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CONTENTS

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CONTRIBUTIONS TO THE ROYAL ENGINEERS JOURNAL.

All contributions for *The R.E. Journal* from Officers on full pay should be forwarded to the Editor, as laid down in *K.R. 547 (c) 1940*, in duplicate if possible, together with a statement from the authority (if any) under whom the writer is serving, that such authority has no objection to publication. The Editor will then apply to the War Office for permission to publish. Articles written by officers serving in India must be submitted for permission to publish to the Commander-in-Chief in India before despatch to the Editor.

Very few contributions concerning recent events have been received from officers on the Active list during the last eighteen months, but those received have proved most valuable. Such articles enable other officers of less experience to visualize the conditions under which field engineering is carried out under existing war conditions, and give a clear picture of the numerous and unforeseen difficulties which arise on service through human failings, accident, enemy action, or under-estimating.

It is realised that officers, when in the field or out training, cannot submit articles typed in duplicate as in peace time. The editing of an article received in the form of notes, and the reproduction of rough drawings for the normal magazine form, can be done at the Secretary's office. Payment will be made for all articles accepted.

Articles from those with experience on the following subjects would be very welcome :—

Road Work.
Bridging.
Reconnaissance problems, including the use of air photography.
Mining.
Airfield Construction.
Use of Mechanical Equipment.
Works Problems, overseas and at home.
Organization of work with native labour overseas.
Demolitions.
Airborne R.E. work.
Engineer organization, including works in formations and units.
Engineer Stores.
Water Supply, Geology and Geophysics.

Even though it prove impossible to pass all articles through the Censor's office for immediate publication, they will have great value after the war.

Articles are none the less valuable because they raise matters which are controversial. *The R.E. Journal* is in no sense a text-book.

THE ROYAL ENGINEERS JOURNAL

VOL. LVIII CONTENTS DECEMBER, 1944

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Christmas Card given to the Engineer-in-Chief, France, by his Staff. Christmas, 1917

War Babies - opp p 223

THE CONCEPTION AND BIRTH OF SOME OF THE R.E. WAR BABIES, 1914-18.

By Brig.-General Sir James E. Edmonds, C.B., C.M.G., D.Litt., *p.s.c.*†

THE coming into official existence of the many "R.E. War Babies," the new units of the Corps, has received due notice in the volumes of the *Official History, France and Belgium*, 1914-18. My aim here is to relate, as far as I know them, the earlier and embryo stages of these infants.

I entered the war prepared for great engineer developments. In 1908 I had attended German combined operations on the Rhine, near Coblence, conducted by General von Beseler, an engineer officer, the captor of Antwerp in 1914. They included a night passage of the Rhine and an accelerated attack on the fortress of Ehrenbreitstein. In the land operations nearly all the apparatus of trench warfare was employed, including trench mortars, hand-grenades, minefields with trip and tread mines, periscopes, camouflage clothing for the engineers to wear whilst wire-cutting (canvas suits painted black, green, and brown), and the light-ball pistols (*Leuchtpistole*) which one got to know only too well in 1914-18.

Sir Douglas Haig, then D.M.T. War Office, tried to get similar stores introduced into the British Army, pointing out that the light-ball pistol, of which, by the kindness of General von Beseler, I had brought home a specimen, would be invaluable in Indian frontier warfare. Lack of funds, however, prevented anything being done. Thinking over what I had seen in Germany, at Coblence and on other occasions, I suggested in a lecture in the winter of 1908-9 at the R.A. Institute, Woolwich, on the campaign in Virginia in May and June, 1864,* that the next war would be "one of what may be called siege operations in the field." Others had come to the same conclusion. The subject was worth a little thought; but "fire and movement" was the doctrine in the period between the South African War and August, 1914, and the cavalry charge was still practised both in the British and the German Armies.

Entrenching had not been much employed in the South African War, the rocky soil was against it. The majority of "blockhouses"—the "pill-boxes" of 1914-18—were built of two sheetings of corrugated iron, with stones packed between them. It was proposed by a War Office economist to abolish as obsolete the entrenching implement carried by the infantry; but this was prevented by Field-Marshal Lord Wolseley, who said that "we are too apt to base our equipment on our last war instead of preparing for the next."

At training the infantry usually devoted one day to digging "the half-hour shelter trench."

At manœuvres there was little time for entrenching; and it was not encouraged by the order that units which dug trenches must return and fill them up. One advanced-guard cavalry regiment, sent forward to delay the

* Printed in *the Journal of the Royal Artillery*, March, 1909 (p. 546).

opponents, did dig in, and I heard Field-Marshal Sir John French curse the lieutenant-colonel for so doing: he concluded his harangue by saying, "I hope never again to see such a horrid sight as cavalry digging." The mounted arm dug very stoutly in 1914-18.

The B.E.F. in August, 1914, took no trench warfare apparatus into the field except a little barbed wire, a few pickets and shovels, and some packages of sandbags, carried by the field companies. For bridging, each field company had three pontoons and some trestles. The bridging trains did not accompany the original force, and at the Battle of the Marne, bridges were made of barrel piers, a brewery having been found conveniently near at hand.

Tanks.—The first new idea came very soon. On page 64 of *Eyewitness*, Major-General Sir Ernest Swinton says with reference to the British efforts to advance during the Battle of the Aisne (official date, 12th-15th September, 1914, but it lasted much longer), that they were "in most cases frustrated by machine guns, frequently in combination with an obstacle hastily made from rabbit wire or fencing" (actually in the Chivres woods there was a "wire-netting fence six feet high, through which there was only one entrance.")* He continues: "During the first week of October my mind continually returned to this. And, vaguely, I pictured to myself some form of armoured vehicle, immune against bullets, which should be capable of destroying machine guns and ploughing a way through wire."

The first thought, I feel sure, occurred earlier to the "Father of Tanks" as the *Militär Wochenblatt* has called him, actually on the 20th September, 1914. On that day he and I were sitting near Chassemy on the edge of a shell-crater, whence we had a view over the whole of the western half of the Aisne battlefield. We could see a fight going on around Vailly between the Germans and what I now know was the 7th Infantry Brigade (which had "some four hundred casualties, nearly half of which fell on the 2nd South Lancashire"). Swinton was much upset at the sight of our men falling, and said "something must be done to protect their naked bodies from bullets." To this I replied "You will want a war chariot or steel bathing machine drawn by an armoured horse."—I remembered that *Punch's* supposititious war correspondent in the Franco-German war had been represented as galloping over the fields of France in such a vehicle. Whereupon he told me not to be frivolous. That evening he came round to the "Engineer-Adviser's" room, and there was a discussion about thickness and weight of armour, but nothing was said about caterpillar traction. It was obvious that a man could not carry sufficient armour to protect much more than a small portion of his person, nor even push a sufficient shield on wheels. The rest of the story Swinton has told himself. He has the reward that the Commission which enquired into inventions gave him the credit for the Tank idea.

That I heard and saw so much that happened after this was due to my being commandeered in October, 1914, by Brig.-General (Lieut.-General Sir George) Fowke, the Engineer Adviser, G.H.Q., and I worked in the same room with him for 18 months. This was not all joy; for, an expert in explosives, after dinner with a big cigar in his mouth, he delighted in taking German hand-grenades and such like to pieces.

It has often been mentioned in these pages that the technical staff allotted to G.H.Q. in August, 1914, was one Major-General R.A. (W. F. L. Lindsay) and one Brigadier-General R.E. (G. H. Fowke). They were called the Artillery and Engineer "Advisers" and had to share a motor car—they

* See *Official History France and Belgium*, 1914, Volume 1, p. 369 (1st edition).

were both big, heavy men and known in the higher circles as "Gog and Magog." To each was assigned one clerk, who was provided with a push-bike to accompany his master. After the move to Flanders, Fowke was given authority by the Commander-in-Chief to collect an engineer staff, and he asked me, whilst I was resting at G.H.Q., to join him. I consulted Sir William Robertson, then the Q.M.G. of the B.E.F., who had been at the Staff College with me, and he advised me to accept, as he thought the Engineer Staff would be busier than the General Staff in what lay ahead. I fully agreed.

Fowke also seized on the late Major-General R. N. Harvey, who, being C.I.F. at the S.M.E., had been sent over to put Antwerp in a state of defence —he arrived in time to take part in the retreat of the garrison—and had then been sent to put Le Havre (or Cherbourg; I forget which) in a state of defence. Finding that the French were attending to this, he had made his way to G.H.Q. We two were Fowke's only assistants for some weeks, and the two "Advisers" with their staffs shared a single room. Then Major C. C. H. Hogg and Lieut.-Colonel (Major-General Sir William) Liddell, and later others were added to our numbers.

Labour Battalions R.E. The First War Babies.—My first and principal job was to site a line—a Torres Vedras line, as Sir William Robertson called it—to cover a possible re-embarkation at the ports of Boulogne, Calais and Dunkirk. Hence the "B.C.D. Line" came into existence. All R.E. units being required at the front, "Labour Battalions R.E." with civil engineers as officers, were formed in England to construct the line, but when they arrived in France all but two were at once seized on by Colonel Liddell, who was in executive charge of roads and bridges in the B.E.F. area, to maintain roads and do other more urgent work, or by the Director of Works, L. of C., and the two battalions did not remain long on defence work. Thus, little actual work was done on the line beyond marking it out by digging shallow trenches.

Hand-Grenades and Trench Mortars, etc.—Soon after our arrival at St. Omer in October, 1914, Field-Marshal Sir John French appeared in Fowke's office in the Rue Carnot. He said "the Boches are throwing sticks of dynamite at my lads. What is to be done?" As the Germans had thrown a few grenades on the Aisne at the end of September, Fowke had already demanded from home a supply of the Service hand-grenade. This missile, devised after the Russo-Japanese War, had a long stick, a white canvas-tape tail about a yard long, three or four safety devices, cost 23s. a piece and was quite unsuitable for trench warfare. So Fowke ordered the 2nd Bridging Train, then quartered in a Chateau west of St. Omer, to set about improvising hand-grenades. Under the superintendence of a Special Reserve subaltern, Lieut. E. S. R. Adams (who later was in command of the Experimental Section R.E. at G.H.Q.), a manufactory was quickly in working order. Very soon after, Brig.-General H. C. Nanton (C.E. of the Indian Corps) took over an iron foundry in Béthune, and began making not only hand-grenades but trench-mortars, periscopes and other trench stores. The introduction of a trench-mortar, or, as he called it, a "bombard," to support the last stages of an infantry attack, had been proposed at a General Staff Conference in 1912 by Brig.-General (later Lieut.-General Sir William) MacCracken; but the idea was somewhat rudely rejected by a general, an infantryman, then in power, who during 1914-18 was superseded in important appointments no less than three times. The story of the improvisations of trench stores will be found in the *Official History France and Belgium*, "1915", Vol. I, pp. 7 and 8. The French proprietor of the Béthune foundry, with his family,

remained on the premises, and after it had been shelled several times by a 6-inch high-velocity gun, I said to him, "I wonder you don't clear out," to which he answered "On s'accoutume à tous."

Tunnelling.—A history of the Tunnellers has been written by Captain Grieve and Mr. Bernard Newman. All that I can personally contribute is that in December, 1914, when how to deal with Messines ridge was under consideration, Major (later Sir John) Norton Griffiths, *M.P.*, of 2nd King Edward's Horse, an engineering contractor, "blew into" General Fowke's office—this exactly conveys the impression of his entrance—with the suggestion that "clay kickers," men specially skilled in boring drain tunnels in clay, should be employed to mine under the ridge. The E.-in-C., remembering how little work had been got out of the navvies shipped to the Sudan to build the Suakin-Berber railway in 1884, demurred at first at enlisting civilians. But Norton Griffiths's enthusiasm carried the day, and, on Fowke's recommendation, he was authorized by the War Office to collect 500 clay kickers, and the Armies were instructed to form "Brigade Mining Sections" from suitable personnel. (See *Official History* "1915", Volume I, pp. 32-3.) There were eventually 28 Tunnelling Companies, including Canadian, Australian and New Zealand, and few troops worked so enthusiastically as the Tunnellers, but no "clay kicking," as far as I know was ever done. A vocabulary of German Mining terms was got out in the E.-in-C.'s office, which was developed by "I" into the *Vocabulary of German Military Terms and Abbreviations*.

Sound Ranging.—When the French were developing Sound Ranging in March, 1915, four officers, two R.A. and two R.E., were sent to see the experiments. The artillery officers returned and reported that they did not consider the idea worth pursuing. The engineers, one of whom was Major H. P. T. Lefroy, reported in its favour, and a proposal to organize an experimental Sound Ranging Section was made to the War Office and approved. (See *Official History* "1915," Vol. II, p. 19).

Gas.—On the 22nd April, 1915, I went out to visit my former divisional commander, the late Lieut.-General Sir Thomas Snow, then commanding the 27th Division, at his head-quarters at Potijze Chateau, a mile north-east of Ypres. In the garden was a terrace with a pavilion at the end, whence there was a good view. Whilst we were having tea heavy firing broke out to the north, where the front was four miles from Potijze, and we saw a bluish-white mist arise. This was the first gas attack, though we did not know it. Returning through Ypres I heard the word "gas" from French stragglers, who pointed significantly to their throats—the bulk of the French Territorial and coloured troops, however, fled across bridges north of Ypres. Sir William Robertson, on hearing of the panic, was moved to say: "I think there must be something exhilarating about that gas: I am sure I couldn't have run from Ypres to Dunkirk without a tonic."

The War Office in May despatched two professors of chemistry, Haldane of Oxford and Watson of London University, and two cylinders of chlorine gas to the E.-in-C. for trial. The gas was loosed outside St. Omer in the presence of a distinguished assembly of "brass hats," and it burnt the grass. No supply of chlorine would be available for some time and the question of protection was urgent. One of the two professors advocated a respirator and the other a bag, with a window pane in it, to go over the head. These were tried, again in the presence of a distinguished multitude. Each professor had an assistant, and, equipped first with the respirator and then with the

bag, both ran a quarter of a mile. Each declared that he was quite comfortable in his own and stifled in the rival device.

The bag, soaked in glycerine, found more favour with the R.A.M.C. experts, and it was adopted. Professor Watson, a most talented and likeable personality, was asked to remain at G.H.Q. as Adviser, and did so until the end of gas warfare, soon after which he unfortunately died, having inhaled too much gas. A corps of what were known at first as "Kitchener's Comical Corporals" was raised in England* and, augmented in France by transfers from the infantry, was officially called "Special Companies R.E." Major (now Major-General) C. H. Foulkes was placed in charge by the E.-in-C., who appropriately selected the village of Helfaut for his headquarters and laboratories. For the rest the *Official History* "1915," Vol. II, p. 151, etc., and Foulkes's book *Gas*, should be consulted.

Steel Helmet.—In March, 1915, a liaison officer with the French, Lieutenant E. L. Spears (now Major-General Sir Edward Spears, *M.P.*) brought to the E.-in-C. a steel skull-cap, to be worn inside the *képi*, which the French were trying. This seems to have been the embryo of the steel helmet, a few specimens of which arrived for trial in August, 1915.

The Beetle.—Spears at this time took me out to Tinques, behind Arras (then in the French area) to see a "beetle" which the French engineers had invented. Manœuvred by wires, like the Brennan torpedo, it waddled across No Man's Land carrying a high explosive charge which could be fired at will. The idea was dropped, as the party working the beetle usually became casualties. A kite to drop explosives on the enemy was tried—and very nearly brought about the end of Sir Ernest Swinton.

Rocket Gun.—A rocket gun invented by the American Colonel Lewis, of the Lewis gun, had a long trial under the E.-in-C's auspices. Its feature was that the rocket, instead of depending on the rush of gas generated by a rocket composition for its propulsion, was driven by a screw propellor in its base kept revolving by the flow of gas—jet propulsion. It was not a success, being very irregular in flight and very sensitive to wind. On one occasion the rocket, with a following wind, turned over and dropped 200 yards behind the firing point. At the final trial, arranged to condemn it, the last rocket exploded on the trough, just as the spectators were moving homewards, knocked some of them over and killed Colonel Lewis's assistant. So no more was heard of it.

Camouflage.—On a sunny afternoon at the end of December, 1915, two French officers, one of them de Scevola the artist, looking as if freshly shaved and bathed, in brand-new horizon-blue uniforms and the recently introduced steel helmets, appeared in the C.-in-C's room to explain "Camouflage," a word which neither I nor General Fowke, though both of us spoke French "ful fair and fetisely" had ever heard. They explained how natural objects such as blasted trees, rocks, ruins, and dead horses lying in or near No Man's Land, could be replaced by counterparts made of steel, devised for use as O.Ps. Screening roads, covering guns, etc., with branches, and disruptive colouring (used on the Spithead forts in the 'eighties), we had practised; and one division had its bivouac tents painted to look like cows. When we were leaving the Aisne, Swinton suggested that country wagons should be placed in the Grand Place of Fère en Tardenois to represent the staff cars that had filled it. But this was a real, new idea.

*Colonel (Major-General Sir Louis) Jackson, R.E., under instructions from Lord Kitchener, was dealing with "Gas" at the War Office.

Fowke saw Sir Douglas Haig, recently appointed Commander-in-Chief, that evening, and next morning one of the Chief's favourite General Staff officers came round to say that he wanted camouflage started at once. The E.-in-C. replied that he was already considering where he could find a suitable range of buildings. Where upon the G.S.O. replied, " You can have the Fish Market." This was a paved hall about 70 feet by 40 feet !

Mr. Solomon J. Solomon, R.A., who was specially interested in the subject of concealment by shade and shadow, with whom de Scevola had communicated, came out from England and was attached to Colonel Liddell's staff to advise, and between them the idea of screening by fish netting with grass tied on was devised. How the " Special Works Park " was organized under Captain (Colonel) F. J. C. Wyatt is related in *Official History* " 1916 " Volume I, pp. 81-6.

Experimental Section R.E.—About this time a Section R.E. was formed to try the many inventions which were being put forward. Lieutenant E. S. R. Adams was placed in charge. It had a lively time, particularly with percussion grenades, but never a casualty. Its senior N.C.O. was named Griffiths, very expert in handling explosives, and eventually promoted to Warrant rank. I said to him one day, " What are you going to do after the war, Mr. Griffiths." He replied very seriously, " I was thinking, Sir, of offering my services to the Suffragettes." Alas, for him, before the war was over the girls had got the vote.

Flame Projectors.—After the Germans had made use of flame projectors in July, 1915, the French produced an imitation one, and I was sent by the E.-in-C. to see its operation at the engineer park at Vincennes, near Paris. There was no difficulty about squirting an inflammatory mixture ; but the lighting of it without danger to the engine and its crew was still in the experimental stage, and was temporarily solved by throwing a special hand-grenade into the spray. It was not until June, 1916, that the "Special Companies R.E." acquired flame projectors. (See *Official History*, " 1916 " Vol. I, p. 78.)

Nissen Hut.—About March, 1916, a note came into the E.-in-C. that a very efficient, but somewhat elderly temporary officer, a civil engineer, captain of a field company, required a rest. His name was Peter Nissen, a Canadian of Scandinavian descent. He was well known at Johannesburg as the inventor of the Nissen Stamp, and as being of a most ingenious mind. The Acting E.-in-C. directed that he should be sent in to G.H.Q. where in a short time he was made O.C. Army Troops and, later, C.R.E.

In the summer the problem of housing troops on the Somme uplands during the winter was taken up. Brig.-General Liddell, the Deputy Engineer-in-Chief, invited me to accompany him to Hesdin, 20 miles inland from G.H.Q., where he was to meet Nissen, who had an idea. We met on the large barrack square, and I noticed under a shed a machine for bending corrugated iron. Hence, no doubt, the selection of the place of rendezvous. There and then Liddell and Nissen settled the general design of the Nissen hut.

Screw Pickets.—Steel screw pickets had been turned down when proposed some time before 1914 because no military use for them could be foreseen. A few " Made in Germany " were captured near Fricourt at the beginning of the Battle of the Somme, July, 1916. Major-General (later Sir Reginald) Buckland of the Fourth Army at once sent a specimen to the E.-in-C., with the request that he would order some like it—and Major-General (later Sir Robert) Rice, being in an economical frame of mind, ordered a thousand.

Geology.—In the early days after the B.E.F. had reached Ypres, General Fowke and I provided such geological knowledge as was required, and we got hold of some French geological maps. Colonel Liddell, who was concerned with water, road metal, etc., suggested importing a professional geologist, and the services of Lieutenant W. B. R. King, of the Geological Survey, were obtained. Later, when the Australians arrived, and expert advice was required for mining, deep dug-outs, inundations, etc., Professor (Sir Edgeworth) David, who had come with their Tunnelling Battalion as technical adviser, was transferred to the E.-in-C's Staff and took charge.

Our two "war-geologists," as we called them, had every reason to be proud of themselves. After Lille had been "freed" in 1918, Colonel (Professor) David paid a visit to an eminent French geologist, named Barrois, who had taught in the University there. On his return, he said that Professor Barrois had told him the following story. The day after the explosion of the Messines mines, the twelve German geologists who had been working in his museum and laboratory were paraded there. A German general had then appeared and cursed them for not discovering that his men could be undermined and what the British tunnellers were about, and he ordered those under 40 to join units at the front; those over 40 to return to their wives in Germany. It was obvious that two British geologists had got the better of twelve German.

Air Photographs.—Until January, 1915, when the General Staff made other arrangements, the E.-in-C's Staff undertook the reading of air photographs to plot the German defences. I remember that they were much puzzled by what seemed to be recently excavated long straight lines of narrow trenches radiating from Lille. They turned out to be the first of the buried cable trenches.

Establishments.—The birth pains of the War Babies were often considerable. The establishments of the new units were drawn up in the E.-in-C's office. There was invariably trouble in getting them approved in London. More than once it had to be explained that "the unit is required for use in the European War now raging." Even the General Staff had to explain at length why they wanted a "Security Section." The authorities who "vetted" and sanctioned the establishments could never understand why an assortment of tradesmen was required in an Engineer unit: "We are hard up for carpenters, would not men of other trades do as well," was one comment. The equipment was quite beyond them: it took months to obtain authority for Army Troop Companies to possess lorries. Never, however, was the E.-in-C. able to obtain authority for the C.R.E's of divisions to have motor cars issued to them, and officially they had to do their work on horses, a very considerable handicap in getting to and from the front. Sir Ernest Swinton has pilloried for all time the clerkly officer who, in reference to a 12-inch lathe in the establishment of a Tank battalion, asked "would not two 6-inch do equally well?"

ALEXANDRIA EMERGENCY WATER SUPPLY

By Brigadier G. Streeten, C.B.E., M.C.

Requirements

THE importance of Alexandria during this war, both as a Naval Base and as part of the land base for the Middle East Force, can hardly be over-stressed. Vast quantities of war material of all descriptions were landed at its docks. The desert surrounding the town was covered for miles with base camps, depots, hospitals and other installations needed to support an army in the field. Within the immediate neighbourhood were camps for more than two Divisions. All these were dependent on the town water supply.

In addition, up to 4,000 tons of water were pumped daily from Alexandria along the desert pipe line to supply the Western Desert Force, to be known later as the Eighth Army. This supply was reinforced by water from wells and aqueducts at Fuka, Baggush, and Mersa Matruh, but they provided only a small proportion of the total needed by the Army.

Of this quantity the desert railway from Alexandria to Tobruk required a share. Between 1,500 and 3,000 tons a day were used by locomotives on this line. Only a small proportion of the slightly saline water from the wells and aqueducts could be introduced into the pipe line without rendering it unsuitable for locomotive boilers. Also, the civil population of Alexandria, some 700,000 persons, consumed daily an average of 25 gallons per head. Thus the total consumption for all purposes was approximately 100,000 tons a day.

Source

This large quantity of water came ultimately from the River Nile, which, South of Cairo, has its waters backed up by the Delta Barrage, so as to form a pool from which canals emerge and radiate to irrigate the Delta. It is from these that Alexandria draws its water supply. The first link in the chain of canals, which eventually reaches the town, is the Raiyah el Beheira ; this flows rather West of North for about 60 miles to the Taufiqiya system of regulators. Here the Khandaq el Sharqi canal takes off and carries the water for about 30 miles until it joins the Mahmudiya canal, which empties into the sea at Alexandria. (See Plate I, page 232.)

The water for the town is then pumped from the canal into the Siouf and the Rond Point waterworks, which are interconnected, but some 4 miles apart. Here it is purified, an important point since the Mahmudiya canal, being used as a waterway, acts as a cess pit for innumerable *dahabiyahs* and villages along its banks.

At el Atf, on the Rosetta branch of the Nile, and the Eastern end of this canal, there is a pumping station which acts as an additional feeder to the canal from the river. This station cannot be operated when the Nile is very low, nor at high flood level. At the best of times it is only capable of providing a small proportion of the water needed for irrigation and for Alexandria.

There are, in addition, a few shallow wells in and around the town, whose yield is insignificant.

In normal times the water in all these canals forms a substantial reserve but the reservoir in the town can hold only 8 hours' consumption of filtered water.

The Problem

It would appear at first sight that the canals which feed the town would be exceedingly vulnerable. For long stretches they flow at a level considerably above the surrounding country, and the subsidiary canals for irrigating the land are largely fed by gravity from the main system. Occasionally the *shaduf* and the Archimedes wheel are used for lifting water from one canal to another, but the larger canals are normally tapped by sluices, through which the water flows by gravity. In practice, however, this apparent vulnerability is somewhat illusive, as far as the supply to Alexandria is concerned. Unless the attack were in its immediate neighbourhood, the enormous reservoir formed by the canals themselves would probably suffice until the situation was restored. A crater caused by a bomb can quickly be filled and the canal banks returned to normal. Egyptian labour is good at muck-shifting and it is surprising how soon a hole can be filled in by the use of *fas* and basket. Moreover, unless the breach is considerable, a long time will elapse before the length of canal below it can be emptied.

However, since the water supply was at stake not only for the Alexandria base but for the fighting troops, the provision of a further reserve was essential. To provide a month's reserve 3 million tons would be required. Two proposals for storage were put forward. One, known as the Kalaa Reservoir Scheme, involved the flooding of an area of land that had recently been reclaimed from Maryut, the salt water lake which bounds the southern side of the town. This area had been put into cultivation at some expense and formed a considerable vested interest for the owners of the land. Consequently the proposal was extremely unpopular with the Egyptian Government. It was estimated that £12,000 a year would have to be paid in compensation to the land proprietors. The other was the filling of the Seaplane Base, then under construction, with fresh water instead of salt water. As the Base was only in the early stages of construction, it would be many months before this proposal could be carried out.

The following gives a brief description of the two proposals.

Kalaa Reservoir

Alongside the Mahmudiya canal, and separated from Lake Maryut by the Alexandria–Cairo railway, which here runs along an embankment, there is a cultivated area of about 700 acres which lies more than 2 metres below sea level and still further below the level of the canal. (See Plate II.)

There is a bund along the Northern side of the Ramla Drain. Thus the area enclosed by this bund, the railway embankment and the −2 metre contour, would form a natural basin which could be filled with water. The only work required would be the construction of a few small additional bunds and the blocking of certain culverts through the railway embankment.

The proposal was to place a pipe, regulated by a sluice valve, in the bank of the Mahmudiya Canal to enable water to flow by gravity from the canal into this basin. It was estimated that it would take 12 days to fill it up to the −2 metre contour level; less if pumps were used. This would give the

necessary reserve of 3 million tons of water. If filled only to the −2.50 metre contour, the basin would hold approximately 1½ million tons.

To make use of the water, should circumstances so demand, it only had to be pumped back into the Mahmudiya, after blocking the canal above and below the intake. This latter operation could quickly be performed by Egyptian labour carrying soil from borrow pits nearby and dumping it into the canal so as to form earthen dams. Suitable pumps to lift the water from the reservoir to the canal were available.

Seaplane Base

Close to the civilian airport, shown in Plate II as Nouzha Aerodrome, a seaplane base was under construction in the summer of 1941. A bund was being erected with dredgers, so as to enclose an area of the bed of Lake Maryut. The lake here is nearly dry and its bottom is covered with reeds. What water there is, is very salt. It was originally intended to fill the seaplane base with sea water, but it was proposed now to use fresh water from the Mahmudiya Canal instead, and so provide the necessary reserve for Alexandria.

