiments, and an infantry reserve division under General Moore. The voyage was accomplished in fair order, notwithstanding the weather; but one mule ship foundered and some of the other smaller vessels, carrying mostly animals, got separated; this caused great anxiety least all the horses and transport animals should be lost. Two Royal Engineer officers, sent in to reconnoitre the coast, unfortunately fell into the hands of the French in Aboukir Bay, one being killed and the other taken prisoner. Furthermore a French vessel, which had by mistake fallen in with the British flotilla in the night, sailed in the company of the British vessels for some days, wisely hoisting the English flag and answering all the signals made; she kept her identity quite secret till near Alexandria, where she eventually arrived with news as to the approaching expedition.

The British expedition arrived at Aboukir Bay on the 3rd of March, but the weather was so bad that no landing could be attempted till after the 7th. These circumstances combined to give the French ample notice of the intended invasion, of which they were not slow to take advantage.

One may ask, why did not the expedition change its point of attack, since all chance of surprise was over? It was very much a question of Hobson's choice; there was no other suitable place; by reason of the surf on the north shore it was impossible to land there. Moreover it must not be supposed that Aboukir itself was the sole objective; it was intended to take Alexandria, and so secure a sea base of operations for further operations in Egypt. Aboukir was a sheltered harbour; and on the northern side of the coast, between it and Alexandria, there was deep water so close in shore that vessels could work alongside the troops and keep them supplied with the necessary provisions, especially with water. Furthermore the place itself was one well calculated to inspire an Englishman with a high spirit. It was the actual site of the battle of the Nile. In that action the French fleet had been destroyed as nearly as possible on the five-fathom line of Aboukir Bay. On this occasion the British fleet took up exactly the same position as the French fleet in 1798; and one of our men-of-war, the *Foudroyant*, actually chafed her cables against the wreck of the *L'Orient*, and later on fished up her anchors. One can imagine what thoughts filled the British troops at the idea of another conflict with the French on this historic ground, and how our army must have determined that if the navy had a victory of the Nile the army must have one also.

On the 7th of March, as the weather had somewhat moderated

and the surf to some degree subsided, the Admiral and General went in a boat to examine the shore by personal inspection. At the same time Sir Sidney Smith was sent with three armed launches to endeavour to get information. This little party landed at the entrance to the Lake of Aboukir (Lake Maadie), and drove off a party of 50 of the enemy who held a blockhouse; but as observers on the ships could see a large number of French moving down to attack the party, it was recalled to the ships. They brought away the ferryman at the point, but he could give no information. It was, however, clear that the French had made full use of their opportunity of organising a resistance, and it became known that they would oppose the landing with at least 2,000 men and 15 field guns, all under excellent cover behind the sand hills which abound on the beach. The appearance of the beach from the sea shows a succession of these sand hills, rising at times to a height of 180 feet and interspersed with a few date palms. The French further had the service of 10 guns and 2 mortars in Aboukir fort.

On the other hand the English men-of-war could not approach close enough to assist the landing to any material extent with their fire. It should be observed that the five-fathom line is about two miles from the shore at this place. Small vessels, such as gunboats, could stand in close; but the assistance of the broadsides of the battleships was denied. There was not sufficient boat accommodation for the whole force to land at once; so it was decided that the first landing party should consist of the Reserve Division under Major-General Moore, the Brigade of Guards, a portion of the 1st Brigade under Major-General Coote, and 1,000 seamen under Sir Sidney Smith to drag the guns up the hills. This force (numbering about 5,500 with 10 guns) was put into about 150 boats; the remaining men of the 1st and 2nd Brigades were placed in light-draught ships to stand as close in shore as possible and act as a support, with the idea of being landed by the boats as soon after the first party as could be managed, by which means the second trip of the boats would be reduced in length.

At 2 a.m. on the 8th of March the troops destined to form the landing party entered their boats. At 3 a.m. a signal was made for all boats to proceed to the rendezvous, a light-draught vessel anchored in front of the fleet about gunshot from the shore. Seaward of this vessel the boats were to form up in three lines; the first consisting of launches and flat-bottomed boats containing the infantry and artillery; the second of all the ships' cutters which were to give assistance to the first line on landing; and the third of ships' cutters and boats in tow. One can imagine the difficulty of accurately deploying a boat flotilla of this size, and the operation of lining up was not completed until 9 a.m. The flanks of the boats were protected by armed gunboats; two bomb vessels were placed to cover

the landing with their fire; three other vessels were moored with their broadsides to the shore for the same purpose, but the water was so shallow that none of these could render material assistance.

The undertaking was an imposing one, and the risk of failure extreme. There was no question of elaborate tactics: it was just a frontal attack, imperfectly supported by artillery, against a vigilant enemy in a prepared position. The French, formed up in a semi-circle, well covered, and with their left flank resting on a fort, could not believe the English were really mad enough to attempt to force a landing at this point. But it must not be supposed that the latter were acting recklessly, or in any but a properly thought-out and cool manner. As I have said, if they wanted Alexandria they had but one point where they could effect a satisfactory landing. The risk was thoroughly realised, and elaborate and careful preparations were made. There was no question of seeing red and charging a strong position in a reckless, bull-headed fashion. The Admiral in command of the fleet had, while at Marmorice, issued most elaborate instructions to his officers. So early as the 24th of January, six weeks before the actual operation, general principles were settled and circulated, and the orders in general terms of both the Admiral and General issued. In this we have distinct evidence of the value of the practice obtained at previous landings.

There is one point which is interesting. The formation was that of companies in company column. The second and third lines of boats contained men of the same company as the first line, so that when the boats of the first line took the shore they were supported by other boats containing men of the same companies. I should think the conditions are so different now that this plan could hardly be carried out. It was intended that the second and third line boats should run up between the first line flats, which were to take the shore at about 50 feet intervals; the flats hauling off clear, as soon as they had discharged their load, by means of stern grapnels. The boats were in four divisions, each under a Naval Captain.

At 9 a.m. the signal was given for the boats to advance. They at once pulled for the shore, keeping a very good line. Directly on arriving within range they were met by a tremendous artillery fire, both from Fort Aboukir and from the batteries of artillery on shore. Very little harm was done; three boats were sunk, but the cutters in the second line brought assistance without checking the onward movement. When it came to the musketry stage the British began to suffer heavy loss; but there was nothing to be done except to keep on rowing as hard as they could, and the boats reached the shore in very good order. The first regiments to touch land (the 23rd and 40th) formed up rapidly, and their flank companies, without firing a shot, charged the enemy's position at the point of the bayonet and drove off a half-brigade, capturing three guns. The 28th and

42nd regiments attacked in front and repulsed the charge of 200 French dragoons. The next troops ashore were the Guards; they were also charged by the same cavalry but, supported by the 50th regiment, drove them off; a French counterstroke by 600 men against the left of the Guards was met by the 54th regiment and also repulsed. The actual fighting in the attack lasted about twenty minutes. After a desultory combat in the sand hills for another hour and a-half the French were fairly beaten, with the loss of 400 men, 8 guns, and many horses. The British loss was about 750 killed and wounded. The next day the British marched four miles to the westward, masking the fort of Aboukir with one battalion and a regiment of dismounted dragoons.

It has been suggested that the attack and the landing could have been more scientifically conducted; that the blockhouse captured on the 7th should have been held, and a flotilla of gunboats passed through the Lake of Aboukir to turn the French right while they were occupied with a frontal attack, very much in the same way as the Japanese gunboats assisted the other day in carrying the strong Russian position at Nanshan. Sir Sidney Smith recommended this course from his knowledge of the ground and water; and though it certainly seems to us to have been a good plan, we must not suffer ourselves to detract from the courage and resolution of the Commanders, who were determined to force a landing. I am sorry that I can find no detail of the actual landing of the stores, nor of the land transport; but I gather that the army landed necessaries only, and kept itself supplied from the fleet which advanced parallel with it. The service of supply was very difficult by reason of the surf, and over 100 lives were lost, in accidents in the surf and in the landings, before the occupation of Alexandria.

We can now consider how far steam affects the question of landings. Steam allows vessels to proceed much quicker than they could when they had to rely on sails. On the other hand most countries have railways, on which steam enables troops to be assembled at given points with great rapidity. These changes, together with modern artillery and rifles, enormously increase the difficulties of an expedition such as I have described. Supposing the boats have been formed up at a spot far out at sea, they are subject to artillery fire the moment they leave the protection of the men-of-war; and when they get closer in, say within a distance of 2,000 or 1,500 yards, they come within range of machine guns and rifles; thus they stand a poor chance of ever reaching the shore.

It is easy to see how the difficulties are greatly enhanced; but there is no doubt that we shall again have to undertake expeditions of this sort in the future, and, as every Englishman of course hopes that if fighting is to take place it will be across the sea and not at home, it is important that we should pay attention to such operations.

One can imagine some of the objects we might have to undertake. We might have to seize a Colonial possession; or we might have to take a harbour containing the enemy's fleet, and establish a base for moving inland. The objectives of expeditions of this sort are well known to the Intelligence Department, and the matter of details is not neglected.

The sort of *modus operandi* in carrying them out would be this. The main objective would be settled by the Ministry, and the Naval and Military Executive Commanders would be admitted to their counsels. The main objective having been decided on, it would rest with the Naval and Military Executive Commanders to work out the details—the force to be employed, the taking up of the transports, the embarkation, the rendezvous of the expedition (some suitable harbour or protected water), the voyage, the landing on the coast—all these things are of the greatest importance. During peace time, too, naval and military officers are engaged in finding out all particulars as to the places where troops might require to land. It is absolutely necessary that all the above should be known beforehand. It is also necessary that the Navy and Army should co-operate together in working out the details. For instance, in the chartering of transports the Navy would say they could take so many thousands troops; the Army would want a voice in the allotment of the troops to those transports, because they would require the commands to be kept intact as far as possible and the troops arranged in the most convenient manner with a view to landing. In the landing itself also it is essential that the two services should work together.

The principle to be kept carefully in view in working out an expedition of this kind is to first settle the objective and the tactical method by which the troops, assisted by the fleet, will attain it; and from this work out the details of the fitting out and embarking of the expedition. All details of the landing and tactical employment of the troops must be clearly arranged before those of transports and embarkation are worked out. It is wrong to settle the embarkation first and the landing afterwards.

(The lecturer then illustrated by means of a number of photographic views the disembarking and re-embarking operations at Clacton in the Essex manœuvres of last year. The transports used were described, as well as the means adopted for lowering the horses, wagons, and guns into the boats for conveyance to shore. It is now intended to introduce a special steel float of a larger type than the boat hitherto used, which takes ten horses, or two large transport wagons, or four or six two-wheeled vehicles. A great deal of trouble was caused when the wagons were not properly loaded and their contents well pressed down; they were then top heavy; on one occasion a boat containing two wagons capsized in deep water, from which the wagons could not be recovered. New rules are to be introduced that the top of the load on any vehicle must not be more than 8½ ft. from the ground).

TRAINING OF FIELD COMPANIES, R.E.

By Major R. U. H. Buckland, R.E.

The following remarks apply only to the men of the Field Companies. From what I have seen of the work of the Bridging and Telegraph units I think that the hand of the reformer had better leave them severely alone; first-rate at their own jobs, they are always ready to help others; I have seen the old "A" Pontoon Troop employed in fitting up an extensive hut hospital, and men of the Telegraphs assisting to erect the wire fences of a remount establishment.

What is required of a Field Company on service?

We all know the long list in which are enumerated the various kinds of work that may fall to our lot in the field. But in what shape does any job present itself to the men?

We may assume that, under normal conditions, to judge of the necessity or otherwise of any particular piece of work is outside the province of the rank and file. The O.C. of the Company is told that a certain piece of work is to be done; he tells a subaltern to see what is required, to visit the site if necessary, and get the work carried out.

The subaltern roughs out in his mind's eye, or still better on paper, a "project," with a list of material and tools necessary. If wise, he consults his senior N.C.O. to see whether he has forgotten anything. He then selects from his section the men whose *trades* are most suited to the work contemplated. The result is that on most days whilst on service the sapper is employed at his trade, or at some kindred trade where his technical skill tends to facilitate the accomplishment of the work in hand.

The sapper's training at his trade is therefore a matter of the highest importance, and the modern tendency to take the men away from their trades must result in lowering the standard of technical skill. To this point I will revert later.

Turning to the table given on the first page of Capt. Craster's excellent article in the July number of the *R.E. Journal*, and excepting Ballooning as being a special branch, it is to be noted that a sapper recruit, whatever his trade may be, has to receive instruction in:—(I.) Field fortification, (II.) Siege works, (III.) Bridging, (IV.) Hutting, (V.) Water supply, (VI.) Roads, (VII.) Railways, (VIII.) Telephones—a fairly comprehensive list.

The question is what standard of knowledge in each subject is to be

expected of (*a*) The trained recruit, (*b*) N.C.O.s of each rank; and how is the recruit to be instructed so that he may reach this standard.

(A). Taking first the case of the recruit:—

(I.). *Field Fortification.*—The only dimensions which a recruit need be made to learn are those which represent the penetration of the latest model of rifle into all classes of material. This can be taught him by letting him see bullets go through a parapet or shield of insufficient thickness and mark an iron target behind it. He must be continually questioned on this subject, and shown that the penetration of the enemy's bullet is the ruling factor in all hasty field defences. A trained sapper who cannot at any moment quote the penetration of rifle bullets should at once be placed on the lower rate of Service Pay—he is useless.

Having learnt that earth is a protection against bullets, the recruit must next be shown, on all sorts of ground, where an infantry firing line is most likely to be placed *in connection with some tactical idea;* and when he has quite grasped this idea, he must be allowed to dig at his own sweet will till he can in that firing line protect himself from hostile bullets, and still be able to fire with suitable elevation at certain objects pointed out to him beforehand.

His first efforts may be ungainly; they will vary according to the intelligence of the individual; but some sort of hole will be dug, and some sort of mound of earth will spring up. The best instructors will at this period interfere the least; they will merely ask the recruit whether the earth is thick enough to protect him, and whether he can see to fire at the objects pointed out to him. (Of course all field-work instruction must be done under arms). Something having been accomplished the recruit will be shown how, if time allows, his firing position may be made more secure by better protection for his head; and out of such material as may be at hand he will be taught to make a loophole. At the same time the necessity for concealment must be impressed upon him.

The next steps in advance are the connection of these various holes into short trenches, with means of entrance and egress and drainage.

On all occasions, before any digging is commenced, each man must know the tactical idea and what he himself has to fire at. If, when his trench is completed, he cannot show that he can aim his rifle with correct elevation at the prescribed objects, his labour in digging is wasted.

The further development of overhead cover from shrapnel, and all such elaborations, will follow easily enough, if once the fire trench is correctly sited and made.

The idea of the above suggested system is to subordinate the digging of the trench to the tactical conditions which obtain on the spot. The site of the trench is infinitely more important than the amount of protection it affords.

It is essential that the recruit should produce something himself and be then shown how it can be improved; to show him a model trench with model loop-holes and tell him to copy it is to begin at the wrong end. It causes him to expend all his thought on copying the model with exactness, instead of evolving protection suited to the scheme on which he is engaged.

The old system used to be to make a perfectly straight trench, with beautiful slopes and a carefully patted parapet, the blue-frock-coated instructor running about all the time with a 6-foot rod and a field level.

The making of hurdles, gabions, and fascines is an important branch of the recruit's training, and leads on to (IV.) hutting,—the more finished class of huts being the work of men of building trades, and not fieldworks in the ordinary sense.

The use of the field level should not be taught in connection with fire trenches; but it is necessary for the laying out of batteries (II.) and comes in again in roads (VI.).

(III.). *Bridging.*—Individual knowledge of knotting and lashing is indispensable, and ignorance of any knot in the *Manual of Military Engineering* should cause a trained sapper at any time to be reduced to the lower class of Service Pay.

Recruits need do nothing more elaborate than trestle, single-lock, and double-lock bridges and barrel-pier rafts, but they should go through a prolonged course of pontooning.

If instruction in pontooning is carried out properly the men get the benefit of the drill, that is to say they work quickly and energetically at the word of command, whilst the heavy weights exercise all their muscles. The further lesson of everything being always in its place, so necessary for night work, is not without its value. Pontooning is at the same time a most useful training in responsibility for the junior N.C.O. instructors, and teaches that "ganging" of men which is the secret of carrying out work on any large scale. A man who can warp a raft satisfactorily on the Medway, when the wind is high and blowing against a strong flood tide, will be a useful man at any job. A short course of pontooning is of little value, it is forgotten as soon as learnt. Landing stages, fixed and floating, afford a useful variety in the instruction, whereas bridging on a large scale over spans of 50 feet and upwards should be left to the Field Companies at their annual training.

(V.). *Water Supply.*—As regards the rank and file this is to a large extent a question of carpenters' and plumbers' work; once men have been in camp they know what sort of thing is required, and can carry out intelligently their officer's orders on the subject.

(VI.). *Roads.*—As far as the rank and file are concerned this is a question of laying out directions and slopes with a field level and putting in culverts, the latter being work for the bricklayers and masons.

(VII.). *Railways.*—It is rather for the R.E. railway experts to say what amount of assistance they count on receiving from the Field Companies; but whatever they require must be taught thoroughly, and be kept up every year in the annual training. This standard should be clearly laid down; probably it need not be a very high one.

(VIII.). *Telephones.*—The usefulness of telephones on the outpost line seems as yet hardly appreciated in our service. If there is to be in future a Field Company with each brigade, the Brigadier should be able to count on at least 10 miles of telephone cable with an exchange and (say) 10 instruments being available whenever required. All ranks must be taught to make joints, lay out a roll of cable, and make up batteries, but instrument repairers will be required in much greater numbers than exist at present.

(B). To review the same subjects with reference to the standard of knowledge to be expected from N.C.O.s:—

The standard must be clearly laid down for each rank, and men falling short of the prescribed standard should not be promoted. Only when they see how it affects their promotion will men take care to keep themselves up to the mark in fieldworks.

The following is a rough outline of the standard I would suggest.

In (I.) a Lance-Corporal must be able:—

To show on a selected easy piece of ground, by means of a tape, the line of an infantry fire trench to fulfil the conditions of a given tactical idea; to say how long the task would take the infantry, and what elaborations could be carried out simultaneously if a given number of R.E. were available; and to give a list of tools and material he would want were he in command of the sappers.

2nd Corporals and Corporals, as above; but the questions would be made more difficult, proportionately to rank, by selecting less easy ground, and communications would have to be provided for.

A Sergeant should be capable of arranging the defence of a farm or homestead and a certain extent of open ground on either side. Given a section of R.E. with their tools (which he must know), and a fixed number of infantry allotted to the defence of this section, he must evolve on paper the best that can be done in the number of hours available; he must clearly show where all the material on which he counts is to be found. The compass bearing of probable lines of attack should be given him, but probable hostile artillery positions he must notice for himself.

In (II.) a Lance-Corporal must be able to trace siege works at night, and estimate working parties, tools, and material for simple works.

More difficult works for the higher ranks.

In (III.) a Lance-Corporal must be able to show on a sketch the means of bridging small gaps with given material, estimating working parties, tools, material, and time required.

For higher ranks more difficult questions would be set, including landing stages with derricks over water and temporary platforms at railway stations. A Sergeant should be capable of bridging any gap up to 40 feet, showing in addition where his material is to come from.

It is not worth following the question of fieldwork instruction any further, but I would again insist on simplicity of instruction for recruits, and the necessity for all ranks to show qualifications up to a high standard before being considered eligible for promotion.

The standard of knowledge which it is intended that recruits should reach must be clearly laid down and known throughout the Corps. A batch of recruits joining a Field Company would be at once tested as to their knowledge of fieldworks, and if any fell short of the standard the matter would be at once reported through the Divisional General to the Commandant, S.M.E. Only in this way can the Instructor in Fieldworks at the S.M.E. know to what extent his staff are successful in imparting instruction.

The next point is the annual training of the Field Company, which may be considered to begin on 1st April.

To work Royal Engineers in large numbers together is to invent conditions which do not frequently obtain in war. To my mind an R.E. Company *as a whole* digging a fire trench is pure waste of intelligent skill. As a rule R.E. will best be used in assisting infantry; therefore their training in peace time must be with infantry.

Infantry commence their company training on 1st April. G.O.C.s of Divisions might well call upon the officers commanding Field Companies to put at the disposal of each battalion commander a certain number of their N.C.O.s and men (the number will of course vary according to the number of battalions in the command), the R.E. being sent to live with the battalion to which they are allotted if it is at an out station. Each infantry company will do about 10 days fieldworks during its 6 weeks' training, and with a little arrangement the O.C. Field Company will be able to ensure that all his men get their share of this most useful practice of working with infantry under infantry officers. The R.E. company officers should see their men at work without in any way interfering with the instruction given by the infantry officers, but the O.C. of the Field Company will have an opportunity of making observations on this instruction when submitting his report on the annual training of his company.

After the infantry training is over the company can go on with its training in subjects in which on service it will work either unassisted or assisted by only small parties of infantry. The best practice for the company is to work with a minimum of R.E. assisted by other corps. In a case that came under my knowledge the men of a field battery came and helped a weak half-company of R.E. to make a trestle bridge on rather an awkward site; the battery afterwards

took their guns over it, fully horsed, the R.E. subaltern in charge having been made responsible that the bridge stood the test.

All ranks of all branches are wonderfully keen now-a-days on any genuine work with as little as possible make-believe about it, and with the assistance of the Divisional General and his Brigadiers it ought not to be difficult to work out small schemes for training in combination with other arms.

Certain subjects, such as sapping, mining, demolitions, and pontooning, are for R.E. only ; but in almost all other forms of bridging, and in using rafts and landing stages, all arms can help, and can gain useful experience for themselves.

The old hard and fast annual "fieldwork course" of the company must now give way to a "scheme of training" in which we can work with other troops as on service. This training and the work in connection with camps of instruction will keep the Field Company employed from 1st April to the end of August, and the musketry course will account for another 10 days or so.

Semaphore signalling, range finding, and other such necessary subjects, must be taught in the mornings before breakfast from 1st April onwards until the necessary degree of proficiency is obtained, and occasional practice at other times will be necessary to ensure that the instruction is not forgotten.

As soon as the Divisional General has done with the company and the musketry is over, the O.C. can turn his attention to the important matter of the technical skill of his men.

Good tradesmen will not enlist if they see no chance of improving their technical skill whilst serving ; skill at fieldworks is of no use to a sapper seeking for employment on return to civil life !

The best training is steady employment in workshops, and the best test of skill is the moneying out of the value of the work done. Such men as plumbers, bricklayers, and masons cannot as a rule work in a shop ; but their work can always be measured and moneyed out, and this supervision is the province of the subalterns, who will thereby get most useful experience as to the cost of work and the time it takes. If the C.R.E. can be induced to hand over some small items of his Barrack Annual Estimate to the O.C. Field Company to carry out, the instruction thereby afforded is excellent ; but the difficulty is that, when apportioning his work for the year, the C.R.E. probably does not know for how long the company will be working for him, and if their outdoor work is stopped by frost during the winter months, he may be left with unfinished work on his hands at the end of the financial year.

The difficulty could best be overcome by the Divisional General fixing early in the year a certain period during which the company would be available for the C.R.E.'s work ; and during this period all military considerations, such as field days and ceremonial drill, must

cease as far as the dismounted men are concerned. Route marching is a waste of the sappers' time ; but the officers of the company and the mounted sections should always go out with their brigades or divisions to represent a skeleton company, so that other troops may be accustomed to their presence, and the Generals and their staffs learn to include them in their orders and to make use of them.

The only interruption to the work period is the furlough season. This will cause the least possible loss of efficiency if it is arranged that all the sappers entitled to, and wishing to take, furlough should go away at the end of the week before Christmas ; so that during this period the works, as far as the company is concerned, would be shut down. For the mounted men this arrangement is not possible, as the horses must be fed and exercised ; they must go away a few at a time throughout the furlough season.

The question of organization for war of the R.E. Regular units, and the full utilization of the R.E. Militia and Volunteers, is a fascinating one, but this paper is limited to the training of the men of R.E. Field Companies.

My only excuse for writing at such length is that the training of our men must always be a subject of the greatest interest to the officers who serve with them. The comfortable feeling of the commander of any R.E. unit in the field when the strain of work is exceedingly heavy, the weather vile, and circumstances conspire to upset all arrangements for transport, rations, etc.—the certain knowledge that *somehow* the men will get the day's work done, and be ready to go at it again on the morrow—makes days of toil and discomfort days on which one can look back with pleasure.

THE CONSTRUCTION OF THE NATHU LA ROAD, TIBET MISSION, 1904.

By CAPT. R. ST. J. GILLESPIE, R.E.

THE Nathu La is a pass over the range of mountains which divides the State of Sikkim from the Chumbi Valley in Tibet. The construction of the road was undertaken in connection with the Tibet Mission in 1904, with the object of providing a road from Sikkim to the Chumbi Valley which would be practicable for pack transport and, at a pinch, for *ekkas**; at the same time the possibility was to be kept in sight that it might be necessary at some time to man-handle field guns over the road.

The only route into Tibet which was reasonably practicable for animals was that over the pass known as the Jelap La. This was very steep and liable to interruption by slips, and was not considered capable of sufficient improvement.

Orders were issued by the General Officer Commanding on the 12th June, the day on which the first part of the Lhasa Column left Chumbi, for the construction over the Nathu La of an 8-foot road on a maximum grade of 1 in 15.

The staff originally detailed for the work consisted of one Field Engineer, Capt. R. St. J. Gillespie, R.E., two sergeants from the Military Works, and four sub-overseers and a small office establishment from the Public Works. At the time of commencing work, a rough path existed from Gantok, the capital of Sikkim, to the Chumbi Valley. This was originally a trade route; but it was very seldom used, and was in fact little more than a smuggler's track, scarcely deserving even to be called a path.

The track had been improved to a certain extent, and had been made practicable for animals for the greater part of its length. For the first five miles out of Gantok, it had been widened to a minimum of 10 feet and was well graded, but unfinished and unmetalled. From the fifth mile onwards it was a mere mule track, about 5 feet wide and on no particular grade, roughly paved with undressed stones as far as the Changu Lake (12,800 feet), twenty miles from Gantok (5,500 feet). This lake is an example of a very distinctive feature of the country; it is about a mile long by half as much broad, and very deep. There

* *Ekkas* are light two-wheeled native carts.

are three or four others near the road above Changu, the last being close up under the Nathu La; and there are many other similar lakes among the hills in the neighbourhood.

At Changu the path ceased altogether, and there was nothing but an ill-defined cooly track till the pass was left behind and the path met again some two miles down on the other side. The distance from Changu to the top of the pass was about seven miles, two lower passes having to be crossed before the final ascent to the Nathu La was commenced. These minor passes, the Tunni La (13,200 feet) and the Sibbu La (13,750 feet), were across spurs which projected from the main feature, up the side of which ran the general line of the route. The Sibbu La was very steep and difficult, the Tunni comparatively easy.

The whole of the country on the Sikkim side of the pass is exceptionally difficult, the difficulties being exaggerated by the excessive rainfall, which, over a large part of the line, amounts to about 300 inches per annum. (At the time the work was started, the rainfall was at its worst). The portion above Changu was about as rough as can possibly be imagined, and it is a standing wonder how the animals were got over it in the early part of the year.

After crossing the Nathu La the country becomes much easier, and the track descended fairly easily for a couple of miles till a made path was again met about two miles from the Transport post of Champitong (13,200 feet). From Champitong the old path descended for some seven miles to strike the road at the bottom of the Chumbi Valley, about five miles from Chumbi and at an elevation of about 9,800 feet.

The first problem that presented itself was the lack of labour, almost the whole of the local labour having been taken up for Transport work in connection with the Mission. It was estimated that about 3,000 coolies would be required to get the road through by the end of October, which was the date fixed by the General Officer Commanding for completion. But only about 500 coolies could be obtained on the spot, and it appeared improbable that more than another 500 at most would ultimately be obtainable.

Proposals were made, and accepted by the Government of India, for the formation of two Cooly Corps of 1,000 men each, commanded by R.E. Officers. The original proposal was that a Corps of 2,000 Hazaras—the navvies of India, as they are called—should be raised; but it was not found possible to get enough of these. Finally two separate Corps were raised. One, under Lieut. L. N. Malan, R.E., was made up of 600 Pathans, recruited at Quetta, and 400 Garwhalis from round Mussoorie; this was known as the Mussoorie Cooly Corps. The other Corps was raised at Peshawar by Lieut. A. F. S. Hill, R.E., and mostly consisted of Pathans from near Peshawar.

These Corps arrived at the base at the beginning of August, and were despatched to Gantok in batches of 200 or so at a time. This

arrangement did not work well, as officers were not available to accompany each batch, and a good deal of trouble ensued. The Peshawar coolies found the weight of their tents beyond their strength, and left them all behind, half way between Siliguri and Gantok. The Quetta Pathans brought up most of their tents, but varied the monotony of their march by getting up a free fight with some Sonthali coolies that they met on the way, in the course of which a village was burnt and several men injured.

The Field Engineer was now confronted with the depressing spectacle of some 1,000 odd men, who had no protection from the heavy and incessant rain beyond the clothes on their backs and their waterproof sheets. Fortunately there were a certain number of huts ready up the line, and others under construction, and into these the Peshawar coolies had to be crammed to wait for their tents. They were set to work on that part of the new line which happened to be near their huts. This proved in the end to be sheer waste of time, as, owing to the stoppage of the work, this part of the road was never finished.

The Mussoorie Corps was pushed up as it arrived, and was concentrated at a delectable spot called Yokontang, where the Transport coolies changed, just below the Nathu La and at a height of 13,200 feet. As the majority of the men came from a country where rain is almost unknown, they found some difficulty in appreciating the beauties of life in tents at this altitude and in continuous heavy rain; and they required a certain amount of forcible encouragement to bring them into a proper frame of mind. At the time they were enlisted they had a very hazy idea of where they were going and what they were going to do; one man fell out at Gantok, and explained that he had enlisted under the impression that he was joining a cavalry regiment!

While the Cooly Corps were being raised, the route had been thoroughly explored and the alignment of the road determined. Capt. P. E. Hodgson, R.E., had joined as Assistant Field Engineer, and had taken over the troublesome and unpleasant job of tracing the new road through the thick jungles on the Sikkim side of the pass. Between Changu and the Nathu La the country had been explored and a line marked out by Capt. Gillespie. On the Tibet side of the pass the line had been settled and a trace cut by half a company of the 1st (Bengal) Sappers and Miners under Lieut. E. F. J. Hill.

A very satisfactory line had been obtained right through, considering the nature of the country. The only real engineering difficulties occurred between the 7th and 12th miles; but even here, although the ground was very difficult, Capt. Hodgson had, after much trouble, found a practicable route. It was found possible to avoid almost entirely the difficult ground between Changu and the Nathu La, the new line being taken round the spurs which the old track had crossed at the Tunni La and Sibbu La; by this means the irritating ascents

and descents of these passes were escaped, and an almost level road over quite easy ground was carried up to within a short distance of the Nathu La.

The tents of the Peshawar Corps gradually filtered up to Gantok, and by the end of the first week of September this Corps was under canvas and hard at work between Changu and Yokontang. The Mussoorie Corps were put on the length between Yokontang and the Nathu La, with the object of getting the highest part of the work done before the cold weather set in. The local coolies were at this time employed mostly on maintenance work and on carrying up rations and tools; as their numbers increased they were put on to Capt. Hodgson's piece of the road, where the foreign coolies would have been of little use owing to the nature of the jungle.

Towards the end of September rumours began to arrive that the work might possibly be stopped altogether, and it became practically certain that the road would not be completed as originally intended. Consequently all plans had to be changed, as it was obviously useless going on with any portion of the work that was likely to be left unfinished.

The part of the line on which Capt. Hodgson was engaged was abandoned, and the coolies were turned on to widening and improving the existing track between Gantok and Changu, metalling it throughout; some of them were sent over the pass to help on the further side. The Mussoorie Corps crossed the pass and started on the fifteen miles between the top of the pass and the village of Phema, where the route was to strike the road along the Chumbi Valley. The Peshawar Corps were left to finish the piece between Changu and the Nathu La. By these arrangements it was hoped that it would be possible to have a practicable road right through from Chumbi to Gantok by the end of the month, and to make a great portion of it passable for the Lhasa Column on their return journey to India.

The definite orders for stopping work on the original scale arrived on the 7th of October, giving the 31st of that month as the final day. By the time they arrived work was already in full swing on the new lines. The alignment had been changed wherever economy made it desirable; the width was reduced to 6 feet; and the maximum gradient fixed at 1 in 10 on such lengths as it was possible to re-align.