The bund was to be built in stages and it was estimated that when the first stage was completed the reservoir would contain 5 million tons. On the completion of the final stage it would hold approximately 18 million tons. Before starting to fill the reservoir it would be necessary to pump out the salt water and to cut the reeds. Water from the canal was to be carried by gravity in a pipe discharging into a channel connected with the proposed reservoir, at the rate of 100,000 tons a day, so that it would take 50 days to conserve the first 5 million tons. The same system for using the water was to be adopted as for the Kalaa Reservoir.

The Kalaa Reservoir Scheme was to be put into operation only if need arose before the Seaplane Base was filled; and the pumps installed at Kalaa were to be transferred to the Seaplane Base when the water reached the 5-million ton level.

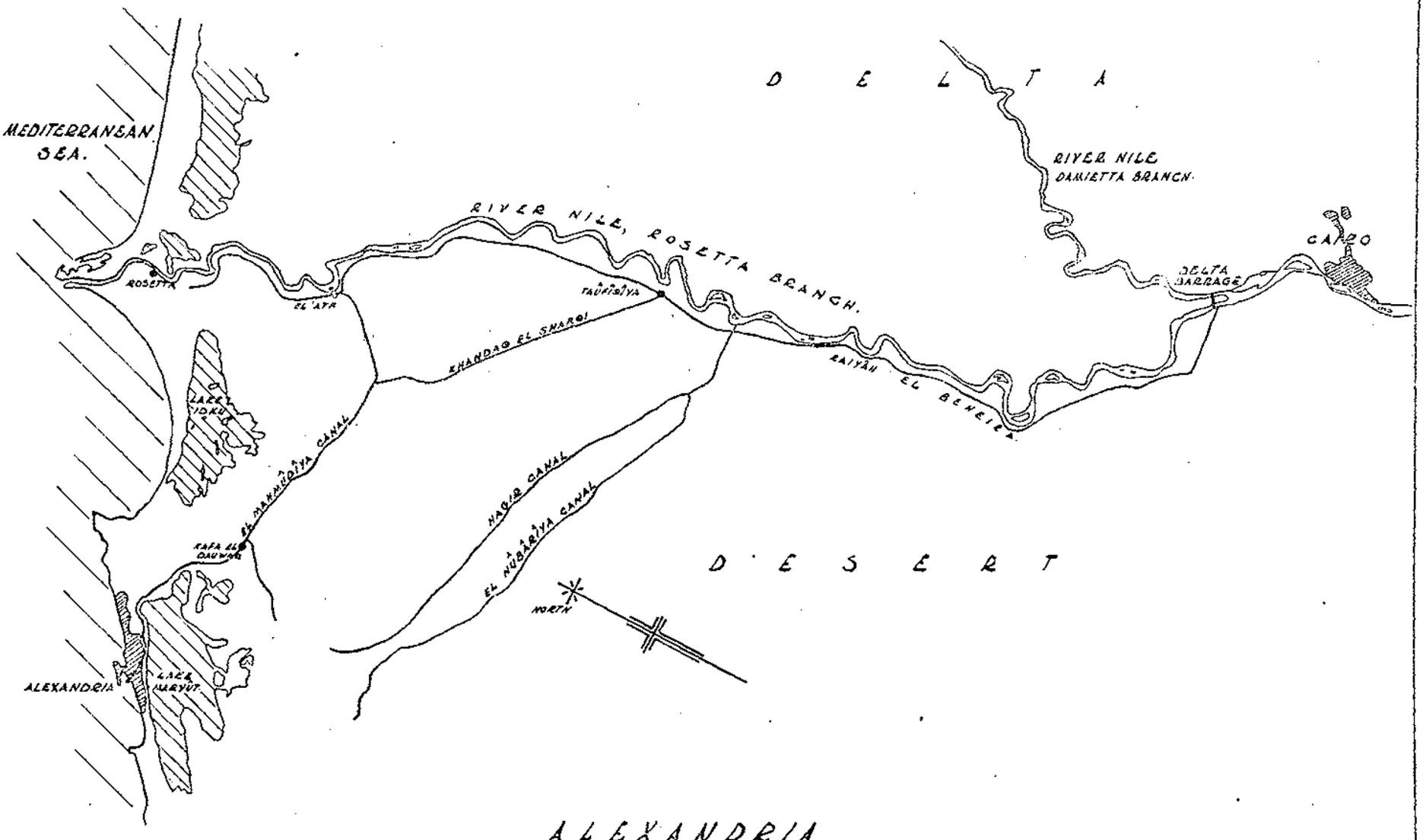
Progress of the Work

In June, 1941, the Kalaa Scheme was first formulated, and permission was obtained from the Egyptian State Railway to use the railway as one side of the Reservoir. At the same time the project was submitted to Kawi Pasha, the Egyptian Minister of Public Works. He raised objections at first, owing to the proposed destruction of cultivation, and put forward an alternative scheme whereby the Mahmudiya Canal should be fed at Kafr el Dauwar from the Hagir Canal. This was not practicable and his consent to the Kalaa Scheme was eventually obtained, on the understanding that the area should not be flooded until the military situation so demanded.

The scheme was then put into operation, pump houses being built and two pumps installed, by June, 1942. The enemy had then reached el Alamein, only 70 miles from Alexandria. The question whether to fill the reservoir was debated in August. Early in September it was decided not to do so at present. The defeat of the Germans in October relieved the tension and the reservoir was never filled. It had, however, served its turn as a measure of insurance.

The project for the filling of the Seaplane Base with fresh water was not finally approved until November, 1941. Shortly after that, the laying of the pipe and the construction of the channel were put in hand while the formation of the surrounding bund was being completed. By June, 1942, the work was

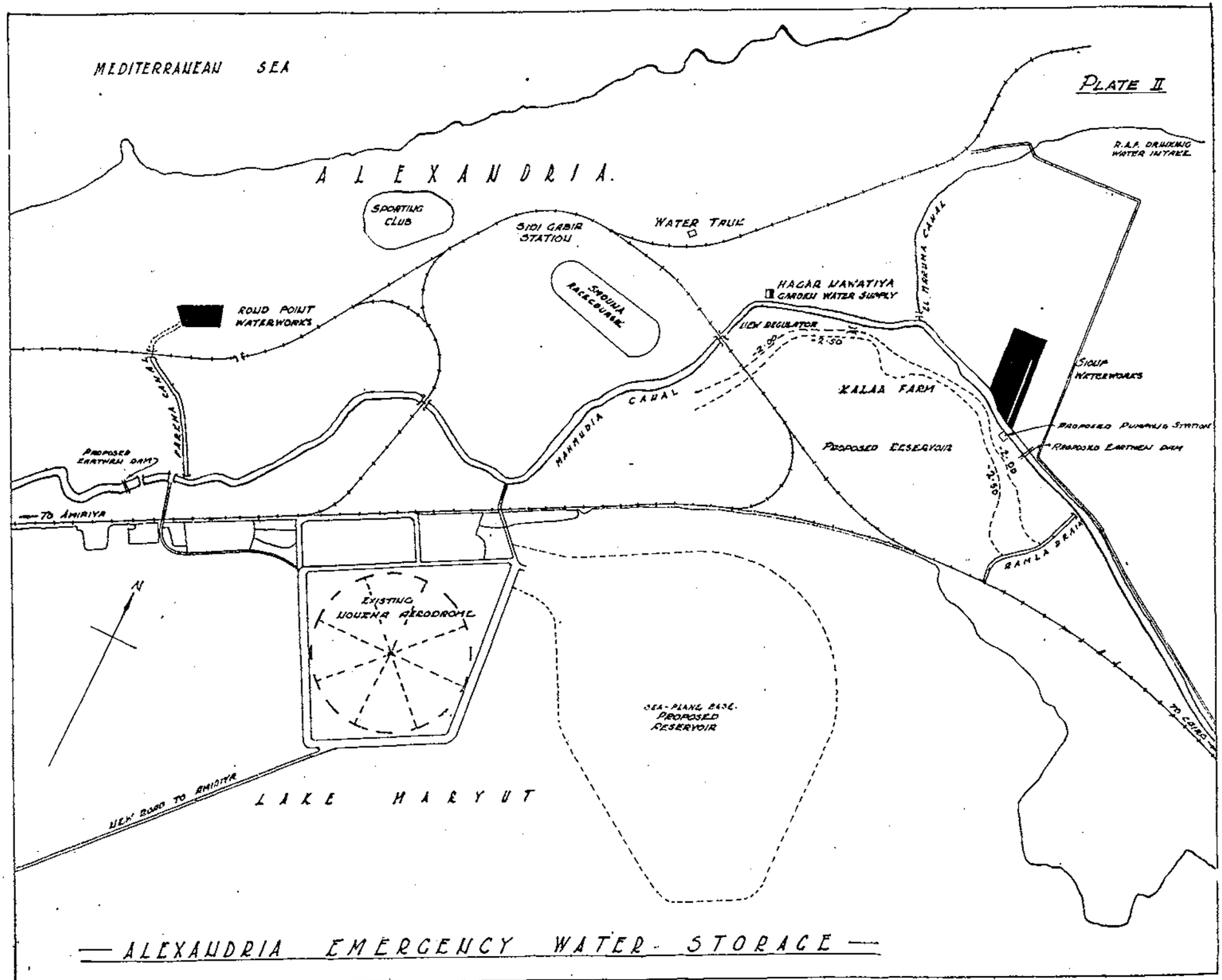
PLATE I.



ALEXANDRIA
EMERGENCY WATER STORAGE

Scale 1 : 750,000

DRAWING NO C.L.E.C 4294/11/44



Drg. no N° C.E.E.C. 1294/2/44.

Scale 1 : 37,500

finished and the Irrigations Authorities undertook the filling. At this period of the year the Nile is low and there is always a shortage of water for irrigation purposes. Moreover, this year the Egyptian Government had been persuaded to curtail the planting of cotton by some 25% and to plant rice, which needs more water, instead. The water level in the Mahmudiya canal was consequently very low and the filling proceeded too slowly, at a rate no greater than 50,000 tons a day. Continual pressure by the military authorities was needed to get the rate increased to the 100,000 tons a day originally proposed. Even this proved insufficient, largely owing to the high rate of evaporation. It was decided therefore to enlarge the pipe and channel so as to feed at the rate of 300,000 tons a day. This meant considerable work and was not completed until early in 1943.

Conclusion

Anyone who has not served in Egypt can hardly realize how difficult it is to achieve any object which depends upon the concurrence of the Egyptian Government and upon the activities of one of its departments, particularly if it interferes with vested interests. The two schemes described above were not by any means major engineering projects but each took about a year to carry out, and would not have been finished in that time had not continuous pressure been applied. Fortunately the interim scheme, the Kalaa project, was ready when the danger to Alexandria was greatest and could have been accelerated, had the situation demanded, by the use of suction dredgers to return water to the canal. The other, long term, scheme was carried out to avoid the destruction of cultivation and to provide a permanent reserve of water for the town of Alexandria; it was not therefore an essential war-time measure.

ENGINEERING IN ANTIQUITY
THE ATHOS CANAL AND BRIDGING THE HELLESPONT

By Colonel J. V. Davidson-Houston, M.B.E.

About the year 480 B.C. occurred two feats of military engineering which, for magnitude and boldness of conception, have few equals in history. Both of them were undertaken by command of Xerxes in order to facilitate his invasion of Greece, and both have been dealt with in some detail by Herodotus, writing less than 40 years after the events.

The works in question were :—

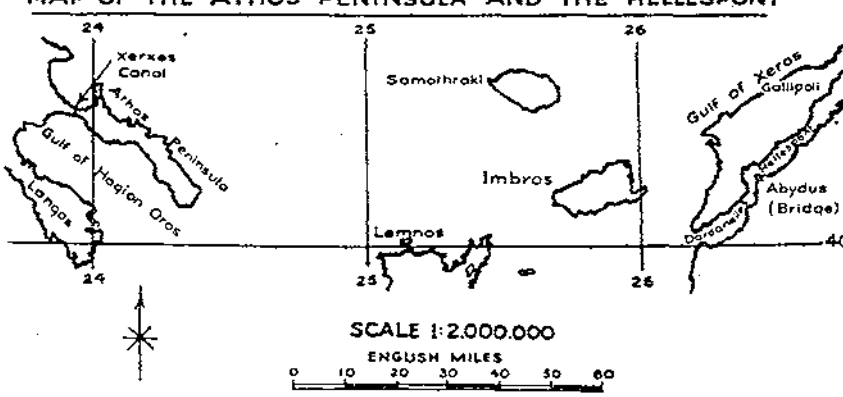
(*a*) The canal across the Athos Peninsula.
(*b*) The bridges over the Hellespont.

In describing these undertakings, frequent recourse has been had to the writings of " the father of history," from whom all quotations have been taken.

(*a*) The Canal across the Athos Peninsula.

Herodotus describes this feature as a " great and famous mountain, stretching far out into the sea. Where it ends toward the mainland it forms a peninsula; and in this place there is a neck of land about 12 furlongs across, the whole extent whereof is a level plain, broken only by a few low hills."

MAP OF THE ATHOS PENINSULA AND THE HELLESPONT



Ostensibly because the Persian fleet had previously suffered a disaster in rounding Mount Athos, Xerxes ordered a canal to be cut through the isthmus, of such a width that two triremes could be rowed through it abreast. It is difficult to appreciate the necessity for such an immense labour, which took

3 years to complete, seeing that the light ships of the ancients were wont to be drawn considerable distances overland, and such a method would have been far more economical in this case. Herodotus ascribes the actual reason to megalomania, which certainly tallies with what we know of Xerxes's vain and extravagant character.

Working parties were collected from the various satellite armies composing the invading host, "which relieved one another at intervals, and worked beneath the lash of taskmasters." The construction was supervised by two Persian engineers.

The method of work is described as follows:—

"A line was drawn across the peninsula, and along this the various nations parcelled out among themselves the work to be done. When the trench grew deep, the workmen at the bottom continued to dig, while others handed the earth, as it was dug out, to labourers placed higher up upon ladders, and these taking it, passed it on further, till it came at last to those at the top, who carried it off and emptied it away. All the other nations, except the Phœnicians, had double labour; for the sides of the trench fell in continually, as could not but happen, since they made the width no greater at the top than it was required to be at the bottom. But the Phœnicians shewed in this the skill which they are wont to exhibit in all their undertakings. For in the portion of the work which was allotted to them they began by making the trench at the top twice as wide as the prescribed measure, and then, as they dug downwards, approached the sides nearer and nearer together" (see *M.F.W. (All Arms)*), "so that when they reached the bottom their part of the work was of the same width as the rest." Breakwaters were also built at the mouths of the cutting in order to protect it from the surf.

It is not possible to say whether the other working parties had perforce to learn from the Phœnicians, or how effectual the undertaking turned out to be; traces of this canal have, however, remained until modern times, consisting of a line of ponds varying from 60 to 90 feet in breadth.

(*b*) The Bridges across the Hellespont.

While the Mount Athos canal was being dug, material was collected for floating bridges, and by the time that Xerxes and his main force had reached Sardis, two bridges had been constructed at Abydus, where the width of the straits was some 1,500 yards.

These bridges were made up of boats moored to cables stretched across the straits; in one case the cables were constructed out of flax by Phœnician craftsmen, while the cables of the other bridge were of Egyptian manufacture, and built up from papyrus. This first operation was not, however, successful, for a storm broke up the bridges before they could be crossed. The effect of this failure upon the careers of the responsible engineers was decisive. They did not, after our fashion, have the opportunity of exchanging their military headgear for civilian hats, for the King commanded that they should lose their heads. Xerxes, moreover, vented his rage on the waters in the following curious manner; "he gave orders that the Hellespont should receive 300 lashes, and that a pair of fetters should be cast into it. Nay, I have even heard it said, that he bade the branders take their irons and therewith brand the Hellespont." As the executioners set about "their unpleasing task," they were ordered to inform the water that "Verily Xerxes will cross thee, whether thou wilt or no. Thou art of a truth a treacherous and unsavoury river." How many an engineer has since voiced a similar complaint!

New experts were now set over the work, doubtless spurred to make greater efforts than their predecessors.

"They joined together triremes and pentecosters,* 360 to support the bridge nearer the Euxine (Black) Sea, and 314 to sustain the other; and these they placed in the direction of the current of the Hellespont, relieving by these means the tension on the shore cables. Having thus joined the vessels they moored them with anchors of unusual size, that the vessels of the bridge towards the Euxine might resist the winds which blow from within the straits, and that those of the more western bridge might withstand the winds which set in from the south and south-east."

Instead of "forming cut," intervals were left between the vessels in three places "for such light craft as chose to enter or leave the Euxine," and which, presumably, were able to pass under the deck.

"They made the cables taut from the shore by means of wooden capstans. This time, however, instead of using the two types of cordage separately, they assigned to each bridge 6 cables, 2 of which were flax and 4 of papyrus. Both types were of the same size and quality, but the flaxen were the heavier, weighing not less than 1 talent the cubit." Taking the Attic talent as approximately 57 lbs., and the Cubit as 1′ 6″, this works out at the incredible figure of 38 lbs. per ft. run. It may be, however, that the weight was intended to apply to the sum of several cables, but unfortunately there are no other data from which the size of the cordage can be determined.

"When the bridge across the channel was thus complete, trunks of trees were sawn into planks, which were cut to the width of the bridge, and these were laid side by side upon the tightened cables, and then fastened by ribands. This done, brushwood was brought, and arranged upon the planks, after which earth was heaped upon the brushwood, and the whole trodden down into a solid mass. Lastly, a bulwark was set up on either side of the causeway, of such a height as to prevent the pack-animals and horses from seeing over it and taking fright at the water."

The crossing was so organized that one of the bridges was reserved for the fighting troops and the other for transport and camp-followers. The whole army, according to the historian, amounted to 1,700,000 men, surely the greatest number ever to make a single crossing. The passage occupied 7 days and 7 nights without pause, and was executed "under the lash," presumably to keep the men closed up. The Arabian contingent crossed last, to avoid frightening the horses, which cannot endure the sight of a camel."

The bridges appear to have stood up well to the crossing; but their subsequent maintenance seems to have been neglected, for when the Persians were retreating after the Battle of Salamis, both were found to have been broken up by the weather. It is presumed that the Chief Engineer, Hellespont, also lost his head.

* A fifty-oared ship of burden.

THE CONCEPTION OF THE BAILEY BRIDGE

By Lieut.-Colonel S. A. Stewart, R.E.

FOR a long time the cloud of censorship has hovered over the Bailey Bridge. Now that it has at last been lifted, and certain information has appeared in the press, it is thought that some of the details of the early history of the bridge would be of interest to many members of the Corps.

The press information was based on the write-up issued from official sources, and on the results of an "interview" at the Ministry of Information. This interview was attended by Mr. D. C. Bailey and other officers who had been concerned with the design, all of whom had come prepared to answer any reasonable questions, but none of whom had expected to have to address a large room full of War Correspondents. It is to be feared therefore that their remarks did not produce that fluid sequence of facts which might otherwise have been presented. But most of the information which was printed was reasonably accurate; the majority of it was, of course, already well known to a large proportion of the Corps.

The bridge was based on the original idea of Mr. Donald Coleman Bailey, chief designer at the Experimental Bridging Establishment. It was developed by the design and experimental staff at E.B.E. in the same way as any new piece of equipment, but the name "Bailey" was given to it as a compliment to the inventor, although many other items of present service equipment could equally well have been given the same name.

A photograph of the team responsible for the design and production of the bridge was taken to commemorate the event, and this is reproduced (*see page* 240). It might perhaps be mentioned that a high proportion of this team, including of course Mr. Bailey, had been engaged upon the development of military bridging equipment for some years. It is safe to say that had this background not existed, the bridge could never have been designed, tested, and put into production in the short time that was in fact available.

Before going further into the history of the design, a short review of the problems before the bridge-designer will not be out of place.

1. The Bridge-Designers' Problems

For many years the Experimental Bridging Establishment had been trying to compete with the problem of designing bridges for tanks whose weight increased at the rate of "x" per cent. per month, and to which the final straw was usually added in the shape of a transporter—normally after the bridge design was complete.

The various equipment bridges, S.B.G., pontoon, etc., were efficient up to the limits of their capacity, but there invariably came a time when it became necessary to exceed these limits. This usually occurred in two stages. First, abnormal use of the equipment had to become the normal use, i.e., S.B.G. and L.B.G. had always to have 4 girders, which made assembly difficult, and pontoon bridges had to have 3-pier rafts which were inefficient. Eventually there came a time when capacities could not be stretched further and a new equipment had to be produced.

Under present conditions it takes over a year from the time the G.S specification is given, to the time the troops first see a new equipment. In peace time it used to take longer. As this is not always appreciated by the man in the field, it might be of interest to see how the time is spent in the evolution of a design of a major item of equipment. This usually takes the following form after the issue of the G.S specification.

(i)	Consideration of the basic design	½ month
(ii)	Adoption of final design for pilot model, production of working drawings, and ordering stores through the various controls	1½ months
(iii)	Manufacture of pilot model	2 months
(iv)	Tests, troop trials, and improvements	2 months
(v)	Production of final manufacturing drawings, determining requirements, finding production capacity, ordering and obtaining materials	4 months
(vi)	Smoothing over manufacturers' difficulties and agreeing upon inspection tolerances	2 months
		12 months

At the end of this period production is usually under way and first deliveries may be expected some 2 to 3 months later. A certain amount of additional inspection and tests are normally carried out before the start of a contract of this nature.

It will be appreciated that requirements cannot be decided until trials are complete, also the production of materials has then to compete not only with other army requirements, but with other service requirements as well. Any change in the specification or design at any stage of the development adds untold delays.

It is therefore apparent that in time of war, the adoption of new equipment is a major decision which is normally avoided unless such a course is inevitable.

Up to 1937 the heaviest class of bridge was 19 tons, the old "heavy" class. By 1939 the *Matilda* tank had arrived, starting at 23 tons and gradually increasing to 26 tons. To carry this load, S.B.G., L.B.G., and pontoon bridge had been re-designed for 24 tons, and were in production. By stretching them to their limit they could just be made to take 26 tons. To carry a *Matilda* on a transporter, the spans of S.B.G. and L.B.G. had to be reduced to inefficient proportions, and the pontoon bridge would not carry it at all.

Then the *Churchill* appeared on the horizon.

2. The Conception of the Idea

For some years Mr. D. C. Bailey had had at the back of his mind the idea of making a bridge girder out of panels, but he had never had time to investigate this fully and no calculations had been made. The panel had obvious advantages over the box girder, since the manufacturer only had to worry about accuracy in one plane, and its transport did not also involve the transport of a large volume of air. The advent of the *Churchill* necessitated a complete re-design of all existing equipment in any case, and the time seemed ripe for this to be investigated. The solution to the problem was a matter of extreme urgency. The Press has quite correctly reported that this discussion took place in a car on the way back from a meeting held to decide what should

be done after the recent failure of some other piece of equipment, and the first ideas were in fact discussed over sketches made on the back of an envelope, in an atmosphere of some despondency.

The idea seemed promising but nothing could be decided until some sizes and weights could be worked out on paper, so this was accordingly put in hand next day. It soon became apparent that a panel of a suitable size to fit into a 3-ton lorry could be made which would not be too heavy, and that these panels could be made into a girder to take the *Churchill* over a considerable span. After telephoning the news to London permission was given to go ahead. Having had considerable experience over the shortcomings of earlier equipment it was decided from the outset to eliminate as many of them as possible, and the following points were therefore selected as data :—

(i) The girder and deck system to be capable of being strengthened at will, preferably *in situ*. This would take care of increases in weight of the tank and of any reasonable transporter.
(ii) All parts to be made of readily available materials, and to be welded ; special steels are almost impossible to obtain in war time.
(iii) Parts to be capable of manufacture by almost any engineering firm. All previous bridging equipment had been difficult to produce, as only a limited number of firms could make it.
(iv) All parts to fit into a G.S. 3-ton lorry. We had all had enough of special bodies, and so, no doubt, had the R.A.S.C.
(v) Nothing to be heavier than a six-man load.
(vi) Underside of girders to be kept smooth for rolling on launching rollers.
(vii) A properly designed jacking system to be incorporated, since this operation can cause untold delays in the field.
(viii) Adequate bearings and bankseats to be provided. None of the present equipment bridges had them, and loads were rapidly becoming heavier.
(ix) Close manufacturing tolerances to be avoided. All previous equipment had caused difficulties in this respect.

3. The Design

The actual design was carried out by Mr. D. C. Bailey and Capt. (now Major) H. A. T. Jarrett-Kerr, R.E., who did much of the detailed work. In the early stages almost hourly conferences were held, at which first the main features and finally the details were examined from every angle. For several weeks members of the " team " used to arrive at the office every morning with fresh brain-waves and the best of these were incorporated. Mr. Ralph Freeman, the designer of the Sidney Harbour bridge, was a member of the Structural Engineering Committee and took a great interest in the project from the first. He was consulted frequently in the early stages and gave much valuable advice.

Various forms of construction were considered for the panel, but after examining different forms of truss (M, N, K, etc.) it was decided that existing rolled sections fitted most economically into the present design. Two extra vertical members were added at this stage, since the structure was theoretically not a closed one and it was not known to what extent reliance could be placed on the stiffness of the welded joints. Later, as a result of tests, these members were eliminated. This was an advantage, not only because of the saving in weight, but also because the presence of the extra verticals made it extremely difficult to climb through the girder.

A mild steel panel was hastily made in E.B.E. shops to see if there were any assembly difficulties or inaccessible welds, and to see if it could be handled reasonably well before proceeding further with the design. No difficulties were encountered.

The original conception of the bridge was that it should always be erected as double storey, and for this reason the pilot model was designed with one chord of the panels stronger than the other, the intention being that these two weak chords should bolt together halfway up the girder. Later, the value of the bridge in single storey construction became apparent and when it went into production the two chords were made equal. In this form it has turned out to be a very adequate substitute for the S.B.G., although this had not been envisaged in the first place. Apart from this, there has been no major change in the design from the experimental model.

The bridge was originally designed for dry gaps, but from the start the possibility of using it as the superstructure of a pontoon bridge was borne in mind. The extension of the design to include this feature followed on immediately after the dry gap trials had been completed.

4. The Pilot Model

The construction of a pilot model was beyond the capacity of the Experimental Bridging Establishment workshops, so the services of a suitable firm were co-opted in order to produce the bulk of the bridge. For this reason, the design of panels and decking proceeded ahead of the remainder in order to allow the firm to start. Great care had to be taken at this stage that all necessary fittings were incorporated in the panel and that no subsequent alterations were made which would delay production. The remaining items were designed one by one and manufactured in E.B.E. workshops.

The manufacturing firm took the greatest interest in the design and suggested several features to ease manufacture. They also supplied details of their jigs and welding procedure which were subsequently distributed for the benefit of other manufacturers. As they were made, panels were delivered by road, a dozen at a time, which enabled us to start tests on some of the shorter spans at the earliest possible moment.

In comparison with the time normally taken to put a new piece of equipment into production, as outlined in Section 1, the time taken in this instance was considerably shorter. Design and production of pilot model proceeded concurrently and the pilot model was in fact ready for test in $4\frac{1}{2}$ months and production was under way in 7 months. For such a major item of equipment, these times were quite exceptional. Luck undoubtedly played its part, but the sense of urgency took possession of all concerned, and some phenomenally long hours were worked, particularly in the drawing office.

5. Tests

Owing to the indeterminate nature of the structure, it was decided that all calculations should be checked by more than usually exhaustive tests, and further, that such tests should be carried out to destruction.

The bridge was accordingly erected on a flat field, about two feet clear of the ground, so that jacks and safety packing could be arranged underneath. All test loads were applied statically, jacks being placed under the centre of the span to hold the bridge until the load was in place; then they were slacked off. The static load included an extra allowance for impact, and was applied at maximum possible eccentricity on the roadway, i.e. against one kerb. Only by this means could an accurate assessment of the

THE BAILEY BRIDGE TEAM

Sitting (L. to R.): H. J. Taylor (Chief Clerk E.B.E.), S. Mountney (Shop Foreman E.B.E.), Lt.-Col. S. A. Stewart, R.E. (Superintendent E.B.E.), D. C. Bailey, O.B.E. (Assistant Superintendent and Chief Designer E.B.E.), Major H. A. T. Jarrett-Kerr, R.E. (Experimental and Design Officer E.B.E.), Major H. W. Kenyon (Workshops Officer E.B.E.).