It was now a case of racing against time, and the road won by a narrow margin. The first party of the Lhasa Column crossed the pass in a heavy blizzard, and had an exceedingly hard time of it. The snow, which was quite unexpected, lay about three feet deep on the top of the pass, and stopped all work for several days. The unfortunate men of the Peshawar Cooly Corps, most of whom had never previously seen snow at close quarters, suffered severely; many of their tents came down under the weight of snow in the night, and their camp presented a dismal spectacle next morning. Fortunately

for the troops, the road was finished sufficiently to enable them to avoid the Sibbu and Tunni La.

The road was open right through from Phema to Gantok on the 23rd of October, and General Macdonald left Chumbi on the 24th. After the General had gone through only a few days remained for work; these were spent in finishing up as far as possible and in repairing the damage caused by the storm. The effect of a heavy fall of snow and a hot sun on the surface of a newly-made unmetalled road was of course appalling; but considering the severity of the storm, it is satisfactory to record that no serious damage was done.

The Cooly Corps were started off on their homeward journeys at the end of the month; and all work was stopped, except as regards clearing up and collecting tools and surplus stores, which were taken down to Gantok and sold.

The total results of our labour were some 25 miles of road newly made and 20 miles of old track metalled, widened, and generally improved. In addition a good deal of work was done on the new line between Gantok and Changu, which was left in an unfinished state.

The most serious question that arose in connection with the work was that of the food supply of the 3,000 odd coolies employed. The country was uninhabited and everything had to be carried up from below. The original arrangement was that the Supply and Transport Corps should deliver all the required rations at Gantok and that the Field Engineer should arrange for its further carriage and distribution. Unfortunately, owing to the pressure on the Transport, the S. & T. Corps were unable to carry out their part of the arrangement, and the officer in charge of the road work was suddenly called upon to make all the arrangements for the supply of food. Without any staff of storekeepers this was a serious undertaking. However, contracts were made for supplies, godowns built, storekeepers improvised, and a regular supply and transport service instituted; the work required of this service was carried out with considerable success, no deaths from starvation being reported.

The quantities of stores dealt with were considerable. The food consumed by 1,000 coolies in one day was about 30 *maunds*,* and about 3,400 was the greatest number of men employed at any one time. This meant that over 90 *maunds* of rations alone had to be carried daily out of Gantok, and on an average as much again of tools and other stores.

The carrying was done partly by contract and partly by coolies working on a system similar to that employed by the S. & T. Corps, but somewhat simplified as regards office work. Each cooly carried one *maund* a day over a five-mile stage, each animal taking two *maunds* the same distance.

* A *maund* = 80 lbs.

The furthest point at which stores were delivered was Champitong, 30 miles from Gantok. This distance required about 500 coolies and about 100 pack animals.

The greatest difficulty in connection with the stores was the absence of trained storekeepers. None were allowed in the original establishment, and they had to be extemporised out of any one that could be induced to take the job. They had to be taught their duties and to carry them out at the same time, which was not a convenient arrangement.

The supply of tools was a serious difficulty. When the work was ordered a large quantity of tools were ordered from Calcutta, and were sent off with commendable promptitude by the supplying firm. Unfortunately their arrival at the Base coincided with a period of great pressure on the S. & T. Corps and with bad blocks on the road up to Gantok, due to slips and breaks in the Testa Valley. The result was that many urgently wanted tools did not arrive till the work was over, and some never arrived at all. The worst trouble was due to the lack of blacksmiths' tools; this meant that for a long time there were no means of sharpening the hundreds of jumpers in daily use, and much delay and loss ensued.

The question of supervision of labour was also a difficult one. Practically there was one officer available for each thousand men. A thousand men at work on a narrow road inevitably get spread out over a considerable distance, amounting at times to as much as ten miles; when these ten miles are composed of ground over which a goat would have to be careful, it becomes a hard job for the officer. Three more officers were under orders to join on this account, but owing to the work being abandoned their orders were countermanded. In such a country as this road runs through, three officers per thousand coolies would be a fair allowance. For such work, where time is of the first importance, subordinates, whether European or Native, are of little use unless they happen to be picked men.

The British sergeants proved of great value on the supply and transport work, as they formed a check on the eccentricities of the Bengali *babus*.

An interesting feature of the work was the high altitude at which it was carried on. The greater part of the new road was at a height of over 13,000 feet, and many of the men were camped for a long time above this level. On the whole the altitude caused little trouble. At first the foreign coolies suffered to a small extent, but they soon got accustomed to the height; at the same time the amount of work of which they were capable must certainly have been less than at lower elevations. There was a slight difficulty in cooking some portions of the rations, notably *dhall* or lentils, which required extra boiling on account of the decreased pressure; but fortunately there was no difficulty in getting firewood.

The principal lesson we learnt appears to be that, in an undertaking of this nature, it is a great advantage if all services in connection with the work can be carried out by those most nearly interested in it, and no dependence be placed on other departments.

If the food supply had been entrusted to the Field Engineer from the commencement, the enormous amount of trouble involved in having to make arrangements at a moment's notice would have been avoided. In the case of the tools it would have been quite easy to get them up from Siliguri by private arrangements, though of course the cost would have been considerable. Even with the best-managed Transport, hitches must occur in difficult country where the roads are bad; and when they do happen it must be a case of the most urgent things taking precedence. Of course it is not always possible or desirable to employ private agency; but when it is practicable there are many and great advantages to be gained in return for a certain amount of additional responsibility and a little extra work.

THE TELEGRAPH SECTION, 1st SAPPERS AND MINERS, AT THE MEERUT DIVISIONAL MANŒUVRES, FEBRUARY, 1905.

By Capt. B. W. Mainprise, R.E.

Since the Afghan War all Field Telegraph work required for Indian Frontier Expeditions has been carried out by the Government Telegraph Department, which occasionally employed such officers and men of the Sappers and Miners as were under instruction at the time in that department. The Director General of Telegraphs has had full control of such work, and the sending of Sappers on any expedition rested entirely with him. Under this system the Military Telegraph Sections, which form part of the organization of the three Corps of Sappers and Miners in India, had but little inducement to keep themselves efficient; their equipment was never used in the field, and the *personnel* only went on service as adjuncts to and under the orders of the civil staff of the Telegraph Department.

Considering that during peace time neither the necessary war *personnel* nor stores are a direct charge on the Military budget, this Civil Department has provided efficiently, and probably economically, what has until recently been considered a sufficiently good Telegraph service for a force acting on the frontier. This service has consisted of lines throughout the Lines of Communication and possibly to certain more or less permanent advance posts. There have been practically no mobile Telegraphs of any sort, not that they could not have been undertaken, but because their utility had not been understood.

In past years the advance of Telegraphy and, more especially, the growing use of Telephones have not been appreciated in India from a military standpoint, although the greatest attention has been paid to all forms of visual signalling. During the last five years, however, various attempts have been made to increase the utility of the Sapper Telegraph Sections. That these Sections could perform the required work when called upon was proved in the late China Expedition, where a fair mileage of semi-permanent line was erected and the existing lines repaired and maintained without assistance from the Civil Department. The Telephone equipment was found to be out of date and faulty; but when suitable instruments had been obtained, Telephones became very popular, and the maintenance of these is now

the chief work of the Telegraph Section which is still maintained in North China.

The equipment of the Sapper Sections has lately been overhauled and increased, although it is still officially known as "instructional and for use at camps of exercise"; and some account of its employment last spring may be of interest.

For the Meerut Manœuvres (February, 1905) the Telegraph Section of the 1st S. & M. (under Lieut. D. A. Thomson, R.E.) was divided into two squads, each of 4 N.C.O.s and 12 Sappers with 5 military signallers (specially trained British privates). Each squad had 10 miles of air line and 5 miles of cable, with 2 officers, the whole being carried on 5 carts and 6 mules. An experimental Telephone unit, consisting of 4½ miles of cable and 3 Ericsson's portable telephones, carried on 4 mules, was attached to No. 2 Squad. Owing to the smallness of the manœuvre grant the Telegraph Section was only allowed to proceed to the manœuvres on condition that no extra expense was incurred; accordingly all its transport had to be found regimentally by attaching company mules.

On arrival it was found that there were three main camps, viz., (A) Headquarter Staff and No. 1 Brigade, (B) No. 2 Brigade, (C) Divisional Troops and Supply Depôt. A Central Telegraph Office was at once opened in camp (A) and connected to a spare wire running into the Delhi Government office, 12 miles distant, which wire the civil authorities had been good enough to place at our disposal. The site for a Central Telephone Exchange was also selected. Next day Field Telegraph Offices were opened in camps (B) and (C), distant about one and one and a-half miles respectively from the Central Office. Four Telephone Offices were also opened and connected through the Exchange.

These arrangements stood for nine days, during which the troops were exercised in field firing and brigade field days. On two of the latter occasions the Telephone unit was employed, and it was soon noticed how useful these units would be if there were at least two to each brigade.

On the tenth day the main body moved out to attack Delhi, leaving two detached parties to discover and retard a body of the enemy marching from Meerut to the relief of the former city. These two detached parties were placed in communication with each other by Telephone, and were connected by an air line with the main body moving on Delhi. The country was easy, so that the two air-line squads had no difficulty in keeping up with the main column. After advancing 9 miles the force fell back two miles and bivouacked at Shahdara for the night. Supplies were called up by Telegraph and were distributed before the troops marched out next morning, when the attack on Delhi was continued. On reaching the bridge over the Jumna outside Delhi, the "cease fire" was sounded, the troops

marched back to their main camp at Ghaziabad, some 12 miles distant, and the air line was dismantled.

On the following day the attacking force concentrated at Loni, 10 miles from Ghaziabad. A Telegraph Office was opened here by noon, and the next day, when the force fought its way back to Ghaziabad, this line was dismantled again. On this day the Telephone unit was fully employed in keeping the Commander of the force in communication with his left flank, where most of the fighting took place.

On arrival in camp that evening, the Telephone unit was at once despatched by train to the Barkacha Artillery camp at the request of the Camp Commandant who wished to experiment in the use of telephones for control of battery fire.

The instruction and experience gained on these manœuvres was of the best possible kind; and the value of well-organized and properly-handled Telephone units, when employed well up with the firing line, cannot be overestimated. It must be the Telephone which has enabled the Japanese to fight so successfully over such extended fronts.

THE RUSSO-TURKISH FRONTIER COMMISSION IN ASIA MINOR IN 1857–58.

By MAJOR-GENERAL E. RENOUARD JAMES, LATE R.E.

THE appointment of an International Commission for the delimitation and demarcation of the Russo-Turkish frontier in Asia Minor was a consequence of the war of 1854–6. The British Section was composed as follows :—

Lieut.-Colonel J. L. A. Simmons, R.E. (the late Field Marshal), Commissioner.
Lieut. E. R. James, R.E.,
Lieut. C. G. Gordon, R.E.,
Lieut. H. Helsham-Jones, R.E., } Attached.
A party of Sappers and Miners.
Assist.-Surgeon S. Woodfull, R.A.
Captain De Normann, for the Foreign Office.
Mr. Stabb,
Mr. Hidayet, } Interpreters.

The party reached Trebizond in May, 1857, and marched from there, by way of Erzeroom and Kars, to Alexandrapol, a point on the frontier where the several Commissioners had agreed to meet. From Alexandrapol, the joint body followed the line of frontier southwards to Mount Ararat; and then, after returning to the starting point, northwards to Fort St. Nikolas on the coast of the Black Sea, where the work of 1857 was finished and the Commission broke up. In 1858, Lieuts. James and Gordon returned to the country to act as arbiters in the demarcation of the frontier by Russian and Turkish topographical officers.

On the completion of the labours of the Commission, a mass of barometrical and other observations for determining the altitudes in the country traversed by the English Section remained in my hands, as no one seemed to want them. I always intended to work out results from them, but in the pressure of my official life, I was unable to devote enough time to the study of the subject to do so thoroughly. In 1859, I joined the Ordnance Survey, and made an effort to do something with the assistance of the late Sergt.-Major J. Steel, R.E., one of the ablest calculators ever attached to the Southampton staff, who sent me a very learned memorandum on the calculation of

altitudes from barometrical observations and supplied me with some valuable formulæ. I found, however, that much labour was still necessary before satisfactory results could be worked out and tabulated; and the difficulties involved in the minute corrections enjoined in the text-books were so great that I was compelled, again and again, to defer the matter to "a more convenient season." It thus happens that I offer the following notes rather late in the day. My original purpose in commencing this paper was simply the determination of the altitudes; but the stirring up of my memory in regard to events which occurred nearly half a century ago leads me to think that a short account of the share of the Royal Engineer officers in the work of the Commission of 1857–8, which has not been previously given in the Corps publications, may not be entirely without interest to my brother officers.

The accompanying skeleton map of the country traversed shows that the English Section passed through three main geographical basins, those of the Black Sea, the Persian Gulf, and the Caspian Sea; and visited a district of great historical and geographical interest.

Between Trebizond and Erzeroom three principal watershed lines were crossed at altitudes varying from 6,300 to 8,336 feet above sea level, the plain of Erzeroom, in the basin of the Persian Gulf, being over 6,000. In the march to Kars, the pass of Soghanli Dagh is at an elevation of nearly 8,300 feet. Along the course of the Araxes, in the Caspian Sea basin, the height fell below 3,000 feet; but the mountains on either side, Mount Ararat and Mount Alagos, reached altitudes of 16,950 and 12,820 respectively. On the northern portion of the frontier, the Commission remained encamped for a considerable period at altitudes varying from 7,000 to 8,000 feet. In the course of the marches, many places of high interest were visited.

Starting from Trebizond, a place rich in Greek, Genoese, and Byzantine remains, and once the capital of the mysterious Empire under the rule of the Comneni, where a pack caravan was organized, the Section on the third day crossed the Zigana Dagh pass at a height of 6,611 feet. This mountain is noted as the point at which the army of Xenophon came suddenly, after tedious months of marching, within sight of the Black Sea. On its slopes grow the splendid rhododendrons and azaleas, from which the intoxicating honey that maddened the Greek soldiers was made.

Near Gumüsch Tchaneh, with its orchards and silver mines, Xenophon had a fight with the local tribes.

Before reaching Baibürt, the pass of Tchadrak was crossed by us. Although the lowest in altitude of the three between Trebizond and Erzeroom, it is the chief in strategic importance, as an army approaching by the valley of the Tchoruk Sou (which would be a probable route under present conditions) could, by seizing this pass, turn both Trebizond and Erzeroom, and gain a point within easy reach of

Erzingan. From the last-named place, a spring forward down the Euphrates Valley would enable it to occupy the line between Erzingan and the Mediterranean, and, by dividing the Turkish dominions in Asia Minor in half, isolate Constantinople.

Descending the valley of the Tchoruk Sou a few miles, the Section passed Baïburt, which is noted as the most advanced point reached by the army of Paskiewitch in 1828; and crossed the dangerous pass of Khoshabounar Dagh, at an elevation of 8,522 feet, to the plain of Erzeroom, on which the Euphrates takes its rise. The altitude of this plain exceeds 6,000 feet. Local traditions say it is the site of the Garden of Eden, but no argument can be adduced in favour of such an idea except that at Bac Dagh, a neighbouring mountain, which I assume to be approximately 9,000 feet above sea level, the watershed lines separating three seas converge, while a very short distance westward another—that of the Mediterranean Sea—is to be found. The country round Erzeroom is a sterile, treeless waste now, producing at the best some miserable crops of grain on the plain. The city, the modern capital of Armenia, possesses some fine examples of ancient buildings—so-called Genoese, Saracenic, and Armenian—which frequent earthquakes have left in a semi-ruinous condition.