Standing (L. to R.): R. S. Lane (Administrative Officer E.B.E.), Col. P. K. Benner (D.D.R.E.E., R.E.6 (Production) M. of S.), Brig. F. E. Fowle, M.C. (Director R.E. Equipment, Ministry of Supply), Col. S. G. Galpin (D.D.R.E.E. R.E.7 (Development) M. of S.), B. M. Furneaux (Chief Draughtsman E.B.E.), A. T. Bines (Senior Draughtsman E.B.E.).

Appointments shown are those held at the time.

The conception of the Bailey Bridge opp p 240

stresses in the members be made ; these stresses were measured at numerous points by De Forest scratch-recorder strain gauges.

The actual arrangement of some of the test loads would have filled a laboratory man with horror. For various reasons it was necessary to apply a considerably greater load to one particular span than had ever been done by the E.B.E. before, and the application of this load, to an area of deck 12 feet long, presented certain problems of its own.

This was actually achieved by driving an old 1917 Mark V tank on to the centre of the bridge. A scissors bridge was then placed as a ramp up the back of the Mark V tank and a timber platform erected at the top of it. On this, two additional tanks were poised, one in front of the other on the top of the Mark V. " Poised " is the correct word. The Mark V was further filled with pig iron, and some tons of R.S.J.s were added to the heap wherever room could be found for them. The photograph shows this nightmare erection.

On one occasion, when demonstrating the bridge under test before the Structural Engineering Committee, the " team " was feeling a little shy at showing such a crude arrangement before such a distinguished scientific body, and this embarrassment was increased by a light shower of rain which wetted the surface of the scissors bridge just sufficiently to prevent one of the upper tanks from climbing it. It was finally accomplished with the assistance of a large gang of men heaving on a rope. We tried to get the Committee to look the other way while all this was going on, but they would not do so. Fortunately, when the jacks were lowered away from under the bridge, it successfully withstood the load.

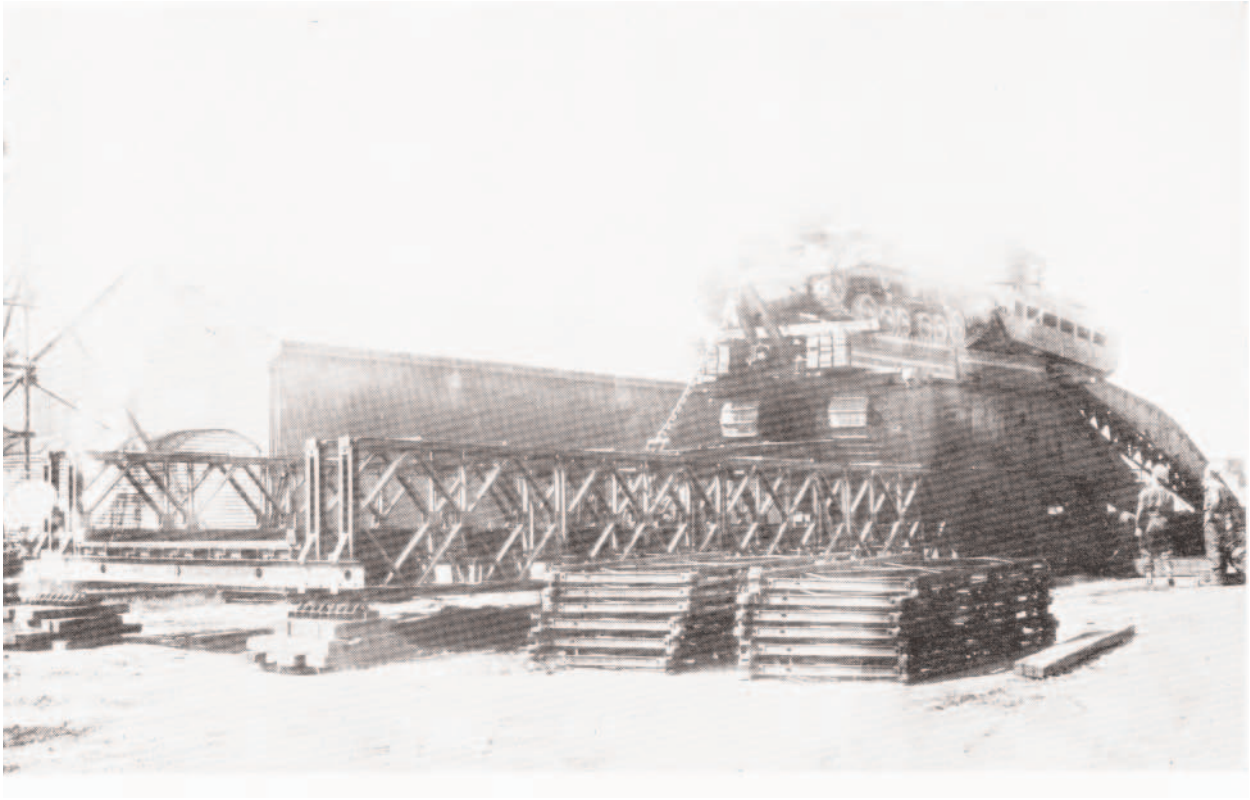
On another occasion a test caused us considerable concern. The Structural Engineering Committee was once more in attendance and the intention was to load a bridge successively with gradually increasing overloads until a point was reached, just before failure, which had been decided upon as the load necessary to pass the bridge. Tests had by this time reached such a point that one more success would have ensured acceptance of the design. Owing to our crude methods these tests took nearly all day and the final overload could not be applied until about 6 p.m. Many of the Committee were in fact temporarily away from the site at which they had spent many weary hours.

The men on the jacks supporting the centre of the span slacked off and finally reported all clear, but just before taking measurements of deflection, etc., one jack-man said " Just a minute, sir, I've still got a little load." He slacked off, but the load still remained and it was then found that the top chord on one side of the bridge had failed by buckling, but so gently that no one had noticed it.

The Committee was hastily collected and an examination of the damaged panel was made. It was found that one side of the top chord had a bad scar, where it had evidently been struck by a tank in an earlier test. This, coupled with the severe overload, had been sufficient to cause failure.

At this discovery the designers breathed a sigh of relief, men were put on, to work all night if necessary, to replace the damaged panel, and rooms were booked for the Committee at the local hotel. The test was applied again successfully next morning.

As the result of some weeks of adjustments to loads and spans, a provisional table of safe spans was compiled. In practice it was found that the tests allowed loads slightly in excess of those calculated, which was most satisfactory. So far, very few adjustments have had to be made to this table, but it will be noticed that some spans still bear the asterisk, meaning " to be confirmed by test." From the above it will be apparent why this has not yet been done.



The conception of the Bailey Bridge opp p 241.

Acceptance tests for a bridge normally require it to sustain a load equivalent to the full load plus impact allowance plus 50%, applied at maximum eccentricity, i.e. with a wheel against one kerb. The bridge must withstand eleven applications of this load and there should be no increase in permanent set between the tenth and eleventh application. It should be realized that this test should, if the designer has done his work correctly, load the bridge almost to the point of failure. It does not mean that bridges in the field can be loaded to this figure, since field conditions will lower their capacity considerably. It is in fact unsafe to exceed the figures given in the book. The factor of safety is only 1.5 on a well made and well erected bridge, compared with a factor of at least 4 which is normally used by the civil designer.

A note on the type of failure which occurred in tests to destruction might be of interest. In bending, the failure invariably occurred in the top chord, which failed as a strut between bracing frames near the centre of the bridge. In shear, the end upper diagonals in the end panels failed by buckling. In each case the stress at the moment of failure was practically equal to the theoretical yield point of the material, which showed that the bracing system was adequate.

Very few modifications were necessary as the result of the tests, the main one being to the deck system. It was found that the acceleration and braking of heavy tanks caused the transoms to bend sideways, so that the stringers tended to slip off. The addition of the present anchorage system, between stringers and transoms, has eliminated this and effectively ties all transoms together so that they assist each other.

6. Production

It had now become apparent that the bridge was a success and that it was urgently required. Drawings were finalized with all speed and handed over to officers of the Production and Inspection branches of the Ministry of Supply, who were already engaged upon large-scale planning. They approached a number of firms who agreed to act as " parent firms " and who would be responsible for placing such sub-contracts as they thought fit.

A demonstration of the bridge was given to representatives from these firms, but owing to the numbers of sub-contractors engaged, it is certainly true to say, as has been reported in the Press, that a number of them did not know what they were making. This has now been corrected by the issue of posters to all firms making components, and by the organization of demonstrations for factory workers.

The nature of the components is such that a variety of firms can manufacture them, as is borne out by the fact that not only large engineering firms but also the much publicised garages, bedstead makers, window-frame makers, paper makers, confectioners, and football pool proprietors, are all undertaking to produce parts.

In order to achieve uniformity of production from this large number of firms, the Inspection staff of C.I.E.M.E. had no small problem, and only by the provision of a considerable number of gauges has the necessary standard of interchangeability been maintained.

7. Handling Trials

During the early stages of production, troop trials, loading trials, and launching trials were being carried on, and a provisional handbook was issued.

The system of launching was an obvious development from the S.B.G. launching nose, which had up to that time been the quickest and most successful of any method. The bottom chord had been deliberately kept clear of steps, slopes, knobs, etc., with this in view, and the drill as originally envisaged has required very little alteration.

It was feared at one time that the number of small parts, which was certainly larger than in previous equipments, might prove a source of irritation to troops, and that losses might be great. The losses, however, are not great, and the irritation is confined only to store-holders. On the other hand the "meccano" principles seem to appeal to the troops, who have shown considerable keenness in the equipment from the beginning.

8. Floating Bridges

Reference has already been made to the application of the equipment to floating bridges. The development of the centre pontoon, to fit between two existing bow sections, was the main problem here, and did not cause much difficulty. The remaining special parts were not complicated, and a set was ready for trial very shortly after the "dry-gap" tests had been completed.

The advent of the Bailey pontoon bridge incidentally overcame one of the greatest worries which has existed ever since pontoon bridges have been used in the army, in that, for all normal river-crossing operations, it eliminated the trestle. Pontoon bridges with trestles have been standard equipment since about 1870. They have always been difficult to erect, particularly the trestle on the far bank, and once erected are a constant source of danger. The increases in weight of tanks had necessitated greatly enlarged trestle feet, with consequent increased difficulty of erection, and even with these, a number of accidents had occurred. The pontoon long landing bay was an attempt to get over this, but had considerable limitations since it was of necessity a makeshift designed to adapt an already existing equipment. The Bailey, with its landing bays of 100 feet or more, completely solved the problem.

For the bridging of tidal estuaries special cribs or trestles may still be required, but this can be accepted, since the crossing is in the nature of a deliberate operation. It is an operation which had in any case become impossible with Class 24 loads, until the introduction of the Bailey equipment.

9. Further Developments

It is not possible in this article to refer to further developments. The "meccano" type of construction lends itself well to other uses which were not originally envisaged, and there is a great temptation, which must be resisted, to add more and more special parts for these additional uses. Some are undoubtedly valuable and provision has been made for them; others may be classed as refinements and luxuries.

After the war it is even possible that the provision of a few corner pieces and a front door will solve the pre-fabricated housing problem!

WAR OFFICE SELECTION BOARDS (O.C.T.U.)

By Colonel F. I. de la P. Garforth

Note:—The opinions in this article are personal and not official. The writer has been casually interested in industrial psychology for many years, and has recently spent 3 months as President of a normal W.O.S.B. and then 7 months as President of a group of 3 W.O.S.Bs. dealing with both military and civilian candidates chiefly for R.E. and R.E.M.E.

EVERY practical student of society and human nature is aware of the waste, inefficiency, and unhappiness, which arises from occupational misfits. Men are constantly found condemned to do work which is uncongenial, or above or below the scope of their abilities. It follows that any development in the science and art of personnel selection has a wide social significance beyond the material concern to the group affected. There has been such a development of technique adopted by the W.O.S.Bs. in the British Army during the last 2 years—carried out under the Adjutant-General by the Director of Selection of Personnel. These authorities were assisted by the G.O.C.-in-C. Scottish Command, and the Director of Army Psychiatry.

Quick and scientifically valid methods have been found for selecting personnel for training and employment as operatives such as tradesmen, industrial, and manual workers, etc. In this direction much has been accomplished in Germany and America; and here by the National Institute of Industrial Psychology and others. A very different problem is that of selecting administrative or executive personnel, or officers in the services. Until recently, little attention had been paid to this matter except in Germany, where psychological methods have been extensively used for selecting, among others, the particular type of officer required by the German Army.

In peace time the process of selecting administrative or executive personnel for Government services, the professions, and private enterprises, is a long one. It embraces school, university, and subsequent careers; examination of all kinds; the exercise of personal choice; interviews, etc. This method is palpably impossible for selecting officers for an expanding or expanded army under emergency conditions of man-power shortage. Time is vital; there are few *obvious* pointers to ability for military leadership in the back history of most candidates. The duties and responsibilities of an officer represent a radical departure from anything previously experienced. Military leadership has many useful varieties, and now public opinion demands that a real attempt shall be made to find the potential leaders among types of candidates who do not conform closely to the previously accepted pattern.

Before the establishment of W.O.S.Bs., selection of candidates for commissions was based on the recommendations of C.Os. sifted by a very short interview before a Command Board consisting generally of several senior officers. Such a system may be acceptable when the supply of candidates is large in relation to demand and contains a fair proportion of suitable material. The margin of error must have been appreciable and can safely be said to have included more rejections of likely candidates than acceptances of unsuitable ones. This degree of error is not tolerable when the general man-power situation becomes acute.

It is impossible here to give more than a bare outline of the general structure and procedure of a typical W.O.S.B., and to touch on a few of the more controversial and interesting aspects of the methods of assessment employed. Though the general structure and working principles of Boards are similar, each has its own individuality of programme.

In outline, a W.O.S.B. is a team of 4 officers—President (Colonel), Military Testing Officer or M.T.O. (Major or Capt.), Psychiatrist (Major or Capt.), and Psychologist (Subaltern)—charged with the task of assessing the acceptability of candidates for O.C.T.U. training and forecasting the probable future standard (6 months after being commissioned) of accepted candidates. To this team one or more visiting officers from units are generally added for each batch of candidates; though not members of the board their opinions are invited and are generally of value. Technical interviewers are included as necessary (R.E., R.E.M.E., R.A.S.C., etc.).

A normal testing period is 3 days. The essential problem of the W.O.S.B. is to try and reach sound conclusions in 3 days over a problem on which one would like to spend 3 months, or even 3 years. Candidates are of all ages from 18 to 50 and have included university professors, distinguished engineers, ex-civil servants, at least one extremely clever and able ex-Cabinet Minister from Central Europe, as well as musicians, journalists, actors, and errand boys. The candidates are treated as potential officers during their "course," and every effort is made to put them at their ease while under test and when off parade. The testing officers mess with the candidates and it is remarkable how much success attends the efforts made to produce an atmosphere comparable to that of a good officers' mess. The actual tests are conducted in the spirit of trying to find enough basic good qualities in each candidate for acceptance, rather than in trying to fault him. No single test is decisive and the candidate is told this.

Candidates on arrival are organized into "groups" of 7 to 12 men (8 is generally accepted as the ideal number) and allotted numbered armbands. They are known by these numbers during the course. Rank and service are disregarded as between candidates.

In outline a programme includes :—

(*a*) Written Tests	Questionnaires	2. One educational and occupational, the other personal and medical.
	Intelligence Tests	3. Each 20 minutes.
	Psychological tests	3. Indicate basic personality characteristics.
	Maths paper	1. Used chiefly for technical arms.
(*b*) M.T.O.'s Practical tests		7. Plus short interview.
(*c*) Interviews	Officer quality	1. Each interview about 30 minutes.
	Psychiatric	1. Psychiatrists are generally unable to interview all.
	Technical	1. Technical only when required.

Intelligence Tests.

The limitations of Intelligence Tests are frequently misunderstood. It is a pity that no other word can be found to substitute for "intelligence."

This is very loosely used in ordinary conversation. A good parrot-like memory and the "gift of the gab," coupled with an attractive personality, are convincing to most ordinary observers, but in some cases these cover a marked lack of real intelligence. Alternatively, some highly intelligent and able young men are not impressive at first sight. There are rare cases of men with a very high specialized aptitude for some particular activity who by virtue of this may be commonly, but wrongly, regarded as having much general intelligence. Such men will not get a high score in the types of intelligence test used in W.O.S.B. Speaking broadly, a fairly high score in the Intelligence Tests is a reliable indication of a quick and flexible brain, with a capacity for rapidly grasping and analysing all the factors in unfamiliar subjects and situations. "A man with his wits about him" is a fairly close description.

A high intelligence rating is a valuable asset to an officer, provided he also possesses the essential qualities of character, leadership, and personality.

The man who gets a poor intelligence score may have the assets of character, drive, and personal energy. He may, by prolonged study and application, have attained success in his own line of business. It is unfortunate however, that even so, he is unlikely to make a satisfactory officer. This has been proved at O.C.T.U. where he has a tendency to break down and be "R.T.U.d.," due to the difficulty of absorbing the crammed and varied instruction. He is not adaptable or quick to grasp new subjects, and would be unlikely to react wisely in unfamiliar, sudden, and complicated situations in which he would have to bear responsibility. He may, therefore, be a menace in the field, not only to himself but to the men under him. He would also find it hard to inspire the confidence of subordinates of considerably greater intelligence than his own.

In W.O.S.Bs. the intelligence test results are checked against performance in other tests; when there is any good reason to doubt their accuracy alternative ones are given. Sometimes a candidate is off-colour at the time of the tests owing to a long and awkward journey the night before, a bilious attack, or some other cause.

The intelligence tests used are of a standard type which have been scientifically validated by prolonged research. For the purpose of arriving at the particular scale to be used in army selection, a large sample of serving officers and men were tested. The scale used in W.O.S.Bs., based on a combination of the results in all three tests, is :—

(*a*) Of outstanding analytical intellectual ability, normally capable of 1st class University Honours given suitable education and application.
(*b*) A long way above the level of the *average* serving officer.
(*c*) Distinctly above the level of the average serving officer.
(*d*) Average serving officer
(*e*) Just below the level of the average serving officer.
(*f*) Below the level of the average serving officer.
(*g*) Above the level of the *average* private soldier.
(*h*) Just above the level of the average private soldier.
(*i*), (*j*), (*k*) } Round about the level of the average private soldier.

It is a finely divided scale but is justified by statistical investigation. If the scale were to be continued to embrace the whole population, a number of additional points below (*k*) would have to be added. Candidates are seldom

accepted unless their test results are (*h*) or higher, but a candidate is never rejected on intelligence grounds alone unless he is below (*g*).

Personality Pointers

This is the name given to the inferences made by the psychologist about the personality of the candidate. These inferences are not used by the Board as independent evidence, but are used by the psychologist and psychiatrist as part of their data in making a final assessment.

The " pointers " are based on evidence which is provided by the two questionnaires and the three psychological tests. The questionnaires are carefully designed and comprehensive, and help a candidate in setting out all relevant information regarding his background, education, hobbies and interests, social activities, games, occupational record, military record, and medical history.

It is impossible to go into the theory or details of the psychological tests in a short article. It is a fact, however, that expert interpretation of the three tests, in the light of the information given by the questionnaires and the intelligence tests, leads to a provisional assessment of basic characteristics. This assessment can be arrived at without the assessor ever meeting the candidate. Its results are regarded as nothing more than a " pointer " and are of value in deciding which candidates should be interviewed by the psychiatrist. It also assists the psychiatrist in his interview by giving him lines of enquiry. The " pointers " are useful in suggesting matters needing special observation or testing in the M.T.O. tests or " officer quality " interview. It sometimes happens that the pointer provides the first clue that a candidate, who seems unimpressive, has much more in him than appears on the surface.

M.T.O. Tests.

The specification for an ideal M.T.O. is that of a superman. He should be first and foremost a good regimental officer, preferably with battle experience, or his ideas may be too hazy and divorced from the " feel " of military leadership and man management. He should have high intelligence, or he may fail in interpreting the reactions and behaviours of such candidates as have high intelligence. He must be interested in human beings and reasonably free from pronounced personal prejudices and intolerance. He must be willing to learn, and conscious of how superficial and inaccurate are ordinary methods of rapid judgment and grading of human material. The tests are of many types and can vary infinitely within each type. They can be classified in several different ways, of which perhaps the simplest for the present purpose is :

(*a*) Individual situations.
(*b*) Command group situations.
(*c*) Leaderless group situations.

Within each of these categories tests may vary from those demanding primarily powers of thought and understanding, to others in which capacity for action and command is the chief requirement. These two attributes do not always go together in balanced proportions. The more useful tests, particularly in a short programme, are those which provide evidence on both counts —but the more specialized tests have their uses.

Examples of "Individual" tests are :—

(i) A particular candidate is picked out and "put in the picture" of some situation which may be military or non-military. He is then asked to describe, or to take, the course of action which he would follow. The situation is generally simple as regards "ingredients" but offers a variety of solutions, good, bad, and indifferent. In military situations careful allowance must be made for previous training and experience, or for its absence.

(ii) Company office (man management). The candidate is put in the position of a newly joined officer who has to deal with a personal interview (*not* disciplinary) question affecting one of his men. Another candidate is briefed as stooge and brought in. The validity of this test excites controversy among the experts, and certainly demands skilled and experienced observation if unwarrantable deductions are to be avoided. Alternatively, candidates are given a few moments to prepare and deliver a short talk to their men (represented by the other candidates) on some straightforward subject affecting morale, behaviour, or discipline.

(iii) Individual selective obstacles. After carefully planned briefing and reconnaissance, the candidate is faced with a variety of obstacles or tasks, each carrying differing point values, and is given a limited time in which to make the best score he can. One or two of the dozen or so obstacles may be compulsory. This is a most illuminating test, but again needs experienced and intelligent observation and judgment. Performances cover a very wide range—from a brilliant combination of mind, guts, and athleticism, to a complete failure to plan or perform, accompanied by astonishing loss of head and nerve.

(iv) In "*Command Group Situations*" candidates are in turn placed in charge of their group and faced with some problem or task which has to be planned, organized, and executed by the group.

Leaderless Group Situations are tests in which the Group is faced with a task or situation without any leader having been appointed by the testing officer. This is, in the opinion of the writer, by far the most valuable and, all things considered, the fairest type of test, provided the M.T.O. is a well-trained and naturally acute observer. Tests may vary from the "Group Discussion," in which the 8 or 10 candidates sit round in easy chairs and are told to select a subject for discussion and talk about it to each other, to a "Group Task" which may involve improvising, with limited materials found on the spot, some method of "escaping" as a group over a wire entanglement, including electrified wire and alarms. In another form of the test Groups are told to invent their own situations and act on them. In judging these tests the observer watches above all the interpersonal reactions of the group, and the significance of the contributions to direction or execution made by each member of the group. It is by no means always the candidate who talks the loudest or most, or apparently takes the lead, that gets the highest grading.

The Psychiatric Interview

It is perhaps worth explaining the difference between a psychiatrist and a psychologist. The former is, in this country, a doctor who has also qualified

in psychology and the treatment of nervous and mental patients. The psychologist is not necessarily a doctor and in the realm of psychology, he is concerned, more than is the psychiatrist, with the study of ordinary human beings in relation to intelligence, aptitude and other tests; working and social conditions; fatigues; and "normal" behaviour generally. There are, unfortunately, few fully qualified and experienced psychologists available.

The majority of men, especially in this country, are healthily devoid of any interest in psychiatry. This indifference tends to turn into aversion, ridicule, or alarm at the mere suggestion of any close approach to what is regarded as a queer interest for queer people Though robust, this state of mind has the effect of missing certain practical benefits which can be attained through psychiatric and psychological methods, more readily and efficiently than in any other way yet devised.

Because a part of current psychological theory has been based on the investigation of abnormalities of mind and personality (just as much medical theory has been founded on a study of exceptionally morbid conditions of the body), some people jump to the conclusion that psychiatrists have no other interest but in abnormal cases. Other, perhaps more rational, critics feel a revulsion against the invasion of mental privacy which is unavoidable in prolonged psychiatric investigation. Yet others have a well justified sense of the youth of the science of psychology—a point of view which is fully shared by every psychiatrist with whom the writer has discussed the matter. The critics take counsel of their fears to the extent of opposing any trespass by psychiatry beyond the field of the admittedly abnormal.

In the past 30 or 40 years the field of psychology has expanded more and more to a study of what may be called normal behaviour and mental processes, and unquestionably in the future will develop in the direction of prevention of mental stress and strain, and in promotion of mental hygiene. Public opinion will be wisely cautious in accepting these developments, and in demanding that all claims shall be tested and re-tested before acceptance.

To return to W.O.S.Bs., in the experience of the writer the types of case over which, as President, he found the expert psychiatric opinion of most value were as follows:—

(*a*) Cases of young candidates, who might profit by more time in which to develop or adjust themselves to Army conditions before going to an O.C.T.U. (This is a medical as well as a psychiatric matter).

(*b*) Cases where there is doubt whether a candidate would, as an officer, be likely to look after his men well. (The Psychiatrist is often able to dispel or to confirm doubts on this point.)

(*c*) Border line cases as regards self-confidence and self-reliance.

(*d*) Discussion of cases in which the intelligence test results were border line or unusual.

(*e*) The uncommon cases of exceptionally taciturn, unforthcoming, or apparently diffident candidates, who have shown up poorly in other tests, but in whom there may be more than appears on the surface. Also the outwardly meek and mild, or intellectual type of candidate who may also possess a hidden reserve of determined pugnacity which is likely to emerge in action. (In such cases the psychiatric opinion was often decidedly in favour of the candidate.)

(*f*) The very rare cases—probably less than one per cent—in which, on purely technical psychiatric grounds, the psychiatrist is strongly against an otherwise acceptable candidate. Such a candidate may be good material, except that he has some psychiatrically recognizable kink

in his personality which makes him liable to break-down or black-out under great strain or emergency—he is therefore, an " unjustifiable risk " both to the Army, the men under him, and to himself, as a junior officer in the field. In boards where more than one psychiatrist is available, it is common to take a second opinion on these cases. The candidate can always appear before another board, if recommended by his C.O., and the second board will have no knowledge of the previous grounds of rejection.

The sincere impression of the writer is that he has taken part in more discussions in which the psychiatrist was advocating acceptance of a controversial candidate than the reverse. Psychiatrists are generally adept at putting a subject at his ease in an interview, and often a candidate does himself more justice in talking freely, to the psychiatrist, about his past interests and achievements, than to the " officer quality " interviewing officer.

The " Officer Quality " Interview

This interview is carried out by the President or Deputy President in a W.O.S.B. Its object is to get to know the candidate and assess, so far as is possible by interview alone, his suitability as a potential officer.

Part of the evidence is of course the report of the candidates' Company Commander or C.O. Every effort has been made to improve the quality of these reports. In many cases they are of great value to the Board but in others it is quite obvious that they have been prepared without much care or thought and with little personal knowledge of the candidate. This and the candidate's answers to Questionnaire 1 act as a guide to the interviewing officer, who then tries to put him at his ease while leading him to talk about his achievements and interests in the past, with particular reference to any activities involving leadership, his hobbies and games, his conception of an officer's responsibilities and role, his knowledge of current affairs and personalities, and his real reasons for wishing to become an officer. Usually to obtain evidence to back his judgment, the interviewing officer must be prepared to spend 20 to 30 minutes on each interview, although it is often possible to reach an unsupported " intuitive " (and possibly erroneous) conclusion in a few minutes.

The science and art of interviewing is a fascinating subject. Every interviewer must develop a technique which suits his own idiom and personality but there are certain fundamental rules which apply to ensure reasonably fair judgments. The interview must follow a flexible but nevertheless definite plan ; the interviewer must know his own foibles and be on his guard against unfounded likes and prejudices ; he must be sensitive to the various indications of nervousness, confidence, evasion, bluff, hostility, and sincerity ; he must have utmost patience. However skilfully conducted an interview may be, the result can never be absolutely reliable. Cases occur in which there is a wide difference between officer quality interview assessment and the assessments depending on the M.T.O., psychological tests, and the psychiatrist. On examination and discussion it is generally found that each of the four assessors have been perfectly justified in reaching their own separate conclusions on the particular evidence within their observation. Then comes the task (at the final Board conference) of integrating these different opinions into a final assessment of the candidate's performance as a whole.

The Technical Interview

The technical interview, in the case of R.E. and R.E.M.E. candidates, generally lasts 30 minutes. To save time, the interviewing officer is normally

given in advance the mathematics test paper done by the candidate and his technical occupational record and qualifications. The balance between theoretical knowledge, practical experience, intelligence, trainability, and specialist, as opposed to general qualifications, presents a problem of very considerable complexity in which great care and skilful judgment are needed if consistent standards are to be maintained. Very valuable indications on the subject of officer quality (i.e., powers of leadership, control of men, integrity, self-reliance, loyalty, and determination) are often obtained in the course of the technical interview and provide a useful check on the results of the officer quality interview.

The Final Board Conferences

At this conference the opinions and observations of all officers who have had dealings with each candidate during his three days course are thrown into the pool and, after discussion, a final decision is made by the President as to whether the candidate is accepted, rejected, or "put back" for further general or specific training.

The procedure varies in different Boards, but it is usual for the candidates to appear before the Board. The President then checks certain details—unit, age, medical category, choice of arm, and the candidate withdraws. The appearance of the candidate in person helps to stimulate the memory of the members of the Board and avoids any possible risk of talking at cross purposes. After he has withdrawn, his intelligence test grading is read out and in turn each member of the Board states his own grading assessment of the candidate. Very often these gradings agree or only differ slightly. Such cases need little discussion. It should be repeated here that the interviewing officers have generally observed two or three of the M.T.O. tests, in addition to doing their interviews. The interesting cases in which discussion is often prolonged are those in which there is a wide divergence of opinion, border line cases of acceptance or rejection, "put back" cases, and cases where one or more members of the Board assess the candidate as "outstanding." After discussion the President makes his decision, which is final as far as the Board is concerned (but subject to W.O. approval)—except, as happens occasionally, when the candidate is held for a further interview or test before a final decision is made. A rejected candidate is not debarred from appearing later before the same or a different board.

The grading system employed is based on comparing the Board's forecast of the future ability of the candidate, after O.C.T.U. training and 6 months commissioned service, with their estimate of current standards among serving subalterns in his proposed arm of the service. The classifications used are:—

(i)	Outstanding	1 in 100 of satisfactory serving subalterns
(ii)	Much above average	Top 10%
(iii)	Above average	Next 20%
(iv)	Average	Middle 40%
(v)	Below average	Lower 20%
(vi)	Borderline but acceptable	Bottom 10%
(vii)	Put back for further training and experience	
(viii)	Rejected	

This classification may appear elaborate. A newly arrived member of a W.O.S.B. tends first to classify on a three-point scale (above average, average, and below average) but will soon feel the necessity of refining the scale to include categories (ii) and (iv) above, as well as (i). The practical value of this grading of accepted candidates is two-fold. First it is of value in the "follow up" of candidates, subsequent performances which provides the scientific check of the validity of W.O.S.B. procedure. Secondly the establishment of these standards permits adjustment of intake when the demand and supply situation changes for any particular arm of the service. For instance if, say, Royal Corps of Signals get full up and only need a small intake, the War Office may decide only to accept categories (i) and (ii).

Careful investigation has been made into the particular characteristics, both mental and physical, required by each arm of the service, and in cases where a candidate is not suitable for his originally chosen arm he can often be guided into another arm fitted to his characteristics.

Visitors to W.O.S.Bs. who have remained sceptical over certain aspects of the procedure are, generally, convinced by the fairness and thoroughness of the Final Board Conference. At this appears all the information which has been amassed about the past history and record of the candidate, his abilities, his personality, and his performance during the "course," is placed before the Board.

The judgment of one human being regarding the personality and potential ability of another can never be wholly "scientific." On the other hand, the field of evidence on which that judgment is made, and the organization of subordinate contributory opinions, can be prepared on a balanced and scientific system in which every precaution is taken to eliminate or compensate for human prejudice and error. That is what W.O.S.Bs. attempt to do as compared with the more or less haphazard, casual, and largely "intuitive" methods previously in use. Intuition has its place and value but is an unreliable guide when unsupported by objective observations and evidence.

In a good W.O.S.B. the margin of error should be very small. Follow-up statistics at O.C.T.U. and in units have proved beyond doubt the superiority of the W.O.S.B.

The question is sometimes asked as to how far candidates can be crammed in advance for W.O.S.Bs. and so put up a performance in excess of their innate capacity. It is next door to impossible to "cram" for the Intelligence or psychological tests, unless the particular tests (not *type* of test) to be used have been studied, solved, and memorised in advance.

The matrix test—i.e., that part of the "Intelligence test" which proves the candidate's basic intelligence, mental acumen and ability—has been given to a person, of below average intelligence, every day for a month without producing any improvement in results. On the other hand, a candidate of high intelligence may make a still better score if given this test again within a few days of his first attempt.

It may be possible to train a candidate to improve his showing in the M.T.O. tests but if so this training will probably have had a permanently beneficial effect on his personality.

At the end of a course candidates are often asked for written anonymous comments and criticisms. One of the most common is "What I liked most about the course was the friendly helpfulness of the staff." The same comment is often volunteered by candidates in interviews towards the end of the course —sometimes by men who were extremely nervous and uncomfortable on arrival. Nearly all say with obvious sincerity that they have thoroughly enjoyed it and feel they have had a square deal. This does not prevent some of

them from shooting a fine line about its terrors and difficulties when they return to their barrack room. In the same way a disgruntled candidate will spread alarming tales of the horrors of a psychiatric interview, though in actual fact most of those who experience it describe it as interesting and helpful. An overwhelming majority of those who passed through W.O.S.Bs. have formed a favourable impression of the advantages and possibilities of the system.

Conclusion

This article furnishes an outline of the technique developed in W.O.S.Bs. and of some of the more controversial aspects of the system. The procedure compensates the time factor by the substitution of trained, multiple, concentrated, and organized observation over a short period which includes elements of stress. The examination factor is taken into account in the academic history of the candidate, but is supplemented by the viva-voce examination, elements of the officer quality, psychiatric, and technical interviews and practical performance in the M.T.O. tests. The intelligence and psychological tests disclose fundamental capacity rather than the products of experience, educational circumstances, and specialized application. Character and personality are tested not only by assessment of past performance and record, both military and civilian, as disclosed in the questionnaires and interviews, but by observation of practical performance as a member of a group of previously unknown personalities under conditions of stress and effort.

The system is in its infancy. It is imperfect, still in large measure experimental, and many pitfalls lie in its path, but it represents a marked advance on any previous attempt to devise practical, logical, and sound methods of rapid selection of excutive personnel. These methods happen to have arisen to meet the problem of selecting army officers, but they are capable, and in certain experiments have already been proved capable, of wider application. If prejudices can be converted to healthy criticism, if enthusiasm be tempered by wisdom, and if motives are reasonably altruistic and impersonal, the work done in W.O.S.Bs. can make a material contribution to beginning that improved democratic social organization which we hope to see developed after the war. Equal opportunity for equal capability, will be an important goal of that society, and reliable and fair methods of assessing individual capacity, character, and special aptitude, will be demanded.

"WHAT BOOK?"

By Colonel J. C. T. Willis, O.B.E.

A FEW weeks ago an earnest enquirer asked the Brains Trust to say what book they would recommend to a man who was to be forced to live in solitude—perhaps on a desert island—for several months, supposing that one book and one book only could be taken.

I forget now what the answers were. Probably Commander Gould modified his original intention of taking the *Encyclopædia Britannica* on the grounds that on second thoughts he reckoned that he knew it all. Equally probably was Professor Joad unable to make any reply until a more precise definition of what is meant by a "book" could be provided. Commander Campbell, if I remember aright, recalled at some length an incident in his colourful past which, though absorbing in itself, had little or no bearing on the question under discussion.

It certainly is a fascinating problem and one best thought-out in front of the fire-side as one runs an eye down a list of titles on a well-filled bookshelf and ponders on the question "Well, which *would* I take?" It is not quite so fascinating and certainly far more of a problem when one is forced to take this very decision, not in the warmth of a book-lined study, but in the heat of a Survey camp in the jungle. One book and one book only. The weight to be carried admits of just that and no more.

Some years ago as a subaltern R.E., I had to take this decision myself just before a month's surveying trek in Johore, with the prospect of no other companionship than that provided by twenty Borneo Dyak carriers. Rapid movement, breaking camp every morning, was essential and loads had to be cut to the minimum. All available "lift" was needed for instruments and for food, for it was impossible to live on the country. Food for Master; food for the carriers who carried Master's food; food for the carriers who carried the food for the carriers who carried Master's food—it could be elaborated indefinitely (and *would* be if I were being paid at space rates!).

What book would one take? The first instinct in my own case was the Bible, a grand repository of ideals, behaviour, and history. But is it a good book to read alone for a long stretch? Loneliness plays queer tricks with the mind, and only a week previously I had had to take kind but firm steps to deal with the case of a Corporal who had found it impossible to omit references to the Scriptures from his monthly progress reports. It would have been a fine, but a very risky, choice. I did not take that risk.

In *Journey's End* the hard-pressed soldier turned to *Alice in Wonderland* for the odd moments of relaxation, but would it last long enough? . . . . And so on through all the lists of possibles. The choice finally narrowed down to the *Oxford Book of English Verse* and the *Pickwick Papers*. The *Pickwick Papers* won. Telling this story to friends there is generally, at this juncture, a murmur of "How wise" from those who have perhaps read parts of the book long years ago, and have never bothered to glance at it since.

So off into the jungle, in the wake of a long file of carriers, each bearing a load slung in a basket, in one of which reposed a tin box containing a change of clothes, one bottle of whisky and the *Pickwick Papers*.

Each evening camp was pitched and a carefully calculated inroad was made

into the store of tinned food. Each evening I read, and loved, the *Pickwick Papers*. Then, when half the work was done, came the rain. Not the ordinary rain, which occurred at about half past four every evening and lasted for half an hour, leaving just enough hot sunlight when it was finished to dry one's soaking clothes ; but real Rain. A steady pitiless downpour, blotting out the whole of one's little universe like a grey curtain, turning tracks and paths into streams, and streams into rivers.

The long file of carriers, headed by a dejected R.E. subaltern, struggled on for a further day, soaked and miserable, but buoyed up by the hope that rain of this sort could not possibly last. It did ; and we finally came to a halt and made camp, prepared to sit tight and wait until it had finished. By the end of two days the rain had scarcely paused and all doubts as to whether to attempt to push on or not had been resolved, for any movement had now become absolutely impossible. Big, unfordable rivers ran where mere trickles had been before. I sat in my tent, read my *Pickwick Papers*, and ate my food. At the end of several days the food was all but finished and I was reduced to the rice with which the Dyaks were well provided, but which I have always loathed ever since having been told so frequently to " Make a clean plate," some twenty years before.

So the days passed, sitting in the tent waiting for the rain to stop and feeling that Noah's tribulations had been badly underestimated by the chroniclers. Rice for breakfast ; rice for dinner ; rice for supper. A tedious diet, even when enlivened with the dregs of oil from sardine tins. It became really dull later when the sardine oil gave out. And all the while nothing to read but the *Pickwick Papers*. I had long since given up reading it from cover to cover and used to open it at random and start where my eye rested.

Dickens' gift of graphic description is justly admired. Seldom have I realized its potency so much as when, rice-logged and hungry—and it *is* possible to be both—I found myself tackling such paragraphs as :—

" . . . . Cold fowls, tongues, and bottles of wine . . . Now, hand up the tongue ! . . . . now the pigeon pie. Take care of the veal and ham, and mind the lobsters. Take the salad out of the cloth and give me the dressing. . . . "

" At three o'clock Mr. Weller produced on the table a roast leg of mutton and an enormous meat pie, with sundry dishes of vegetables and pots of porter—a steak and a dish of potatoes."

" Cold beef and oysters were promptly produced . . . arranged on the table was a boiled leg of mutton, hot, with caper sauce, turnips and potatoes and cake. . . . Dinner was as hearty an affair as breakfast ! "

Flesh and blood could stand no more and I hurled it from the tent. Half an hour later, repentant and feeling rather foolish, I waded out and fetched it in again, sodden and muddy. It was the only printed word I had and it seemed the only link with civilization. So I tried again :—

" . . . . there was a glorious supper downstairs at the ' George and Vulture ' . . . . a very nice ham and a beautiful cold larded fowl in the snug little bar." " There was kippered salmon and finnan haddocks and a lamb's head and haggis " . . . . " a huge cod fish and half a dozen barrels of native oysters " . . . . " a mutton chop and a glass of sherry " . . . . " a devilish good dinner . . . . "

There is a moral to this story, *Pickwick* is a splendid book, but if you are preparing to take it on a lonely journey, take also all the food that you can possibly want and then twice that. If, however, you cannot take enough food, take along a dozen pre-war menus from the Savoy Hotel and read these instead. One goes out of one's mind far more quickly that way, and, as a result, the agony is not quite so prolonged !

AN OLD PLYMOUTH LETTER-BOOK

By Major-General A. G. B. Buchanan, M.Inst.C.E.

ONE spring day in 1784 the copying clerk in the Engineer Office on the Gunwharf at Plymouth Dock went to his cupboard and took out a new book bound in calfskin. Having mended his pens he inscribed on the outside "Letters Receiv'd from 20th May, 1784," and on the flyleaf in red ink "No. 99." He then addressed himself to the task of copying his first letter for the book.* This is what he wrote in his beautiful copperplate script :—

Whitehall, 20th May, 1784.

Dear Sir,

I am directed by the Master General of the Ordnance to desire that you will send him your Estimates for 1784, made agreeable to the new Prices for work in your District and in the manner settled between you and his Grace when you was in Town, particularly the Expence of the Revetments of the Redouts and finishing that upon the Right on Maker Height. These Expences to be Estimated separately from the Works at Merrifield.

His Grace begs of you to transmit the same to him as soon as possible, for Parliament being now met, the Treasury is calling every Day on the Ordnance for their Estimate for Parliament, and the Duke only waits for yours to complete it.

I am
Dear Sir
With great regard and esteem
Your ever obedient
humble Servant.
Aug : Rogers.

To Colonel Dixon.

The Master-General of the Ordnance at that time was Charles, 3rd Duke of Richmond, Lennox, and Aubigny, K.G., 49 years old, and described in the *Encyclopedia Britannica* as one of the most remarkable men of the XVIIIth Century. He was born in 1735, succeeded to the dukedom in 1750, and was British Ambassador in Paris in 1765. At the time of the American War of Independence he was a staunch supporter of the colonists, and in 1778 had initiated a debate calling for the removal of troops from America. Furthermore he had been an advocate of concessions to Ireland.

He served as M.G.O. in Rockingham's 2nd cabinet, January 1st, 1782, to March 31st, 1783, and took office again on January 1st, 1784, under Pitt, after which he developed strong Tory opinions! He remained M.G.O. till 15th February, 1795, and died in 1806.

It is perhaps not out of place to mention that the Duke had inherited his title of Aubigny from his great grandmother Louise de Keroualle Duchess of Portsmouth. Aubigny-en-Artois is a small place in the department of Pas de Calais between St. Pol and Arras. One remembers it as the site of a

* The book was discovered recently in the course of a search for documents in the office of the C.R.E. Devon.

Third Army R.E. Park during the War 1914-18. Lord Edward Fitzgerald, the famous Irish rebel, and the Duke's nephew, stayed there as a child.

The Duke's younger brother, Lord George Henry Lennox, was Governor of the Citadel at Plymouth at the time that the book was written. He succeeded his brother as 4th Duke, and has achieved fame as the giver, with his wife, of the famous ball at Brussels before Quatre Bras.

So much for the Duke. We turn to Colonel Dixon, who at that time was Commanding Engineer at Plymouth.

Matthew Dixon was probably a man of over 60 at the time. He served at Dettingen in 1743, though not as an Engineer. On March 13th, 1744, he received his first appointment in the Engineers, and after service in India and Nova Scotia was present at the second siege of Louisburg in 1758 and at Havannah in 1762.

He was promoted to Captain in 1759 and Lieut.-Colonel in 1777. He was thus a man of ripe experience, and one cannot fail to notice when perusing the letters in the book that considerable deference was paid to his views. He was not averse to taking the Duke to task if necessary! So the picture that we can form of him is that of a somewhat elderly soldier of 40 years service, doing his job thoroughly; a bit short in the temper perhaps, but none the worse for that.

The letter book itself consists of copies of 141 letters received in the Engineer office between May 20th, 1784, and November 11th, 1785. The subject of the letters can be roughly classified as under :—

	%		%
Repairs	25	Contracts and Observations ..	8
Personnel	18	Thefts	4
Lands	13	Miscellaneous ..	20
Estimates ..	12		

Perusal of the letters forms a fascinating study.

Board of Ordnance

The office of the Board was at the Tower of London, but practically all the letters signed by the Duke emanate either from Whitehall or Goodwood. The Engineer staff at the Tower consisted of the Engineer-in-Chief, Gen. James Bramham, and a Committee of three, one Colonel, one Lieut.-Colonel, and one Captain.

Centralization

As one might expect, the Commanding Engineers at Stations had very little power. For example, the Board reserved the right to approve coal and candles for use in the office and drawing room in the winter.

Colonel Dixon tried hard to get some latitude as regards the repair of storm damage, but in the last letter in the book dated November 11th, 1785, the Duke tartly remarks "When storms or unforeseen accidents cause damage, the Commanding Engineer can lay out £10 without making an Estimate or waiting for an order, and the distance of Plymouth being within reach of receiving an answer in a fortnight to any application to the Board, when any greater expence becomes necessary, no inconvenience of long duration can possibly arise, and therefore no further discretionary Power can be given."

Time in the Post

The above raises an interesting question as to how long the ordinary mail took from London to Plymouth in those days. It would appear that delivery could ordinarily be expected in the third day after despatch. A letter

sent express from London on June 12th, 1784, is particularly noted as received after 11 o'clock in the morning of the 14th.

Storm Damage

Returning to storm damage, there is much correspondence on this subject both with the Lt.-Governor at the Citadel and with the Master Gunner at Pendennis Castle. The following is a fair sample :—

Citadel Plym°.
Nov. 16th, 1784.

Dear Sir,

I have a letter from Lord Geo. Lennox (the Duke's brother) acquainting me he proposes paying us a visit the very first opportunity it is in his power —and desiring to know if there is a House belonging to the Governor and if there is, the condition of it. I shall let his Lordship know Bad Enough— and am sorry to acquaint you that after being just Repaired we are again unroofed. Hardly a house in the Citadel that has not suffered by the late winds—mine in particular. Having the backyard and the Cistern full of slates, and if not prevented, am afraid many more will follow: your directing the Damage to be inspected and repaired will oblige.

Yours sincerely
J. Campbell
(Lt.-Governor).

Colonel Dixon.

An interesting forerunner of Army Form K.1306 !

Thefts of Government Property

These appear to have been distressingly frequent. The M.G.O. had strong views on the subject. Here is an extract from his letter to Col. Dixon dated 30 September, 1784 :—

" I am sorry you have not been able to discover the offenders, but if you can only ascertain when the theft was committed or what Corps had the Guard at that time I desire you will make a regular complaint to the Lieutenant-Governor, and request to have the value made good by the Corps who were on duty."

The drive against these depredations ended a year later with the following letter from the Lt.-Governor :—

Cit[l], Plymouth, Sept. 20th, 1785.

Sir,

As you wished to be informed of the consequence of a late Court-Martial, Major Johnston acquaints me the soldier of the 70th who stole the Fraize has been flog'd, and I almost wish the two Sentries who suffered the lead to be stolen lately had been hang'd at same time.

* * * * *

J. Campbell.

Colonel Dixon.

Humour

In contrast with the somewhat grisly note of the foregoing is a letter written by a newly appointed Clerk of the Checque to the Board of Ordnance. This is an extract from it :—

" And as I find there is no stable here for the Clerk of the Checque, although the Storekeeper and Clerk of the Survey are each allowed one,

I trust and humbly request that you will please to grant me the Indulgence of a Stable likewise, as I unhappily am much afflicted with a Bilious Disorder for which I am advised to use Horseback Exercise as often as I conveniently can."

He protested too much. The Board were not moved!

Observations on Bills

Observations on bills emanated from the Surveyor-General in those days. A specimen runs as follows :—

"I am to beg you will be pleased to inform me whether the above articles (lengths of timber) are with or without sap; also whether the oak plank is the best English or ordinary oak. I cannot money the Bills till I am favoured with your answer."

Typical!

Servants of Engineer Officers

Colonel Dixon took grave exception (as might be expected) to the following letter sent by the Duke to the Clerk of the Works direct :—

"Having been informed that a Practice has prevailed in some places of Engineers charging as Labourers their Servants and other Persons who do not perform Labour on the Works: I am to desire you to acquaint me by the Return of the Post whether the like practice has prevailed at Plymouth, specifying to what extent, and how long it has continued."

The Duke's reply to Colonel Dixon is very interesting, and is given in full as it sheds light on the manners and customs of the time.

Whitehall Nov. 27th, 1784.

Sir,

I received your letter of the 19th instant, and cannot but applaud the Honourable motives which make you alive to the least suspicion of want of that Confidence, which I most readily agree with you is the only Principle upon which an officer with proper feelings can act; but I trust that when you are informed of the circumstances of the Transaction to which you allude you will not perceive with respect to your self any want of it in me.

If you will look to the letter written by me on this occasion to the Clerk of the Works and Storekeeper, you will observe that I had been informed that the Practice therein mentioned had prevailed in some places. You will I am sure be surprized when I tell you that in one place it extended to *Eight Domestic Servants* for one Engineer, and you will readily concur with me in opinion that such an abuse required remedy; uncertain to what extent it might have gone in other places, and desirous of knowing whether there could be any pretence for a Justification from Practice I thought it necessary to make Enquiries upon this Subject.

My first idea was, that which seems also to have struck you, that I should write directly to the Engineers themselves, but on second thoughts I judged that if in any other place a like practice had prevailed, tho' in a small degree, there would be a want of Delicacy in applying to an Officer to accuse himself; I therefore thought it better to make my Enquiries of the office itself, conceiving that where no abuse existed the officer would be better pleased that it should so appear from official examination than that it should barely rest on his own Authority. Such I was ever persuaded would be the result of my Enquiries at Plymouth, for altho' I do not find any Order of the Board absolutely authorizing any Labourer being returned

as such and employed in attending the Engineers, yet I find the Practice of having one Labourer for an Engineer of a certain Rank, and sometimes two for a Commanding Engineer, has been so general, that if I cannot admit it to be strictly regular, I must allow it to be not unreasonable. You will see by the Orders which will be communicated by General Bramham that this Enquiry has produced a Regulation by no means unfavourable to the Engineers, at least it will be found so at Plymouth; as it goes beyond what you had allowed.

I trust this Explanation will prove satisfactory, and that you will be convinced that the method of this Enquiry was not adopted from any want of confidence in you, but merely for the reasons I have mentioned; but I must however at the same time maintain the Right of the Master-General or the Board to inquire at all times of the officers under them concerning the Expenditure of Public Money, and that such Enquiries which they may think it their duty to make in various shapes and manners, must not be considered as want of Confidence in the Superior officers.

I am
Sir,
Your most obedient
humble Servant
Richmond &c
Master-General.

Colonel Dixon.

It is only necessary to add that on 14 April, 1785, the Board "allowed of a Second Labourer to attend Colonel Dixon agreeable to the Regulation."

In other words the Servant Allowance of Engineer officers was charged to the Works Vote.

Condition of Barracks

Even in those days due attention was paid to the health and comfort of the troops. This is part of a letter from the Lt.-Governor to Lord George Lennox.

"It may be necessary to say that in the last Weekly State of the Fusileers I was surprized to find 42 sick and I have since received a letter from Major Darby representing that from the very bad winds and weather we have had lately he imputed such sickness to be colds the men catched in their beds and that unless at least the doors and windows were mended he had reason to believe the number of sick would be considerably increased."

Establishment of the Corps

A very interesting letter on the Establishment and Pay of the Corps is given below:—

Whitehall, 12th July, 1784.

Sir,

I have been under great difficulties with respect to the Employment of the Corps of Engineers, almost all are, or soon will be, wanted in the Execution of the various Works that are to be carried on at home and abroad. Lord Townshend struck off many Gentlemen from the Staff to lighten the Expence, and there is no doubt that the Employment of the whole Corps on the allowance of double Pay at home, and still greater abroad, as enjoyed during the War, would amount to a greater sum than would be justifiable during Peace. The alternative as matters now stand is to forego the use of perhaps half the Corps, and to expose them to ruin by remaining perfectly idle, or to load Government with a very unusual

Expence in time of Peace, by employing them; unless I were to make a Reduction of the Corps which I should be very sorry to be obliged to do.

I have therefore been under the necessity of forming a Plan on a more economical system for times of Peace: It is to reduce the extra pay in Africa to 20s. per day; in the West Indies and Jamaica to an allowance equal to the ordinary Pay according to the Rank held in the Corps, and everywhere else to an allowance equal to half the Ordinary Pay.

I mean at the same time to form a Corps of Invalid Engineers, consisting of one Colonel, one Lieutenant-Colonel, 2 Captains, one Captain-Lieut, one first-Lieutenant, and one second-Lieutenant. They are of course not to rise in Rank. This I hope will be an ease to those whose situation entitles them to this Retreat.

I also propose to make the Acting Corps of Engineers consist of the Engineer-in-Chief, five Colonels, five Lieuten'.-Colonels, Ten Captains, Ten Capt.-Lieuts, Twenty first-Lieutenants and Ten second-Lieutenants. By this alteration there will be one Colonel and one Lieut.-Colonel less, one Captain and one Captain-Lieut. more, two first and twelve second-Lieutenants less.

By this change the chances of Promotion will be far greater than they were before, as the number of Field Officers and Captains will be equal to that of Subalterns, which is a much greater promotion of the higher Ranks than any Corps in the Service whether Guards or others enjoy. And I hope these circumstances will compensate for the reduction of Extra Pay which necessarily must fall on some of them: Especially when they recollect that now being constantly employed, they will have constant though reduced Extra Pay. Whereas if the present system had continued, a rotation must have taken place, and they would frequently have been unemployed. It will also naturally occur to them that during the last Peace no extra Pay at all was allowed on Works at home. I therefore hope they will be satisfied with the allowance now proposed. At all events I trust that the advantages I am endeavouring to procure for them will prove my earnest desire of doing everything I can for a Corps I esteem so highly.

On the new Establishment of Engineers the Corps will consist of Ten Companies or Divisions, each composed of one Captain, one Captain-Lieut., Two first-Lieutenants and one second-Lieutenant. This is the same proportion of officers of these Ranks as in the Artillery. I propose to dispose of these Companies or Divisions in the following manner, viz. To have one at Gibraltar, one in the West India Islands, one divided between Jamaica and Quebec, one in Nova Scotia and Newfoundland, one at Plymouth, one at Portsmouth, one in Kent, one in Scotland and the North of England, one for the Islands of Jersey, Guernsey and Man, and one to be employed on Surveying and ready for Field Service. I think of distributing six of the Field Officers to six of these Divisions and the other four are to remain in London to form a Committee with the Engineer-in-Chief to examine and report upon all Plans and Estimates for Works and Buildings.

I presume you would wish to continue at Plymouth where I should be happy to see you conduct the Works I have in contemplation; but if you should prefer being one of the Committee that Station is at your Service: I mean that you should make choice of that which is the most agreeable to you; the Extra Pay equal to half your ordinary Pay will be the same in either case. I am sorry that it is less than you received before, but as I have fully explained to you the reasons which have induced me to regulate this object in the manner I have mentioned, I trust you will see

that in a matter of such general Regulation it would have been impossible for me to have made an Exception in favour of any particular Person.

As this Letter is already so long I will not mix any other subject with it, especially as I shall very soon have to trouble you with respect to the Works to be carried on this year.

I have the honour to be
Sir
Your most obedient
humble Servant

Richmond &c
Master-General.

Colonel Dixon.

It is necessary to add that by a Royal Warrant of July 21st, 1784, nine days later, the Establishment and Pay were fixed as under :—

1	Engineer-in-Chief	44/-	Corps of Invalid Engineers			
5	Colonels	18/-	1	Colonel		
5	Lieut.-Colonels ..	15/-	1	Lt.-Colonel		
10	Captains	10/-	2	Captains	With pay	
10	Captain-Lieuts. ..	6/-	1	Capt.-Lieut.	as contra.	
20	First-Lieuts. ..	4/8	1	First-Lieut.		
10	Second-Lieuts. ..	4/-	1	Second-Lieut.		
61						

As Colonel Dixon was promised extra Pay at half the ordinary pay, presumably he received 27/- a day, a not unhandsome amount having regard to the value of money in those days.