Soon after leaving Erzeroom, the Section passed the position of Devèh Bouinoŭ, on the watershed line between the Persian Gulf and the Caspian Sea, at a comparatively low altitude, estimated at 6,500 feet; but over a pass which for ages has been of strategical importance. Having made a careful study of the events of Xenophon's march, from a translation of the Anabasis by A. J. Valpy, published in 1830, I find every reason to consider that it was at this very pass that the disciplined Greek Army made a successful assault against the tribes assembled to oppose its advance; and the tactics used in turning the position defended seem to have been precisely similar to those employed by the Russians at the same place. In the war of 1854–6, the Turks fortified the pass, and as the Section of the Commission crossed it the remains of the redoubts which were erected were still visible. When this pass is taken Erzeroom is at the mercy of an invading army. Mention has been made by me of the importance of the Tchadrak pass also, and, with the advantageous situation of her frontier at present, Russia, in a future war, would probably be in possession of both positions before Turkey had awakened from her customary lethargy. Russia appears to wage war in Asia Minor every twenty-five years or so (*e.g.*, 1828; 1854; 1877); possibly she will find a pretext some day for getting on to Erzingan; and after that, with a like interval, she may endeavour to acquire the Mediterranean port she has been so long dreaming of, which would probably be at Iskanderoom opposite Cyprus.

Descending the head waters of the Araxes, in the Caspian Sea basin, the main river was reached near the point at which Xenophon's

army, coming the reverse way from a pass leading from the valley of the Upper Tigris, arrived on its bank. Not far from the same place there is a ruin known as "The Tower of the Son of Cyrus," the name of which seemed to indicate the former existence of a tradition in connection with the retreat of the 10,000; but we were unable to ascertain if this were still extant. At the same point we diverged from the great pack-road, by which long trains of heavily laden animals carried carpets, spices, and Oriental goods from Persia to the Black Sea along the exact route we had followed from Trebizond. The dangerous passes of Zigana and Khoshabounar are not free of snow until late in spring, and many pack-horses are sacrificed in crossing them. We had, with the Section, a train of about a hundred pack and saddle horses; for there was no wheeled transport to be had in the country, and, in fact, no vehicles of any sort except some very primitive carts with solid wheels, which we saw in use by the peasants on the high plains. The pack-horse traffic of this part of Asiatic Turkey is in a declining condition; for, since Russia has gained possession of Batoum, she has constructed railways connecting Persia with the Black Sea, and the flow of commerce is rapidly changing its direction. The Turkish Government has displayed its customary apathy in failing to do anything to maintain so important a line of commerce, and nothing could now be done which would restore it to its former prosperity.

Leaving the Araxes, the Section entered a mountain district, through which the track was even rougher than those we had already traversed. There were no formed roads at all, unless a single mile of old *chaussèe*, leading out of Trebizond, could be called such. The story about this is that a certain Pacha, having been ordered to make a good road to Erzeroom, had, after much enforced labour and many exactions, ended his efforts with the very small result apparent. His first duty, he considered, was to make his own fortune before he was removed from his post through the intrigues of some other pacha hoping to succeed him, this being the customary rule of every government official in Turkey. The *chaussèe* had become impassable, and the pack animals picked their way outside its rough stones.

The direction of tracks in Turkey is often peculiar, and the road the Section ascended to the pass of Soghanli Dagh seemed a very strange one to reach Kars by, when by following the course of the Araxes we might have got there on comparatively level ground. For this reason the pass named, as long as it was in Turkish hands, could be readily turned by a Russian column and offered a very slight obstacle to invasion. On reaching its summits, for there are two at an altitude of 8,261 feet, the track passes for a short way along the *versant* of the Black Sea. There is no vegetation, and the ground is covered with lava, pumice stone, and scoriæ, and especially with obsidian, the sharp-edged chips of which resemble black bottle-glass. The horses' feet

sunk in the loose volcanic refuse, and the animals, who slipped and stumbled at every step, would have been wounded if they had not been shod with flat plates of iron in the Turkish method. The plain of Kars, 2,000 feet down, was reached at break-neck speed.

Lieuts. James and Gordon were left at Kars with instructions to make a survey of the place, but were called on to Alexandrapol before they had time to do more than make a commencement of the task. The few days' delay gave them an opportunity for studying the positions held by the Turkish Army during the ever-memorable defence of the place, under the advice of Sir William Fenwick Williams, in 1855. The "Narrative of the Siege" was told by Sandwith in a book with that title, published in 1856, an abstract of which with a plan was printed in the *Royal Engineers Journal*. I need not, therefore, do more than offer some general remarks on the famous incident. The ancient Genoese citadel, on a height surrounded by a bend of the Kars Tchai, commands the town; but is itself commanded in every direction by the neighbouring hills at distances of from 2,000 to 3,000 yards. Although smooth-bore ordnance was in use in 1855, the power of artillery had already commenced to advance, and it was essential to occupy the commanding points in order to make a proper defence. The entire fortified position covered a circular space round the citadel of an area of seven square miles, the longest diagonal of which was roughly 6,000 yards. There were nine redoubts on an outer line, and four on an inner line, in advance of the citadel and town. The establishment of such a circuit of detached works, mutually supporting each other, was an early—if not the earliest—example of a modern fortress of the kind. The Turkish army was 15,000 strong, insufficiently supplied both with ammunition and food, and the soldiers were in rags and in an enfeebled condition of health. The proper defence of the too-extended line with so small a force was impossible, yet the features of the ground were such that the effective occupation of any shorter line would have been a most difficult problem; and it seems questionable whether it was not a mistake to attempt to hold Kars at all, locking up a force there which might have been profitably employed in field operations. The gallant defenders held the place, however, from June to November, and were only constrained to surrender by disease and starvation. The Russians besieging the fortress were greatly in excess of the garrison in numbers; and the failure of Mouravieff, their commander, to take it sooner can only be accounted for by his absolute incapacity.

In studying the problems of Kars, the officers of the English Section of the Commission could not fail to observe that the successful campaign in Mingrelia, and victory on the Ingour in 1855, in which our chief, Colonel Simmons, had been the moving spirit in the army of Omar Pacha, must have been an important factor in causing Mouravieff to fail. With Omar Pacha on his flank and rear, the

Russian force was necessarily in danger of being isolated. Many critics of the conduct of the war of 1854–6 were of opinion that the main theatre of operations against Russia should have been in the Trans-Caucasian province, which she held at the end of a slender thread of communications through mountains occupied for the greater part by the hardy Circassian, Lesghian, Tchechnian and Daghistan tribes, under the famous chief Schamyl. It was believed by some, and on very good grounds, that the mountaineers were anxious to declare themselves for Turkey, and would have done so if they had been supported in force by the Western armies. It was argued by the advocates of an invasion of Georgia that it would have resulted in Russia losing her entire territory south of the Caucasus mountains; and, from my conversations with Simmons, I was always under the impression that he would have favoured such a strategical operation very warmly. We know, with certainty, how he urged in vain that the army of Omar Pacha should be strongly supported by the Allies, for he knew the small force in Mingrelia could do but little by itself. This little, however, it performed to the fullest extent possible under his own splendid guidance.

The entire Commission assembled at Alexandrapol on the frontier, the British Section having marched about 350 miles. The representatives of the Powers concerned in the delimitation were Simmons for England, M. Pelissier for France, Hussein Pacha for Turkey, and General Tchirikoff for Russia; and attached to each was a staff of topographical officers. On the Russian side a squadron of Cossacks of the Black Sea acted as escort, and on the Turkish side one of cavalry. The Commission remained a few days at Alexandrapol to exchange powers, and constitute the order of proceedings; and during this period visits of ceremony were paid and received.

A small fortress with Vauban fronts commanded the valley of the Arpa Tchai and the approach from the direction of Kars. It was agreed that the thalweg of the river named should form the frontier from Alexandrapol for 45 miles southwards to the confluence of the stream with the Araxes; and along this part of the line the topographical officers had merely to verify the map supplied by the Russian Commissioner. The whole body made a leisurely march of four days to Hadji Bairam, resting the whole of one at Kizil Kilissa on the left bank to afford us an opportunity of visiting the ruined city of Ani on the Turkish side of the frontier. A sight of this place, which occupies a defensive situation on a triangular space enclosed by cliffs and encircled by a bend of the Arpa Tchai, was, to myself at least, worth all the fatigues of our long journey on horseback. Absolutely deserted when we saw it, except by a few nomadic shepherds, it was said to have once had a population of 100,000; and the magnificence of its remains attest that this might have been the case. A line of solid walls still stands across the base of the triangle, and

some twenty large buildings, described to us as—"The Cathedral of the Patriarchs," "The King's Palace," "The King's Chapel," "The Chief Mosque," "The Armenian Church," etc.,—are still in good condition. They are built in variously coloured lavas, in chequered courses, carved in geometrical designs or with inscriptions in Armenian and Arabic. In the case of the Chief Mosque, an inscription copied and translated for me afforded proof of an antiquity of nearly one thousand years. Ani, the seat of the monarchs of ancient Armenia, was founded at the period of the introduction of Christianity by St. Gregory. It fell, in turn, under the power of Saracens, Osmanli, Armenians, Georgians, and Persians, until a disastrous earthquake caused its abandonment in the 15th century. It must rank in antiquarian interest with such places as Pompeii, Herculeaneum, and our own Silchester. The Turks did nothing to preserve the ruins; but since 1878 Ani has become Russian property, and it is to be hoped is now well cared for. I visited the place a second time in 1858, and had leisure to take some sketches and photographs.

The Commission halted at Hadji Bairam on the Araxes, and from that place ascended the river for a few miles westward to Parnaout, from near which place one of the rivulets flowing from the crest of the Ararat range was decided on as the frontier. It ran through a district of wild mountain scenery, inhabited in summer by pastoral Kurds, and there was some delay while negotiations were conducted with the chiefs in regard to the ownership of the pasturage in the upland valleys. It had been decided to give the tribes the option of choosing their future nationality after the delimitation had been made, and proof of ownership became a valid qualification for applications to become subjects of either Russia or Turkey. Evidence, which was frequently false on both sides, was given by the representatives of the tribes affected, and a kind of "give-and-take" line was ultimately decided on for the frontier. Whether the line was a watershed division or a thalweg, the claim of a pastoral tribe to the ownership of a prairie on one side, while they remained subjects of the other, could not be logically upheld. The evidence before the Commission proved that the Kurds preferred to become nominal subjects of Turkey, as they would then be "a law unto themselves." The Bashi Bazouks, or irregular cavalry of Turkey, were largely recruited from the Turkish Kurds; while on the Russian side, though excused from obligatory service, the mountain tribes were encouraged by heavy bribes to join the army. We saw much of the Kurds, especially those of the tribe of Yezidis, or demon and sun worshippers, and frequently visited them in their black camels' hair tents, which were primitive enough to be such as were dwelt in by Father Abraham. With our escort, we could go into their encampments without fear, but we knew them to be brigands of the most dangerous sort.

The Commission reached the watershed line of the Ararat range, at

a point nearly fifty miles westward of the chief mountain, Great Ararat, which had been visible to us for some time, and for several weeks after this we did not lose sight of its conical snow-clad summit. Perli Dagh, near which we first arrived on the range, is a mountain about 10,500 feet in altitude, easy of ascent on horseback; we were therefore able, without any difficulty, to take an observation of the temperature of boiling water at its apex. We marched on Turkish ground a little to the south of the ridge, halting at Balýk Gol, a large lake, and other places. We made an excursion to Bayazid, a town of importance, which has played an ignoble part in the wars between Turkey and Russia, and saw there the remains of two fine palaces. Keeping round the base of Great Ararat, we encamped on the pass of Sardar Boulak, directly between the greater and lesser summits, at an altitude of 8,000 feet. The first mountain, 16,950 feet above the sea according to Russian measurement, rose to our west in a magnificent cone everlastingly capped with snow; while the second, 12,865 feet high but easy of ascent, the point of junction of the three frontiers of Turkey, Russia, and Persia, was on our east side. Our tents were pitched in a deep depression between the two peaks, which, in eagle-flight, are not nine miles apart. Early every afternoon, as we fell into the shadow of the great mountain, the temperature of the air dropped rapidly from July heat, and continued to do so until it was almost at freezing point. After this change had commenced, a curious and anomalous phenomenon was observed in the commencement of a flow of water in channels near the camp which had remained dry until about 3.0 p.m. The rays of the morning sun had melted some of the snow at the high levels, but the running water had not had time to reach so far until this late hour. It would continue to flow past us for two or three hours, after which the watercourses would again dry up. The treeless scenery round Ararat has an awe-like solemnity; the distant prospect of the Araxes Valley, with the river stretching far away, and Mount Alagos on the north, 57 miles distant, standing out sharply in the clear atmosphere. The local traditions in connection with the Biblical Story of the Flood are said to date from the foundation of Armenian Christianity in the 4th century only, but are very firmly established in the minds of the dwellers in the district—Armenians, Persians, and Kürds alike—who point to the names of villages round the mountain as affording incontestable proof of their truth. The names are, among others, as follows:—"The place where Noah built an Altar"; "Noah planted the Vine at this place"; "The Burial Place of Sarai."

Leaving Sardar Boulak the Commission returned to Alexandrapol by a direct route. Crossing the plain of the Araxes at less than 3,000 feet above sea level, a halt was made at Etchmiadzin, the cradle of the Armenian faith, where, in the grand Cathedral of St. Gregory, the founder of the religion, many sacred relics are preserved. The most

treasured of these is believed by good Armenians to be a fragment of the Ark, the legend concerning it being that St. Yakob, a monk contemporary with Gregory, received it from the actual hand of the angel Gabriel. Yakob, ascending Mount Ararat, was met by the angel at the snow level, and, after being admonished for his impious attempt to perform a feat forbidden to mortal man, was presented with the relic for the preservation of his faith. It was shewn to us by the Patriarch Nerses, who entertained us hospitably and displayed the riches of the monastery and the celebrated manuscripts there.

The impossibility of making the ascent of Ararat is held as a dogma by the poor Kurds and Armenians, who, although they acknowledge to have seen persons on the summit with their own eyes, persist that their appearance there was a deception, due to the evil spirits of the mountain, which they would imperil their immortal souls by believing to be true. Time has brought them to the belief that it was the Patriarch Jacob, and not the Armenian monk Yakob, who received the relic from Gabriel. The monks at Etchmiadzin do not share these beliefs, although they do not seem to discourage them. The ascent of Ararat was undoubtedly made by Dr. Parrott, a Russian savant, in 1828, whose success was attested by sworn evidence. None of our party reached the summit; Corporal Fisher, R.E., honestly imagined he had done so, but we did not quite accept the fact as proved; Gordon, in 1857, admitted having failed; and Dr. Woodfall and myself, in 1858, did so also, although we reached an altitude we estimated as about 16,000 feet above the sea. The superstitious fears of the Kurds prevent their going beyond the snow line; and they are therefore not of any service as guides. To skilful Swiss climbers, provided with the proper appliances, the ascent is not difficult, and it has been accomplished since I was in the country by members of the Alpine Club.

The notes I made at Etchmiadzin of the ancient history of the Armenian nation would require an article to themselves. From there we made an excursion to Erivan, the capital of the Persian province acquired for Russia by Paskiewitch in 1828, a most interesting place. We there saw remarkable types of Persian architecture in the ancient mosques and the Salamlik of the old Sirdars, in which coloured lavas and tiles were lavishly used; and we found a novelty in the Persian life in the bazaars, which greatly charmed us.

Returning to our road, we made a halt at Kazafar, under the shadow of Mount Alagos, a mountain approximately 13,450 feet in altitude. I was one of three English officers who made its ascent, with a Cossack who dared not disobey orders; but the Russian officers and our Hungarian interpreter, who commenced it with us, were soon tired of the exertion necessary to climb up a jagged ridge of rocks jutting out from the snow, so the four first spoken of reached the top alone. We fired off the Cossack's musket as a signal to the

camp, and ascertained the temperature of boiling water. The view was splendid. The descent by the same rugged rocks was difficult, as we had to drop from ledge to ledge with care. Charles George Gordon, with his characteristic impatience at our slow progress, seated himself on a steep snow slope, and commenced sliding down before Dr. Woodfall and I could stop him. We held our breath in terror as he was carried down with great velocity and we lost sight of him as he shot over a ridge which concealed him from our view. We continued the slow descent, with much anxiety as to his fate, and I cannot express the relief it was to our overstrained nerves when he met us, smiling as if nothing unusual had happened. It appeared that, after sliding down for possibly a thousand feet, he had been carried on to a smooth rising slope where his descent had stopped. His life's history might have been a very different one if he had not escaped so providentially.