It is interesting to note the absence of Majors from the Corps at that time.

A Distribution of Engineers by Companies and Posts was signed by the M.G.O. on November 29th, 1784, and issued two days later by the Engineer-in-Chief. It contains a few well-known names such as :—

Colonel William Green of Gibraltar fame, who succeeded Bramham as Engineer-in-Chief 1786-1802.

Lt.-Colonel Robert Morse, later first Inspector-General of Fortifications 1802-11.

Captain Gother Mann, 2nd I.G.F. 1811-30.

Captain Elias Durnford, later C.R.E. Plymouth.

Chatham had but two officers !

The designation of the Corps as Royal Engineers did not come till rather more than two years later on April 25th, 1787.

Control of Works

Turning to the control of works it seems that detailed Estimates by trades were given for works of any importance.

No excess beyond 5% *in each trade* was allowed without explanation.

Arrangement for Jobbing Work

There was not of course a Term Contractor, but advertisement was made from time to time for tenders for work by trades. The following letter explains the method employed :—

Office of Ordnance,
15 June, 1784.

Sir,

The Master-General and the Board having considered the proposals from Mr. Bray and Mr. Bignel for Plumbers Work at Plymouth, and Mr. Bray's appearing upon the whole to be the lowest. They have been pleased to agree thereto, and command me to desire you will make a contract with Mr. Bray agreeable to the List of Prices enclosed and that you take proper Security for his duly performing the same.

I am in the absence of the Secretary

Sir,
Your most obedient
humble Servant
John Parish.

Colonel Dixon
Com[e] Eng[r]
Plymouth.

List of Mr. John Bray's Prices of Plumber's Work and Materials.

		£	s.	d.
Sheet Lead	per C.Wt. ..	1	1	0
Milled Lead	per C.Wt. ..	1	6	0
Pipes, Cistern heads and pumps	per do.	1	1	0
Solder	per lb.			6
* * * * *				
Labour for a Plumber ..	per day		2	0
Labourer	per day		1	3
Sheet copper and copper nails for magazines	per C.Wt. ..	6	10	0
Coals	per bushel ..		1	8
Carriage of Lead and Materials to be allowed.				
Price of old Lead allowed in Exch[e]	per C.Wt. ..		16	0

Lead is now 38/- per cwt., copper nails £8 8s. per cwt., and old lead fetches 18/- cwt., so there is no great advance in the price of metals, but whereas labour was 2/- a *day* it is now approximately 2/- an *hour*.

Annual Estimates

They seem to have been slow in approving Estimates in those days. It was not until July 23rd, 1785, that the Board approved of the Estimate of Repairs to be done in the Plymouth Division for the year 1785 amounting to £3,296 15s. 2¾d. (no rounding off here), also for one for New Works amounting to £5,366 1s. 5d. with an extra £139 6s. 4d. for Repairs to the Storekeeper's House. Colonel Dixon was exhorted by letter to be "particularly careful to adhere to the three Estimates above mentioned, and not by any means to exceed the same in any one article."

The distinction between Parts I and III was already in being!

Fortification

Though a comparatively brief period of peace was being enjoyed by the country, considerable attention was being paid to fortifications. Twice during the eighteen months covered by the book the Board of Ordnance visited Plymouth.

Various Points

The following have been noticed during the reading of the letters :—

(*a*) " Indifferent " still has the sense of " impartial " as in Tudor days. In a notice of October 9th, 1784, it is stated " The value of the Damages to be settled by two indifferent Persons."

(*b*) The price of excavation per solid yard or fathom is asked for.

(*c*) 21% discount for ready money is mentioned (what a calculation !)

(*d*) The Master Gunner at Pendennis Castle directed a Carpenter to repair the bridge at Saint Mawes Castle " with the greatest frugality and in the best manner."
Rather contradictory instructions !

(*e*) Writing from Goodwood, the M.G.O. enquired into the price of marble.
One can hardly believe that it was proposed to use it on the Works.

(*f*) It seems to have been the practice for the Storekeeper to pay Works Bills.

(*g*) A human little touch. A particular plan was to be sent to London carefully packed up in a box covered with oilskins to prevent its being wet and with particular directions that it may come *in* the Coach.

Postscript

Finally an interesting postscript to the book is given by a small bundle of letters tucked away at the back. They are all originals. Seven bear dates in 1793 and five are of 1804.

In 1793 Lt.-Colonel Elias Durnford was C.R.E. Plymouth, and in 1804 the post was occupied by Lt.-General Mercer (though this seems rather peculiar).

We can see the Duke's own signature to a letter of January 25th, 1793, and it is somewhat amusing to read in an official letter that " By some unaccountable stupidity Lady Louisa informs me that Mr. Tutt has not sent down the Locks for the Doors of the Governor's House."

This letter bears on the outside a rudimentary postmark R.E.E. AP. 3 93. of the usual circular shape in crimson.

Note

I have consulted Porter's *History of the Corps*, the *History of the Royal Regiment of Artillery* and the *Encyclopedia Britannica* in the course of writing this article.

TUBULAR BRIDGE

2" SWR
2" Tubular Strut
2" Treble cordage block
Double SWR block
Tubular derrick
These tubes cut off on completion
Two Spars mean diam 9" length 30' 0"
strut removed on completion
These tubes moved to dotted position on completion
2" SWR
Four pivot tubes filled with cement for two feet
Double SWR block forming tackle to winch
Timber block
Hydraulic Jack
Bailey chord
Bailey chord
2" Decking
Temporary bankseat
Permanent bankseat level
SWR sling
To winch
4 Bailey chords
Wire lashings
Solid strutting out of sleepers
12" x 6"
6" x 12"
12" x 12"
Tackle for swinging bridge past centre of balance
1 READY FOR LAUNCHING
AT CENTRE OF BALANCE
2
3 HALF DOWN
2" cordage guy.
H.W.M.
To winch for lowering.
To winch
Water level (Low Tide)
5 DE-LAUNCHING SPARS
Strut out of 8x2 tubes
Sound trestle leg.
Tubes let in decking
6 COMPLETE BRIDGE
15 cwt
60' 0" Span

Pressed steel spigots
2" steel tubes
Pressed steel couplings
diagonal brace
2" SWR for lowering bridge
2" SWR block
9' 0"
SIDE ELEVATION OF CENTRE BAY

7' 0"
Raker tubes in each bay.
2" decking.
3' 0"
7' 0"
Sway bracing tube in each bay.
CROSS SECTION

4 BRIDGE LOWERED

2 ton Winch
3-2-1 picket hold fast in sea at high tide
4A PLAN VIEW
2 Spars
2 ton Winch
3-2-1 picket hold fast

Estimated Deadweight	3·8 tons
Launching Weight	4·2 tons
Bridge Span	61' 2"
Bays 9' 0" End bays 8' 1"	
Rise 2' 3" for Bottom chord	
Upper chord angles	174°
Lower chord angles	178°
Tubing	2070 ft Total
Couplings	430 in No
Spigots	120 in No
Decking	27½ cu. ft.

MAJ J.R. GRIMSDELL RE

AN UNORTHODOX METHOD OF LAUNCHING AN IMPROVISED BRIDGE

By Major J. R. Grimsdell, R.E.

MOST Field Companies in this country, during many months of training, have built innumerable bridges from standard equipment but, possibly because of the difficulty of obtaining the necessary materials, it is seldom indeed, that one has the opportunity of building an improvised bridge of any size, and to have a free hand in its design.

In consequence, great interest was aroused in the Div. R.E. when the C.R.E. requested each of the four companies to submit, within a few days, a design for a bridge to span one of two gaps in a pier. The companies producing the best schemes were to build the bridges.

A 63-feet gap had been made in the pier close inshore at the beginning of the war when the invasion scare was rife, and another gap had been blown later by a sea mine about midway in its length. These gaps were a great source of disappointment to those of the local inhabitants who were keen members of the Sea Angling Society, since they were unable, without difficulty, to pursue their sport from the end of the pier. They were therefore delighted when they heard of the proposition to build these bridges, and consequently were only too pleased to give all the assistance they could in producing materials, etc.

The specification for the bridge was briefly as follows :—

(*a*) It was to be made almost entirely of 2" tubular scaffolding, of which there was a plentiful supply in local defence dumps.

(*b*) Timber for the decking was if possible to be obtained from the local authorities.

(*c*) The bridge was to be designed to take a live load of 150 lbs. per sq. ft.

(*d*) No steel wire rope was to be used for the bridge itself, but normal training stores could be used for launching purposes only.

Now it had occurred to the writer, on several occasions before, that it would provide a most interesting project to build a bridge vertically in the air and then to lower it through 90 degrees into position, particularly as, as far as he knew this had not been done before. Therefore it seemed a glorious opportunity to try out the theory as the gap was of a suitable span, and the weight of the bridge was unlikely to be too great for the tackle and winches available.

Initial reconnaissance was carried out, and it was found that the building space for the first gap was so limited that it would be difficult in any case to launch a bridge by any of the more normal methods. It was therefore decided, after rough calculations had proved it to be practicable, that the bridge should be built upright, and that it could be made to work despite all its apparent difficulties, and the scepticism of those who would have to build it.

Two advantages of launching in this manner were immediately apparent :—

(*a*) Very little building space was required.

(*b*) No stores of any description were required on the far bank, since any bankseat material could be taken over on the bridge itself, after it had been lowered.

These two advantages are of course outweighed by many disadvantages that would make this type of launching impracticable in the field; but it was still decided to launch in this way because it provided so many interesting problems and so many difficulties to be overcome.

Within two days a design was produced, the drawing was completed, and notes and sketches showing the method of construction were submitted, together with a detailed list of the stores required. The scheme was accepted for its originality, and the Company was asked to build it as soon as certain Exercises that were about to take place, had finished.

Materials were collected immediately, and a workshop was set up in the camp then occupied by the company. At the same time an arrangement drawing *see page* 265 and detailed drawings of every part were produced. Approximately 20 templates were made up. Sample tubes were tested for strength, and, in addition, tests were carried out to ascertain the best way of using the weak type of coupler that was available.

Erection began at about the rate of a bay each day and, when the bridge was 45 ft. high, a trial launch was made to test the tackles, and to make sure that the four tubes, on which the bridge was to pivot, would take the load. The launch was satisfactory and removed all doubt, that may have existed in the minds of the men, that the scheme would work.

The bridge was then completed and launched. The actual launching process took one hour. Then the telegraph poles which were used as levers for the lowering tackles were de-launched. This was quite simple, in fact, after the tackles had been rigged they came down in three minutes.

Decking, weighing approximately 1,100 lbs., was then put on and the bridge tested under a load of 38 men. The bridge was perfectly rigid, but a coupler slipped a little. It was thought, however, that it was merely settling to take its proper proportion of the total weight and that the bridge would stand a considerable greater load.

Building was to begin on the site the following day and time was short. It was considered that little improvement could be made without the use of better couplers which were *not* available, and it was decided to strip the bridge then and, if possible, to weld the couplers *in situ* on the bridge when it was completed. The day after the test, building commenced on the pier, preparations having been made beforehand to strengthen the timber structure of the pier where necessary.

The beach nearby had to be cleared of mines and a number were found in an extremely delicate condition. After some four years with nothing to do they seemed capable of going off if you looked at them, but their presence had never deterred an extremely aged old gentleman from walking daily over the beaches with his dog in search of scraps of wood.

Each day saw a taller tower on the pier (*see* Figs. 1, 2 & 3) and it was, of course, the source of some speculation to the population as to what it was going to be. When two-thirds complete it attracted the pilot of a *Thunderbolt* so much that he flew his plane up and down many times, each time closer and closer, until his wing tip was literally only about four inches from the structure. It was difficult enough for the four men working at the top to cling on and work without such distraction, and so the airfield, from which our inquisitive friend had come, was informed that we should really have to shoot him down if he was so naughty in the future. He didn't do it again and fortunately it created no ill feeling with our allies.

After each bay of bridge was completed it was checked in every respect and the next bay was not commenced until the one below was exactly correct.

Whilst erection was going on a separate party of men were reeving tackles, bedding down the two 2-ton winches on the shingle, putting in holdfasts

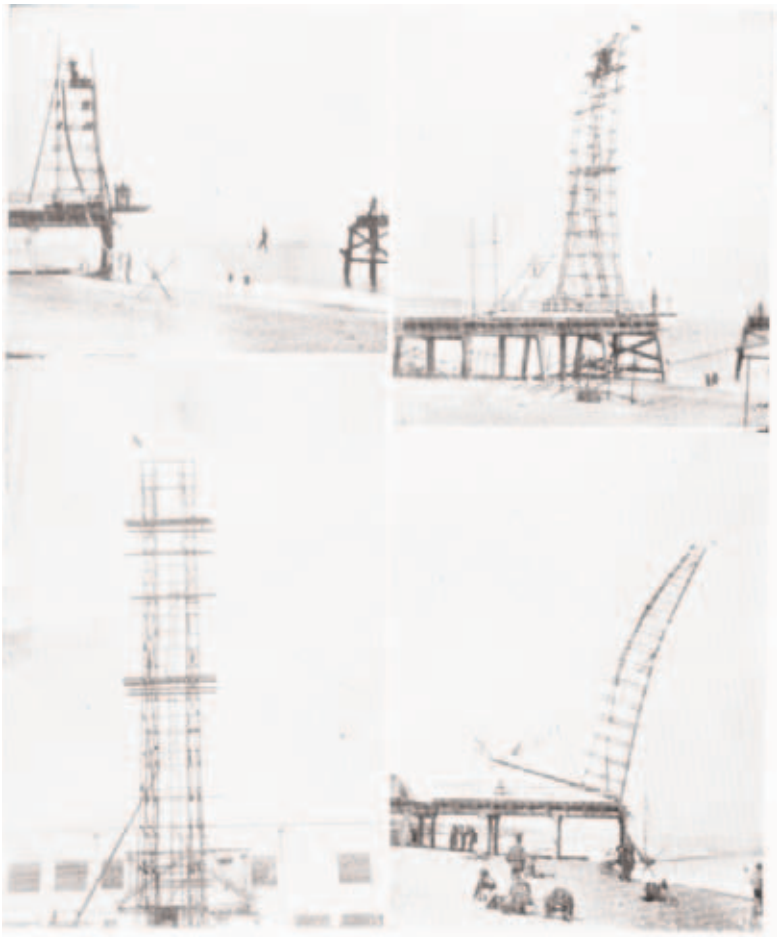


Fig. 1.—*Top left:* 3 bays completed. Fig. 2.—*Top right:* Almost ready for launching. Fig. 3.—*Bottom left:* Full height. Fig. 4.—*Bottom right:* Tilting over.

An unusual method of launching an improvised bridge
Figs 1 - 4

Fig. 5.—Nearly down.

Fig. 6.—Jacking device.

Fig. 7.—End details.

Fig. 8.—Complete.

An unusual method of launching an improvised bridge Figs 5 - 8

(some in the sea itself), and strengthening the pier on the far side to prevent any movement laterally. This was necessary, as although the top chord of the bridge was strong enough to take the load, it was desirable to keep the bottom chord in compression because the spigots joining the tubes together were quite useless in tension. Hence the camber of the bottom chord and the wedges at the ends of the bridge. The pier was prevented from moving by means of a diagonal strut of tubes down to the bottom of one of the few sound trestle legs.

The time for launching arrived six days after building commenced. Remote control telephones from No. 22 Wireless Sets were laid out to each winch, to each side guy, and to the party underneath the bridge; ("the bellringers" as we called them, because in their job of getting the bridge past its point of balance they looked much as if tolling church bells). Further telephones were laid out on the far bank, and one on the pier behind the bridge for control.

The "bellringers" were directed to "take in" and the winches to "pay out" so many feet at a time and the great erection, which appeared to be pretty high from beneath, lurched and then gradually swung forward until it was past the point of balance (*see* Fig. 4). After that the "bellringers" merely paid out, and so did the winches, but to a regulated amount each time in order to keep the stresses in each winch cable approximately the same.

When the bridge was well past the centre of balance (*see* Fig. 5) it was necessary to stop lowering and to put in timber packing and the hydraulic jacks shown in the photograph at Figure 6. Thereafter launching was stopped, after every 12 ft. had been paid out from the winches, in order to take up the "play" between the wood and the pivoting tubes of the bridge. These jacks served two purposes (*a*) to take up the inevitable thrust backwards when the bridge was nearly down and (*b*) to position the bridge longitudinally if necessary when down.

This was not necessary and the bridge came down perfectly on to its bankseat, which pays high tribute to the remarkable skill of the 42 men of the platoon that built it. The spars were de-launched, tackles were unreeved and all the extra tubing, provided only for building purposes, was removed. The shore end of the bridge had to be jacked down on to its permanent bankseat and the grillage was taken away leaving the bridge decking flush, as will be seen (in Fig. 7) with the deck of the pier.

Final dressing of the bridge and a coat of paint and the job was complete (*see* Fig. 8) and available for the use of the fishermen.

Typical phases of construction are illustrated in the photographs; but it must be emphasized that although this rather original method of launching provided a most interesting problem and was in fact most excellent training for all the tradesmen employed, it should *not* be taken as an example of how a bridge might be launched in operations.

The circumstances that would go to make this method worth while in action are most remote, and it is therefore unlikely to be of any practical value in the field.

MUSINGS ON ROADS (*Part* II)

By Colonel E. St. G. Kirke, D.S.O.

Main Roads without Dual Carriage-Ways

THE danger of these roads lies in the fact that there is no physical obstacle to prevent head-on collisions. White lines are only a palliative, because in English law they do not constitute a prohibition so much as a definition of responsibility. They have, however, certainly been instrumental in reducing accidents on straight roads when in the past each of two stiff-necked drivers going in opposite directions determined that he was not going to be "crowded" by the other, and continued in this determination until it was too late to avoid a collision. Even when there is a white line the Courts, for reasons best known to themselves, do not always take the view that the driver of a car involved in a collision on his wrong side of the line is necessarily at fault. This indecision leads motorists to run risks which they would avoid if the law were as definite as is the port and starboard rule at sea—understood and obeyed by seafaring folk all the world over.

Perhaps three-lane two-way roads are the scene of most bad accidents, because the middle lane is common ground for vehicles going in either direction, and right of way is decided, perhaps unconsciously, by the respective weight of the vehicles or the truculence of their drivers. When neither will give way fatal accidents happen, since the two vehicles collide with the combined velocity of both. Insistence by the police that cars shall not straddle the white lines is again very important. Straddling is often caused by excessive camber, which is a legacy from the days before tar-sprayed or concrete roads existed, and road engineers had to make sure that water-bound metalled roads were adequately drained to prevent the surface from being broken up by frost. This danger is particularly insistent round corners, where camber in the wrong sense leads drivers to encroach on their wrong side (to get the benefit of favourable camber) and so to run risks which they would never take if the corner were properly banked for the whole width of the road. In short, camber at corners is a menace and should be replaced by proper super-elevation at the earliest opportunity.

Cross Roads and "Y" Roads

The danger of cross roads needs no emphasis, and it is amusing now to think of the strenuous opposition offered by motorphobe magistrates and others to those realists who spent years pressing for their classification, clearly indicated on the spot, into "major" and "minor" roads. Even this classification did not restrain hair-brained drivers on a minor road from "rushing" the crossing—on the principle that the shorter time they spent thereon the less danger was there of being hit by traffic on the major roads —until "Halt" signs were put up on minor roads and it was made an offence to disregard them.

Traffic lights are not always practicable for technical reasons, e.g., lack of electricity, but round-abouts are a very good substitute and, in the judgment of many, preferable in that they only impose a partial delay on traffic but yet physically compel it to slow down, which lights cannot do. In India, round-abouts have sometimes been built on straight stretches of roads (in

towns) which were beginning to be used as speed-ways, but there is seldom enough room for them in English towns without pulling down houses.

A third method of slowing down traffic on the minor of two cross-roads has been tried with success, where there are no lights or room for a round-about. This consists in the provision of dips, preceded by warning signs and shallow warning dips for foggy weather (when head-lights are useless), broad enough and deep enough to break the springs or back axle of a car which takes them at speed. The dimensions of the dip must be such that they are effective at 60 m.p.h.; for the faster the car is going the less time will it have to drop at the dip and risk damage. Some years ago this device was successfully introduced at a dangerous cross-road in Quetta. An enterprising Sapper discovered, however, that the dips were harmless at 35 m.p.h., and public outcry shortly afterwards led to their removal. Within a fortnight two cars came into collision at this point, with dire results to most of the participators in the performance—one car rolling over several times.

Two roads converging into one to form the letter " Y " are particularly dangerous, because drivers are apt either to misjudge the speed of other vehicles or to try and pass the meeting point first. Until round-abouts are built in such places, danger of accidents can be reduced by drivers slowing down, clearly indicating their future course, and acknowledging similar signals given by other drivers.

Curves

Curves are so well understood and regulated on railways that a guard rail has, by law, to be provided wherever their radius is less than 660 ft.; whereas on many main roads the word " curve" cannot by any stretch of the imagination be applied to some changes of direction. For instance the 60 m.p.h. alignment along the Hog's Back west of Guildford ends near Farnham in a right-angled corner (wrongly cambered and at the bottom of a hill) where speed has to be reduced to less than 20 m.p.h. On a busy day the repercussions of this and similar checks are felt miles back.

In railway practice there is a definite relation between the radius of a curve, the speed at which trains can run round it, and the super-elevation required to ensure smooth riding. Modern road speeds render it no less necessary that these factors should equally be applied to roads, so far as may reasonably be practicable. English roads were originally intended for use by pedestrians, riders on horses—not on noiseless bicycles—carts, and stage coaches. Moreover the owners of property, whom there was then no power to compel, insisted that alignments should follow estate boundaries and the edges of fields. There is thus no possibility of such roads being in any way suited to fast mechanical transport until they are radically re-aligned, widened, or replaced.

Trains cannot comfortably negotiate curves of less than 5° (1,146 ft. radius) at 60 m.p.h. and this might well form the minimum curvature for roads. On English railways, $5\frac{1}{2}$ in. is the greatest super-elevation normally used, roughly 1 in 10 (in extreme cases 8 in., or 1 in $7\frac{1}{2}$) and goods trains have to use the same track as expresses. In the case of trunk roads, however, super-elevation can be adjusted to the class of traffic for which each lane is designed and this results in *differential super-elevation*, which ensures that the fast traffic lanes shall be more steeply banked than the lanes for commercial vehicles. This is only logical and is the application to roads of the banking applied to racing tracks such as Brooklands—where, incidentally, the super-elevation designed for 120 m.p.h. is already quite out of date. (The writer remembers being told by the owner of a fast car which he was driving along a

fairly new arterial road before the present war that he would have to slow down to 85 m.p.h. because the super-elevation was " not enough for modern speeds.")

Curves, whatever their radius, should be kept constant throughout their length so that drivers in fog, dust, or at night with dimmed lights, may not be in constant fear of running off the road. (This does not, of course, apply to transition curves, when such are thought to be necessary for fast traffic). Under the condition of poor visibility, indicated above, white lines are an invaluable aid to drivers, who should keep well inside them.

The most dangerous curves and corners are those which are bounded by banks or hedges, are without footpaths, and have been given no extra width. Two measures are therefore vital in the interests of safety. The first is that stopping anywhere round the curve should be prohibited. (Only very inexperienced drivers or those of weak intellect would attempt to overtake at such a place.) The second is that footpaths should be provided as soon as possible, and pedestrians prohibited from using the roadway. Pedal cyclists need particular consideration in that they cannot get out of the way even if they want to. The most dangerous times of year for these unfortunates are the early spring and late autumn, when the day's work stops just before lighting-up time and they are trying to get home without lighting their lamps. Tiredness, too, is apt to make them less attentive than usual, and rain or fog aggravates the danger.

Vertical curves, if convex, need almost the same consideration as do horizontal curves, because, by reducing visibility, they add in like manner to the danger of accidents. The problem is best tackled by imagining a driver's eye at a height of 4 ft. from the road. If he is travelling at 100 ft. a second (68 m.p.h.), for example, he will want to see other traffic 4 ft. high which may be stationary 200 ft. away on his own side of the road, thus giving him 2 seconds to make up his mind as to his course of action. This means that the versine to a chord 200 ft. long must not exceed 4 ft., i.e., the radius of the vertical curve must not be less than 1,250 ft. In simpler language, the summit of the road must be four feet below the point at which the two slopes would meet if the vertical curve were not put in.

Concave vertical curves should be designed to prevent vehicles breaking their springs, or dislodging their loads, when travelling at their usual speeds.

Miscellaneous Dangers

In many rural areas " cattle crossing " notices are to be seen, and by some perversity of fate these often seem to be situated at bends in the road or on blind corners. It is difficult to see how such crossings can be abolished unless the road is made to form the boundary between two adjoining farms, instead of both having some of their fields on each side of the road. In some places subways might be a possible solution. Farm carts and agricultural machinery emerging from behind hedges and banks on to the road constitute another danger, which the replacement of hedges by wire and the cutting down of banks would do much to reduce.

Loose animals, such as wild deer in Surrey or stray ponies in the New Forest, are a constant menace to motorists, and it seems strange that no adequate steps have yet been taken to prevent the latter from wandering on to the road at will. They are doubtless responsible for some of the local accidents whose cause cannot be traced, particularly at night.

Unexpected narrowing of the road, narrow, hump-backed, or single bridges, unheralded cross roads and side roads, are still to be found in abundance throughout England. It is good therefore to know that the authorities

have in hand both short-term and long-term programmes to deal with these and other matters affecting safety on roads.

Wet leaves in autumn and ice in winter, concealed by a thin layer of snow, are both liable to cause dangerous skids. In the former connection, motorists in the West of England may have painful memories of the road between Bideford in Devon and Barnstaple.

In country districts, carters have a habit of zigzagging up hills to reduce the load on their horses, while " errand boys and other trick cyclists " (to quote " A.A." in Punch) do the same almost anywhere. When a hill has blind corners this practice is particularly dangerous.

Drainage

Nowadays the drainage of roads is better dealt with by giving them a slight cross-fall than by camber, and Air Ministry practice for the runways of airfields forms a valuable guide. The greatest cross-falls allowed by them is 1 in 40 and may be as slight as 1 in 150 on machine-surfaced concrete. The criterion is whether pools of water will form which can be turned by frost into patches of ice large enough to throw aircraft into dangerous skids.

Ice on roads cannot wholly be prevented. Sometimes, after a change in the wind, rain falling on a frozen surface turns instantly into ice and even pedestrians cannot keep their feet. The wise motorist will stop, even if it means staying out all night, for this is better than to run the almost certain risk of losing complete control of one's car—a frightening experience—and colliding with whatever obstruction may offer, such as a brick wall at a bend, trees, telegraph poles, or other vehicles. This danger becomes particularly insistent on hills which become veritable death-traps during a " silver thaw." Even in ordinary frosty weather, hills are bad enough and experienced drivers get into a low gear to descend them, because the braking effect of the engine seems to exert a steadier retardation than even hydraulic brakes. Whether hydraulic or mechanical brakes are preferable will long be matter of heated debate among motorists.

A great advantage of cross-fall drainage, as compared with camber, is that only one side-drain is required to deal with rain water and the expense of making a second is saved—except when a catch-water drain is necessary to protect a road from being flooded.

The drainage of mountain roads presents a variety of interesting problems. Among these are the cross-sectional area of culverts and drains, the prevention of scour and of blockages. The first of these depends not only upon the rainfall, the catchment area, the gradient of the drainage system, and the percentage of run-off, all of which can be calculated from maps and text books, but also upon the intensity of rain. In Hong Kong, for instance, falls of six inches *per hour* are possible, and as more and more areas were built over or paved the percentage run-off increased so much that drains, which were at one time adequate, ultimately overflowed. On mountain roads drainage should always fall towards the inner edge, so that water cannot scour away the outside of the road and eventually destroy it.

Prevention of scour in drains and culverts is a very variable problem which depends upon keeping the velocity of drainage water to a safe figure, having regard to the nature of the floor and sides of the drain. Even when concrete is used, the floor may have to be stepped in the form of a staircase down which the water tumbles and, by so doing, loses velocity. In extreme cases a series of break-pressure tanks may have to be built, one below the other to form water-cushions, until the water can be discharged so far away that it cannot cut back and endanger the road. Sometimes the large " sausage "

of boulders in a stout steel net, familiar to Indian engineers, will give adequate protection against scour.