The Commission did not stay long at Alexandrapol on its second visit, but moved northwards along the frontier, which ascended the Arpa Tchai to near its source and afterwards followed the line of crests separating generally the basins of the Black and Caspian Seas; the highest point was Gumbet Tepi, about 9,800 above sea level. The district traversed, known by the name of Adjara, lies to the south of Georgia and contains the large towns of Akhaltzik and Akhalkhalaka. In natural beauty this country exceeded every part of Asia Minor we saw, for it had in succession the most picturesque hill and dale, river and lake, covered with forest in which the virgin trees were of indescribable grandeur. In many places the smooth hog-backed crests formed the only road; we constantly encamped on them at high altitudes, enjoying the loveliest views conceivable from our tent doors. In any western land such a district would have long ago become the resort of the tourist, but the absence of hotels and roads tended to enhance its charms to us. The frontier dropped at a few points, between height and height, and crossed the valleys of the tributaries of the Kur, which find a meeting near Akhaltzik, from whence the river, after passing Tiflis, about 160 miles on its course lower down, flows on towards the Caspian Sea.

A halt of some days was made at Akhaltzik, the chief town of a district of Georgia, where there is a garrison and civil administration. The place is remarkable for having been the scene of the heartless massacre of its inhabitants by the Russians in 1828. It is now the centre of the manufacture of the artistic silver work generally known as Caucasus Niello, which is much used in the ornamentation of sword hilts and arms. At Akhaltzik, I experienced the greatest grief in the death of my valuable servant, Sapper Crompton, who died in the Russian military hospital from the effects of a gun accident. He had followed my fortunes for two years, and I was much attached to him, for he was a splendid soldier and typically a "handy man."

The Commission finished the clerical work of the delimitation at Osurgeth, capital of the province of Guriel, where we stayed ten days. While there the English Section gave a final entertainment to our colleagues and the local gentry; this was the greatest success, and afforded us a favourable opportunity for noting some curious customs of the Georgian people and seeing our guests in their gala costumes. The title "Knaz" is that which they use to designate a landowner of importance, but we translated this into "Prince"; and we had twenty "Princes" and a dozen "Princesses" at our gathering, the main feature of which was an excessive consumption of Kaheti wine by the men after the departure of the ladies, who first amused us by dancing *pas seuls* in their own peculiar fashion.

We marched along the coast to Batoum, where we embarked for Constantinople. In 1857, Batoum was in Turkish hands. It became Russian in 1878 and is now connected with Tiflis and the petroleum wells at Baku on the Caspian shore, as well as with Alexandrapol, Kars and Erivan, by lines of railway, which must greatly affect the prosperity of the Turkish pack-trade between Persia and Trebizond.

I have already mentioned that Gordon and I returned to Asia Minor in 1858 to act as arbiters in the demarcation of the frontier. We went over all the ground a second time, but did not take any more barometrical observations. The line of boundary was indicated by "Marques de Bornage," built where deemed necessary, and these were described in a "Cahier de Specification," the marks being fixed by the bearings of "Points de Repère." The plans and other documents were signed "en triple expedition" by "Messieurs les Commissaires Demarcateurs," and the English copy is no doubt in some pigeon-hole at the Foreign Office. But the frontier line, with which we took so much trouble in 1857–8, ceased to exist as such in 1878, when Russia acquired the additional territory shewn on the map I append.

After concluding our labours at Alexandrapol, Gordon and I marched through the provinces of Kars and Ardahan, which are now Russian, and reached the Black Sea at Batoum by way of the Tchorük Sou. As we approached the coast, the country was so densely wooded that we found it impossible to get further than Artwin with pack horses; and on reaching that place there was no alternative, except a very long circuit by way of Baibürt to Trebizond, to embarkation in the most primitive of canoes and a rather hazardous voyage down the Tchorük Sou to Batoum. As the season was getting late for crossing the mountain passes, we decided on the river; and after selling our horses and most of our stores at a great loss, we reached the sea in two days. We heard that this route had never been chosen by other western travellers before that date; and as, by this time, the Russians have doubtless made a road for wheel traffic between Batoum and Artwin, the chance of making such an exciting voyage is now past.

Before we left the country, I accompanied Gordon in a trip with a hired carriage to Tiflis, the capital of the Trans-Caucasian Government, where we were hospitably received by our friend Baron Finôt, the French Consul, who had been our guest in camp the year before; under his guidance we enjoyed several days in the city very pleasantly.

The remainder of Major-General James' article consists of technical details regarding the determination of the altitudes from the various observations recorded by the British Section of the Boundary Commission. In the course of the summer barometrical readings were recorded three times daily, at altitudes varying from sea-level to almost 10,000 feet; and at a few of the higher points the temperature at which water boiled was observed. As the methods employed in calculation have been greatly simplified since 1855, it is unnecessary, now, to give the details *in extenso*.

As regards the formulæ used by Major-General James, an adaptation of his own from one deduced by Serjt.-Major J. Steel, R.E., from the theories of Laplace, Vince, Allinson, Dalton and others gave fairly good results; and the calculated heights obtained by this formula are compared with those by several other methods in a lengthy table for which there is not space. One of the other methods,—and, apparently, that which on the whole produced the most satisfactory results,—is the rule given in the *R.E. Aide Memoire* of 1876 (Part I., Article 95), and a selection of the heights obtained by this method has been made for the accompanying map. A few of the altitudes, however, have been taken from Russian sources or from calculations based on the Boiling Water temperatures.

From the circumstances under which the records were made, the impossibility of comparing those at the lower station (Trebizond) with the observed upper readings at once became evident; and the application of the usual corrections would have been futile. In fact, the altitudes obtained by applying a deduced table of multipliers (not printed) to the approximations found by the mere subtraction of the observed barometrical readings from 30,000 compare with surprising accuracy with the results by the best of the other methods. The heights obtained from the Boiling Water temperatures are less reliable, and have been rejected for the map when others were available.

Major-General James justly states "heights obtained by barometrical and thermometrical observations, although they afford an approximation to the truth, cannot be assumed accurate enough to bear comparison with those determined by spirit-levelling or vertical angles." Accepting this principle, most geographers are agreed that it is not material to elaborate a formula, it being recognized that the investigation, originally worked out by Laplace, is a simple problem in hydrostatics not capable of producing absolute accuracy. Simple tables have, therefore, been framed for travellers, those most in use by British surveyors being due to Baily. There are well-known tables, also, by Williamson, Guyot, and others. Mr. Gilbert, of the United States Geological Survey, has recently brought

forward a new method, depending on the employment of two base barometer stations,* which is said to produce satisfactory results.

Details are also given in Major-General James' article of the instruments employed in 1855; and the difficulties experienced by the British Section will be understood when it is stated that the last of the seven mountain barometers which remained serviceable was broken a week before the return of the Commission to the sea level.

Edr., R.E.J.

* See *Topographic Surveying*, by H. M. Wilson (Wiley & Sons, New York).

AN EARTHQUAKE THEORY.

By Capt. H. L. Crosthwait, R.E.

After an earthquake one is naturally impelled to ask the questions :— What is the cause of seismic disturbances ? What agency, or agencies, are at work to produce such far-reaching effects, sufficient to be felt, or at least instrumentally recorded, all over our planet ? A complete answer is, of course, not forthcoming. All it is proposed to do in this paper is to point out what appears to be the most probable direction in which to look for a solution of a problem that must always be most fascinating.

Direct observation has not contributed much. It has been truly said that, if we were to visit the scene of one of the most appalling disasters after a lapse of, say, two years or so, when houses had been rebuilt and artificial structures generally repaired, it would be almost impossible to tell that anything had taken place. It is the works of man that suffer most. The severest shock has so little apparent permanent effect on the crust of the earth that it requires a trained eye, and often delicate measurements, to detect it ; though there are indeed some notable exceptions, such as Allah Bund in the Sind desert, the result of an earthquake that occurred in the first half of the last century.

Although observations have not done much to unravel the cause, they have solved such questions as the depth of the disturbance below the surface and the rate of propagation of the seismic waves. But this subject is much obscured and complicated by the nature of the waves themselves and by the want of homogeneity of the medium through which they have to travel.

If we want an intelligible explanation we must look to theoretical considerations. There is a theory, dependent on a mathematical demonstration, which appears best to account for the phenomenon. It is this that it is proposed briefly to explain.

In a paper entitled "The Distribution of Strain in the Earth's Crust, resulting from Secular Cooling,"* based on the theoretical researches of Lord Kelvin and Professor G. H. Darwin, Mr. C. Davison has shown that the *rate* at which the earth loses heat increases with the depth below the surface up to a certain point, when it becomes a maximum, after which it decreases towards the

* *Philosophical Transactions*, Vol. 178.

centre. The depth of the position of the greatest rate of cooling constantly increases, and "varies as the square root of the time which has elapsed since the consolidation of the globe." This seems a remarkable result. It has been arrived at by purely mathematical reasoning, and is vouched for by the highest authority. It will account not only for most of the seismic phenomena but also for features in the configuration of the earth's crust.

Suppose the crust of the earth to be divided into a series of thin concentric shells.* Consider two consecutive shells situated above the point of maximum rate of cooling. As they are losing heat at different rates, there must also be different rates of contraction. The inner surface of the outer shell (which loses heat at a slower rate) contracts less than the outer surface of the interior shell. The result is that the exterior shell is thrown into a state of compressive strain. Apply this reasoning to the crust of the earth as a whole, and we have an outer solid shell ever endeavouring to accommodate itself to a smaller interior. In other words, there is a constant tendency to disturb the existing state of equilibrium; but whenever such is the case there is also always a tendency towards its readjustment.

Here there are all the elements of an earthquake. When an attempt to restore equilibrium takes place the result is a seismic shock.

As the cooling continues the strain on the earth's crust becomes greater and greater; a time comes when resistance can no longer be maintained, and then rupture ensues along some line of weakness. A slip takes place, and the outer crust suddenly endeavours to accommodate itself to new conditions, which it has perhaps been striving after for a long series of ages. Equilibrium is probably never fully attained because the processes are never completed.

Observation seems to indicate that these lines of weakness are coincident with the great mountain ranges of the earth. In fact the forces that cause seismic disturbances may also produce the crumpling of the crust which we call mountains.

There would seem to be a further subsidiary cause at work, tending to make earthquakes more frequent in the neighbourhood of mountain ranges. In the process of denudation, which is always going on, enormous masses of alluvial matter are continually being transported from the hills and distributed over lower ground. This must, in the course of time, alter the relative distribution of weight on the portion of the earth's crust concerned. It is something like moving material from the crown of an arch and placing it on the haunches; when a certain amount has been removed a place of weakness is developed, and finally fracture occurs. So it is with the earth's crust. By the action of the process indicated, what were probably natural zones of

* Each shell is assumed to be so thin that its rate of cooling is uniform.

weakness become intensified and less able to resist the strains they have to bear. In the case of the Himalayas the haunches of the arch may be represented by the great Bhábar* deposits, known to be thousands of feet thick, which lie at the foot of this range. Professor Milne† instances a case, in Japan, where frequent earthquakes have their origin near the mouth of a river. It is known that this river is constantly depositing immense masses of material at its mouth, thereby altering the relative distribution of weights.

With regard to the theory itself Professor Darwin remarks "the stretching and probable fracture of the strata at some miles below the surface will allow of the injection of lower rocks among the upper ones; and the phenomena which we should expect to find, according to the theory of Mr. Davison, are eminently in accordance with observation. It therefore appears to me that his view has a strong claim to acceptance."

To say that the theory of secular cooling as a cause of seismic disturbance has been accepted by geologists would be perhaps to overstate the case. They are naturally, and not without reason, very cautious. The list of accepted theories is small, and seldom suffers enlargement; but the theory in question may be said to occupy an honourable place in dynamical geology among the causes usually discussed.

* These deposits represent the results of continued denudation of the mountains.

† *Encyclopædia Britannica.*

TRANSCRIPTS.

PRECAUTIONS AGAINST FEVERS.*

As mosquitoes and flies undoubtedly carry disease, such as Malarial, Enteric, and Yellow Fevers, etc., I would suggest that it is advisable to attack these pests as far as possible.

1. Mosquitoes breed only in water, usually in that standing in artificial places.

2. Mosquitoes occur in the vicinity in which they breed. Invasions from long distances are exceptional.

3. The young mosquito lives in water from seven to twelve days.

4. Destroy the breeding places, and you will destroy the mosquitoes.

5. Empty the water from all tubs, buckets, cans, flower vases, etc., once in every 48 hours.

6. Fill or drain all places where water stands.

7. Change regularly every day all water needed in hen coops, dog kennels, etc.

8. Clean away weeds, grass and undergrowth about ditches, ponds and other possible breeding places, since they afford a hiding place for the adult mosquitoes.

9. Keep the vicinity of your house clear of all cans, tins, bottles and rubbish.

10. Tubs used for catching water, and which are in daily use, should be covered with a fine wire netting. Water from such tubs should not be used for cooking or drinking purposes, and the water in the tub may be treated with paraffin oil.

11. Any pond in the grounds which cannot be drained or filled in should be treated with a little paraffin oil; an ounce of oil will spread over about 12 square feet of water.

Flies as well as mosquitoes carry disease into houses, and a common method of introducing it is by food contamination.

All meat and other eatables should be kept in a fly-proof safe, and even when on a sideboard they should be protected by wire gauze meat covers or pieces of muslin.

Great care should be exercised in keeping the kitchen premises very clean; any refuse left exposed outside will attract flies, and these will settle on food in the kitchen.

* We are indebted to Colonel E. Harrold Fenn, C.I.E., R.A.M.C., Administrative Medical Officer, Chatham, for permission to publish these notes, which he has issued officially to drafts proceeding abroad from Chatham.

Milk should be carefully protected from flies.

Enormous numbers of flies can be destroyed daily by using fly papers or fly traps.

General Precautions.

Water.—Never drink doubtful water; if you are obliged to do so, boil and filter it; if no filter is available, boil.

Sun.—Never expose yourself to a tropical sun without a proper helmet.

Drink.—Never drink beer or spirits in the tropics before the sun goes down. Lemon squashes are more refreshing in the hot time of the day, or well-made barley water, which ensures the water being boiled.

Clothing.—Wear woollen, or silk and wool, sleeping suits at night, and a flannel belt round your stomach. Wear some absorbent material for shirts during the day.

Mosquito Nets.—Always sleep under nets where mosquitoes exist.

HEAVY MILITARY BRIDGES MADE OF IMPROVISED MATERIALS.*

Extracts from an Article by LIEUT.-COLONEL R. SCHOTT *in the* SCHWEIZERISCHE ZEITSCHRIFT FÜR ARTILLERIE UND GENIE, *December*, 1904.

MODERN warfare demands a mobile army. Only such an army, however, can be mobile which receives assistance from its technical troops in overcoming quickly and easily all possible obstacles. The Commander who possesses superior technical appliances and the most skilled Engineers possesses the greater mobility, and, other things being equal, has a great advantage over his adversary. Such technical troops, however, must be numerous in order to cope with the task allotted to them; and it is necessary that, in addition to careful training, they should be provided with the most modern technical appliances. Many foreign armies carry light bridging material with the advanced guard. Such material should be so light that its vehicles can follow an advanced guard anywhere. It should assist the cavalry in crossing large rivers by providing ferries (horses swimming). Further it should be possible to construct with it light foot bridges across small and medium streams, to enable infantry to cross two abreast, horses one at a time, and the lighter military vehicles (unlimbered if necessary) to be run across by hand. Such light constructions should be replaced by full-sized bridges constructed with the heavy equipment as soon as the latter manages to come up. In most cases, however, the technical troops in front, *i.e.*, the sappers, will manage at an earlier stage to construct trestle bridges with improvised material.

In rivers with soft bottoms, where trestles would quickly sink in, or in rivers with very rapid currents, where the supports would be scoured out, also in cases where, during the summer, strong and unexpected floods are possible, a trestle bridge will not satisfy the requirements of traffic for any length of time, and it will be necessary to replace it by a pile bridge.

PRELIMINARY CONDITIONS FOR BRIDGING.

Above a certain depth of water and velocity of current it is desirable to have the legs of the trestles shod with iron points; if necessary one shoe

* Communicated by the Chief of the General Staff, W.O., and printed by permission of von Huber & Co., Frauenfeld.

for each trestle would suffice (*Fig.* 1). These iron shoes, used for the first time by Lieuts. Schrafl and Zuppinger during this year's bridging in Turgi, have proved their value beyond doubt; the trestles are immediately held in position when they touch bottom, while without such shoes they always glide a considerable distance down stream, so long as the erecting carriage is not stationary. With a very rapid current and with a moving river bottom, the trestles have often been moved down stream by the force of the current after they were considered perfectly secure, and

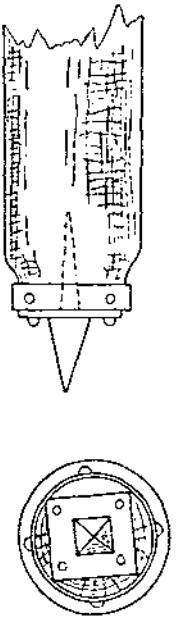

Fig. 1.

even after the bridge had been entirely completed. In such cases it is desirable to construct the bridge so as to form in plan a gentle curve up stream, which stiffens the entire structure on the principle of the arch. If the velocity is great, it is necessary to anchor the trestles into position; in the case of narrow rivers such anchorages can be provided from both shores, but in the case of broad rivers it is necessary to lay them in the bed.

PREPARATIONS FOR BRIDGE CONSTRUCTION.

For round timber it is best to use freshly cut and green pine trees. Old timber is very often worm-eaten, and if it has been lying for some time in the open it is probably partially rotten and defective; it is not possible to make reliable structures with it. Green timber is also more elastic and stronger. For bridges constructed in a strong current and with water of a considerable depth, it is absolutely essential for trestle bridging to employ green timber owing to its considerable specific gravity; dry timber is too buoyant and will not sink to the bottom. The bridge Commander will have to make out a list of timber required, and he will be well advised to provide some spare material (say 10%) for all parts of the

bridge. Where it is not possible to take a careful cross section of the river, it is desirable to provide strong road-bearers for the last span, capable of spanning 8 m. (26 ft.). Instead of 5 road-bearers 7 or even 9 may be employed, thereby saving an extra support, which is often difficult to get into position. If a spare trestle has been provided, for which cross bracing has been prepared but not fixed, it is possible to cut off the legs to the requisite length, and to fix the cross bracing in a very short time (say 10 minutes). Such a trestle must be adapted to the greatest depth of water, so that it will be available at any point required. Besides this it is necessary to provide spare road-bearers for one span of the roadway. Some spare transoms should also be available.

A careful cross section and a carefully prepared project immensely facilitate the execution of the work. A mistake that is frequently made is to take a cross section only within the breadth of the waterway, and to measure vertical ordinates only at the probable positions of the supports. This is insufficient. Firstly it is necessary to include the two shore approaches in the cross section. Secondly it is necessary to measure the bed of the river, especially if it is irregular, at points intermediate between the supports. This is generally necessary near the shore. With such careful preparation of the cross section it is possible to avoid placing trestles on a steeply falling bottom, or in positions where one leg has to be much longer than the other.

For taking the cross section it is usual to use a cord or tracing line on which the normal spans are marked off. I have often noticed that in fixing these marks the cord is laid loosely on the ground. But it should be borne in mind that there is a difference in length between a slack cord and the same tightly stretched. The spans should, if possible, be marked off on the line when in position, but if that is not possible the marks should be made on the line when tightly stretched. The spans in execution never turn out to be of exactly the same length as assumed in the design. If the river is a broad one, say 100 ft. and upwards, the bridge Commander should first of all see to the construction of an erecting carriage (*Fig.* 5), for which a very solid two-wheeled under-frame from a cart should be obtained. It is, however, necessary to avoid the worn-out carts that peasants frequently possess; the vehicles of sapper transport, which are on springs, cannot be used for this purpose either. Four well-trained carpenters with four assistants can fit up a carriage in about two hours. The following materials are required :—

2 saddle beams, preferably squared, 3·6 ft. long and 5 × 6 inches in section.
2 longitudinal beams about 43 ft. long and 7 to 9 inches in diameter.
1 lever for prolongation, 23 ft. long and 5 inches in diameter.
Sundry small spars.
1 anchor rope.
30 lashings.
10 dog-spikes.
5½ lbs. nails.
1 strong two-wheeled under-frame.

The carriage, when fully equipped, weighs about 15 to 20 cwt.

The longitudinal poles should project towards the front a distance of L plus 5 ft., where L is the greatest span to be bridged.

The two-wheeled under-frame of the carriage should be capable of bearing the following loads :—

Dead weight of carriage equipment, 20 cwt.
A trestle, weighing as a maximum 12 cwt.
The men of the carriage squad who act as a counter-weight, 23 cwt.
Total, 55 cwt.

In order to be able to withstand sudden blows and jars during erection, a certain margin should be allowed, so that the total carrying power of the carriage should be at least 69 cwt.

Insufficient attention is frequently given to fixing the shore transom, ignoring the fact that the total horizontal pressure of the bridge must be taken by the shore transom, until the road-bearers are connected with the opposite shore. I have seen large temporary bridges over the Ergolz at Liestal collapse like a house of cards when the shore transom had given way. It is generally advisable to employ a very long and strong piece of timber as a shore transom, and if necessary to anchor it strongly towards the land side by means of iron wires, etc.; it should be sunk into the ground. By this means a ramp is avoided, and the jolts against the end board, produced by approaching vehicles, can be entirely prevented. In front of the bridge it is desirable, wherever the approach is not on perfectly hard ground, to provide brushwood foundations with road metalling on the top, in order to avoid deep ruts in front of the bridge.

Where it is difficult to secure the shore transom it is desirable to provide one or more supports on the near shore consisting of pile piers, which should be thoroughly braced both to each other and to the shore transom. It is thus possible to give the bridge considerable strength. These piles are often connected by double transoms like trestles; but it is simpler to cut off the piles at the top to a uniform height, and to nail thereon a log, which should also be securely spiked to the piles. The piles can be driven either by means of heavy mauls of wood or iron, or by a monkey, weighing about 1 cwt., which can best be made of a block of hard wood. This block should have an auger hole, about 1 inch in diameter, bored lengthways through the centre; it should be provided with iron rings top and bottom, and also with four or six side handles, which can be made of round iron dog-spikes, or of ordinary dog-spikes wrapped round with string. If the river bed consists of coarse gravel, the piles should be provided with iron shoes.

Such structures should only be provided on the near shore, as they take much time to make, unless it is possible to prepare them during preliminary preparations on both banks simultaneously. Whenever possible the bridge engineer should attempt to arrange for a normal type of construction on the far shore, if he desires to complete the bridge as rapidly and as smartly as possible. If it should be impossible owing to

insufficient height to provide an ordinary trestle for the last support, a special framed trestle, resting on a ground sleeper, should be made, or a sleeper crib consisting of two or three layers may be prepared beforehand, ready nailed and spiked.

The bridge trestle (*Fig.* 2), which it is now proposed to lay down as a

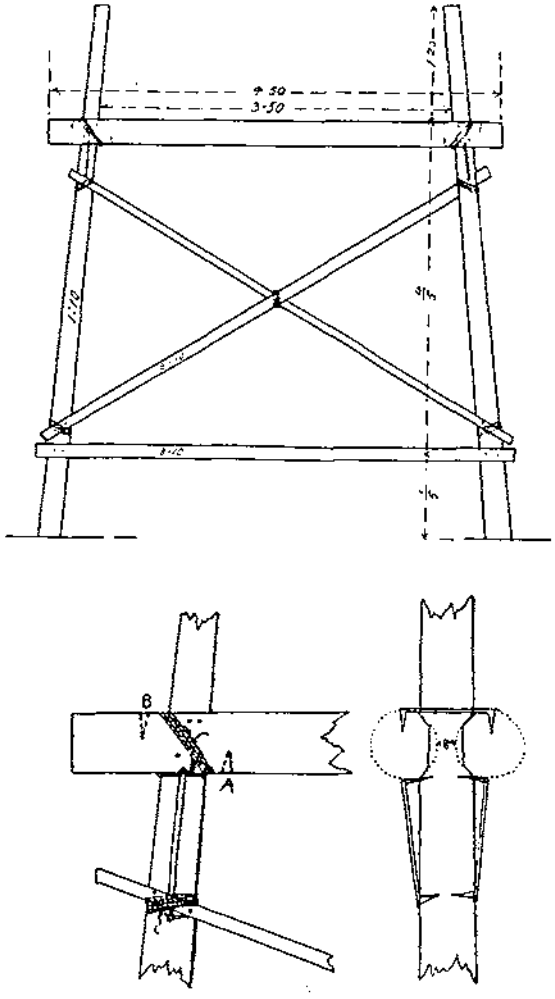

Fig. 2.

type in the new regulations, was found to be very suitable and durable during the recent large bridging operations.

Formerly it was usual to secure the transoms by bolts, which is rather a tedious and slow process. Nails and lashings by themselves are insufficient with stout timbers; if the bridge is much used, and if the weather changes frequently from wet to fine, the lashings are bound to get slack. A very secure connection between the transoms and the

legs is the fundamental condition for good trestle construction. In place of bolts it is possible to use four dog spikes, which can be driven into the transoms flush with the wood, as shown at A and B. It is best for this purpose to use short dogs not exceeding 14 inches in length, the spikes of which can be driven entirely into the wood. In order to prevent transoms from splitting, it is desirable not to drive the spikes at the extreme end of the transoms; it is better to make them break-joint and to fix the lower ones first and inside the legs, the upper ones subsequently and outside.

All other joints on the trestle are nailed and lashed. It is desirable to remove the bark at all joints where timber comes to bear against timber.

On a bad foundation in water with a moderate current, the legs of trestles are provided with bearing plates (*Fig.* 3). To employ dog-spikes

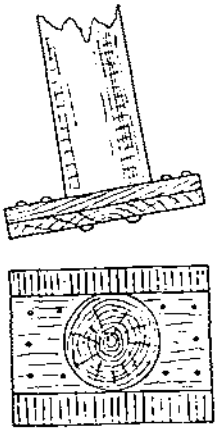

Fig. 3.

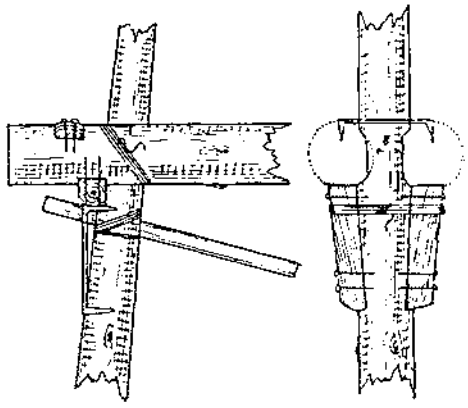

Fig. 4.

as bearers is altogether unsound; I should employ them principally for connecting the transoms together, and should use a different means for transferring the load from transom to leg. The old Schöne's trestle, as used by us 20 years ago, employed only two spikes, which were driven below the bearing blocks (*Fig.* 4). If such a bearing block (best made of hard-wood) is carefully fitted and nailed to the legs and transoms, a very strong joint is made, which is especially to be recommended for low trestles, where dog-spikes fixed at the sides make it difficult to secure the diagonals. In order to tie the transoms well together a smaller hard-wood block may be housed into them (perhaps by dovetailing) and secured by nails. It is, however, also possible to employ the Swedish system (*Fig.* 4), which does without any spikes, and uses hard-wood brackets nailed underneath the transoms; in this case, however, it is desirable to use especially strong legs, so that notches can be cut into them sufficiently deep to provide a level bearing for the brackets.

Strong door or window hinges, which can be found in every house and every shed, can be employed as a substitute for dog-spikes. Straight straps from large gates can be used for tying the transoms together by

bending them round the latter and securing them with nails; while the gates themselves can be used for forming the roadway.

The mistake is frequently made of not lashing the two transoms so as to have their top surfaces at the same level, and this brings the whole load on to one transom. If a bridge slopes towards one bank it is necessary to fix the transoms to the legs to suit this condition.

The roadway, from excessive caution, is often not placed sufficiently high. By giving some extra height the trestles are not made much heavier, more play in construction is thereby obtained, and with steep river banks high bridges are absolutely necessary in order to avoid deep approach cuttings.

When a trestle is found to be much too low and the current is very strong, making an alteration in the position of transoms too risky, it is possible to adopt an expedient which was used in the construction of a bridge over the Landquart, where it was impossible to prepare a cross section owing to the torrent. The outer road-bearers were placed one after the other somewhat nearer the centre than usual, and were there spiked; across these road-bearers new transoms were placed, and on these the real road-bearers were secured. It is also possible to secure short cross pieces between the lower old transoms and the upper new ones; then, when the centre road-bearers have been permanently secured, the outer ones can be released and refixed in the upper position; such cross pieces, which are best made of square section, should be prepared beforehand in various sizes, and set apart with the spare materials.

The road-bearers are provided at each end with a hard-wood trenail, at least 1½ inch thick and 6 inches long. For the trenails it is best to use very tough and green hard wood, like white or black thorn, hornbeam, oak, maple, etc.; alder, willow, pine will not do, because they are not sufficiently tough. Dry wood is brittle and is also not to be recommended.

As regards the roadway, at least one-third of the boards should be provided with notched ends, and it would be better to provide such notches to half the boards, so that there should be no delay or difficulty in rack lashing.

The ribands should be of equal length. Each span should be provided with independent rack lashing. It is not desirable to allow a riband to overlap its own span.

In cases where narrow paths lying close along the bank of a river lead up to the bridge, it is best to make the first span of double width. The structure thus gets a firm support on the shore, and the approach is comfortable. If the approach road is very narrow indeed, and is situated at the foot of steep and high banks, I generally arrange to have the first two spans made of double width.

CONSTRUCTION.

We shall only deal with the construction of large bridges, for which at least one company of sappers should be available. With such bridges it is usual to commence launching only when preliminary work has been sufficiently advanced to favour the prospect of the bridge being completed without a hitch.

For normal construction with the erecting carriage (see *Fig.* 5 and *Photos*), parties should be told off as follows:—

1 boat	party ...	1	N.C.O. and 2 men per boat.
1 constructing	,, ...	1	,, ,, 6 ,,
1 carriage	,, ...	1	,, ,, 20 to 30 men (usually the former).
1 carrying	,, ...	1	,, ,, 10 to 16 ,, ,, ,, ,,
1 road-bearer	,, ...	1	,, ,, 10 ,,
2 chess carrying	,, ...	2	,, ,, 8 ,,
1 chess laying	,, ...	1	,, ,, 2 ,,
1 rack lashing	,, ...	1	,, ,, 8 ,,

Store detachments with the rest of the company.

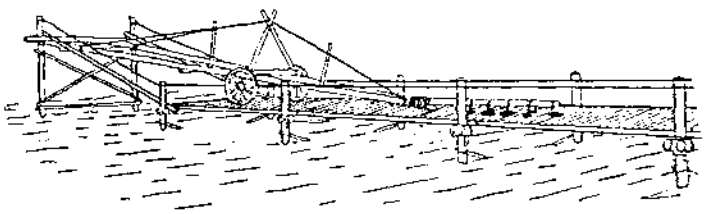

Fig. 5.

The four company officers undertake the following duties respectively. The Captain, who is generally the bridge commander, supervises the whole work. The Erecting Officer directs erection at the head of the bridge; the handling of the erecting carriage, the placing in position of trestles and road-bearers, and of the roadway itself. The Officer in rear controls the movements of the various squads, so that there may never be an excessive number of men on the bridge; he supervises the rack lashing and the fixing of hand-rails. The Depôt Officer supervises all work on the storage ground; above all he should take care that, by careful selection and sorting, all materials are employed to the best advantage; the strongest and heaviest materials should be reserved for spans in mid-stream.

For the Constructing Detachment carpenters who are specially skilled, smart, and willing should be selected; they assist the Carrying Detachment in getting the trestle over the last pier. The near transom of the trestle last brought up is placed on the legs of the last fixed trestle. The first road-bearers to arrive are the two outer ones, which are provisionally spiked and lashed to the near transom; the same transom is also attached loosely by means of lashings to the long poles of the erecting carriage. Two lashings joined together are attached to each leg of the trestle near the top, so that the position of the trestle can be regulated with them; these lashings can be used for a temporary hand-railing after the trestle has been pushed out. As soon as the trestle is in position, two men provided with hand-axes and dog-spikes go across the road-bearers on to it, and ascertain whether the pier is vertical. If this is not the case, the trestle must be raised and again lowered until it is in the correct position. After this the carriage is unlashed, the outer road-bearers are unlashed and spiked securely, and the remaining road-bearers are also fixed.