It is not always easy to prevent bridges, culverts, and drains from getting blocked, and even wide rivers cannot be stopped from changing their course, when so minded, or from silting up and overflowing their banks. The Yellow River, for instance, periodically does this, destroying vast areas of land and drowning millions of riparian Chinese. No remedy has been found nor seems possible short of constant dredging, and this is not practicable in a country like China, which is as yet only beginning its engineering development.

The cause of such blockages and silting lies in the fact that the specific gravity of boulders and sand is too great to prevent the water wholly carrying them away, but is not great enough to prevent the water moving them along. And so obstructions build up, blocking channels and culverts. For this reason culverts under a mountain, or any road, should be wide enough (2 ft.) to enable workmen to crawl in and clear them out. Steel grids are not satisfactory as they need periodical painting and are a constant source of expense. Silt-traps fill up too quickly to be of much value under ordinary conditions of road maintenance. Freedom from stoppages will in the long run make up for the initial extra expense of 2 ft. culverts.

A road blockage is sometimes caused by sand. One such is the sand river, some 200 ft. wide, which flows across the Quetta-Mastung road in Baluchistan. The cure devised for this is a sand-shed—similar to a snow-shed—over which the sand blows, leaving the road comparatively clear.

Bridges

No essay on roads would be complete without some reference to bridges, many of which have had to be strengthened in southern England to take modern military loads, and a few purely engineering points may be of interest. When steel bridges are in question, the calculation of their strength is not a difficult matter and that such calculations will be necessary no one with experience of active service will deny. There is an easy hope in some quarters that because bridges have been classified in England to correspond with military loads the same facilities will exist overseas. The enemy will certainly not be so obliging as to assist us in this matter and bridges will have to be classified if, indeed, he leaves us any bridges at all.

Considerations of the position of wheels or tracks may at once be dismissed as unnecessarily meticulous, except as regards a bridge's decking. All that matters is the total load and its equivalent equally distributed load. Nor need the old bogeys of " factors for impact and live load " cause much concern, except to remark in passing that they were really factors of ignorance, and that, by enabling bridges actually to carry much greater loads than those for which they were originally designed, they have, in many instances, appreciably delayed the day of their replacement to meet the ever-increasing size and weight of road vehicles. Heavy road loads will, and can, only go slowly, and if a bridge is strong enough for them it is strong enough for lighter fast moving loads. (Scores of tests taken on Indian railway bridges over many years showed that the test train produced a greater deflection *at rest* in the middle of the bridge than did the same train crossing the bridge at speed.)

In practice it is impossible to reproduce in a bridge the reversals of stresses which laboratory experiments have shown will produce " fatigue." Thus, pieces of steel cut some years ago from a railway bridge at Warrington answered the original tests as specified fifty years before it was dismantled.

It had been stressed to six tons a square inch *without* any factor for impact or live load.

Returning to calculations in the field of the strength of a steel bridge, it is only necessary to reverse the mental processes of the bridge designer who was given a certain load to support over and above the dead load of the structure itself. He works out or estimates the latter from experience and, by dividing the gross load by the number of girders in the span, he arrives at the load on each girder. This, and the span to depth ratio, which he can generally decide for himself, enables him to calculate the square inches of steel which he must provide at the centre of the lower boom (in tension).

When the span of a girder is eight times its depth, the stress at the centre of the lower boom is the same as the equally distributed load. *This is the cardinal fact* and the stress increases or decreases in inverse proportion to the span/depth ratio. If then a two-foot rule discloses a net steel section of, say, twenty inches at the centre of the lower boom of a girder, we know that it will stand a stress of 120 tons at that point. If the span/depth ratio is 8 : 1 the girder will take a load of 120 tons, less the estimated dead weight of itself and its decking. If the ratio is 12 : 1 it will only take 8/12ths of this load—and so on. Thus the strength of a steel bridge can very quickly be ascertained with the aid of a two-foot rule, since it may be assumed that the bridge designer knew his job and that other members of the bridge have the requisite strength. In short, it is not necessary to know anything about " moments " of this, that, or the other.

Space forbids the exposure of other fallacies current in connection with steel girders, except the constant misuse of the word " shear " when bending, buckling, or just " load " is meant. The *Oxford English Dictionary* disposes of the matter by referring to a " confused use of the word partly for stress and partly for strain." " Shear " can only properly be applied in steel structures to rivets which can be sheared by the scissors-action of the plates which they hold together.

Conclusion

If roads are to be developed to the extent outlined above, what is to be the effect on railways ? Obviously, railways must lose more and more of their " smalls " business, since this can so much more easily be dealt with by roads on a door-to-door basis, with a minimum of delay and damage. Nothing however, can take away the usefulness of railways for sustained long distance or mineral traffic, while they must remain, so far as can be foreseen, quite irreplaceable for heavy Service traffic in war.

Whether they can survive the fierce competition from the roads, to which they were subjected before this war, without a government subsidy, or full permission themselves to use road and air transport, remains to be seen, but it is clear that they, and the roads, must lose some at least of their long distance passenger traffic to the Air. In fact it may well be that within a few years we shall find airfields every fifty miles along the trunk roads and railways and two or more landing strips in between them.

THE TEACHING OF ENGINEERING

(Wanted—many thousands of technical instructors)

By Colonel Donald Portway, T.D.

With two destructive wars in the space of a single generation, so much has been lost in the human domain, that it has become clear to all that we must make the most of what is left to us. Heavy though the material losses have been, our greatest asset is still in some measure intact, i.e., the possibilities latent in the skill, the intelligence, and above all, the common sense of our men and women. The new Education Act recognizes this and bids fair—subject to certain vital conditions being satisfied—to introduce a changed and greatly improved outlook on training for life.

Education can enable this country to avoid the many pitfalls in the way, and so aid us in rescuing what is left of our civilization after so many disasters. Education, however, will fail unless it can awaken something of the spice for adventure, and so give the same inspiration in peace, which love of country and the common danger evoke in time of war. While it is all-important to widen educational opportunity, this must not involve the destruction of educational values. Under modern conditions there is a real risk that it may mean levelling down instead of levelling up, i.e., the attainment of a kind of educational Lowest Common Denominator.

Thus we have an immense problem, but also an immense opportunity. It is now agreed that secondary education is to be the rule instead of the exception. Education is to begin earlier and end later, and there is to be a new feature in the "County Colleges," and one of their most important functions will be training the engineer in theory, and to some extent in practice, in all branches of his art. These Colleges are to replace, and it is hoped will be a great improvement on, the old night classes, where, too frequently, tired pupils, after working all day, were taught by equally tired, badly paid, and often inefficient instructors. In addition, the Technical Secondary School is to be raised to the level of the Grammar School; so the Masters in the former have a real opportunity, at long last, to raise the status of engineering to the equal of that of other professions—one which all engineers trust will be eagerly seized. To make a real success of this "educational revolution," the schoolmaster's profession must be recognized as dynamic and of the utmost importance to the community.

The complete training of an engineer should be a combination of secondary education (with some technical background, under the new proposals, up to at least 16 years), college training, and technical pupilage or works training, the last providing the essential background of social relations.

At present the various schools of engineering tend to treat all students as if they were destined for high-grade scientific and technical work. For the few who are likely to reach this category, the Honours courses in the University Engineering Schools already provide a perfectly adequate training. Our immediate need is to make provision for training the far more numerous class so necessary for the production, planning, and administrative sides of industrial organization. This class requires less instruction in advanced scientific and mathematical subjects, but more in economics, law, and social

science. Their training will be in the main the responsibility of the " County Colleges " and to some extent the Technical Secondary Schools, since it is of real importance that the aspirant for professional status in any mechanical branch should have a good understanding of craft processes, sufficient to appreciate both the limitations and possibilities of skilled craftsmanship, though he need not acquire the skill that is essential for the genuine craftsman.

It follows, therefore, that instructors will be wanted most, and wanted quickly, for the County Colleges and the Technical Secondary Schools. It is the object of this article to suggest one source from which these many thousands of technical instructors, of the less academic type, essential to ensure the success of the new proposals, may be obtained.

Let us first consider what is wanted in these technical instructors, who form the major portion of our immediate needs. It is essential that they should break away from the old " talk and chalk " tradition ; and the slogan must be " training by doing " : the eye and hand must be utilized as much as the ear as a medium for instruction. In the typical Training Colleges of the past, human contacts, which are worth far more than the history and theory of teaching, were often neglected ; no doubt Aldous Huxley had this in mind when he asserted that " many who go through a course of academic education emerge either as parrots or specialists." We must therefore shun the one-track mind, and eschew both the theorist and the so-called " practical man," although theory, whether in engineering or in the art of teaching, must not be despised. It is the carefully adjusted blending of theory and practice that meets the real need. The instructors we require must also possess the quality of leadership of a persuasive kind, coupled with the necessary technical knowledge.

The Army forms an excellent initial, and practical, training ground for the less academic type of technical instructor. The Army Officer and N.C.O. throughout their training are led by precept and practice to think quickly and logically, to appreciate a situation, and to use their own judgment in making decisions by which they must stand. In the course of their daily duties the value of human contacts is emphasized, and they have priceless opportunities to acquire the difficult art of man-management, without which the engineer, especially one who aspires to impart his knowledge to others, can achieve little ; whilst for the quality of persuasive leadership we can safely rely on those who have led the soldier in war. Officers, Warrant Officers, and N.C.Os. from the Royal Engineers, R.E.M.E., and other Technical Corps, should possess sufficient technical knowledge for these appointments. Also, as a result of the conditions which obtain in the Army, they will naturally and automatically adjust the balance between theory and practice which years of academic training may fail to achieve. Many of these officers, etc., will probably have no special jobs ear-marked for them on demobilization ; they would be particularly suitable, therefore, to provide instructors in large numbers, after a relatively short training, which no doubt the Ministry of Education will provide.

There are many officers in the Royal Engineers who can hardly claim engineering proficiency in the civilian sense, but who have a genuine love of teaching ; for these the " Technical School " will provide an obvious sphere for their activities, as so much of the work in these schools will be non-technical. For the " County Colleges " the type of instructor required will be the man who is really competent in one particular branch, e.g., building construction, architecture, or machine design ; such men should be obtainable in considerable numbers, after the war, from the various technical Corps of the Army.

One word of warning may here be permissible : the teacher of engineering differs in one respect from other schoolmasters, in that he is, and must remain, an engineer. In order, therefore, to be successful in his work he must keep himself up-to-date in his profession. This will involve contacts with industry and something in the nature of industrial refresher courses. The Officer or N.C.O. who takes up technical teaching will have to be satisfied, in the first instance, with but a short course of instruction, and therefore must take advantage of every opportunity afterwards to keep in touch with the progress of industry, and the outside world. It is, however, only fair to state that this should come easily to one who has experienced the value of the many short courses, held away from the unit, which have for many years now been an essential feature of the Army's curriculum.

The White Paper issued by the Ministry of Education, giving their new policy, suggests that undue emphasis has been laid on buildings. It is the *man* that counts in education far more than the bricks and mortar. If the new technical colleges are to be successful, they must be staffed by men capable of giving every opportunity and encouragement to the students to develop their talents, and this not merely in a technical direction. Balanced citizens as well as trained engineers are required, ready to take their part in civic activities in a way that becomes members of a great profession. No narrow training will secure this. The teacher of engineering is concerned on the whole with the use of existing contrivances ; thus scientific study in his case tends to become professional and even de-humanized. Consequently every opportunity for cultural refreshment should be given to the engineer. Ex-Service officers and men, who have been trained both as soldiers and technicians, realize the importance of both sides, and how each helps in the usefulness of the other, so they will readily appreciate the need to encourage good citizenship for the civilian as an important part of the make-up of a proficient technician.

It is widely recognized that the prestige of the schoolmaster, as well as his financial inducements, must be increased if the man with the necessary qualities are to be attracted into the profession ; but the type of schoolmaster we need will not be bribed to undertake the work. He will be influenced by his love of teaching and his respect for the value of the work. Rudyard Kipling's eulogy of the schoolmaster, to be found in full in *Stalky & Co.*, may well be quoted in conclusion :—

> " Let us now praise famous men,
> Men of little showing,
> For their work continueth,
> Greater than their knowing.
>
> This we learned from famous men,
> Knowing not we learned it,
> Only as the years went by
> Plainer we discerned it."

MEMOIRS

COLONEL SIR HENRY GEORGE LYONS, F.R.S.

THE reputation of the Corps, both with the public and in learned circles, is largely based on the work of the engineer officers who rise to eminence in careers outside the Corps' regular sphere of activity. To the men who have thus served and made their contribution to the increase of that reputation—in his case in the scientific world—Henry Lyons most certainly belongs.

Son of General T. C. Lyons, C.B., he was born on 11th October, 1864, and educated at Wellington (1878-82), where General Sir John Du Cane and Sir Beechcroft Towse, V.C., were among his contemporaries. Entering the R.M. Academy direct from school, he passed out in February, 1884, 17th in a batch of 19 sappers, which included the late Sir George Fowke and Sir Aylmer Hunter-Weston. He was not greatly interested in games or sports, either at school or the "Shop" or the S.M.E., but it is on record that he captained the 4th XI at Wellington. Some indication of his tastes is given by the fact of his being an F.R.G.S. when he joined at Chatham.

After service at Gibraltar and in the 1st Division, Telegraph Battalion, at Aldershot, in January, 1890, Lieutenant Lyons was posted to the 12th Company in Cairo, and next year was attached to the Egyptian Army for engineer duties at Aswan, and soon became interested in Egyptology. Promoted Captain in 1892, he was employed on the reconnaissance of desert routes, and in 1894, whilst serving on the Sirdar's Staff as D.A.A.G. "B" (actually concerned with "Q" business—which Lord Kitchener superintended as his own Q.M.G.), he was borrowed by Lord Cromer to become Director-General of the Geological Survey of Egypt. Two years later he founded, and became Director-General of the Survey Department, which undertook not only cadastral, but hydrographic, geological, meteorological, and archæological work. His activities are recorded in his *The Physiography of the Nile, Report on the Island and Temples of Philæ, The Cadastral Survey of Egypt*, and *Rains and Flood of the Nile Basin*. In the Survey Department came pre-eminently to notice the powers of organization and the thoroughness which distinguished him throughout his career.

Finding the work suited to his taste and having married in 1896, he retired from the Army in 1901; but he remained in Egypt as Surveyor-General until 1909. His services there are commemorated by the Lyons Gate at the Bahariya Oasis.

His scientific services had been recognized by the election to the fellowship of the Royal Society (1906), the conferment of D.Sc. of Oxford (1906), and the Sc.D. of Dublin (1908). The award of the Victoria Medal of the Royal Geographical Society he received in 1911.

On return home he became lecturer on geography at Glasgow University, holding this post for three years, until his appointment as assistant to the Director of the Science Museum, South Kensington.

On declaration of war in 1914 Lyons went back to Chatham to assist in the R.E. Record Office, and did good service in reorganizing it in order to deal with the immense amount of work thrown upon it by a national war.

He was also Acting Secretary of the Royal Engineers Institute from October, 1914, to July, 1915.

In 1913 he had been nominated by the Royal Society to a seat on the Meteorological Committee, and early in 1915, in which year he was elected President of the Royal Meteorological Society, he was released from military duty to supervise some meteorological work required by the Admiralty in connection with the operations in the Mediterranean. In May of that year, when a meteorological field service in France was organized, Lyons made the preliminary arrangements and secured the co-operation of the French Meteorological Service, acting as agent for the exchange of information and later, in the same way, for the Macedonian and Italian theatres.

Gradually he acquired a larger share in the work of the Meteorological Office, and at the beginning of 1918, now a Lieutenant-Colonel, became its Director "for the duration," actually until September, 1919, when he returned to South Kensington as "Keeper," to succeed in 1920 to the joint office of Director and Secretary of the Museum. During the 13 years that he was in office the attendance of visitors more than doubled, and rose to over a million a year, and the Science Museum became one of our most popular educational institutions. Perhaps the best proof of the soundness of his rule—besides his knighthood (1926)—is that on his retirement the authorities came to the A.A.G., R.E., War Office, to seek a successor.

Lyons's activities, though hampered by arthritis, were by no means at an end. He had been Vice President and Foreign Secretary to the Royal Society 1928-9, and for the next ten years served as its Vice President and Secretary. Its President has paid tribute in a letter to *The Times* to his services in managing its finances and developing its amenities. He was a governor (from 1923) of the Imperial College of Science & Technology; General Secretary for nine years (1928-37) of the International Council of Scientific Unions, of which he was the founder; a trustee of the National Portrait Gallery (1934-42) and Chairman of Committee of the Athenæum Club.

His final great work was his *History of the Royal Society*, compiled during the last years of his life. He had got as far as correcting the final proofs, but did not live to see it in book form.

Lyons was endowed with the useful gifts of good looks and a charming personality; but behind these were much genial wisdom, untiring energy and accurate knowledge; whatever he touched he did well. Professor Andrade, writing to *The Times*, has exactly hit off one source of his administrative success: "He cut down formalities to the minimum necessary for efficiency, and brought to his work a friendliness and helpfulness which many must have experienced."

J.E.E.

Colonel Sir Henry G Lyons Kt DSc FRS

Colonel Herbert Kent CB

COLONEL H. V. KENT, C.B.

HERBERT VAUGHAN KENT was the fourth son of Mr. G. B. Kent of Ruislip Park, Middlesex. Educated at Clifton College and the R.M. Academy he was commissioned in the Royal Engineers on 14th February, 1883. He was an expert swimmer, and keen on sailing and boating, so at the end of his course at the S.M.E. he elected for the Submarine Mining Service. At the end of 1885 he went to Halifax, Nova Scotia, moving the next year to Bermuda and ending his five years' tour at Halifax. On return home he served at Chatham, Pembroke Dock, and Plymouth, becoming Captain in 1891. In 1895 he volunteered for a second tour of service in Halifax and Bermuda returning home in 1899. For a short time he was employed in the Intelligence branch of the War Office, and for the next two years, as a Major, commanded the 52nd Fortress Co. at Portsmouth. In December, 1902, he was appointed Assistant Inspector of Submarine Defences at the War Office, but in 1904 this was one of the appointments reduced by the Esher Committee and Kent had to revert to Division work in the London District. In 1906 he became C.R.E., Straits Settlements, at Singapore, and was promoted Lieut.-Colonel in 1907. In 1909 he returned home as C.R.E., Newcastle-on-Tyne and officer commanding North-Eastern Coast Defences, which included the Tyne, Tees, and Humber, completing his regimental service on 19th August, 1912, when he was placed on the Colonel's list. There were few appointments at this time for Colonels and Kent remained on half-pay until appointed A.D.F.W., War Office, in August 1914. On the outbreak of war Kent took charge of the Barrack Branch and was responsible for the early hutting schemes, but after a few months he was moved to his original work, the fortification branch. Here he interested himself in trench warfare, making two visits to France and starting in Kensington Gardens an instructional group of field defences. In 1915, as the Admiralty began asking for increased assistance from the fixed defences Kent had to design and construct what the D.F.W.—Scott-Moncrieff—described as: "As big a scheme of defence works as had ever been carried out by the R.E."

For his services Kent received the C.B. in 1917 and also the 2nd class of the Order of S. Stanislas. He retired in January, 1919, and took up the construction of cheap and quickly built houses on the *pier and panel* system and worked at it for some years, but failed to interest the public. On the outbreak of the present war he was in the South of France with his wife; they escaped with some difficulty to Lisbon, and then to the United States. There his wife's health failed, but they reached Coburg in Canada where she died in 1942. Kent's own health then failed and he passed away in June, 1944.

Kent was a first class Engineer, but he was perhaps better known to his friends for his proficiency in sports; he was an expert skater and wrote several books on the subject, and was one of the first to introduce the Norwegian *ski* into Switzerland. He was also proficient at swimming and diving, but his best loved sport was sailing. In 1883, as Secretary, R.E. Yacht Club, he took a leading part in the purchase of the "Buccaneer," raised the funds for a new raft of a much improved pattern and, among other details, introduced

Canadian canoes into the club. In 1885 he became the owner of a small yacht, when the writer of this memoir often sailed with him as "crew." Kent was always proud of having been one of the crew of the *Buccaneer* in 1885 which won the two big amateur yacht races of the year, from Dover to Ostend, and from Ostend to Portsmouth.

When he was ordered to Singapore, he found a flourishing yacht club which each season organized a series of races and regattas. The sailing was done on somewhat different lines to those in force in England, the boats being the local *prahus* and all races started with sails down, and the boats at moorings along the starting line. At the starting gun sails had to be set on the move if the wind permitted. The Malays are excellent boatmen, and Kent collected a smart crew which he trained and drilled; this coupled with his own seamanship put him right in the forefront as a prize winner, until he was weighted by a severe handicap. He also took the lead in swimming and diving at the local aquatic sports. After his retirement he was a member of the Bembridge Yacht Club and with his elder daughter as *crew* had several excellent seasons, his proportion of wins being phenomenal.

He married at Washington, U.S.A., in 1891, Helen Chauncey, the daughter of Lyman Tiffany of New York. They had four children, their eldest son G. H. S. Kent, joined the R.E. in the 1st Great War, was mentioned in despatches and promoted Captain, but was killed at Poperinghe in March, 1918; their eldest daughter is the wife of Rear Admiral H. H. Bousfield. The second son served with the R.A.S.C. in the Great War and now lives at Salisbury, Southern Rhodesia; the younger daughter married Mr. John C. Williams.

W.B.B.

LIEUT.-COLONEL ARTHUR W. G. DOBBIE, R.E.

ARTHUR DOBBIE, whose death in action while commanding a Field Company in Italy, has been reported, was the elder son of Lieut.-General Sir William G. S. Dobbie, G.C.M.G., K.C.B., D.S.O., Colonel Commandant Royal Engineers, and of Lady Dobbie. He was educated at Belmont School and Cheltenham College, where he was head of the O.T.C., and won his rugger colours. He also ran the hurdles for the School. In 1925 he passed into the Shop, being top in Higher Mathematics, and there obtained his "rep" for fencing. Later he played twice in the Army Rugger Trials, being reserve for the Army once. He also played for the Sappers v. Gunners, and for the Aldershot United Services Team. In 1930, in the Inter-Company Sports, the 38th Field Company won the mile relay, Arthur Dobbie being one of the team.

From 1926-28 he was at the S.M.E., Chatham, and then with the 38th Field Company in Aldershot 1929-30. Seven happy years followed in Egypt, partly with the 2nd field Company, and later as G.E. Abbassia. In recognition of his exploration work in the Egyptian desert, he was made Fellow of the Royal Geographical Society. In 1936 he was promoted Adjutant of the 4th Divison Engineers.

In 1938 he entered the Staff College as a student and gained his *p.s.c.* On the 2nd September, 1939, he was appointed Staff Captain Q.M.G.(M)., B.E.F. France, later becoming Brigade Major, 143rd Bde., with which he saw much fighting in Flanders. He was mentioned in despatches for distinguished service March-June, 1940, and awarded the 1939-43 Star.

Then in succession followed appointments as D.A.Q.M.G., of a Division; A.Q.M.G. (M) G.H.Q. Home Forces, O.C. — Field Squadron; S.O.R.E. E.4, War Office and finally G.S.O.1. of a Division. From 1941, to January, 1944, he held the rank of Lieut.-Colonel, becoming Substantive Major in 1942.

Proceeding to the Italian Front, he was appointed O.C. of a Field Company, and reverted to Major pending a vacancy as C.R.E. He was wounded (but refused to leave the Company) in May, being killed in action on 19th June, 1944.

The Second-in-Command of his Field Company writes: "He was fearless and unafraid, and I had sometimes to check him for his enthusiasm, but it was always 'We must get on and finish with the job.' This became a by-word in the Unit." Such was his attitude to duty and his inspiration to his men.

Of his relationship to those over him, the G.O.C. of the Divn., to whom he was G.S.O.1, writes of his "outstanding qualities of loyalty, conscientiousness, and the most infectious and inspiring enthusiasm." His G.O.C. wrote of his service in Italy: "During the time that he was with us, he did really brilliantly. He had many most difficult tasks to do, and he always did them, whatever obstacles there were. We all felt we had lost one of our best officers."

Arthur Dobbie also had a clear faith in Christ, which both moulded his character and conduct, and also gave him confidence instead of concern at the issues of death. As in action he came to realize this, he wrote with evident happiness about it from the front.

He was a born leader, a keen soldier, and an efficient Sapper. Command of a Field Company on Active Service was the height of joy to him. He leaves behind him a wife, the daughter of the late Capt. Coltex, R.A., and a keen, alert son of five years old—Ian by name.

B.G.B.

COLONEL R. OAKES, C.B., C.B.E., M.I.Mech. E.

RICHARD OAKES, son of Colonel R. F. Oakes of Tunbridge Wells, was born on the 12th March, 1876, and died on the 14th July, 1944. Built on slight and wiry lines he enjoyed robust health, and was a very good racquet player; until taken ill in 1942, he had never been on the sick list all his life. The last two years of his life were clouded by sickness patiently borne. He was married twice, first in 1903 to Mabel, daughter of Charles Trubshaw of Derby, who died the year after, and secondly to Audrey, daughter of F. J. Hawksworth of Natal, who survives him, as do one son and one daughter by this marriage.

Educated at Harrow, and the R.M.A. Woolwich, Oakes obtained his commission early in 1896, and after two years at the S.M.E., was selected for a mechanical engineering course in the Locomotive Shops of the Midland Railway at Derby. He went to South Africa at an early stage of the Boer War, and worked first with R.E. Railway Companies, and subsequently in the Locomotive Department of the Central South African Railways for ten years in all, his final posting being personal assistant to the Chief Locomotive Superintendent. On his return home in 1909, he was for three years in command of the 8th Railway Company R.E., at Longmoor.

In 1912, he was posted to the War Office, first as Staff Captain, then from 1914 to 1917 as Inspector of Iron Structures. This period covered the first three years of the war, and the department expanded enormously. He finished up the war period as Deputy Director of the Mesopotamia Railways. He then had a four-year tour in India, becoming eventually Deputy Engineer-in-Chief (E. & M.) at Army H.Q., Simla. After returning to England in 1925, he held until 1929, the appointment of Assistant Director of Transportation, War Office, being promoted Colonel on taking up the post. This was followed by two years as President of the R.E. Board. In 1931, he came to the head of the Colonel's list, but as there were no vacancies in sight for a Major-General's appointment for an officer of his training, he decided to retire into civil life while young and active. He first had an appointment which took him in connection with a citrus-growing concern to South Africa where his family were at the time. Soon after he joined the staff of the Royal Society for the Prevention of Accidents, where he worked for ten years until overtaken by his final illness in 1942. A busy life and a full one, as he gave of his best to whatever master Fate decreed that he should render service.

For his war services he was mentioned in despatches—twice during the South African war, and twice in the 1914-18 war. He was promoted Brevet Lieut.-Colonel in 1915, awarded a C.B.E. in 1919, and a C.B. in 1931. It was a considerable compliment to his ability that he was retained so long on the South African Railways at the close of the 1899-1902 war, the last of Girouard's British Officers to be so employed.

Subsequently, as Inspector of Iron Structures his work at the War Office during the last war, though known by few, was of immense value. His untiring energy and sheer determination enabled him to surmount all difficulties and to meet urgent requirements far earlier than would otherwise have been the case. Similarly in his other appointments, both military and civil, his determination carried him over many obstacles and through many impasses.

His contemporaries look back on him as a cheery companion, easy to get on with; one who needed a little drawing out rather than one who thrust himself into the limelight.

A.E.D.

BOOK REVIEWS

(Most of the books reviewed may be seen in the R.E. Corps Library at Brompton Barracks, Chatham.)

THE STORY OF WEST POINT 1802–1943

BY COLONEL R. ERNEST DUPUY

(*The Infantry Journal*, Washington, D.C., price $1.00)

This little book by a Colonel of the General Staff Corps, U.S. Army, is not a formal history of the Military Academy at West Point, but the interesting, yet authoritative, story of the men who made the school, and of the work done in the making of the United States by the officers trained there. The sub-title is "The West Point Tradition in American Life;" and of the influence of the graduates of the Army in the U.S.A., of the high estimation in which they are held all over the world, there can be no doubt. For the British reader this interesting record lacks a few photographs to show the magnificent position of the Academy on the heights above the Hudson river (think of a Royal Military Academy established at Cliveden), and its array of halls and buildings; for the U.S. Government has never grudged expenditure on its military school—an American has said that West Point is the one luxury that the nation allows itself.