The Carriage Detachment works the erecting carriage. The position of the commander is on the carriage itself, for facility of supervision and so that all men can see his signals. In a strong current it is necessary to push the trestles as far up-stream as the play of the outer road-bearers, which are jammed in at the back, will allow, and then the trestle can be lowered with a jerk. In order to be able to raise the trestle again, if necessary, the tail end of the carriage should be provided with 4 or 6 lashings. On each side, near the wheels, one man is posted ready to scotch up the carriage by means of a hand-axe. The carriage is taken off the bridge as soon as the trestle is in position.

The Carrying Detachment has to bring up new trestles, legs in front, suspending the trestles as before described, with the aid of the Constructing Detachment, above and in front of the outermost pier.

The Chess Layers should exchange sides from time to time, which is best done at each new span. This prevents planks being placed crookedly on the bridge; this is especially likely to happen on a long bridge, because the planks are never pushed home with equal force by two different men.

In constructing the bridge the most important thing to attend to is that all piers are perfectly vertical. I attach much less importance to a pretty and straight bridge than to a substantial and strong one. In a strong current it is very difficult to maintain the correct alignment for the bridge; in such cases it is always desirable to try and point up-stream at the commencement; then the bridge of its own accord will gradually attain a correct alignment.

BAIDGE CONSTRUCTION DURING RECENT SAPPER TRAININGS.

The Sapper Recruits, amongst other bridging exercises during their period of training, constructed a bridge across the Aare at Brugg with improvised material only. The Aare has a breadth of 130 m. (430 ft.) at this spot; during the exercise the mean depth of water was 6½ ft., the maximum depth 8½ ft., with a velocity of 8½ to 10 ft.

In mid-stream, where the velocity was very great and the depth measured more than 6½ ft., three supports on river boats were allowed for. With so strong a current and with such depth of water it was not thought possible to place trestles in position; experience has since proved that this view was erroneous.

An opening of 82 ft. was left in the centre. In order to close this opening 3 floating supports, consisting of coupled fishing-boats, were prepared, anchored, and floated into position by pontoon troops, who happened to be doing their refreshing course.

REVIEWS.

AN AUXILIARY PORT FOR LONDON.

Under this title P. S. King & Son (Orchard House, Westminster) are publishing a series of pamphlets on the subject—"Can London spend her money to better purpose?" The first Paper is by 'Innovator,' and deals with "The River: Its Enlochment." Other Papers are to follow on:—Sewage Disposal, Improvement of Metropolitan Traffic, and a System for Supply Delivery in the Metropolis.

Paper I. deals with a subject that was discussed in this *Journal* in the early part of the year under the heading of "The Future of London." 'Innovator' sees many disadvantages in the proposals both for extensive dredging of the Thames channel and for constructing a barrage at Gravesend. He proposes to erect a barrage across the *estuary*, about 2 miles above Southend, thus creating a huge lake; and he calls his scheme the 'enlochment' of the river, in contradistinction to its 'canalization' by a barrage higher up. The Southend barrage would transform the whole river up to Kew into a vast lake, with practically permanent high water; the area of the harbour proper being about 10 square miles, and the depth of the lake varying from 20 to 30 feet at London Bridge to 50 feet at the barrage, which would be 2 miles long. The two sides of the barrage would provide great lengths of quayage, and the loch would become a deep sea port, capable of accommodating the largest vessels at all times. The lake would be kept clean by the water contents being changed in the course of every four tides. Across the barrage would be a broad thoroughfare between the two shores of the river.

In connection with his proposal the author suggests, in addition to minor schemes:—(1) The generation of electricity by water power, firstly for use in the port itself and secondly for distribution to the Metropolis; (2) an electric road from the port straight through London to Brentford, connecting with all the existing railway systems that converge into London; (3) the utilization of Canvey Island and the adjacent marshes as a huge Farm for the Sewage of the Metropolis; (4) the reclamation of some 5 miles of foreshore at Southend; and (5) the erection, opposite Canvey Island, of "Silverstrand," a 'City on the Sea' or 'Venice in London.'

'Innovator' enumerates the various advantages which his scheme possesses over others already proposed, and deals in general terms with its cost and the revenues likely to be derived; but he does not enter into engineering details.

A. T. Moore.

WRITING FOR PUBLICATION: THREE BOOKS FOR THE ASSISTANCE OF AUTHORS.

(1). *Author and Printer*, by F. Howard Collins. (5s.; Henry Frowde). This is a combined spelling, pronouncing, and explanatory dictionary, which, though actually arranged in one alphabetical sequence, may be divided, for the purposes of review, into six main portions:—

(*a*). Ordinary words, place names, and proper names, which provide the most common pitfalls for the writer:—*e.g.*, the use of 'who' and 'which'; the spelling of 'connexion' and 'affection'; the pronunciation of 'Marjoribanks'; the spelling of 'Mohammed' and 'Lhasa.'

(*b*). Abbreviations:—*e.g.*, 'M. Inst.C.E.'; 'M.J.I.'

(*c*). Celebrities:—*e.g.*, 'Mozart (W. A.), 1756-91, Austrian composer'; 'Sir Sydney Smith, 1771—1845, wit.'

(*d*). Foreign words and idioms:—*e.g.*, 'cui bono'; 'diner par cœur'; 'giaour'; 'nirvana'; 'rilievo.'

(*e*). Technical words used in the printing trade:—*e.g.*, 'em'; 'forme'; 'pica'; '12mo.'

(*f*). Hints for authors under:—'capitals, use of'; 'italics, use of'; 'paper, sizes of'; 'proof correction marks'; 'punctuation'; 'type, sizes of.'

The information under the first four heads is of great value to everyone. But that under the two last is useful principally to the author. From the author's point of view, therefore, the book would be more useful if the technical terms in printing, and the information and hints particularly helpful to a writer, were separated from the rest.

Mr. Collins does not attempt to differentiate between 'shall' and 'will.' This is probably a case of discretion being the better part of valour, as there is no rule that is of any practical utility. Indeed—so the reviewer has been told—one of the leading prose stylists of the present day has to have his manuscripts read by an Englishman in order to ensure these words being correctly used. In this connection book (3) below quotes the rhyme:—

> In the first person simply *shall* foretells;
> In *will* a threat or else a promise dwells.
> *Shall* in the second and the third does threat;
> *Will* simply then foretells the future feat.

The book may be looked upon as a standard guide, as the author submitted proofs (sometimes more than once) to some fifty experts, besides receiving assistance from many others, and consulted all the standard dictionaries and literature on the subject; and the result has been approved by the Master Printers' Associations of London, Edinburgh

and Belfast, and by the Executive Committee of the London Association of Correctors of the Press.

In his preface, Mr. Collins quotes a distinguished etymologist:—"There is a tradition . . . that a crabbed writing is given to a clever compositor, and therefore one ought to write badly. The gross selfishness of this is simply shameful. . . . A man who is a gentleman will make his copy legible for the express purpose of enabling the compositor to earn more wages (and to save his eyesight)." The author himself adds "Even for his own sake an author should write legibly, for bad copy invariably results in increased cost and in delay, besides greatly multiplying the chances of error. . . . A great deal of delay, trouble, and expense, to all concerned in the making of a book, may be saved if the author will have his manuscript revised by a proof reader *before* it is given to the compositor to be set up in type. . . . One firm of printers, having given this plan a trial, found the result so successful, that now *every* manuscript sent to them is revised by their proof-readers before it is composed."

Altogether a vast deal of information is included in 407 pages, $7\frac{1}{2}'' \times 5''$; and the highest compliment that can be paid to the book is to say that every writer should have it on his table.

(2). *Punctuation: Its Principles and Practice*, by T. F. Husband and M. F. A. Husband. (2s 6d.; Routledge).

The first part of this little work is historical; the second deals serially with the various marks of punctuation, giving some very lucid explanations of their proper use and some typical examples. The ordinary person would probably learn all that is necessary from the seven pages devoted to this subject in the first named book (1).

The work under reference contains one piece of information which may be news to most of us. "In legal documents, where clearness of reference is the first essential, punctuation-marks are systematically omitted precisely because this omission necessitates a constructional expression the meaning of which cannot be mistaken." It is comforting to know that the said absence of stops has its origin in so praiseworthy an object; whether that object is ever achieved is another story. Most people, who have had the misfortune to be involved in trying to detect the meaning of a legal document, have assumed that legal writers systematically omitted stops in order that their successors in the profession of law might earn their living in disputing over the real intentions of the deceased signatories.

The first rule is probably the most important one—Never put in a superfluous stop; so perhaps the lawyers are right after all.

(3). *Composition and Style*, edited by R. D. Blackman. (5s. Deacon & Co.).

As this is the fifteenth edition it may be presumed that the book meets an expressed want; but the greater part of it is useful only to persons deliberately taking up letters as a profession.

The greater part deals with 'Structure of Sentences'; figurative language, such as 'Apostrophe,' 'Hyperbole,' and 'Metaphor'; and the various styles, *e.g.*, 'Concise' and 'Diffuse,' 'Plain' and 'Florid.' It also includes critical examinations of passages from Addison and Swift; and an illustration of the 'Progress of English Style' in the form of extracts from the writings of the best prose authors from Ascham (d. 1568) to Ruskin (d. 1900). The book is somewhat overloaded with examples, and is written in the 'diffuse style' which it condemns; curiously enough too, the system of punctuation is at variance with the commonsense principles adopted in the two books referred to above, (1) and (2).

The earlier pages, however, give some useful hints on grammatical errors, and also on style in general.

"To know what you would say and to say it with freedom and with individuality is the great point." "Practised writers make up their minds beforehand, both as to what they mean to say, and as to how they ought to say it." "An author's meaning ought always to be obvious, even to the most careless and inattentive reader. . . . We must study, not only that every reader may understand us, but that it shall be impossible for him to misunderstand us." The principal qualification for a good style is Perspicuity, the ingredients of which are Purity, Propriety and Precision; Purity is defined as "the use of such words, and such constructions as belong to the language which we write," and Propriety as "the selection of such words, as the best and most established usage has appropriated to those ideas which we employ them to express." Dr. Armstrong's idea of the best language is quoted as "the shortest, clearest, and easiest way of expressing one's thoughts, by the most harmonious arrangement of the best words, both for meaning and sound. The best language is strong and expressive, without stiffness or affectation; short and concise, without being either obscure or ambiguous; and easy, and flowing, and disengaged, without one undetermined or superfluous word." As regards Precision, we think it was von Moltke who defined a well written order as one that did not contain a single word the omission of which would neither affect its sufficiency nor vitiate its meaning.

The quality of Precision is of course largely controlled by the proper ordering of words and the intelligent use of punctuation, to both of which much care should be devoted. Our old friend *Punch* frequently gives extracts from other publications, especially from their advertisement columns, showing the grotesque results that follow from carelessness in these details. Innumerable instances might be quoted of the omission or improper placing of stops. In regard to the even more common fault of neglecting to consider the sequence of words, the reviewer begs leave to quote from the concluding paragraph of a recent book which elsewhere throughout its contents exhibits a perfection of style—"There was a familiar sound of shouts and cab-wheels and omnibuses coming heavily through the open window": not many of us, we trust, are familiar with the entrance of omnibuses, either heavily or otherwise, through the windows of their chambers, but possibly this does occur sometimes during the fogs in London where the book was written, and of course we

occasionally hear of our own traction engines breaking into houses through area walls. We may also quote two orders issued during the late war in South Africa—"All rubbish in camp will be collected every evening and burnt under an officer"—"No one may sleep outside the blockhouse except the sentry": small wonder that blockhouses were now and then surprised, and that officers became scarce towards the end of the campaign.

With respect to Perspicuity in general we are told that Tennyson and Macauley re-wrote their pages over and over again until they attained the gracefulness and dignity which is commonly supposed to have been merely the attributes of peculiarly facile pens. Artists of the brush also possess that 'infinite capacity for taking pains' which usually passes under the name of 'genius'; it is said, for instance, that Phil May's wonderfully articulate sketches were really produced by pruning and trimming more or less elaborate drawings until not one superfluous line remained.

An Addendum to the book, entitled "Printing and Publishing" and apparently included for the first time, contains much information of interest, especially to anyone who has to see his own productions through the press. It deals with such subjects as:—Manuscripts; Proof Correcting; Size of Paper and Type; Binding; Copyright.

The best paper for Manuscripts is 'foolscap quarto,' $6\frac{3}{4}'' \times 8\frac{3}{4}''$; anything much larger is inconvenient for the compositor to handle, whilst smaller sheets are liable to get mixed up or go astray. The best colour is white. A margin should be left, and any emendations should be made thereon, as they are easier to read there than when written over altered words. The handwriting should be distinct, special care being taken with capital letters and with all proper names and technical terms; and it should be readable with certainty, for all interlineations, erasures, etc., add to the work of the compositor and usually also to the cost of printing. Each sheet should be numbered, and headed with the title or part of the title [for the whole of a MS. is not necessarily given out to one compositor; in journalistic work, in fact, it is most often distributed to several]; and the left-hand top corner should be left free for a fastener. Particular attention should be paid to punctuation; the printer cannot be depended upon to supply the proper stops in place of indefinite dots and dashes; the latter often result in disaster to the author's sentences and needless expense in corrections. The lengths of the lines should be uniform; and it might have been added that new paragraphs should be clearly defined, for prose written as if it were blank verse is a fruitful source of error in printing.

The printer follows the 'copy.' If he sets the copy right where it is obviously wrong, the author has to pay. The author has also to pay for all corrections made by him in the proof, except those due to the printer's unwarrantable departure from the copy. A carefully prepared MS. therefore means a saving in expense. Inexperienced writers are to be warned that an apparently small correction to a proof may involve a considerable re-arrangement of type; for instance, making a new paragraph necessitates shifting words from one line to the next to the end of

the original paragraph. This section of the book contains a sample of a first proof corrected for the press, showing all the conventional signs in use, and is worthy of study.

As regards Paper, the book refers to 'laid' and 'wove,' the former being distinguished by linear marks down and across the sheet; but these terms are really only applicable to 'writing paper.' In the trade all paper used for printing books is classed as 'printing paper.' The latter is distinguished by weight, and the same quality of paper can be manufactured in various weights as well as in various sizes; paper of other than standard quality, size, and weight has to be manufactured specially, an expensive procedure unless a large quantity is required. Printing paper should be tough, of good colour, properly sized, and (for ornamental printing) well glazed. It is sold in reams containing 516 sheets. This *Journal* is printed on royal octavo paper, 30 lbs. to the ream.

The size of a book depends on the size of the sheets of paper on which it is printed and on the number of times each sheet is subsequently folded. The papers most commonly used are:—foolscap ($13\frac{1}{2}'' \times 17''$), royal ($20'' \times 25''$), demy ($17\frac{1}{2}'' \times 22\frac{1}{2}''$), and crown ($15'' \times 20''$). The original sheet is usually folded once in the first instance, making 2 equal leaves or 4 pages, called folio size; a foolscap folio page is thus $8\frac{1}{2}'' \times 13\frac{1}{2}''$, prior to the trimming of edges before binding. Subsequent folds always divide the paper again into two equal parts; a sheet folded three times thus makes 8 leaves or 16 pages, called octavo (8vo.); accordingly a royal octavo page is $6\frac{1}{4}'' \times 10''$, and a demy octavo $5\frac{5}{8}'' \times 8\frac{3}{4}''$. Sometimes the original full sheet is folded twice in the first instance, being divided into three equal parts; two further folds into two equal parts produce 12 leaves or 24 pages, called duodecimo (12mo.); a crown 12mo. page is therefore $3\frac{3}{4}'' \times 6\frac{5}{8}''$. Diagrams are given showing how the various sizes of sheets are folded to produce various sizes of pages, and how the type is arranged in the 'formes' for printing, so that when the sheets are folded the pages will be in proper sequence.

Samples are given of the various sizes of Type. The most common are:—'small pica' [used for the main articles in the *R.E. Journal*]; 'long primer' [used for translations in this *Journal*]; 'brevier' [used for the Domestic Occurrences in the *Supplement*]; and 'nonpareil' [used in the *Monthly List*]. The lines are either set solid or spaced with one or more leads [the main articles in this *Journal* are 'single-leaded'].

The information as to Binding is somewhat scanty, and 'casing' and 'binding' are not differentiated; in the former the book is only attached to the cover by book-binders' cloth, glued on; in the latter the back of the book is sewn to short cords, the ends of which are opened out and beaten into the cover. The former method is more generally employed; the latter more durable, but more expensive, one can usually be distinguished by ribs on the back of the cover. Books are usually cased in paper or cloth, and bound in leather; a half bound book has leather backs and corners with paper or cloth sides, but the method of binding is the same as if it were full-bound.

"Copyright is created by statute. . . . In a book it lasts either for 42 years from the date of first publication, or for the author's life and seven years after his death, according as the one or the other period is the longer. It is valid throughout all the British dominions."

"A book may or may not be registered at Stationers' Hall. In either case the copyright remains unaffected. But it must be registered there before legal proceedings can be taken for the protection of the copyright."

A. T. MOORE.

NOTICES OF MAGAZINES.

NATURE.

August, 1905.

WARSHIP DESIGN (*p.* 320).—Sir P. Watts, at the Institute of Naval Architects, in tracing the progress made in the design of warships since Nelson fought at Trafalgar, compared the weights apportioned to the different elements in a battleship of 1805 and one of the present day. The old ship of 74 guns had 20 per cent. of the total displacement awarded to general equipment as against 4 per cent. for the 1905 battleship. Armament in 1805 was 10 per cent. of the displacement; in the present day 19 per cent. The propelling arrangements are somewhat in the nature of a surprise, masts, sails, and rigging absorbing 8·5 per cent., and modern steam machinery only 10·5 per cent. of the displacement. The 74-gun ship required 6·5 per cent. for ballast to give stability under sail, while the 1905 ship takes 5·5 per cent. only for coal. Armour takes 26 per cent. and 35 per cent. for the steel hull of the modern ironclad, total for both 61 per cent., whilst the old wooden hull absorbed 55 per cent. of the total tonnage. The construction of the "wooden walls" was more massive than was needed for ordinary purposes, and a good part of the 55 per cent. might be set down as wooden armour.

LIQUID AIR (*p.* 353) was stated, in some company schemes, as a source of power to eclipse and replace steam and electricity. As an artificial refrigerator it was to banish ice, ammonia, sulphur dioxide, and carbonic acid. In surgery it was soon to be the only anæsthetic, antiseptic, and caustic employed. In medicine it was to cure consumption and many other diseases. One of the most promising applications proposed for liquid air has been the manufacture of oxygen from air by liquefying it and letting the nitrogen boil away before the oxygen, separating them by distillation, but practical success has not yet been achieved in this or in the other schemes above-mentioned. The liquid oxygen or air rich in oxygen obtained by distillation from liquid air if mixed with cotton wool makes an explosive, and has been tried by Austrian engineers in tunnelling under the Alps, but was found to be too cumbrous in application and the results too uncertain in practice.

The most pronounced successes of liquid air have been in connection with scientific research; by being frozen in liquid air the bacilli of typhoid become brittle enough for trituration in a mortar, and then by centrifugalisation the nitra-cellular poison can be separated, and then by the methods of Pasteur an anti-typhoid serum prepared, which promises to be of real value. Also, by the liquid air process, krypton, xenon, and neon have been discovered, and the emanation of radium and thorium proved to be condensable and vaporisable, and helium shown to be produced from radium emanations. Finally, it was by an extension of the same process that hydrogen was liquefied.

RESEARCHES ON EXPLOSIVES, by Sir A. Noble (*p.* 359).—Experiments made on erosion with (1) cordite, (2) cordite M.D., (3) a tubular nitrocellulose, and (4) other explosives have satisfied the author that the amount of absolute erosion is governed entirely by the heat developed by the explosive.

PROFESSOR DARWIN'S inaugural address, as President of the British Association at Cape Town, deals with the fascinating idea that matter of all kinds has a common substratum. It has been shown that the atom consists of a large number of component parts, and that the simplest of all atoms, namely, that of hydrogen, consists of about 800, while the number of parts in the atom of the denser metals must be counted by tens of thousands. These separate parts of the atom have been called corpuscles or electrons, and are particles of negative electricity, moving with high speed, comparable to the velocity of light, and restrained from breaking up the atom by the positive charge of the shell of the atom inside which they are revolving.

Lord Kelvin has shown that if a drop of water were magnified to the size of the earth, the molecules of water would be the size of a small cricket ball. Each molecule contains three atoms, two being of hydrogen and one of oxygen, the atoms bearing to the molecule some such proportion as the molecule to the drop of water referred to. Finally, the corpuscles may stand to the atom in a similar scale of magnitude.

Communities of atoms are called chemical combinations, and we know that they possess every degree of stability. The existence of some of them is so precarious that the chemist can barely retain them for a moment; others are so stubborn that he can hardly break them up. The more persistent or more stable combinations succeed in their struggle for life and are found in vast quantities, as in the case of common salt and of the combinations of silicon. But no one has ever found a mine of guncotton, because it has so slight a power of resistance. Stability is a property of relationship to surrounding conditions; thus salt is adapted to the struggle for existence on the earth, but it cannot withstand the severer conditions which exist on the sun.

GOLD IN SEA WATER is stated by Mr. Beilby, in his chemical address to the British Association, to exist in the sea in the proportion of about 1 grain per ton of water. No drop, however small it may be, can be removed from the ocean which will not contain many millions of gold molecules! From this molecular point of view our ships literally float on a gilded ocean! From time to time adventurers have tried to obtain this gold from the sea, but cyaniding experts, whose business it is to extract gold from dilute solutions, find that it does not pay to carry this extraction beyond a concentration of 2 to 3 grains per ton even, when the solution is ready at hand. If ever the Transvaal gold mines are shut up, it will *not* be owing to the competition of the gold resources of the ocean.

VALUE OF π.—A French mathematician has composed a quatrain of 31 words which sets out the value of π to 30 places of decimals. Each

word contains the number of letters corresponding with the successive numbers in the numerical expression 3·14159265358979323846264338327 9.

Que j aime a faire apprendre un nombre utile aux sages
Immortel Archimède, artiste ingénieur!
Qui de ton jugement peut priser la valeur?
Pour moi ton problème eut de pareils avantages.

GEOLOGY (*p.* 413).—Prof. Miers, in his opening address to the British Association at Cape Town, spoke mainly from the view, not of the geologist or chemist but of the crystallographer, to whom the birth and growth of crystals are a study in themselves. Whether we watch with the microscope a tiny crystal growing from a drop of solution, or contemplate with the imagination the steps by which the fiery lavas of past geological periods sank to rest and crystallised, we view the same process; it is the transformation of liquid into crystal—not necessarily into a solid, for recent researches show that there is no dividing line between liquid and solid; a plastic body may flow; a solid glass is only a supercooled liquid. The real distinction is between crystalline and non-crystalline material, and there is reason to believe that some crystals are liquid without ceasing to be crystals.

STERILISATION OF WATER IN THE FIELD (*p.* 431).—In the Spanish-American War it was proved that infected water was not an important factor in the spread of typhoid fever. The other agents concerned in the dissemination of this disease are dust and flies, blowing or carrying infection from infected latrines, the result of heat, fatigue, and bad food rendering the troops more vulnerable. It cannot be doubted, however, that a pure water supply would lessen the incidence of typhoid fever and dysentery, and probably quite prevent cholera. The Japanese, in the present campaign, sent on ahead of their troops a corps of doctors to select the camping ground and survey the water supply, with great success in preventing disease. Sterilisation of water by heat to about 170° F. is satisfactory, but important considerations are the weight of the machinery and fuel necessary to be carried. Chemical germicides such as bisulphite of soda can be put up in tablets, and in quantities of 15 grains to the pint the typhoid bacillus will perish, whilst the bisulphite imparts little or no taste to the water and is quite harmless.

W. E. WARRAND.

REVUE D'HISTOIRE.

August, 1905.

THE SURPRISE OF THE BRIDGES AT VIENNA IN 1805.—The *ruse* by which Murat gained possession of the bridges over the Danube has been described by Thiers and others, but their accounts are amplified and corrected here from papers in the French archives and from Angeli's

narrative, "Ulm und Austerlitz." The municipality of Vienna, anxious to save the city, played into Murat's hands; and the Austrian commander, Prince Anersperg, was the more easily taken in because he was himself hoping to gain time by negotiation, and wished to have an interview with Murat. Bertrand, who was the first man allowed to pass, gave his word of honour (according to the Austrian report) that an armistice had been concluded, and that he had come straight from Napoleon's headquarters to announce it to Prince Anersperg. Lulled by these assurances, the Austrians allowed others to follow him. Murat, with a column of grenadiers, reached the south end of the main bridge, a wooden bridge a quarter of a mile long, which had been prepared for destruction at any moment. Four French officers, including Lannes and Belliard (but not Murat himself, as is commonly said), strolled across it, and persuaded the Austrian captain in charge to turn his guns away from the bridge and let his men pile arms.

"During this time," says Belliard, "the leading platoon moved forward gradually; behind were the sappers and gunners, who, screened by this body, threw all the combustibles into the Danube, damped the powder, and cut the fuses, so as to prevent the burning of the part of the bridge which we already occupied. The Austrian officer understood little French and spoke less; he noticed the movement and tried to make us understand that the troops were marching, and that that must not be; we told him they were trying to warm themselves, for it was very cold, by stamping their feet. The column of infantry followed, and in this way three-fourths of the bridge were won. Then the Austrian officer commanding the artillery cried 'Faer! Faer!' The men seized their arms, the guns were turned again on to the bridge, and everything pointed to a disaster. Marshal Lannes laid hold of the commanding officer by the collar on one side, I on the other; we shook him, and shouted loudly, that his men might not hear him, holding him responsible for all the blood he was about to shed."

This delayed the execution of his orders, and immediately afterwards Anersperg arrived with Bertrand. While they discussed the conduct of the officer the French gained complete possession of the bridge.

THE CAMPAIGN OF 1797 ON THE RHINE.—The appointment of Hoche to replace Beurnonville in the command of the army of the Sambre-et-Meuse, and other changes preliminary to the opening of the campaign, form the subject of this section.

THE WAR OF 1870.—*The Army of Chalons.*—On the 23rd and 24th of August Macmahon's army marched towards the north-east. It was short of supplies, and there were already disquieting symptoms of insubordination; officers were insulted and the inhabitants were pillaged. The German armies under the two Crown princes were still moving westward on Chalons. The contingency of Macmahon's going to the help of Bazaine was considered at the German headquarters, but was thought improbable.

E. M. LLOYD.

CORRESPONDENCE.

THE PREVENTION OF DAMPNESS DUE TO CONDENSATION IN MAGAZINES.

SIR,

The interesting Transcript on the above-named subject, in the September number of the *R.E. Journal*, recalled to my mind an experiment I made some 40 years ago, when quartered in Guernsey.

It appeared that several Boards of Inquiry had been held, resulting in lining the walls with cement, asphalt, etc., under the idea of the wet percolating through them; and, finally, open-batten doors had been fixed to allow of the free circulation of air.

I obtained permission from the C.R.E. (Colonel Hadden) to take in hand a small asphalt-lined magazine, the walls of which were always streaming with water. To prevent the contact of the moisture-laden air, which I knew to be the culprit, with the rapidly-conducting surface of the asphalt, I painted it over with a thick coating of lampblack, as a good non-conductor, with the result that the walls ceased to weep, except where left unpainted. Nothing further, however, was done, in deference I fancy to the tender feelings of the above-mentioned Boards.

Yours truly,

H. C. SEDDON,

The Editor, "R.E. Journal." *Colonel, R.E. (Retired).*

DEAR SIR,

The article on Magazines in the last number of the *Journal* brings back to my mind a question which I propounded to my superior officer many years ago—

"Why do you want to prevent moisture condensing on the walls of a magazine?

This condensation must necessarily reduce the amount of moisture in the air which is in contact with the powder or other stores. If the moisture is on the walls it cannot be in your powder."

I did not get an answer to the question.

I now ask another—

"Would it not be better to encourage as much as possible the condensation on the walls—making, of course, suitable arrangements for carrying away the water without its dripping on the powder cases?"

Yours truly,

E. ROBERT FESTING,

The Editor, "R.E. Journal." *Major-General, R.E. (Retired).*

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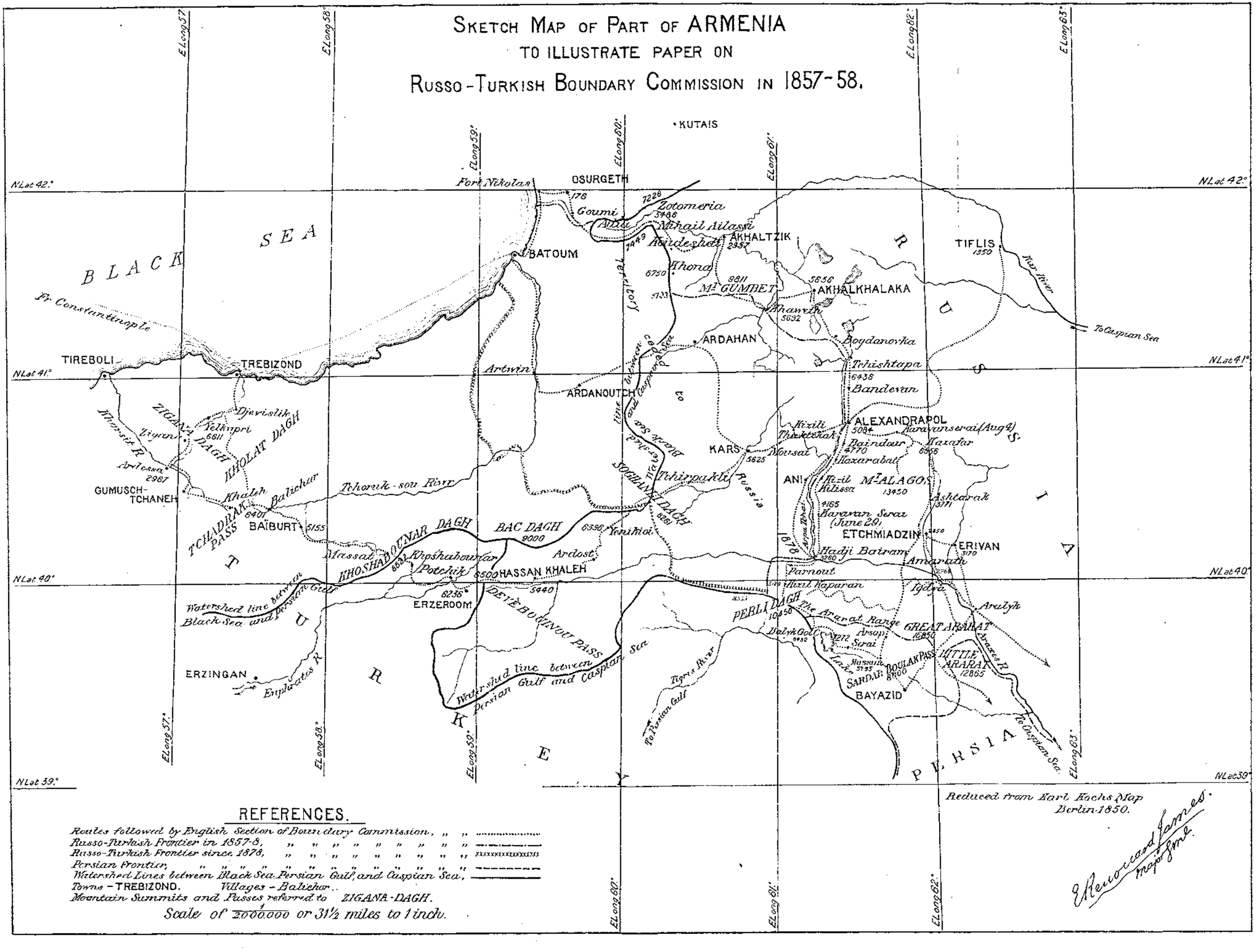
Sketch Map of Part of ARMENIA
to illustrate paper on
Russo-Turkish Boundary Commission in 1857-58.



REFERENCES.

Routes followed by English Section of Boundary Commission, „ „ .....
Russo-Turkish Frontier in 1857-8, „ „ „ „ „ „ „ „ „ „ —·—·—
Russo-Turkish Frontier since 1878, „ „ „ „ „ „ „ „ „ „ xxxxxxxxxxxxxxxx
Persian Frontier, „ „ „ „ „ „ „ „ „ „ „ ————
Watershed Lines between Black Sea, Persian Gulf, and Caspian Sea, ————
Towns – TREBIZOND. Villages – Balichor.
Mountain Summits and Passes referred to ZIGANA-DAGH.

Scale of 1/2,000,000 or 31½ miles to 1 inch.

Reduced from Karl Fochs Map Berlin 1850.

Edmund James. major R.E.

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