The fathers of the Republic as early as 1776 recognized the necessity for a "military school for young gentlemen," and Washington recommended as a suitable locality West Point, then a fortress dominating the Hudson. Classes were held there for artillery and engineer cadets in 1794. Not until 1802, however, was the Academy officially sanctioned for 10 engineer cadets, a number constantly augmented, with all arms included; not until 1807, when Major Sylvanus Thayer of the Engineers became Superintendent, did the Academy take its present shape, and he ruled over it until 1833. To him is due the careful selection of instructors, the 4-year course, the remorseless "sacking" of the "deadwood"—cadets below his high standard—and the splendid discipline. Thayer has his statue at West Point, and an annual military ceremony commemorates his unequalled services to the institution. On the scientific side, Dennis Mahan, also of the Engineers, father of the Admiral, contributed to set the right course.

The careers of these two officers and the difficulties and opposition which they encountered fill more than half of the book.

In the Civil War, West Point furnished 294 generals to the North and 151 to the South. "When the struggle ended all the Armies in the field on both sides were commanded by graduates," the civilian generals—politicians, judges, civil servants, and explorers—nominated to command by political pull, had disappeared.

"In 1917-18, thirty-four of the thirty-eight corps and divisional commanders in France when the war ended were Military Academy men."

The services rendered in civil engineering cover many pages: waterways, harbours, roads, lighthouses, surveys, canals (including the execution of the Panama Canal), explorations, nearly all owe their initiation and exploitation to "West Pointers"; but particularly do railways: more than two score (including McClellan) became presidents of railroads, more than fifty chief engineers of railway systems.

Two generations of Du Ponts (the explosive manufacturers), Edgar Allan Poe, and Whistler the artist, were cadets. Some of the graduates became Ambassadors, successful bankers and commercial magnates.

Truly a glorious record.

J.E.E.

MAKERS OF MODERN STRATEGY

EDITED BY E. M. EARLE, 553 PAGES

(Published by the Princeton University Press. Price 25s. 0d.)

This bulky tome is not so much a " book " as a reference library in miniature ; and its title gives very little clue to its contents.

Its 21 chapters are, in effect, 21 self-contained essays dealing with subjects more or less connected with the development of the Art of War into the Art of *Total* War. The writers of these essays are distinguished American scholars, many of whom are professors or students of military history, strategy and technology. Their erudition and literary skill compel our admiration. Their work is, generally, analytical rather than critical and, in some cases, mainly historical.

Each essay deals with the writings or speeches of one or more thinkers on military strategy, and on the political, geographical or other conditions affecting it. The term " military strategy " is here used in the limited sense of the strategy of land-forces. Sea- and Air-Warfare are treated almost as extraneous subjects; and the co-operation of Sea-, Land- and Air-Forces is hardly mentioned.

Among the thinkers whose work is analysed there are only a few, e.g., Moltke and Foch, who have practised the military art besides writing about it, and their admission to this book appears due to their words rather than their deeds. For the rest the names of many of them will be quite strange to British readers, especially in the essays dealing with our own times. The selection has, doubtless, been made by the Editor and, while criticizing it, one should remember that his book is an American production, written by Americans for Americans ; and their view-point, tastes, and standards are different from ours.

It is, on the whole, a disappointing book—to some extent, perhaps, because it comes nowhere near to fulfilling the promise of its ill-chosen title or of its early chapters. Yet it is a book of some importance, full of valuable matter and well worth a place in the most exclusive of libraries. How is one to get the best value from it ? J.E.E., in the September *R.E. Journal* suggests that it may be taken in small doses with advantage. Good advice ! and the structure of the book makes it easy to follow, for there is hardly any dependence of one chapter upon another.

Thus, the student who has no time to read an unabbreviated edition of Clausewitz will find all he need know in Chapter V—a model précis, contributed by the author of *Carl von Clausewitz, Politik und Krieg*. Similarly, if unable to study Mahan's works in the original, he cannot do better than learn Mahan's doctrines of naval strategy from Chapter 17. Whilst on naval topics, it may be remarked that Alexander Kiralfy's chapter on *Japanese Naval Strategy* is one of the most informative and suggestive in this book. British naval students, whether at the Naval War College or in the Far East or even in Whitehall, will do well to ponder ideas and theories expounded in it which may be strange to them. Mr. Kiralfy summarizes the matter by pointing out that the Japanese Navy has been the floating wing of a powerful army operating in an area militarily far weaker than Europe or North America. It was inevitable, then, that its theories and practices should differ widely from those accepted in Great Britain or the U.S.A.

The Editor's own contributions to this book are outstanding. His *Introduction* is broad-minded and up-to-date ; his essays on *The Economic Foundations of Military Power*, introducing us to Adam Smith, Alexander Hamilton and Friedrich List, and on *Soviet Concepts of War*, " featuring " Lenin, Trotsky and Stalin, reach a very high standard, although the latter perhaps does more than justice to Trotsky. His *Epilogue*, which is not an epilogue at all but rather a study on Hitler, gives a picture of the Nazi concept of War which will command general acceptance, and no one will dissent from his opinion that it is too early to write any final appraisal of Hitler as a military strategist, " although history is unlikely to speak any too well of him," which puts it in a very mild way.

Dealing with modern times and modern developments, the matter in the later chapters of the book becomes more controversial; but even disagreement has its advantages in that it spurs the reader on through what, it must be said, is often very heavy going. *The Emergence of the Civilian* is the title of a chapter which will certainly elicit protest from many a reader. It is not mainly analytical, like most of the others, but definitely critical and to some the criticism will appear prejudiced. Similarly with Chapter XV. *The Doctrine of Defence*, having Maginot and Liddell Hart as its selected prophets. The writer is obviously not "in the know" as far as Britain is concerned. Not many of his readers in this country will agree that Liddell Hart was, in 1925, already recognized as "the leading military writer in Britain" or, more amazing still, that 12 years later he was "the true spokesman of the British mind."

The following chapter, entitled *Haushofer, The Geopoliticians* is too difficult for any normal military student. The author suggests that history may show an intimate relationship between the expansion of Nazi foreign policy and the ideas of Haushofer and other geopoliticians. It may be so; but we confess that "Geopolitics" and Karl Haushofer are names equally strange to us. "Most people look upon geopolitics as a Frankenstein." We may leave it at that!

Only one chapter is devoted to *Theories of Air Warfare*, and one chapter is not enough. Moreover, the credentials of its author carry no conviction and he writes of the theories of three "thinkers" who are little known in this country, an Italian, an American and a Russian. The result is quite inadequate in view of the vast and growing importance of the subject.

We lay down this book with some sense of incompleteness in it. This may be due to the omission of any sort of summing-up by its Editor. It contains all the material required to indicate modern development in the Art of War—not only the operations of war but the conditions inducing war and the preparation and maintenance which the handling of fighting forces demands: but the reader must find them for himself. His search through these 550 pages will require all the determination and staying power of which he is possessed.

T.F.

"ARMISTICE AND GERMANY'S FOOD-SUPPLY 1918–19"

By Bernhard Menne

Translated from the German, 96 pp. in paper cover. (Published by Hutchinson and Co., Ltd. Price 1s. 0d.)

This little *brochure* has been written to contradict the lie that the Allies deliberately starved the German people after the last war and the author is to be congratulated on the diligence with which he has collected his evidence, mainly from German records, and the skill with which he has marshalled it. It is to be hoped that it will be read and will carry conviction in Germany: but British readers will probably pronounce it an instance of preaching to the converted, as far as they are concerned.

Incidentally, however, the book contains a lesson and a warning for us, and for our present Allies, in the picture it gives of the proceedings of the Supreme Economic Council after the Armistice in 1918-19, of the differences between Britain, France, and the U.S.A., and of their weak-kneed attitude *vis-a-vis* German arrogance. Let us be thankful that the enemy's surrender this time is to be *un*conditional. In this connection, the author's preface and the "Foreword" contributed by Charles Jarman have a special value.

T.F.

A GEOLOGY FOR ENGINEERS

By F. G. H. Blyth

(Edward Arnold & Co., 1943. Price 21s. net)

Geology now embraces a large group of highly specialized subjects—the Geological Sciences. An engineer, be he civil (in its narrower sense), or even mining, cannot hope to touch more than the fringe of this group of applied sciences in the course of his college education or professional career. Much less the military engineer. But both the military and the civil engineer have urgent need of a knowledge of the main principles of physical geology, and of its applicability to the problems of engineering. That need is at the present time quite inadequately fulfilled in many educational establishments of civil engineering, and certainly in those of the Corps, including the S.M.E. One outstanding Sapper who did his best to correct this situation, was the late Brig.-General R. F. Sorsbie, who produced an excellent text-book, *Geology for Engineers* (Geo. Bell & Sons, Ltd.).

The work under review, although covering the courses in geology for civil engineering students at the Imperial College of Science and Technology, as given by the author who is an engineer, falls short of what such a text-book should be. It presents more the view-point of the geologist, and what he imagines the engineer should know, than a discussion of geological aspects of engineering problems which are seen through the eyes of an engineer.

Of a total of 15 chapters and 3 appendices, only 5 deal with matters directly concerning engineering. The latter cover briefly the geology of water-supply, reservoir and dam-sites, cuttings and tunnels, as well as an outline of the very important study of soil-mechanics, so largely neglected in this country (by A. W. Skempton); and applied geophysics (by J. McG. Bruckshaw). There is a chapter on geological maps, sections and field-mapping, also, an appendix on certain publications of the Geological Survey of Great Britain. The remaining text-matter, well illustrated, is essentially covered in innumerable existing treatises great and small. Moreover, the elements of geology, thus presented, are too detailed and elaborate for the needs of the average engineer, who is already burdened with an excess of professional data and items of technique. This applies particularly to the chapters on the Study of Minerals, Rock-forming Minerals, Igneous Rocks, and some others.

Clearly the engineer should know the chief fundamentals and principles, and he must learn to apply them. He cannot be expected to be equipped with an advanced and specialized technique in the various branches of geology. But it is important that he appreciate when geology is implicated in his problems, and discern at what stage the specialist should be consulted. Too often the geologist is called in after the engineer has commenced his work, to advise on an undertaking already in progress, with problems perhaps impossible of solution, but which would not have arisen if the geologist had been consulted in the first instance. The value of the present book would have been much enhanced for engineers had there been a wider discussion of such problems, at the expense of the earlier chapters. Moreover, it seems strange to find the omission of such practical "elements" as the physical characters of constructional materials, *e.g.* crushing strengths, toughness, durability, etc., or even reference to methods of testing materials for such characters, except in the case of unconsolidated materials, as given in the chapter on Soil Mechanics. It is disappointing to find no reference to the larger issues of transportation routes and sites, for instance, roads, railways, canals, and aerodromes, where geology is of fundamental importance.

May we hope to see these and other deficiences made good in a second edition?

N.E.O.

PUSHKIN

A Collection of Articles and Essays on the Great Russian Poet A. S. Pushkin. (The U.S.S.R. Society for Cultural Relations with Foreign Countries. Moscow.)

Pushkin was born in 1799. His father belonged to the nobility and his mother was a granddaughter of Peter the Great's Abyssinian Negro protegé, Hannibal. When the Lycée at Tsarskoye Selo was opened in 1811 Pushkin was one of the thirty privileged pupils. He was already a voracious reader of French revolutionary literature and here among the professors were two or three—one was a Frenchman, brother of Marat,—who encouraged his revolutionary and atheist instincts and his hatred of autocracy and serfdom. Before he had completed his six years at the Lycée he had made a name for himself as a poet. On leaving, he was given nominal employment in the Ministry of Foreign Affairs and while at St. Petersburg he sought out and made the acquaintance of all men of revolutionary tendencies. His poems in condemnation of tyranny and tyrants did not escape official punishment but it is curious to read how leniently throughout his stormy career he was treated by the authorities, exile to the South and mild police supervision were his harshest punishments. Exile from St. Petersburg saved him from taking part with the Decembrists in the rising of December, 1825, and sharing their fate, and although in an interview with the Czar, Nicholas I, in the following year he avowed his sympathy with the rebels, he was treated with benevolence and employed to write a memorandum on education which was personally and in a quite friendly manner criticized by the Czar. Pushkin's undoing was his marriage in 1831 to a handsome and frivolous lady whose popularity at Court led to ruinous expenses. Through her influence he was appointed a Gentleman-in-Waiting, but he hated Court life, and quarrels with those with whom he came in contact there led them to suborn a French bully, who insulted him on account of his complacency towards his wife's conduct and shot him in a duel on the 27th January, 1837.

The book includes essays on the various categories of Pushkin's work, his lyrical and epic poetry, his prose and dramatic writing, etc., and is well illustrated with portraits of the poet and illustrations of his life and works by Russian artists.

Pushkin's compositions have been translated into English verse by Babette Deutsch and published in New York under the title *The Works of Alexander Pushkin*.

F.E.G.S.

THE WAR IN OUTLINE

2nd Edition, 1939-1944

This is an interesting publication in a handy book form, prepared by the American War Department and published by the *Infantry Journal*. Its object is to present to the Army a statement of the causes and events leading up to the present war and of the principles for which we are fighting.

The first chapter deals with the immediate background of the war and describes the actions for which Germany, Italy, and Japan, respectively, were responsible between September, 1931, and September, 1939.

The unprovoked attack by Germany on Poland on the 1st September, 1939, brought Britain and France into the war, and eventually all the Allied and Axis powers were dragged into it. The course of the war up to the 31st March, 1944, is subdivided under the following headings :—

(1) German Offensives in Western Europe. 1939-1940.
(2) Japanese Offensives in the Far East. 1932-1942.
(3) Battles for the Mediterranean. 1940-1942.
(4) Campaigns in the U.S.S.R. 1941-1944.
(5) The Tunisian Campaign.
(6) United Nations Counter Offensives against Japan. 1943-1944.
(7) The Invasion of Sicily and Italy.
(8) The War at Sea.
(9) The Air War. September, 1939 to March 31st, 1944.

In a book of such a small size—228 pages, including appendices and index—the text is necessarily confined to a brief statement of the main details of the history of the war on land, sea and air. Although primarily intended for the American army, it is equally well suited for the British general reader. The account given is impartial, and credit is given to the forces of all the allied nations wherever it is due. No controversial matter has been included.

At the end of each chapter a list of observations is given to amplify the text, in which the nature of the country and other matters are described, showing how these have affected the conduct of the campaign.

The appendices contain historical documents of the United Nations, e.g. The Atlantic Charter (August 14th, 1941), The Three-Power Conference (Moscow, November 2nd, 1943), and several others. Among the historical documents of the Axis Nations are "The Anti-Comintern Pact" (November 25th, 1936), and the Pact and Agreement between Germany, Italy, and Japan. It is interesting to record, three years later, Article II of the Agreement (December 11th, 1941): "Germany, Italy and Japan undertake not to conclude an armistice or peace with the U.S.A. or Britain except in complete mutual agreement."

There are some useful little maps at the end of the book that help to illustrate some of the campaigns.

A.S.H.

MILITARY OPERATIONS IN THE NETHERLANDS FROM 10TH TO 17TH MAY, 1940

By Lt.-Col. P. L. G. Doorman, O.B.E.

(Dutch General Staff.)

(Published by the Netherlands Government Information Bureau and by George Allen and Unwin, Ltd.; with four appendices and four maps. Price 5s. 0d.)

This is an authoritative record of the Dutch Army's struggle, hopeless from the first, to preserve the neutrality of their country and the inviolability of its frontiers against German aggression in May, 1940. It should find a place in the libraries of all the more important of our Military institutions; but the story is told in such meticulous detail that it is likely to prove *caviare to the general.*

Statesmen and soldiers alike may, however, derive much of interest and profit from a study of its earlier chapters and the concluding "Final Review," while they need only skim the 45 pages devoted to intimate description of the military events.

Apart from its historical value, this little book may be commended to military instructors in search of material for *T.E.W.Ts.* and Staff College *Schemes.*

The four maps are excellent.

T.F.

THOUGHTS ON WAR

By Liddell Hart

(Faber & Faber. Price 15s.)

The author of this compendium is described in *Who's Who* as a "military scientist," and his text tells us "there have been many famous artists of war, but scarcely any scientists." His book is a collection of jottings and he states that its origin "lies in a long-standing practice of writing down my reflections." These reflections he has now sorted out, carefully giving the month and year of their occurrence, under three major headings, These are :—Elements of War, Conduct of War, and Conduct of Military Operations, each taking about a third of 325 pages, and they are divided under seventeen minor headings. For instance, under the first major heading one finds :—The Nature of War, The Object of War, The Military Aim, Conditions of War—physical and psychological—and The Science of War. The reflections are in the main useful reminders ; but some are trite—"If Armies are deprived of food, fuel, and ammunition they are reduced to helplessness." Others will not meet with universal acceptance e.g., "Professional soldiers, even at their best, are still amateurs of War." The author reflects that "the experience of any individual, however wide," cannot be compared "with the universal experience as contained in military history." Even "lessons learnt from peace exercises have more often proved false than those of pure theory, developed from logical reasoning [the French method by the way] and historical analysis." On the other hand "the benefit of study at the Staff College is apt to be overrated." The author seems to overlook the fact so concisely put by an American soldier, the late General Hunter-Liggett, that "war is the most muddled of all human industries," and by no means a pure science.

It is of course quite right to think, unless one is that rare being "a natural soldier"; but having thought over the logical course, the best recipe for victory is to do something quite different. Unfortunately, military history is generally so "thin" and so lacking in details, that the study of it can rarely yield many useful results to the amateur strategist. Besides, in the military world, even more than in any other, the people who know seldom write.

J.E.E.

BOMBARDIER

By Stephen Gilbert

(Faber & Faber, Ltd. Price 8s. 6d. net.)

This little book of 263 pages (7" x 5")describes the adventures of Bombardier Peter Rendell, a lorry driver in an Irish Search-Light Regiment in Northern France, during the winter of 1939 until the early summer of 1940, and gives a graphic picture of that period of the war as it appeared to the rank-and-file. Although the story is freely interlarded with barrack-room slang, this is redeemed by many finer passages, particularly those relating to the events which culminated in the retreat through Dunkirk and the sinking by bombing of the evacuation ship. It concludes with an account of the rescue of the survivors by a tramp steamer bound for Dunkirk with munitions, and their subsequent safe arrival in England. The book ends rather abruptly, and it would have been interesting to know whether the Bombardier's evident capacity for command was recognized by the grant of a "direct commission from the ranks."

J.H.

MAGAZINE REVIEWS

GEOGRAPHICAL JOURNAL

April, 1944.—T. H. Manning gives a very interesting account of "Hunting Implements and Methods of Present-day Eskimos."

D. C. M. Mather describes a "Journey through the Quattara Depression," The article is an account of a return journey which his party were compelled to take, after a raiding expedition, through the depression, where it was believed that there was a "kind of bridge" over the central bog. There is a graphic description of a most difficult journey by night. When the "crossing" was reached, a broad dyke of soft mud, material was put down and the lorries charged across, and only one was lost.

A. R. Hinks contributes a most careful and able investigation of "The Observations of Amundsen and Scott at the South Pole." He regrets that the published results and discussions of the astronomical positions determined are so meagre and incomplete, since observations made in such high latitudes are so rare and of such special interest. His conclusion is that "the observations of both parties were very much better than has ever before been represented, and deserve praise that has been long delayed."

There is a short article on "Mud Volcanoes on the Makran Coast."

May, 1944.—This number is largely occupied with snow and ice. Dr. Olaf Devik, a Norwegian physicist, contributes a highly technical account of "Ice Formation in Lakes and Rivers," a difficult but interesting topic.

The Rev. H. R. Rokeby-Thomas, of the Canadian Chaplain Service, describes conditions of life in the Canadian Arctic, in "South-east Victoria Island and the Queen Maud Gulf," with photographs.

Lieut. P. C. Spink, gives an account of two ascents of Kilimanjaro, dealing with weather and volcanic activity. He found certain signs of activity in the ice-capped crater of Kibo.

E. J. Wayland describes "Drodsky's Cave," a group of remarkable intercommunicating caverns in Ngamiland. No traces of human occupation were found.

E.M.J.

EMPIRE SURVEY REVIEW

July, 1944.—J. L. Rannie, of the Geodetic Service of Canada, gives in "Aerial Reconnaissance for Triangulation," an interesting account of the methods adopted in that country. Given plenty of water, to permit of low flying in safety with hydro-planes, it has been found possible to save an enormous amount of time in a country where communications are very difficult. The author describes the technique which has been developed, with results which are best described in his own summing up—"The method is especially applicable to areas of considerable relief where transportation is slow and where low flying can be done in safety. Ground checking is advisable, but is greatly accelerated by the aerial work. In such country the method is decidedly economical and to an unbelievable extent faster than ground reconnaissance. With suitable planes it is believed that the system can be extended."

H. L. P. Jolly enters the lists in defence of Clarke, certain of whose work in "The Principal Triangulation" has apparently been criticized. The point at issue is certain discrepancies in azimuth computation which occur in that work. Jolly shows that the discrepancies are due not to inaccurate formulæ, but to the cumulative effect of a systematic error, which appears in turn to be due to slight

errors in the spherical excesses used in adjusting the triangulation, unavoidable because they were necessarily based on approximate sides.

Sir Gerald Lenox-Conyngham offers, in "Nomenclature of Map Projections," some criticisms on the choice of names by L. P. Lee in his article on this subject in the January number.

Among the reviews is an interesting one on the Progress Report for 1942-43 of the Colonial Research Committee.

E.M.J.

THE ENGINEERING JOURNAL

(Published Monthly by *The Engineering Institute of Canada*)

The *May*, 1944, number opens with an interesting and well illustrated article on the *Prince Rupert-Hazelton Highway, British Columbia*. This was chosen for defence purposes in the North Pacific area; it is now practically complete and connects the Port of Prince Rupert with the existing road from Hazelton to Prince George and Vancouver.

The location of the road is along the north bank of the Skeena River; this line involved much heavy rock blasting, and the difficulties of construction were increased by the fact that the permanent way of the Canadian National Railway runs for many miles along the chosen location. The project was approved on March 16th, 1942, by a Dominion Order-In-Council. The location survey was started next month and it was considered essential that construction should commence in June, 1942. Neither the survey nor estimates of quantities could possibly be completed until some time after that date; therefore the placing of "Unit Price Contracts," without plans or estimates was unavoidable—otherwise some six months delay would have occurred. Results have more than justified the course adopted. Under this system it was practicable to call for tenders in April, which were accepted in May. The new highway is some 112 miles long, 20 feet wide throughout between side ditches, with 18 feet of metalling. The average cost per mile of finished road is approximately £22.000.

In *Nylon*, Mr. C. J. Warrington gives an excellent account of the structure, manufacturing details, properties, and uses, of this thermoplastic texture; its tensile strength and resistance to abrasion is remarkable, exceeding that of silk or rayon, and it has the widest range of fabric possibilities.

Effective Foremanship. A very human article on the training of the foreman, that two-way transmitter between management and labour. The author outlines the methods in use in modern Canadian industry and indicates a selection of those procedures that are most likely to give satisfactory results.

Another article on *Cemented Carbide Tools* shows that the arrival of these tools has permitted the use of such high speeds in machining operations that a new problem has arisen in consequence—that of "chip control."

The *June*, 1944, number contains an informative article on the Ogoki Diversion, completed last year—this project resulted in changing the course of the run-off of 5,500 square miles of drainage area, through unsettled territory, into the River Albany, to a course through the most densely populated and highly industrialised section of Canada, viz.; the Great Lakes—St. Lawrence basin. The increase in flow, due to this diversion, which now finds its way into the Plants at Nipigon, Niagara, and De Cew Falls power stations, is some 40,000 cusecs. Before the scheme was started economic studies were conducted to establish the very best proportion between the height of the dam and the dimensions of the necessary channels, to ensure the most economic form of diversion.

The next article, written by the Structural Engineers Public Works Administration, Washington, U.S.A, on the *Problems in Design of the Alaska Highway Bridges* will be of great interest to all those who read the article on the *Alcan Highway* in the March, 1944, number of *The R.E. Journal*.

A Subway Plan for Montreal. Traffic saturation has already been reached in

the centre of Montreal, and a scheme for underground tramways has been prepared, and is under consideration. The routes would be nearly eight miles in length, cost some £12,000,000, and provide employment for 12,000 men directly and indirectly for four years.

July, 1944. This number contains an important article on *Improved Soil Stabilization*. The mathematics of the stability of granulated materials are fully explored, and the essential difference between the use of cohesive materials to improve stability, and of waterproofing materials, such as asphalt, to prevent decrease of natural stability by water absorption is made clear. A form of stabilising agent which has come into use only comparatively recently in Canada is waste sulphite liquor, a by-product in the manufacturing of chemical pulp from wood by the sulphite process. This liquor forms an effective basis for a stabilising agent of the cohesive type when used as a concentrated liquid or, after further evaporation, in the form of a powder. The chemical pulp industry of Canada is so extensive that over one million tons of this sulphite powder or its equivalent can be produced annually.

H.M.F.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA

April, 1944.

Here is a quotation from *Matters of Moment* which deserves repetition. " Economic Security is not a question of economics at all. It is a moral problem. . . . And it is a problem which will only be solved when human beings renounce materialism and practise common Christian charity and ideals in their lives."

The Story of Singapore is a worthy tribute to the behaviour of the troops, British, Australian, and Indian, who took part in that difficult campaign. One and all fought well. The Argyll and Sutherland Highlanders, starting 800 strong, were reduced to 100, when, the last troops to pass the causeway, they were piped across to the strains of " Jenny's black e'en." There are few authentic instances of Malays giving aid to Japs, and those were mostly under threat ; on the other hand, there were many cases of loyal and courageous help to our forces. (*The article is to be continued.*)

The German War Trials of 1921 is timely. A succinct account of each trial, in which the British Empire was concerned, is given. It is commonly believed that little, if any, of the sentences were actually carried out, but the author does not touch on this point.

Mobility in Land Forces, by Auspex, is a study of the methods of applying the increased speed of A. F. V.s plus air power to warfare in general and N.W.F. fighting in particular.

The Royal Indian Navy. The name is barely ten years old, but the forebears of the R.I.N. date back to the early seventeenth century. It has, as we know, done excellent work during the present war. The personnel are now recruited from all creeds and all parts of India.

Burma Roads, Past and Present, by an American officer. An admirable account of what has been done by us in the past, and by the enemy at the present time. Many must have wondered why Burma and India are not better connected by road and rail, and this article gives the answer. The Burma-China road is touched on ; it is not likely ever to become a great highway of commerce.

Some Thoughts on Combined Operations are useful. Though an airman, the author treats mainly of the naval side of a landing on an enemy-occupied coast. It might well have been written before instead of after the landing on the coast of Normandy.

Maintaining Army Equipment. The second part of an article which began in the January number. The difficulties of establishing the I.E.M.E. have been immense ; the number of skilled technicians in India—and the corps consists almost entirely of such—is deplorably small, and the same can be said of machines on which to train them.

F.C.M.

THE INDIAN FORESTER

April, 1944.—The Burma Forest Department is considering its reconstruction after the War. Like many other government departments, it suffers from the tyranny of the "financial year," and a suggestion, based on procedure in Western Australia, is recommended, namely, that the department use a certain percentage of its gross revenue, banking for future use any unexpended balance. Most of the members of the service are now working in India, many in H.M. forces.

Palmyra leaves, owing to the shortage of paper, are being used for correspondence in Ceylon, a reversion to the practice of two generations ago. They are sufficiently durable to be sent through the post.

May, 1944.—*British Timber Interest Plan Counterblast to Alternative materials* —the title might have been shorter—records the protest of the Timber Development Association against the prevalent idea that the day of timber as a building material is passing.

Ex-Soldiers and Land Improvement, an extract from the *Illustrated Weekly of India* treats of the possibility of getting much of the vast uncultivated tracts of India under cultivation. It is essential that rain water does not run off, and this can be done by the use of bulldozers and other machinery in adjusting slopes and erecting contour bunds.

June, 1944.—*Soil Conservation in the Punjab*. Everyone travelling in the plains of Northern India notices the very steep sides of every watercourse; these nullahs are cutting back into cultivatable soil at an alarming rate; the main reasons for this are the felling of forests and over-grazing, both of which tend to quicker run-off. The civil authorities, including the Forest Department, are doing a great work in checking this, and now have many show areas where farmers can see the best methods in operation.

The Gradoni System of Cultivating bare Slopes is being carried out successfully in the neighbourhood of Poona. It consists in making trenches along contours—the V.I. is not stated—and planting trees half way down one side of the trench. Where nullahs furrow the hillside they are plugged by dry stone walls. The experiments have been on for four or five years, and already the sale of grass is considerable. The author pertinently remarks "will the villagers have the sense to keep it up, once the special forest guards are removed?"

It is noteworthy that 18 pages out of the 35 of print in this number of the *Journal* deal primarily with the subject of soil erosion, its cause and cure.

July, 1944.—Not many have had the experience, which Mr. J. N. Sinha has had, of cycling into a tiger. He had a narrow escape.

An address by the Hon. Sir Jogendra Singh, Minister of Agriculture, to young forest officers and rangers, contains some useful remarks. If cowdung were used in India as manure, and not as fuel, as it is at present, the productivity of cultivated areas would be increased by 50%. Cowdung is used as fuel, because wood is not generally available for the purpose. The remedy is therefore to bring the forest to the peasants' door, and there is generally plenty of waste land close to his village where this could be done. Another point mentioned, incidentally, is the average annual yield of certain types of forest per acre, namely:—

Oak or Beech forest, Europe	95 c.ft.
Scots Pine forest, Europe	90 ,,
Sal forest, India	100 ,,
Coniferous forest, India	130 ,,

The timber is of course not all in building sizes, and much is suitable for fuel only.

F.C.M.

AN COSANTÓIR

(Journal of the Eire Army)

July, 1944.—An article on the history of Spike Island (in Cork Harbour) should have a special interest for those who have served in South Ireland. Known as a " Holy " Isle for about a thousand years, it then drops into obscurity for another five hundred—and is " rescued " from being a wild haunt of smugglers, to be fortified against the French at the end of the eighteenth century. From about 1846 to the 1880's it was probably best known as a convict station—and it was convict industry that transformed its whole outline, making it practically one large fort. Before they left, the convicts also produced most of the stone and labour for Haulbowline Dockyard next door and the causeway connecting the two. Since then its history would read as dull as any other insurance premium receipt on which no claim has had to be made—though apparently there are, as yet unwritten, some stories of daring and successful " escapes " from the island, which was used as an internment camp during the " troubles."

An original article surveys the history of Genghis Khan, his sons and grandsons—who so nearly overran all Europe after conquering most of Asia with their brilliantly effective " blitzkrieg " methods. It appears that the Japanese would like to think his mantle has descended on them—and that they are fated to fulfil an old prophecy, still extant amongst his descendants, that Genghis Khan's camp fires may soon burn again and his empire stretch across the world.

August.—Major H. M. Todd of the Home Guard, contributes an article on Training for *Night Operations*. He emphasizes that it is essential for the Home Guard to be trained for operation against an enemy at night to carry out their task of reconnaissance and fighting patrols. He stresses—Silence—Direction—Touch—as the main factors for success, and underlines the truism that—hurry means noise.

Brevity in Orders informs us that General Patton, in effect, moved half an armoured division 35 miles in one day with the following operation order :—

" Attack—destroy the enemy—act aggressively."

From the *Soviet War News* comes a vigorous article on the value and essential need of resolute infantry in modern warfare. Infantry—General Tsvetayov believes—if sufficiently determined and properly supported can overcome anything.

September.—Maj.-General Costello continues his essay on " Leadership " stressing here the value of " loyalty " which must work both upwards, i.e., to one's superiors—and downwards, i.e., to one's subordinates. In the latter, be careful however, not to let it lead you to condone inefficiency ; in the former, it must mean—not only avoiding criticism of superiors in front of subordinates, but also working cheerfully and hard to carry out their orders to a successful conclusion even if the aims or methods are against one's own ideal.

" My country, right or wrong," is quoted with approval and the maxim extended to imply also " my leader, right or wrong." A dangerous doctrine this, unless the country has a near-perfect method for selecting its higher leaders and an efficient method of sacking them, if they fail to rise to and maintain the highest standards !

But this great problem in the running of any country remains imperfectly solved by all.

The remaining articles call for little comment being mostly reprints from U.S. Military Journals—with one from *Defence* (the British Home Guard monthly) on the training of lorried infantry to em-bus, de-bus, and travel safely. Some well-produced snapshots show how an officer with intelligence (and a very ordinary camera) can improve the interest and effectiveness of an indoor lecture, with a little trouble.

D.ff-M.

THE MILITARY ENGINEER

(Published by the Society of American Engineers.)

May, 1944. *Amphibian Engineers in Action.* Brig.-Gen. W. F. Heavey gives an account of the training of the Brigade of Amphibian Engineers in Australia early in 1943, and of its subsequent operations in the South-West Pacific. Training was started at Cairns in conjunction with Australian troops. The Americans and Australians soon learnt to understand one another. The Engineers were handicapped by the fact that the only landing craft available were L.C.V.P'S. Other craft only arrived after some of the troops had already started for New Guinea.

Operations started with the landing of a force on June 29th at Nassau Bay in 30 boats. The Japanese were driven back on Salamaua, where another landing was made with 100 boats. Salamaua fell on September 12th, after a 74-day campaign, during which 3,000 tactical landings were made.

The Amphibian Engineers also took an active part in the Lae campaign. In this campaign, which lasted 12 days—till September 16th—and in the subsequent assembly of troops, which lasted till September 30th, the boat force transported 12,000 passengers and 10,000 tons of cargo.

Next came the Finschhafen campaign, in which (on October 11th) a Japanese force in landing barges attempted a surprise landing on Scarlet Beach, then in American hands. In this attack two shore engineers, manning a .50-calibre gun, kept off a force of 100 Japanese, and contributed very largely to the failure of the attack.

At Arawe, in New Britain (on December 15th) the engineers used their rockets for the first time in a combat landing, and also had their first " naval " engagement with Japanese barges. In their first engagement the American Rocket Dukws opened fire on concealed enemy barges and sank eight of them. The second encounter was not so successful owing to the American force getting into a mangrove swamp.

Among the lessons learnt from this campaign were that coral reefs, unless charted from the air, could be as treacherous an enemy as the Japs. The salvage and boat maintenance forces did almost miraculous work in salvaging and keeping boats in operation. There was never a sufficient stock of spare parts ; improvisation was the rule.

Engineers Must Improvise. By Captain H. C. Broyles.

The X Engineer Regiment was one of the first American units to set foot in Australia early in 1942, shortly after the declaration of war with Japan. It was equipped with tools and plant sufficient only for first and second echelon maintenance. A certain number of additional tools was obtained by local purchase in Australia, but a great many special tools and articles of equipment had to be made and improvised.

July, 1944. *Material Aid to Russia.*

Lieut.-Colonel T. E. Hienton describes the help that the Americans, with British aid, have given to Russia via the Persian Gulf and Iran.

Operations in Iran are affected by two important factors : geography and climate. The region nearest the coast, for a distance of 175 miles, is a salt desert, with intense heat during the summer months. North of this area is the Iranian plateau, averaging 4,000 feet in height, with less intense summer temperatures, but extremes of cold in the winter. The third area, near the Caspian, has a moderate climate all the year round, but a heavy rainfall.

Highway construction was one of the tasks carried out by the Allied forces ; the route extending from the largest Persian Gulf port to a transfer point some 650 miles away. A section of 170 miles at the south end was allotted to the American group ; the rest was entrusted to the British, but, after completion of the southern section, the Americans assisted with the northern section and eventually maintained the whole road.

At one of the ports American forces constructed the jetties and a lighterage

wharf, while British forces built the necessary railway facilities. Much of the material came from India.

The two principal items needed by Russia from the United States were goods wagons and aeroplanes. Assembly plants for these were erected in several places.

Railway operation presented many difficulties. The communication system was totally inadequate ; there was a lack of operating equipment and the railway was not designed for the heavy power units employed. In a track length of 110 miles there are 133 tunnels. The temperature in these tunnels was intense, but matters were improved by the use of Diesel engines in the place of steam locomotives. Their use also solved the problem of water supply which, in many places, was difficult to obtain for steam locomotives.

Operation of the Motor Transport Service began early in 1943. Native Iranians were trained as lorry drivers and did good work.

A small scale map accompanies the article. The text loses some of its interest by omitting all place names.

Policy of Preparedness. By Major-General J. L. Schley.

This article throws an interesting light on the American attitude towards war since the establishment of the Republic. The writer considers the war of 1812, the Mexican campaigns, the Civil War, the Spanish-American war, and the two World Wars. In every instance the regular army was far too small at the outset and had no reserves. Too much dependence was placed on newly-enlisted and undisciplined soldiers. There was a lack of unified command. Some of the higher commanders were superannuated and incompetent. The majority of the officers were non-professional and inexperienced.

Most of these defects were rectified in the course of the war, but in the subsequent peace they were forgotten. The reasons for the persistence of these defects were mainly (1) the ultimate military success in all wars, (2) the remoteness of the country from possible enemies, (3) the potential threat of a large standing army to democratic government, (4) the expense of maintaining a large army in peace time.

Military strength is a valuable asset in conducting diplomatic relations ; preparedness for war is an insurance against disaster.

The ideal objective of a war is to bring it to a successful close quickly. By doing so, much blood and treasure are saved. This has been Germany's policy since the beginning of her wars of conquest in the 1860's over less well prepared adversaries. Her first great miscalculation was in the first World War, but she nearly attained her object.

An examination of the national expenditure of the U.S.A. in peace time and that required for the prosecution of war shows the fallacy of the argument that it is economical to maintain a small army in peace time. Throughout the history of the country it is clear that, in the long run, the cost of maintaining in peace time an army capable of bringing a war to a quick and successful conclusion would have been far less than that actually incurred.

The writer concludes with a dissertation on the preparedness of the country between the two World Wars. At the end of the last war there was a strong opinion in the War Department that the peace strength of the regular army should be considerably increased. A recommendation was made for 500,000 regulars, plus national guard and reserves. The bill finally passed in 1920 compromised with a maximum strength of 300,000. Actually, however, the funds allotted by the Treasury only allowed for a far smaller number : the regular army in 1933 had an enlisted strength of about 119,000 men.

Even between September 1st, 1939, when Germany invaded Poland, and the danger of war became imminent, and the 7th December, 1941, when Japan attacked Pearl Harbour, the increase in the strength of the army was only slight. In 1940 the regular army numbered 258,000 men.

The country was fortunate in having powerful allies to protect it while it made its preparations. More than a year elapsed after the American entry into the war before the army began to be effective.

A.S.H.

INFANTRY JOURNAL

(Published by the U.S. Infantry Association.)

June, 1944. *Encirclement by Air.* By Lt.-Col. J. W. Bellah

This is an account of a combined operation carried out in Burma by components of Major-General Wingate's command, who were transported to their target by an air task force under the command of Colonel Cochran, U.S.A.A.F. It was the outcome of seven months of careful organization and staff planning.

The plan was as follows :—The first wave of the attack was to be towed in gliders by night to certain open spaces in the jungle, known only from aerial photographs, to crush any enemy opposition that might be met. Then the American engineers would start the construction of air strips ; as soon as these were completed, the Troop Carrier Command would start landing the rest of General Wingate's forces.

The operation was carried out successfully ; there were casualties, it is true, but not many. It was seven days before the Japanese discovered the air strip and by that time it was strongly defended by anti-aircraft fire. The mission upon which the force embarked was still in progress at the time the article was written.

July, 1944. *Marksmanship in the Jungle.* By Lt.-Col. G. O. Van Orden

First-class jungle fighters all believe that accuracy of fire is of the greatest importance—precision of all weapons, particularly with the rifle. In dense growth the maximum effective range of small arms is usually less than 250 yards. Precision is obtained by constant practice.

All five firing positions may have to be used at one time or other ; the prone position is that most commonly used, but riflemen should learn them all.

On the Defence. Notes from the Anzio Beachhead. Lt.-Col. A. O. Connor tells of some of the mistakes made by the 3rd Infantry Division when they took part in the landing on the Anzio Beachhead.

Owing to want of experience on the part of officers, guns were not properly dug in or camouflaged. There was no mutual support, and the guns were often too scattered for proper control. Tank destroyers proved very effective, especially when arranged to give flanking fire.

The problem of when to destroy a bridge, and upon whose orders, was a hard one that came up a number of times. On three occasions a bridge was destroyed before the situation warranted it, thus preventing its use during a counter-attack.

When a bridge is being prepared for demolition, the following factor must be considered :—

> A bridge, completely prepared, including wiring and the insertion of a primer into the demolition charge, is very vulnerable to artillery fire. On the other hand, a bridge, prepared with holes for the charges, but with the latter buried close by, is not ; but it naturally takes longer to destroy.

The solution is to increase the degree of preparation as the enemy gets nearer the bridge.

August, 1944. *One Day on Kwajalein.* By Lt.-Col. S. L. A. Marshall

Most battle stories are personal accounts of what a man experiences who has taken part in a battle himself. They may be useful records, but are necessarily restricted to the writer's point of view. In this article Colonel Marshall gives an account of an engagement written largely by all men of Company B, 184th Infantry, who took part in an attack on the Kwajalein atoll in the Marshall Islands on February 1st, 1944.

In order to get the necessary information, the unwounded survivors of the engagement were all collected together, two months after the battle, and were asked to give an account of their own experiences. In this way a valuable and accurate record was obtained.

A.S.H.

REVUE MILITAIRE SUISSE

March, 1944. *Les opérations du Corps expeditionnaire anglais en Mai*, 1940.
In this and succeeding numbers a translation is given (*in full*) of General Lord Gort's dispatch of 10th October, 1941.

Commentaires sur la guerre actuelle. The Editor remarks that rarely has there been, since the beginning of this war, such a perfect synchronization of the military, diplomatic, and propagandist offensives. Diplomacy and propaganda cannot do much without military success. The Allied victories in Italy and their potential threat of an invasion of Western Europe, coupled with the Russian successes in the north, were being paralleled by marked activity in diplomatic channels. Propaganda was busy trying to shake the Balkan Satellites, and Finland had done more than nibble at the bait of an early armistice. The proximity of the Russian threat caused the lesser states to look to Moscow rather than to London or Washington. But Germany countered by pointing to the tangle in which the Italians found themselves, and forced Finland and Hungary to think twice about changing sides.

In March, the Russian offensive against Pskoff opened, while the great four-pronged drive in the Ukraine was in full swing. Unfortunately, the weather turned mild sooner than was expected, and the northern offensive was checked by the softening of the ground. In the south, von Manstein was being out-flanked by Shukoff's drive towards Lemberg, but he had not yet lost the lower Bug. The covering of Rumania was held to be of more importance than the protection of Galicia. The Army in the Crimea had also to be supported, although it would have been much more useful out of the Crimea.

In the Italian theatre there had been no great change. Kesselring had made several attempts to smash the Anzio beach-head, but, without air supremacy, his strongest efforts were of no avail. Allied air support and naval guns once again hammered the German infantry. On the other hand, the Allied Fifth Army had been unable to take Cassino.

April, 1944. *Commentaires sur la guerre actuelle.* The occupation of Hungary in March is the subject of this month's commentary. The Hungarians had been showing distinct signs of a desire to be out of the war. They had already withdrawn their troops from the Russian front, and wanted to bring them home. The loss of the Ukraine, resulting in a serious reduction of Germany's wheat supply, made it more important than ever to retain Hungary's wheat. As the Russians were rapidly approaching the Rumanian frontier, and had already reached the Carpathian foot-hills, Germany could not afford to let Hungary back out, or even allow her to command her troops on the Carpathian front.

The manner in which Hitler took possession of Hungary was typical. He had all the communications cut first; this action confused the rival parties. Paratroops were then landed to take possession of the airfields. Motorised infantry seized key points in the interior, the seat of Government at Budapest, and the wireless stations. Not a shot was fired. In six hours, the transfer of Government to a pro-Nazi puppet authority was complete. The Regent Horthy had previously been invited out of the country, in true Hitler fashion. The troops for this *coup d'état* are said to have been drawn from Yugo-Slavia.

This display of force, and its evident success, seems to have staved off the Hungarian defection for the time being.

May, 1944. *Commentaires sur la guerre actuelle*

After ten months of almost continuous offensive, there was a comparative lull on the Eastern front. Unable to meet all the thrusts, the Germans had nevertheless saved their armies. The front had not yet been broken, but it had developed many awkward bulges. The Russian drive towards Lemburg had not met with the success hoped for, which was the separation of the German armies in southern Poland from those in Rumania. The greater part of Bessarabia and Moldavia were still in German hands. The Russians had completely cleared the Crimea.

The pause was not only due to climatic conditions ; the fronts had travelled so far that the lines of supply had been strained to their limits. The restoration of the Russian railway gauge alone was an immense task.

The commentator remarks that the front, which was most under discussion, did not as yet exist—the mis-called second front. That it was near at hand was interpreted from the systematic air bombardment of the railways in France, Belgium, and Holland ; and the increased air activity of the underground organizations. As he was writing at the end of May, his sensation of the coming invasion was shared by most observers. The Swiss must have felt keenly apprehensive of the future as the day of the great invasion drew near. Would Germany respect their territory ?

June, 1944. *Propos sur nos fortifications*. By Lieut. Maron.

The present war is continually yielding fresh light on the strength and the weaknesses of fortifications. If the Maginot Line was considered to be the end of modern fortifications, the great masses of concrete employed by the Germans have caused a revision of opinion. The Germans thought Panzers and planes would play havoc with fortifications ; they are themselves to-day masters of concrete construction for defence.

So the author is in favour of fortification, provided, as he justly remarks, that fortifications are occupied and served by specially trained troops, knowing how to manœuvre within and around their positions. He refers specifically to permanent works.

He enumerates the well-known factors which determine the value of fortification : site, nature of foundations, shape of the surrounding ground, disposition of neighbouring works, combination of their fire, etc. He likens the fort to a warship : however powerful it may be, it is quickly put out of action unless protected by exterior defence. The discipline and *esprit de corps* of a fort must be as high as that of a man-of-war. It may well be imagined that the Swiss defence is very largely dependent on concrete works, and that the Swiss Command is closely watching the progress of events along the Siegfried Line.

Commentaires sur la guerre actuelle

The invasion of Normandy provides this month's subject for the commentator. At the time of his writing, our forces had been established for a fortnight in their bridgeheads, but the Cherbourg peninsula had not yet been secured.

The Allies, he says, had one main principle in their strategy : only to strike when sure of success ; to engage in the battle when it was virtually won. A very sound maxim, to be sure !

The apparent slowness of the operations seemed to indicate a certain inferiority in the Command ! The critic here was not paying due regard to the neccessity for the invaders to put ashore sufficient men and material to break out of the encircled bridgehead, or to the fact that all such men and equipment had to be landed on open beaches. This amazing accomplishment will in due course receive its full recognition in history.

Nothing less than the invasion of the Continent of Europe was in hand. The commentator asks why the invasion in the west preceded the re-opening of the Russian offensive in the east ? He considers this due to political considerations. For nine months, the Russians had been striking hard ; and their resources had been taxed almost to their limit. It was the turn of the Anglo-Americans whose armies in Britian were intact.

At the time of writing, the Germans had only put their local reserves into the battle ; there were larger strategic reserves grouped in France, which were being reserved for the counter-offensive. This counter-offensive would be, for the Germans, of the utmost importance, for at all costs they must defeat the invaders and gain time to return to the east for the decision against Russia. The bigger the Anglo-American forces in Normandy, the greater must be their annihilation, for the Germans were now being forced to fight on three fronts : in Russia, in Italy, and in Normandy. This was a predicament which all the German Chiefs of Staff had been striving to avoid since Germany practised aggressive war. But so far, this situation was being met by leaving the commanders on each front to wage independent war.

W.H.K.

JOURNAL OF THE BUENOS AIRES ASSOCIATION
of
The Institution of Civil Engineers
1943

The proceedings dealt with in this issue are well up to their usual standard, and several interesting and informative papers were read and discussed.

The Fuel Problem in Uruguay

This country has no indigenous coal or oil and very little timber (except for domestic uses), and therefore in normal times practically the whole of its industrial fuel requirements are imported from overseas. Its South American neighbours cannot help, and the scarcity of shipping has so reduced imports that industry and public utility undertakings have been forced to restrict output in many cases; also they have been reduced to using maize and other cereals and vegetable matter as fuel. No less than 170,000 tons of maize were used for this purpose in 1942.

The available water power has hitherto not been exploited, but the Rio Negro hydro-electric scheme, now being carried out, is capable of producing an annual output of 500 million K.W.H. per annum which should go a long way towards meeting the country's power requirements.

The Work of the Royal Navy

The subject of a short but interesting lecture by Captain H. R. Forster, M.V.O., R.N., the Naval Attaché to the British Embassy at Buenos Aires.

The Work of the Argentine National Road Board

The main problems involved in highway design in a country stretching from sub-tropical conditions in the North to frozen lands in the South are explained and the advantages of mechanical equipment in road construction are stressed.

Mechanization as an Aid to Permanent Way Maintenance

This is in many ways the most interesting paper in the proceedings under review.

The author points out that in connection with the maintenance of track, bridges, and buildings, over 150 different types of mechanical equipment are being employed and of these an appreciable proportion are associated with the upkeep of the permanent way. Most of this equipment has been introduced during the past 10 to 15 years.

The manifold advantages of mechanical equipment are clearly brought out in the paper and in the discussion which followed. The overriding considerations are of course economy in cost and time, but it is distinctly advantageous that the elimination of large gangs of low grade labour results in the attraction of men of a more intelligent type to the employment.

Earth moving machinery is of course very largely employed, but many other types of power driven machinery have been introduced as well—track wrenches, rail sprayers, rail grinders, weed destroyers, etc. Also welding plant which deserves a special note for its services in " building up " worn rails, or in welding lengths together.

Sources of Water Supply in Argentina

This paper is of general interest to Water Supply Engineers, as it deals with the climatic, geological, mechanical, chemical, and bacteriological aspects of the problem.

Some interesting suggestions are made concerning the effects of small traces of the rarer elements in natural waters on the physical characteristics of the people drinking the waters.

The relative costs of asbestos cement, cast iron, and steel pipes are given as :—1 : 2.2 : 2.7.

W.M.

CORRESPONDENCE

THE PROTECTION AND DEMOLITION OF OIL INSTALLATIONS

1st July, 1944.

The Editor, *The Royal Engineers Journal.*

SIR,

Captain J. H. Scott, R.E., has reported that a very similar formula ($C = \frac{1}{3}\sqrt[3]{T^4}$) was used for concussion charges for the demolition of *water* tanks in Burma in 1942. When submerged this was ample and he suggested as an alternative $C = \frac{D}{4H}\sqrt[3]{T^2}$, D being depth of liquid and H height of tank in feet. As far as I know, this has not been tried practically.

2. In earlier experiments on water tanks in England, one 40 ft. diam. by 26 ft. high (i.e. nearly 900 tons) when half full was disrupted by a submerged charge of 33 lbs., while another of about 53 tons, 30 ft. high with 24½ feet of liquid, was damaged, but not demolished, by 2½ lbs. In both cases the plates could have been straightened.

3. For oil tanks, Captain Scott refers to concussion charges of 3 lbs. per 100 cu. ft. in walled tanks, reducing in larger tanks, 150 lbs. having been successful in a 100,000 gallon tank. For non-sheathed tanks, one quarter of these is enough.

4. For economy in explosives, the best way is to set alight the surface of the oil (and not only the oil vapour) by cutting the tank with cutting charges. Two holes are necessary, one in the roof, the other in a wall with its bottom just above the surface of the oil, which, on expansion, overflows and increases the fire. The tank usually collapses from the effects of heat.

5. "Empty" tanks that have contained oil will usually collapse by explosion of the vapour from a charge calculated only to cut the curb ring.

Yours faithfully, C. PREEDY, *Colonel.*

GEOLOGY *v.* "DOWSING"

12th July, 1944.

To the Editor, *The Royal Engineers Journal.*

SIR,

In the article entitled "The Use of Geology in the War Effort" in the June number of *The Royal Engineers Journal* the following passage occurs:—"Unfortunately, there are still too many people who believe in a divining rod, rather than a geologist as a means of obtaining water."

Though this opinion reflects the "correct" official attitude of the geologist towards so-called water-divining, it is open to serious dispute, and is not justified by an unprejudiced survey of the recorded achievements of reliable water diviners.

In the early part of the present war an R.E. Officer, who was a Dowser of skill and experience, collaborated with the geological adviser at Army Headquarters in France. The geologist decided on the area to be explored, whilst the R.E. officer examined the area, selected a fissure flow and pegged the exact position for the bore. In all, some 60 bores of depths varying between 120 and 230 feet were made. All but two of the bores were successful, whilst two others, selected by the geologist without technical assistance, were failures.

Two striking cases of the value of dowsing are described in an article by the Managing Director of a firm of Hydraulic Engineers in a Journal of the British Society of Dowsers:

A case occurred in South Wales, where a borehole was put down in the Carbonifererous Limestone to a depth of 200 feet. The borehole, however, was practically bone dry. The customer called in a water diviner, who stated that a stream of water was flowing within a few inches of the borehole, at a depth somewhere about 100 feet below the surface. Two shots of dynamite were fired, one at 120 feet and another at 100 feet below the surface, and the result was that a permanent yield of over 300 gallons per hour was obtained.

The other case was at Stockbridge Estate in Bedfordshire. From a hydro-geological point of view water was expected to be found in the Lower Greensand formation, under which the Oxford Clay, which would be expected to hold up the water, was known to be present. The borehole was drilled ; unfortunately, however, the Lower Greensand, contrary to expectation, turned out to be entirely devoid of water. A water diviner then made a survey of the ground, and selected a site exactly 50 yards away from the borehole. Here a second borehole was put down, and the beds of strata passed through were almost exactly the same as those met with in the first borehole. In this case, water was met with, the water level being 124 feet below the surface, and a constant yield of 450 gallons an hour was obtained. It is somewhat puzzling why one borehole should have been practically dry and the other one should yield water ; possibly a hidden geological fault may be the explanation."

Over forty years ago I employed a water diviner to locate the position for a well to supply water for a cantonment in the Northern Transvaal. Water was found at a moderate depth ; the place chosen was on a bare stretch of open veldt where there was nothing to indicate that water might be found at one spot rather than another.

It would be interesting to know how, in these three cases, a geologist would have selected the best spot for a well or bore. Perhaps the authors of the article will tell us.

The suspicion which geologists entertain towards water divining, is partly due to the too ready acceptance at his own value of anyone who possesses the necessary degree of sensitiveness to radiation but has failed to acquire a reliable technique. A really skilled dowser should be able to locate water and to give an accurate estimate of the depth of the water itself, its quality, the probable quantity and, knowing the nature of the subsoil, the thickness of all the intervening strata. All such information is now given as a matter of course, by a member of the British Society of Dowsers who, during the last few months, has carried out several locations for the War Agricultural Emergency Committees of Gloucestershire and Warwickshire.

The direct study of the subsoil by using the human body as an apparatus for radio-prospection seems to be on a definitely higher scientific plane than the indirect deductive methods which the geologist has to adopt, and if this fact were fully realized the acquisition of geological knowledge would be greatly facilitated.

Another article in *The R.E. Journal*, " The Fuka Basin," provides a good example of the economy in labour and time which might have been effected by the use of modern dowsing technique, for whereas " about 60 bores were sunk before the structure could be said to be fully determined," the same result might have been obtained by a procedure far less laborious and much more rapid.

Yours faithfully, A. H. BELL,
Colonel.

President of the British Society of Dowsers.

GOLD PIN · MYCENÆAN PERIOD
Discovered in Cyprus.
Reproduced by kind permission of the Trustees of the British Museum

THE EVOLUTION OF THE BROOCH

HOW it came to be spelt that way is a mystery, for though we have been writing "brooch" since the sixteenth century the word is really broach from the Latin brocca, a spike.

And there is the whole history of the ornamental "brooch"—at first a simple thorn to spike or pierce fabric and hold it in place, then made ornamental as well as useful, then fashioned with a flexible and later a hinged pin and finally through the jeweller's art made a thing of beauty which completely masks its utilitarian purpose.

The moral is that even articles of utility can and should be elegant.

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